THE ROYAL SOCIETY OF EDINBURGH

REVIEW OF SESSIONS
2008-2009
(6 October 2008 - 5 October 2009)

2009-2010
(5 October 2009 - 4 October 2010)

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1 December 2008

Chairman
Lord Wilson Of Tillyorn KT GCMG PRSE

Lecture
Professor David Porteous, Medical Genetics Section, University of Edinburgh Centre for Molecular Medicine, Institute of Genetics and Molecular Medicine. Bruce Preller Prize Lecture - Our Genetic Inheritance: for better or for worse, in sickness and in health.

1 April 2009

Chairman
Professor Hector MacQueen FRSE, MA, HonDLitt, Vice-President

Lecture
Dr Alan Rutherford OBE, founder of Airborne introduced Dr Andrew McLellan, HM Prisons Inspectorate and called on him to deliver the Airborne Initiative Public Lecture entitled Realistic Alternatives to prison for young offenders.

Announcement of Scrutineers
The President announced that the ballot papers for the election of the next cohort of Fellows would go out to the Fellowship early in December. Professor John Spence and Mr Edward Cunningham had agreed to act as Scrutineers for this ballot.

15 June 2009

Chairman
Lord Wilson Of Tillyorn KT GCMG PRSE

Formal Admission to Fellowship
Mr Owen Dudley-Edwards FRSE, Honorary Fellow, School of History, Classics and Archaeology, University of Edinburgh, Edinburgh signed the Roll and was admitted to the Fellowship.

Lecture
Professor James Hough FRSE, Associate Director, Institute for Gravitational Research, University of Glasgow delivered the 2009 Gunning Victoria Jubilee Prize lecture Ripples from the Dark Side of the Universe – the Search for Gravitational Waves.

7 September 2009

Chairman
Lord Wilson of Tillyorn KT GCMG PRSE

Lecture
Professor Veronica van Heyningen, University of Edinburgh, Institute of Genetics and Molecular Medicine/MRC Human Genetics Unit. Making Eyes – Lessons from Failed Miracles.

Announcement of Scrutineers
The President announced that Professor Andrew Walker and Professor Gareth Pender would act as Scrutineers for the 2009 election of Council members.
7 December 2009

Chairman
Lord Wilson of Tillyorn KT GCMG PRSE

Formal Admission to Fellowship
Mr Douglas Crombie Anderson OBE FRSE, Executive Director Optos plc signed the Roll and was formally admitted to the Fellowship.

Lecture
Dr Paul Foster, Senior Lecturer, New Testament, School of Divinity, University of Edinburgh. The BP Prize Lecture, The Apocryphal Gospels – Then and Now.

1 March 2010

Chairman
Lord Wilson of Tillyorn KT GCMG PRSE

Ballot
The President announced that Professors Jane Bower and Michael Forde acted as Scrutineers for the Ballot for the election of new Fellows. They reported that 48% of the Fellowship returned ballot papers, and that the names on the list were approved by ‘an overwhelming majority’. The list of new Fellows was released to the media earlier in the day.

Lecture
Professor Jonathan Rees, Grant Professor of Dermatology, University of Edinburgh. The David Anderson Berry Medal Lecture, The Importance of Being Red.

7 June 2010

Chairman
Professor Hector MacQueen FBA FRSE, Vice-President

Changes to Laws
The Vice-President announced that Council had decided that the category “Ordinary Fellow” should be replaced by “Fellow” as referring to Fellows as Ordinary seemed both archaic and inappropriate, given the high level of distinction required to become a Fellow. The phrase Ordinary Fellow is defined in the Society’s Laws and before it would be possible to drop use of the word Ordinary, the Laws will require to be changed. A vote will take place at the Annual Statutory Meeting in October to decide if this Law should be changed.

Lecture
Dr Deirdre Heddon, Department of Theatre, Film and Television Studies, University of Glasgow. The BP Prize Lecture, The Art of Women Walking: an Embodied Practice.
21 September 2010

Chairman
Lord Wilson of Tillyorn KT GCMG
PRSE

Council Ballot
The President announced the Scrutineers for the Ballot Count for membership for Council, explaining that the Ballot Count for the 2010 election for Council members requires that two Fellows be nominated by the President to act as Scrutineers. Professor Janet McDonald and Professor Andrew Ranicki were nominated to act in this capacity.

Formal Admission to Fellowship
Professor Edgar Peltenburg, Emeritus Professor of Archaeology and Honorary Professorial Fellow, University of Edinburgh, elected in 2010, signed the Roll, therefore completing his admission to the Society.

Lecture
Lord Krebs Kt, FRS, FMedSci, Principal, Jesus College, University of Oxford. Facing up to Climate Change.
Minutes of the Statutory General Meeting held on 5 October 2009, ending the 226th Session

The Annual Statutory Meeting took place in the Society’s Wolfson Theatre on Monday 5 October 2009 at 6 pm. Lord Wilson of Tillyorn KT GCMG, President, took the Chair. Lord Wilson reported that the meeting was being recorded and would shortly be available to listen to on the Fellows-only section of the Society’s web site.

A. FORMAL BUSINESS

1. Minutes
The Minutes of the Annual Statutory Meeting held on Monday 6 October 2008 were taken as read, approved by those Fellows present and signed by the President as a correct record.

2. Matters Arising
There were no matters arising.

The meeting noted a Report on Activities for Session 2008/09 prepared by the General Secretary, which had been distributed to Fellows in advance. The President suggested that any discussion of the report should take place after the Office Bearers’ Reports had been delivered.

4. Office-Bearers’ Reports

a) General Secretary’s Report
Professor Geoffrey Boulton gave the following report:

In keeping with charity law our activities during the fiscal year April 2008 to March 2009 are recorded in the Annual Trustees’ Report and Accounts for that period. This has been approved by Council in its capacity as the Society’s Trustees and a copy is available to any Fellow.

“In addition to the papers received for this evening, all Fellows received an Annual Review which summarises the main activities described in the Trustees Report and includes an approved summary of accounts on which the Treasurer will report later. I do not propose to comment on each and every activity mentioned in the very full and varied programme of activities recorded in the Report on Activities for Session. I will let them speak for themselves, but would like to say a few things about the new things that have happened and in part, at least, provide a basis for things we hope to do in the future.”
One of the major developments on which I reported on last year has been a considerable growth in the Society’s policy-related activities, the purpose of which is to better utilise the expertise and breadth of the Society to benefit the broader society of which it is part and, in particular, utilising the rigour that we are able to contribute to public affairs and also our independence.

In the last year we produced over 20 Advice Papers, which involved about 150 Fellows in their preparation. These have been directed primarily in response to government consultations from Holyrood, Westminster and Brussels and, indeed, many of them we have followed up to ensure that they have impact. We only respond to these consultations when we believe we have something to say and when we believe that by saying it we shall have some effect. What we wish to do progressively, however, is to move from a reactive mode in which we are responding to government consultations or consultations by other bodies, to a proactive mode where we believe there are important issues that need to be addressed in the public domain and where we think we can bring them to the public attention in an effective fashion.

There are two proactive reports that are in preparation at the moment, or at least are being prepared for. One of them is likely to be entitled Digital Scotland, the other will be on health demand and provision in Scotland. We believe that both of these can be done reasonably expeditiously utilising the expertise in the Society. We have also produced, at very short notice, briefing papers immediately prior to parliamentary debates, for example, early this year we produced one on swine flu and last week we produced one on energy. The purpose of these is to set out, insofar as we are able to, the facts and options and leave the politicians to argue about the politics. We have also established two very important committees in the last year in response to two vital policy areas. The Education Committee, on which Lord Sutherland will report shortly, and the Business Forum, on which I will report later. They are distinctive Committees in being directed towards policy.

The year also saw a merger with the Caledonian Research Foundation (CRF). The CRF, established in 1990 to support research in Scotland, particularly in the field of biomedical sciences, merged with the RSE Scotland Foundation. As a consequence of that merger there was a capital transfer into the Society of over £6 million, but unfortunately and largely because of the credit crunch,
the inherited commitments of the CRF exceed income. The plan is therefore to draw down some capital to cover the shortfall and to put income and expenditure in balance in 2011 by a small reduction in CRF-related activities.

An important event of the year was the unveiling of the James Clerk Maxwell Statue for which past President Sir Michael Atiyah was the driving force. Michael chose Alexander Stoddart to produce the statue, an inspired choice, raised the money, and master minded an outstanding one-day conference, which included the statue unveiling. It is owned by the Society and is one of the best, if not the best, statues in Edinburgh. The conference also saw the unveiling of a hologram of the statue, which rests proudly in the Society's James Clerk Maxwell room. Professor Andy Walker deserves great credit for making this happen.

This year too we had the first ever collaboration with the Edinburgh International Festival. We had a long series of lectures on the Scottish Enlightenment, delivered by a very distinguished cast of speakers, many of whom were Fellows of the Society.

Looking ahead we are very aware that the financial environment within which the Society works might be a very harsh one over the next few years, and Council is planning to ensure that our fundamental objectives can be sustained even if the funding environment markedly deteriorates, with a particular eye on the probability that public sector finances will suffer considerably in the next few years.

What has been achieved over the last year would not have been possible without the willing and voluntary involvement of a large numbers of Fellows, the support of the Society’s hard working staff, and the voluntary input of many others beyond the Society. On behalf of the Society I would like to thank them all for their contribution.

A number of Office Bearers, Councillors and Convenors step down today having completed their terms of office. They are: Lord Patel as Vice-President, Life Sciences, Tom McKillop as Vice-President, Business, Professor Andrew Miller, as RSE Scotland Foundation Chairman, Professors Sue Black, April McMahon and Chris Whatley as Councillors and, last but not least, the Programme Convenor, Professor David Ingram. On behalf of the Society, I would like to
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thank each of them for their contribution to our work, which was done whilst fulfilling considerable other commitments elsewhere.

b) Treasurer’s Report

Mr Ewan Brown gave the following report:

I would like to speak principally to the summary financial information on pages 14, 15 and 16 of the Annual Review for 2008/09 that was sent to all Fellows. Before doing so I should remind you that what is being presented are the consolidated accounts of the RSE and the RSE Scotland Foundation and therefore present the overall picture of the Society’s activities.

First the consolidated balance sheet at the foot of page 15 you will see there that total funds are up by £6.7 million. That is the net outcome of the transfer of approx £6.3 million at the time of funds to the Society from the CRF, the receipt of a major legacy of over £2 million from Dr Thomas, a larger amount that was anticipated when my predecessor Sir Edward Cunningham addressed you last year, a reduction of over £1.5 million in the value of investments during the year and the Society’s share of the pension fund asset, and a virtual break even on our operating activities. These are the four constituents that take us from the 11.87 million to the 18.6 million.

The individual fund movements for the General Fund, the Restricted Fund and the Designated Funds are shown at the top of page 15. Excluding the 6.3 million of CRF money, they aggregate to a figure of £2.1 million, and that compares with £174,000 the previous year; the difference is almost entirely explained by the legacy that was received. On page 14 there is a reconciliation of this £2.1 million figure, to what we consider to be the real underlying operating surplus for the year, it’s a rather fragile number at £39,000, but it’s better than the operating loss that was budgeted.

The top half of page 16 shows the split of incoming resources as we are required to describe them to satisfy the accounts speak of charitable bodies; the bottom half of page 16 shows how the money was spent. Our finance director Kate Ellis and her team have made considerable progress in breaking these figures down so that we now know with much greater precision how much the Society’s various activities cost and how much they contribute. What we see from the income figures is that around £1 million came from rentals, investments and operations, which included journals, and the provision of conference facilities, and almost £200,000 came
from Fellows. Excluding the distorting effect of the legacy the main income sources totalling over £2.3 million continue to come from the Scottish Government (and that is up from previous years) to fund agreed programmes, from other public bodies and from charitable trusts.

The bulk of the resources expended went, as in previous years, to support the core public benefit purposes of the Society in relation to world-class researchers, innovation and business, promoting science as a career, public appreciation of science and culture, informing and influencing public decisions and fostering international collaborations; a total of £4.2 million, including support to the Scottish Bioinformatics Forum.

The Society does a lot with a little and this is well evidenced in the earlier pages of the Annual Review. The messages conveyed to Fellows in previous years are dependant on a relatively narrow range of funded programmes and sponsors and the need to increase our income by broadening the funding sources if we want the Society to be doing more. The need to monitor costs very carefully and to understand what makes and what costs money has become all the more important in the last twelve months as the economic dark clouds have moved in. The accounts that I am presenting to you this evening are satisfactory but historic. Our current concern is to ensure we understand the potential vulnerabilities that we could face if we had any material income shocks, to be active in developing new sources of income and to ensure that the Society is in a position to support new initiatives that will engage the many talents of Fellows to contribute to the social, cultural and economic well-being of Scotland.

c) Fellowship Secretary’s Report

Professor Peter Holmes gave the following report:

Thank you President. It is my pleasure to be the Fellowship Secretary and I just want to cover three aspects essentially; a little bit about the current Fellowship, the recent elections and a little bit about the process we are in currently in terms of selection. With regard to the current composition of the Fellowship, it is, as you can see, essentially 1500 Fellows, with 1400 of them as Ordinary Fellows, and that has not changed too dramatically since last year. The distribution is as follows, with 36% in Life Sciences, 37% in the Physical, Engineering and Informatic Sciences, 19% in the Arts and Humanities and 8% in Economics, Business and Industry.
We’ve always been aware that the economics, business and industry elements of our Fellowship have of course been lower, and we’ve been looking at ways of addressing that, as some people perceive it as being too low. So that I think is of great interest. Two aspects that have always attracted some attention are the success rates of being elected and the gender balance. If we look first of all at the success rate for the four sectors. The success rate is significantly higher for the sector of Business and Education than for the other three, although it should be noted that the number of candidates coming forward is significantly lower as well. If we look at gender balance overall, I think we see a significant improvement in this area; 9% of our Ordinary Fellowship is now female. From last year’s election of 39 Fellows, eight were women and I think that’s very good. In fact 42% of the women put forward were successful in being elected, compared with 33% the previous year. Of the men elected, it went down from 36% to 21%. The next stage following the election last winter was of course the Fellows’ Induction Day held in May, which was a very successful day and hopefully that tradition will continue.

So if now move to the next stage, which is essentially the election cycle we are currently in. This year we have 182 candidates - 169 are for Ordinary Fellowship and that compares with 149 last year. From the Sectors we have 63 for Sector A, 54 for B, 26 for C and 24 for D this year. Last year we had 15 candidates for Sector D, so we’ve seen the largest increase in fact in this Sector. On gender, there are again 19 female candidates put forward for Ordinary Fellowship, the same as last year.

The Council every year of course debates the allocation, the total and the allocation to each Sector of places for Fellowship, and this is essentially decided on a variety of factors. What you have in front of you the quota for this coming year which is, in fact, the same as the quota for last year.

The five factors that we take into consideration are: the relative numbers of nominations in each sector; the proportions of senior academic staff in Scottish universities and the extent of which there is need for moderating this number in the light of the strengths of the field beyond the academic world; the current balance of the Fellowship; and previous success rates. When all those were taken into account it was agreed to keep the number elected at 40 and that the quota between the different sectors should not alter. In 40 we have two floating places, which essentially are for people who
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fall between the main sector groups, and I think that has been a very useful development. So that’s essentially where we are at the present time.

And if finally I could just point out a couple of things concerning the election process, which is a kind of distillation process. We are getting towards the end of the sectional committee meetings, the top six names are going forward into the sector group meetings who again debate, and so it moves up to the Fellowship Committee and Council and then of course finally goes out to the Fellowship as a Ballot. There is an important other point to mention on this, and that is that under Sector D we have a new Sectional Committee, which essentially is Education and Public Understanding of Science and Letters, and we think that is a very important development.

Two other points to make. We have 14 Sectional Committees, and the average membership is 15 Fellows per Sectional Committee, so over 200 Fellows are involved in the process of electing Fellows, which I think is a very significant portion of the Fellowship. Our thanks to them for doing what is really a very important task; also a very special thanks of course to Dr Lesley Campbell who plays an outstanding role in keeping all this moving along so smoothly and so fairly.

There are a couple of new issues which I think we should point out in terms of the role of Sectional Committees. Sectional Committees are now being asked to do two things perhaps slightly more novel – one is to suggest names to assist Geoffrey Boulton and others in policy advice, and that’s a very important and growing role of course in the RSE, but another is to be proactive and identify issues which they feel the Society should be giving attention to.

Finally, just one point which you might care to consider, and that is that recently there has been a suggestion that we perhaps again should consider the idea of a junior or young academy. The average age of the Fellowship currently is about 55 years and this doesn’t change very much. There is a feeling that we should perhaps be trying to engage with younger groups, younger academics and others in a way that would give some empowerment to them by association. It wouldn’t necessarily mean of course that they would become Fellows of the RSE. Several academies in mainland Europe have gone down this route and I think it is something the Fellowship Committee is going to look at over the next few months. Of course, it will be a long process if it ever comes to fruition, but I
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think it is an interesting concept, and we would appreciate feedback on that at some point.

d) Discussion of Office-Bearers’ Reports

Professor John Francis asked the General Secretary to comment on the proposed Inquiry on climate change impact, and, in particular, exactly what the Inquiry is likely to address and how it plans to go about its task.

Professor Boulton replied that climate change is, arguably, the biggest single challenge to which the human species collectively has had to respond. Under those circumstances, it’s crucial for us not only to be able to be concerned with potential mitigation of climate change, but also with adapting to change. The exact issues to be addressed are a matter for the excellent inquiry group, which has been put together across a wide range of disciplines. One of the issues that is, however, vitally important is the indirect effect of climate change, which will be much greater than the direct ones; in other words those that come about as consequence of dislocation in global patterns of trade and the global economy. The Inquiry will be launched on 19 October. It is premature to anticipate when it might be completed, but hopefully within around a year. One of the things that will happen is carrying on the tradition that’s already been begun by the Energy Inquiry and carried forward by the Hills and Islands Inquiry, which is to enhance the amount of public engagement that takes place both before and during the progress of the report, and afterwards too. Public awareness of these issues is crucially important if the political response is going to be appropriate to the challenge.

Professor James Irvine commented on the Inquiries. On climate change, he stressed the importance of considering the economics. He also referred to the Hills and Islands report appended to the 2008 ASM Minutes and specifically to a mention of farmers getting subsidies for cutting the grass and a few other little things, which he considered to be extremely important activities which keep land in what was traditionally called ‘good heart’, but which bureaucrats now call ‘cross-compliance’ with a restricted number of things they can check on and issue big penalties. He expressed disappointment that such activities were dispelled as almost trivia and a misuse of government money, because if you lose the quality of the land you lose farming in Scotland, in the hills, entirely. He therefore asked that future reports be better balanced. He added that it is important
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that reports, with clear recommendations, are issued quickly, as delays are not helpful and normally lead to procrastination.

Professor Gavin McCrone, Hills & Islands Inquiry Chairman, replied that the issue that had concerned the Inquiry and indeed many other people, was the number of examples of land farmers who were able to draw direct support in the single farm payment, but do extraordinary little in return. The Inquiry even discovered some who had left their farms, but who were still drawing single farm payments. Professor McCrone concurred with Professor Irvine on the importance of keeping land in good agricultural condition, not least because we don’t know when we might need to use it more intensively again, which may very well be the case as the world population rises, and people become wealthier and eat more meat products across the globe. He stressed, however, that the report did not intend in any way to disparage what a lot of farmers do quite properly in tending their land, but that there are quite a number who are not doing very much.

Professor Hector MacQueen referred to the James Clerk Maxwell Statue and suggested that, should the Society ever consider commissioning another statue, perhaps it might appropriately be a female subject and that Elsie Inglis might be an appropriate figure, particularly as she not already commemorated in the City in this way.

Professor Malcolm Wilkins invited those present to express the Fellowship’s appreciation of the magnificent bequest of the late Dr Thomas. He asked if Dr Thomas had given any guidance to the Society about how the funds should be used and if he hadn’t, if Fellows could be assured that the Council will invest the whole of capital so that the income will be enjoyed by the Society in perpetuity to give it an element of freedom from the sort of funds which have got strings tied to them, and to help worries about the security of funding in the years ahead. He added that, as a result of the bequest, the Society had an excellent opportunity to have a bit more independence in its income and expressed a hope that the capital isn’t frittered away on building alterations or redecoration.

The President said Dr Thomas had not laid down any specific conditions as to how his legacy should be used and agreed that the more “independent” money the Society can get the better. Dr Duncan, Chief Executive, added that the legacy had been put in a fund that kept it at arm’s length from the day-to-day running of the building.
Ewan Brown added that the Society would, of course, like to have additional legacies, and part of its ability to secure these will be influenced by the extent to which it can demonstrate tangible benefits arising. He remarked that the Royal Society, in approaching its 350th anniversary, couldn’t decide whether to look for £50 million or £100 million of new money in an appeal and after long discussion decided on £50 million. A few days after this was decided, an unexpected gift of £48 million arrived from Australia, from somebody who had only visited the Society on about two occasions, but thought the Society was doing extremely good work. Within this wider context, Council has decided to use the Thomas legacy over a defined period of time, probably about 15 or 20 years, rather than taking the capital into perpetuity, where often it loses its value simply by being invested. It will be used to support activities benefitting the wider Scottish society. In doing this there will, of course, be due recognition of the contribution made by Dr Thomas.

Professor Boulton commented on the issue of the Fellowship profile, raised by Professor Holmes in his report. He said that, for one reason or another, many people are managing to survive and that this has two consequences. Firstly, the age profile of the Fellowship is bound to get older and older. Secondly there will be fewer available slots for younger Fellows. He said he was not particularly enthusiastic about the idea of “Junior Academy”, but was concerned about there being so few slots available for the new Fellows at an age when they might well be able to contribute a different point of view from a different generation, and wondered whether consideration had been given to having a new category of Fellows over a certain age, who would no longer be counted in the total Fellowship for the purpose of determining the quota of new Fellows. This, he thought, would be a way of introducing more new Fellows without going in the direction of a “Junior Academy”, acknowledging that the two ideas were not necessarily mutually exclusive and urging that they be considered seriously.

Professor Holmes responded that this was a very useful and interesting idea, which might go with the idea of a “Junior Academy”. He added that it might be slightly controversial to some Fellows.
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5. Election of Council and other Office-Bearers for the 227th Session

Lord Wilson reported that all Fellows entitled to vote had been sent a ballot paper. The returned papers were examined by the scrutineers, Professors Andy Walker and Gareth Fender, who reported 645 returns - considerably more than the 515 returned the year before. All those proposed were elected either unanimously or by an overwhelming majority. The President congratulated the newly-elected Council members and thanked all those who were standing down. Membership of Council and the Executive Board for the next Session would be:

**Council**

*President*
Lord Wilson of Tillyorn KT

*Vice-Presidents*
Professor Jean Beggs CBE
Professor Tariq Durrani OBE
Mr John McClelland CBE
Professor Hector MacQueen

*General Secretary*
Professor Geoffrey Boulton OBE

*Treasurer*
Mr Ewan Brown CBE

**Executive Board**

*General Secretary*
Professor Geoffrey Boulton OBE

*Treasurer*
Mr Ewan Brown CBE

*Curator*
Professor Duncan Macmillan

*International Convener*
Professor Sir David Edward KCMG, QC, PC

*Programme Convener*
Professor John Richardson

*Research Awards Convener*
Professor Peter Holmes OBE

*Young People’s Convener*
Professor Mary Bownes OBE

6. Any Other Business

There was no other formal business.
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B. TOPICAL PRESENTATIONS

1. Education Committee

Lord Sutherland of Houndwood KT, PPRSE and Education Committee Chairman, provided the meeting with the following overview of the Committee’s work.

This new Committee arose from an informal group gathered together by Professor Boulton. From that, the Society’s Council decided it would like to have a Committee that was formally part of the Society’s structure, which would present a report and would, within reasonable limits of time and financial and staff support, speak to the outside world on education-related matters.

Now this is fraught with danger because individuals have their views, committees have their views and indeed the Society might have its views and these might not be all the same. It might not be possible to issue reports and comments that says the Society in its totality thinks x or y because there can be controversial issues, but we will do our best and we have put together a Committee which has able people from the school sector, the administrative sector and from the university sector, and indeed from research and from people with very strong research records as well, both in education and other related areas.

I am delighted to say that Professor Sally Brown, who has immense experience in this area, has agreed to be and is serving very well indeed as the Deputy Chair of this Committee and she keeping a finger on the pulse of what’s happening in the interactions currently between school teachers and the national administration in government. So we will try to do our best; we will be as balanced as we can, but we cannot promise that your views will always be the views of the Committee. We will get as near to that, but as you may have seen in the press recently that two members of the Committee, and I put my hand up to this as being one, have sounded off in *The Scotsman* on educational issues. These are our personal views and we don’t hand them over to the Society.

The Committee is currently exercising its mind in relation to three areas that are of huge importance for education within our country. The first is the introduction of CfE (Curriculum for Excellence), which is due to be introduced next autumn. Such a major change in structure and shape in forms of delivery needs careful preparation. If you ask for a series of major changes you have got to help teachers make the adjustment, which is continuing professional development with a very sharp edge to
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it. There is an issue to be addressed and the Society has already, through the embryo committee, made two or three submissions to those responsible for introducing this new CfE. These submissions have been well regarded by those who have received them.

No one could dissent from the CfE’s intentions of promoting successful learners, confident individuals, effective contributors and responsible citizens. To implement a more flexible curriculum and give teachers more freedom to exercise their professional creativity, again one of the aims, is laudable, but it’s the detail that is lacking and many teachers are commenting on this to help them prepare exactly what is being required of them. Exercising professional creativity is something good teachers do anyway and I’m sure the smart ones find ways of exercising their freedom whatever the formal details; they want successful learners, confident individuals and so on. All that’s true, so what’s going to be different? It’s trying to persuade the powers that be to give adequate time and a firmer fuller clearer statement of what’s involved that is one focus of the Committee’s interest. We’re trying to balance critical comment with effectively getting into the business in detail of preparing for how this new curriculum will be. One way in which we are doing this is by seconding a Chemistry teacher to undertake an exemplification project study for creating classroom material in chemistry, one of the subjects in most difficulty in most schools and universities today. This is being jointly funded by the Society and the Royal Society of Chemistry, at a total cost of 36,000. It is a pilot working with classroom teachers in the relevant area. This is practical input and it’s marvellous to be associated with it.

The Society has also engaged with various civil servants who have primary responsibility in this area and has been working with them to suggest mechanisms involving teachers from different schools collaborating and cooperating.

The other topics on the Committee’s agenda are: the introduction of a Scottish Baccalaureate; and higher education funding. The Baccalaureate is not the international one, but a Scottish version involving elements of Highers. This is now moving ahead and the Committee represented the Society at a meeting organised by the Scottish Qualification Authority (SQA) to consider the implications of such a qualification. The Society, through the Committee, has an important ongoing role to play here given, its independence from the SQA and the others involved.
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Higher education funding is once again making media headlines. I think it inevitable that there will be a lifting of the current barrier on fees south of the border and that of course will raise the question of the Scottish position. The Committee has met with officials from Universities Scotland to keep in touch with developments in this area. We hope to be able to spend more time on this particular issue, but the CfE is so imminent, so important and so totally encompassing of what goes on in our schools, that that’s where the weight of our activity has been so far.

Discussion

Professor Roland Ibbett commented on an article in The Times that day about schools not being willing to undertake chemistry experiments anymore because of over zealous health and safety rules and wondered if any of the chemistry funding would go towards encouraging actual practical experiments again in schools.

Professor Ian Halliday agreed that there was a serious and ongoing health & safety issue about low level people setting their own standards because those at a higher level, i.e. Government, were not making the rules clear, and that this should be tackled. On implementing the Curriculum for Excellence, he added that the difficulties, particularly in relation to long-serving teachers, must not be underestimated.

Sir David Edward suggested the Committee should, at some stage, consider the crisis in language teaching in Scotland.

In response to Professor Halliday’s point, Lord Sutherland commented that the Scottish Government has said the changes in education must be financially neutral, but there is a great deal of experience which suggest that major and radical reforms of educational systems and curricula invariably fail unless the resources are put in to make them possible and what happens is there’s a tremendous perturbation of the system to no good effect, and that’s exactly what must somehow be avoided.

2. Business R&D Forum

Professor Geoffrey Boulton provided the meeting with the following overview of the Committee’s work.

I speak on behalf of the Forum because the Chairman and Deputy Chairman are unable to attend this evening, otherwise one of them
would have been presenting this report. The reason the Forum was created was that looking back 13 years or so, the Society was involved with Scottish Enterprise in a Commercialisation Inquiry, an outcome of which was the start of a process of changing the mind set of the universities in relation to engaging with the commercial and business world. Many of us believe that, on the supply side of the equation, the universities are doing as well as one can reasonably expect, but the problem is our ability to exploit the excellence of the research base and, as a result, we have had poor rates of economic growth over the last 10-15 years. We hear the same debates year in year out and increasingly CEOs of highly successful companies located here in Scotland simply don’t involve themselves in these issues. The Forum is intended as a vehicle to bring together senior business people who have and do run major and significant companies in Scotland, with a view to them indicating where they, on the one hand, feel the priorities are in exploiting the excellent research base that we have and, on the other hand, setting out policies which they, from their experience as “high level technicians”, feel should be in place.

It is a group of senior business Fellows, which will be chaired shortly by John McClelland, who will be taking over from Sir Tom McKillop, who has chaired it over the last six months. It has already recognised that the last thing needed is yet another piece of research by a consultant. Instead, it has established a set of propositions, based on various experience, about the key things that need to happen in the Scottish business environment to exploit the research base and to set a sensible forward path. One of the propositions is that we need to clear the undergrowth from all the numerous previous interventions of this sort put in place by Scottish Enterprise and others and look for stronger leverage mechanisms. Individually, Forum members are speaking with the CEOs of major companies to ask if the propositions are ones which they would sign up to. The aim is to gather a strong view of the priorities for business development in Scotland.

The Forum is not a shadow group for the First Minister’s Council of Economic Advisers, which is a very high level macro economic group. The Forum is essentially a group of high level technicians who know how business works. We hope its consultative work will be completed by its next meeting in December. It will then discuss how it might best present its view to government, with the objective of creating mechanisms that are much more likely to create the sort of developments we like to see in Scotland.
Discussion
Professor James Irvine said small businesses must not be forgotten, as they are an enormous part of the business environment and are often actually left out of the equation. He welcomed the initiative which brought together Fellows for discussion, but commented on the remarkably few occasions available for groups of Fellows to actually discuss a topic of interest, such as the one being considered by the Forum.

Professor Boulton replied that the Society was always looking for ways to stimulate debate and discussion involving its Fellows and lots of activities taken place, with various groups coming together to address major policy issues. There has been real intellectual engagement in this area involving over 150 Fellows in the last year or so. It is of course continually looking for ways in which it can be a hub of debate and discussion. In response to the point about small businesses, Professor Boulton said that the Forum considered that while small businesses are important, that there had been an excessive concentration on them in Scotland and if one asks why little growth has taken place it might be argued that it’s actually because of the lack of major companies, which have significant large supply chains and are the “food stock” for small to medium enterprises, which can sell their expertise and sell their ideas to them. OECD statistics for a country like Scotland – same size, same character of economy – shows that one of the things Scotland lacks is not small to medium enterprises, but major companies. If Scotland were at the average level in OECD terms, it would have 75 more companies that were worth more than a hundred million pounds per annum, and that is therefore the area in which Scotland is lacking.

Professor John Francis asked if the Forum would consider the possibility of championing various areas of technologies. Professor Boulton said this was not something which the Forum had discussed.

The President thanked all those who had attended the meeting and contributed to the reports and discussions, and declared the meeting closed.

Lord Wilson of Tillyorn KT GCMG ........................................ 4 October 2010
President
Proceedings of the Annual Statutory Meeting

Minutes of the Statutory General Meeting held on 4 October 2010, ending the 227th Session

The Annual Statutory Meeting took place in the Society's Wolfson Theatre on Monday 4 October 2010 at 6 pm. Lord Wilson of Tillyorn KT GCMG, President, took the Chair.

Prior to the commencement of formal business, the President invited two recently elected Fellows, Jonathan Mills, Director of the Edinburgh International Festival and Dr Louise Richardson, Principal & Vice Chancellor of the University of St Andrews, to sign the Roll.

A. FORMAL BUSINESS

1. Minutes
   The Minutes of the Annual Statutory Meeting held on Monday 5 October 2009 were taken as read, approved by those Fellows present and signed by the President as a correct record.

2. Matters Arising
   There were no matters arising.

   The meeting noted a Report on Activities for Session 2009/10 distributed to Fellows in advance. The President suggested that any discussion of the report should take place after the Office-Bearers' Reports had been delivered.

4. Office-Bearers' Reports
   a) General Secretary's Report
   Professor Geoffrey Boulton gave the following report:
   As required by Charity Law, the accounts for the period 1 April 2009 –31 March 2010 have been approved by RSE Council in its capacity as the Society's Trustee and are available to any Fellow through the website or in printed format, and our activities covering the same period as the accounts are reported in our illustrated Annual Review, a copy of which has been made available to all Fellows.
   My report this evening covers activities during our 227th Session, which ran from the 2009 Annual Statutory Meeting until today. What I wish to do is spin through the important activities and milestones during the period and also look to the future.
   I'd like to start with a sense of purpose. The Society's original charter is the advancement of learning and useful knowledge, but to what extent have we fulfilled these aspirations? For the purposes
of delivery and management, our work is broken down into a series of activities which support and recognise research and excellence across the whole range of scholarship and learning; events which are designed for the public; a very active schools programme; the provision of evidence and advice, particularly to the Parliaments which we address – Holyrood, Westminster, Brussels, and associated governments and civil service; international connections; and, of course, activities which are specific to Fellows.

We continued to award Research Fellowships and moved on to a position where we are covering full economic costs. That’s an important shift, but one that will need to be carefully considered as we move into a tougher financial climate. Over the last seven years, £5 million, which has supported Personal Research Fellowships, has levered around an additional £37 million in research funding. Our Arts and Humanities Research Awards were also particularly successful in the last year and, although the total amount of funding available for this is relatively small, this is a really important area as it’s very easy in the domain of research to forget the humanities and social sciences with the drive from the life and physical sciences.

Our Enterprise Fellowships continued to be highly successful and are now a proven model, with UK Research Councils picking them up and asking to engage with us in relation to these. In the last 13 years, these Fellowships have levered over £92 million of additional investment.

Another key part of our role is, of course, communicating knowledge. Through our Meetings Committee we ran public lectures, discussions and conferences, which were attended by more than 5,000 people; and our schools programme was rich and diverse, with over 3000 pupils taking part in an interesting range of activities.

Providing evidence and advice in relation to public policy matters is something we have driven strongly forward in the last two or three years. In this last year we have produced 17 Advice /Briefing Papers for Parliamentarians immediately prior to Parliamentary debate and the production of these involved about 170 Fellows. This, I think, is part of the benefit the Society brings to its Fellows who are enthusiastic to do these things. It provides a vehicle through which they can utilise their expertise to influence public policy. The sorts of subjects we covered were: fisheries policy, a proposed Alcohol Bill, an End of Life Bill, and high activity radiation waste policy. We will also shortly publish a paper on Digital Scotland, which in my view
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will make a really major contribution and hopefully act as a major incentive to government. We have also had meetings with Government Ministers, civil servants, MSP’s and MP’s. Last, but by no means least, our major Inquiry on Facing up to Climate Change has taken a diverse range of evidence and is expected to report its findings in the early part of 2011.

We have two important committees which oversee some of our evidence & advice activities. These are our Education Committee and Business Innovation Forum. The Education Committee has been very heavily involved in the Curriculum for Excellence. We have funded, together with the Royal Society of Chemistry, a project producing exemplar materials in relation to how chemistry might be taught in the context of the Curriculum, and at the moment a working group is exploring whether that might also be appropriate in the domain of history. The Committee is also heavily involved in advisory groups to the Government and is planning a seminar which is tentatively entitled “What are Universities for?” on the basis that before you decide how to fund them or how much it might cost, you might actually want to ask the question what are they for anyway.

The Business Innovation Forum has had a slow start but, in my view, is now beginning to have a real impact. It is designed primarily as a group of very experienced business people, with a small sprinkling of academics, with a view to utilising the knowledge and experience of these business people in identifying some of the large issues for innovation and business in Scotland and trying to present the case to Government for innovations which they believe are going to be important.

Our outreach activities include a great variety of publications and some of us are rather concerned, essentially in a deliberate way, to review whether the spectrum of publications that we currently produce is appropriate to the modern age. One of the areas we want to enhance considerably is our use of the website as a means of reaching out to a wider diversity of people and we are well down to the road in doing that, with a new site expected to go live in Spring 2011. We also have substantial outreach and public engagement activities associated with our Inquiries and reports, and it is pleasing that we have been able to take these activities, and the expertise that Society’s Fellows can offer, to the whole of Scotland, including rural areas.
The international programme has been diverse in the last two or three years and we have developed increasing connections with China – which is recognition of the role that China is increasingly playing in the modern world. The international programme is, however, an area where we feel we could be much better focused and the International Convenor during this year, his last year as Convenor, is going to focus on developing a new strategic approach for consideration by RSE Council.

We are aware that one of the things we have to do if we are going to engage in outreach and policy is to ensure that our external communication and relationships are very good. Peter Holmes will talk later about a new “Future Leaders Academy” initiative, an interesting idea that stems from the concept that in modern societies there is a strong recognition that the talent of the emerging young is crucially important to support. There have been two or three similar initiatives in Europe, particularly run by the Dutch Academy and the Leopoldina, the German Academy, which have had so-called ‘young academies’ running for several years. These have proved to be highly successful, they’ve attracted the very best and brightest talents, they’ve found ways of giving them things and opportunities which otherwise wouldn’t be accessible to them, and we think this a potentially extremely important development.

We also want to review our Events Programme and, in particular, look at one of the areas which, some of us at least, believe we inadequately cover, that is careful deliberative discussions on crucial issues of the day involving primarily the Fellowship.

During the year the Society has, once again, advanced learning and useful knowledge through a wide range of public benefit activities, which reached many people and places across Scotland and beyond. This would not have been possible without the willing and voluntary contribution of Fellows, the support of the Society’s hard working staff, or the voluntary input of others. On behalf of the Society, I would like to thank all of them for their contributions.

Finally, Vice-President Physical Sciences, Professor Tariq Durrani and Council member Sir John Arbuthnott’s terms of office end today. On behalf of the Society I would like to thank both of them for their valuable contributions to the Society’s work, whilst at the same time fulfilling the many other demands on their time.

That concludes my report. I would be happy to take any questions which you may have.
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Discussion

Dr John Francis: “listening to the General Secretary this evening it occurs to me that he’s charted a very interesting path going forward, but I seem to remember in a not too distant past that we had something within the Society which was vaguely referred to as a Strategic Plan and I wondered whether any of the elements of the Strategic Plan are now in conflict or under resourced in relation to some of these new ideas that he’s putting forward?” Professor Boulton: “strategic plans age and we are a long way down the track of the current plan, which finishes at the end of next year. Of course, the prospect you have in the beginning and the prospect you have at the end of such plans are rather different. On the other hand, it is very important to work along that pathway. In my view, one of the most important ways in which we should deal with the evolution of the Strategic Plan is to have an annual planning cycle where we can see which of the pathways we set are still appropriate and ones where we need to make changes so that we can prepare ourselves for the next plan. My view is that societies like one this need to reassess what they are doing from time to time because circumstances change, the demands and opportunities on them change and I think that’s very much what we are trying to do at the moment. It will be apparent to everyone here today, that at this moment funding is becoming extremely tight and we have to have a clear sense of where our priorities lie; for example, if our funding were to diminish dramatically we would need to know what should or should not continue, so we are trying to be very strategic about it, and I have no doubt that the next Strategic Plan we will be an evolution of current one, but I suspect it will look rather different in reality.”

Dr Chris Masters: “it’s very impressive to hear all that we are doing, but my worry is, are we trying to do too much? Is there a danger that by trying to do too much we actually end up doing a lot of things not very well? How do we actually make sure that we retain the quality of what we are doing and perhaps decide to do less, but perhaps do it better, or at least improve it?” Professor Boulton: “I think that is exactly the rational for wanting to, if you like, annually address priorities. I think that priorities ought to lie in those areas where we are uniquely able to bring benefit to the society around us. Where we are simply doing things that others can do equally well my view is we should retire from those. That of course is easy to say, but much more difficult to do because people commit a great
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deal of time and effort to running very creative very exciting activities, and saying to people that’s not a priority anymore is not an easy thing to do. The key issue is deciding what not to do. It’s really easy to decide what to do, it takes a lot more discipline to decide what not to do and societies like this don’t quite have the rigour and the discipline of businesses, which have to address markets, so changing direction is often quite difficult.”

*Professor Ian Halliday:* “can I reflect some trouble I got into last week where, at a meeting of European Heads of Research Councils, I gave a speech which had a lot of overlap with what has been discussed, but in a different context. It concerned providing advice, and at a certain point a lot of heavyweight government funding agency people cried - we don’t want advice, we want input to make decisions, there is no shortage of advice it falls from heaven. So the question is how do you actually make it effective advice? Equally importantly for this Society is how do you communicate to the outside world, without too much boasting or telling lies, that your advice is having an effect? I am very aware that the most effective way to give advice is to get others to think it’s their idea, but then you can’t claim any credit. You’re aware underneath you had an effect, so it’s how do you measure and then tell everybody that we are making an impact? I think this is as important as providing the advice.”

*Professor Boulton:* “I think firstly getting an organisation like this to really address policy advice and public policy issues is a learning process. Some people are already profoundly familiar with the sort of relationships that you need to have to make it work, but many levels aren’t and I think it’s taken us two or three years to realise how we go about doing things, and increasingly what’s happening is we are seeking to evaluate the impact. Before we start a report now, we ask ‘do we have anything to say?’ The second question is can we make an impact and what is the route through which impact will be created? If the answer to either of those questions is no, then frankly the rationale for doing it is very limited. We have certainly become more aware that one of the things one needs to do is address the people who you are trying to influence, address them directly, understand that psychology, understand where benefit lies for them and preferably at an early stage talk to them about where you can be helpful and useful. The other key thing is to follow things up. What one must not do is simply produce the paper and suppose that somehow everyone is going to adopt it. Of course, the more you do that the more difficult it is and the greater the difficulty in creating
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new things. On the other hand what’s beginning to happen is that we can see that we are actually filling the policy space and we have now done work in many areas which are key areas for Scottish Government. In a sense, very frequently we don’t have to start afresh. We revisit groups and thoughts we have had before and amend them to current circumstances, so I think in the Scottish case it is very much more of a dialogue and one of the reasons why engagement and media relationships are so important.”

b) Treasurer’s Report

Mr Ewan Brown gave the following report:

The summary accounts for the year to 31 March 2010, as set out at the back of the Annual Review document, are fairly straightforward, but the vagaries of accounting for charitable bodies still needs some explanation.

First, a reminder that what is presented are the consolidated figures for the RSE and its connected charities, the RSE Scotland Foundation and the BP Research Fellowship Trust. However, the BP accounts are consolidated and are for the year to 30 September 2009, with the market value of its investments updated to 31 March 2010. Since there are no material issues involved, we have decided to remove this anomaly by changing the BP year end to March – so that future Annual Reviews will show all the component parts in the same form for the same periods.

The largest elements of income and expenditure – the money received for the grant of research and enterprise fellowships and the amounts paid out in support of these fellowships – increased by 15%, a substantial step-up reflecting the implementation of earlier recommendations from Sir John Enderby. Elsewhere, costs were kept under tight control, with governance and management costs representing less than 3% of income. In these difficult times, it is very important that we are able to demonstrate to the Scottish Government that we are working to achieve efficiency savings and improve delivery output.

The consolidated operating deficit for the year was £62k. You may recall that the £2.11m surplus for 2009 shown in the Annual Review included the legacy of £2.16m received in that year – the comparable figure for 2009 was a surplus of £39k.

The 2010 deficit was planned – because Council knew that the RSE would be meeting award commitments made by the Trustees of the
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Caledonian Research Foundation before it was absorbed into the RSE, and there was also further expenditure on improving our systems.

Total funds grew from £18.6m to £21.2m – an increase of £2.6m. Again this needs some reconciliation. On the negative side was the operating deficit of £62k and, of some real concern, an adverse pension valuation of £607k. On the positive side, the investment portfolio produced realised investment gains of £340k and unrealised gains of £2.87m.

The unrealised gains, by definition, are not real; they simply reflect a snapshot of the value of our investments at the balance sheet date. The adverse pension deficit is not real either – accounting valuations are proving to be as opaque as actuarial valuations, but what is clear is that we can expect year-to-year volatility as discount rates and equities go up and down and as we live longer.

What is real is being able to meet liabilities as they fall due. Although net current assets were down by £235k – attributable principally to higher deferred income – they were very close to £2m, which is a healthy position.

The future of public sector funding is uncertain, but our scenario planning for the next spending review is well advanced. The delivery of the RSE’s varied programme of activities with public benefit outcomes will be guided by the priorities set by Council to ensure continuing financial stability. In challenging times, the RSE continues to seek new opportunities and develop existing activities, to enhance its contribution to Scottish society. In this connection, the major legacy to which I referred last year has already proved a most useful helping hand. I hope that Fellows generally will give serious consideration to leaving legacies to the RSE.

I would be delighted to answer questions on the figures, reserving the right to pass the difficult ones to our Finance Director, Kate Ellis, whom I would like to thank for all her efforts.

c) Fellowship Secretary’s Report

Professor Peter Holmes gave the following report:

This is my annual opportunity to say a little bit about the Fellowship. I will begin by saying a few words about the composition of the Fellowship. As it stands at the present time, we have over 1500 Fellows in total, 9.3% of whom are female. The Fellowship is divided between four sectors which cover all the range of disci-
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Disciplines. Within those different sectors, we have 14 Sectional Committees that cover a whole range of different subjects within a discipline. This involves almost 200 Fellows in the electoral process.

At the moment 36%, of the fellowship is within Sector A – the life sciences; 37% within Sector B – physical, engineering and informatic sciences; 16% within Sector C – the humanities and creative arts; and 11% in Sector D – social sciences, education, business and public service. As you might recall from previous years, Sector D is the area that we would like to try and grow.

The success rate of election to Fellowship is of interest. From the figures for the last three years you can see it is highly competitive, and if you look particularly at 2009–2010 you can see that, in general, 24% are elected of the candidates being considered. Sector D, as I mentioned, is an area we are trying to grow and where we have had a high success rate. In 2007–2008 it was 78%, it is now down at 33% and this success rate has some bearing on the distribution of places for the coming year, which I will refer to in a moment. Looking at the gender balance of our Fellows elected last year, we can see that 21% of the males presented for election were successful and 42% of the females presented were successful. This year this was 23% and 32% respectively so we are doing quite well in that respect I think.

An important part of the year is the New Fellows’ Induction Day which is held in May every year. I’m pleased that on the 3rd of May this year we had 38 new Fellows admitted to the Fellowship.

If we now look at the new election cycle which we are really just beginning, that is the 2010–2011 cycle, we currently have 158 candidates under consideration. They are not all of course in their first year because candidates stay on the list for up to three years. We have four for Honorary, five for Corresponding and 149 for Fellowship. You can see from the distribution of those 158 candidates that the largest number by far are coming forward in the life sciences. There are many from the physical sciences but low numbers from Sectors C and D. You may recall that for many years we elected around 55 new Fellows each year, then two or three years ago it was reduced by Council to 40. Council would like to hold it at 40.
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Every year Council decides the total to be elected and the distribution amongst the various sectors, taking into account the size of the community, the number coming forward, and the balance of the Fellowship as it exists.

**Sector Groups**

<table>
<thead>
<tr>
<th>Group A (4 Sectional Committees)</th>
<th>Quota 2010–2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B (4 Sectional Committees)</td>
<td>13 +1 possible</td>
</tr>
<tr>
<td>Group C (3 Sectional Committees)</td>
<td>11</td>
</tr>
<tr>
<td>Group D (3 Sectional Committees)</td>
<td>5 +1 possible</td>
</tr>
<tr>
<td>Floating</td>
<td>7 +1 possible</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

There will not be more than 40, but we do feel it is important to have some flexibility between the sectors. The final allocations will be decided by the Fellowship Committee and those recommendations then go to Council for approval. A group which I think is very important are the cross-discipline candidates. These are people that are strong in more than one field so don’t fit neatly into our Sectional Committees and Sectors, usually between sectors in fact. For these candidates, we have a small number of what we call ‘floating places’ and in the past some very valuable Fellows have come in through that route. So again it is 40 places in total for this coming year.

Currently in the election process we are at the stage where we have a few remaining meetings of Sectional Committees considering this long list of candidates. They each rank their top six candidates and their lists then go forward to meetings of the sector groups who again do further distillation of these names. The names then finally move forward to the Fellowship Committee and to Council, and then of course out to the Fellowship for final endorsement. So it has a natural cycle and we are well under way this year and of course it is all complete by May next year.

I am very happy to take any questions on the Fellowship issue, but whilst I am here if I could also say a few words about the Prizes Review, which started in 2009 and which I was asked to chair. There was a feeling that although we have some important prizes, the management of the scheme for prizes was really not ideal. Not all of them were awarded because it was difficult in some cases for names to come forward, and some of the topics covered by some of the prizes were rather out of date. It really was less than ideal and the
small committee felt we could have a much better and simpler system. We suggested that we should essentially have eight prizes across the four sectors. In the past, some sectors had several prizes, other sectors had almost none, so we believe it should be a senior prize and a junior prize in each of the four sectors. The winner of the Senior Prize will be invited to deliver a lecture, the Junior Prize winner will receive a medal. They should be awarded annually to get away from the confusion about which year we award a particular prize, and they will be awarded in each of the four sectors. We believe that the titles of the prizes should include ‘RSE’ in the name and be linked to very distinguished people associated with Scotland and the RSE. The suggested names and spread of the prizes are: in the Life Sciences, the Senior Prize named after Sir James Black and the Early Career medal after Patrick Neil; in the Physical Sciences, the Senior Prize named after Lord Kelvin and the Early Career Medal after Sir Thomas MacDougall Brisbane; in the Humanities and Creative Arts, a Sir Walter Scott Senior Prize and a Thomas Reid Medal, and in Sector D an Adam Smith Prize and a Henry Duncan Medal. Our suggestions have been endorsed by Council and we believe everything is now in place to move forward with this scheme in November for the coming year.

The Royal Medals will be continuing. The IEE/RSE/Wolson, James Clerk Maxwell prize and award will continue and we hope that the Innovation Award, which has been funded by the Gannochy Trust for the last seven years, will also continue.

Finally, I would like to thank RSE staff and particularly Dr Lesley Campbell and Mrs Anne Fraser for all their help during the year.

Mr Ian Ritchie: you said quite rightly that we are trying to increase the number of candidates from Sector Group D and I think that’s very important. But the fact remains that our academics will naturally want to become Fellows of the Society as they see it as a career enhancing move, but the industrial sector don’t see that, so I think we really need to do something about this. I am a Fellow of the Royal Academy of Engineering and we have a proactive campaign to bring in not only industrialists, but women too and it is quite separate from the membership programme. What they do is they actually go scalp hunting, find the case, persuade them it is worth doing and get the evidence. I think we should consider doing this.
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*Professor Holmes:* I agree with you. I think we have to be much more proactive in this area; the topic of doing more in this area was discussed at Council’s Away Day this summer and we intend to be more proactive in the coming year.

*Professor John Laver:* I would like to ask a question about the success of women candidates. I am rather disappointed to see it is only 9% and I wonder what the possible reason is. I cannot believe, for example, that in academia or in enterprise, women of sufficient quality are not being promoted to the right ranks as it were. So I wonder if you could offer a view as to what the right reason is for the relatively slow progress of increasing the number of women candidates successfully elected, and whether there is something productive Council could do about that in the way of laying down relatively forceful encouragement, perhaps to sectors to do their very best to increase this at a sharper rate.

*Professor Holmes:* It is a very important issue. I think the 42% success rate of female candidates is encouraging. The Committees are giving as much support as possible, but we do need to be perhaps a little bit more proactive. In part we reflect the academic community, if you look at the gender balance of chairs in Scottish universities. It has been quite a slow process improving what is a very small percentage and I think part of our problem is reflected there, we have to give more encouragement. The larger problem is the progression of women. If we take the university route from undergraduate, postgraduate studies to postdoctoral studies you find a dramatic fall off in later years in many areas, for example science, where over the years the proportion of women has increased but you still get exactly the same fall off – indeed international evidence why this happens is really quite conflicting. Addressing this larger problem, would help us to resolve this particular issue.

*Professor Hector MacQueen:* I do think that one of the difficulties we have, and I have expressed this view in the Fellowship Committee and elsewhere, is that the current Sectional Committees and indeed their Convenors and myself as Vice-President, aren’t in a position where we are allowed to actually make nominations. We can do our best to encourage and facilitate, but basically what you have to do is go out through your Sectional Committee inspired and enthusiastic about improving things. The number of women is certainly one of the things in which considerable improvement can be made, but one cannot actually actively put ones’ name to
documents and carry out the nomination process, someone else has
to do it. We are making our processes difficult for ourselves in our
efforts to avoid the problem, which I think is actually a rather minimal
problem, of conflicts of interest.

Professor Holmes: this topic has been discussed in the past and there
is a balance of view about the issues around conflicts of interest and
the point that Hector has been raising, particularly with regard to the
minority groups. We do however really have to try and encourage
admissions from these groups.

5. Laws Changes

The meeting approved changes in the Society’s Laws to reflect a decision
by Council that the category “Ordinary Fellow” should be replaced by
“Fellow”. Council felt that referring to Fellows as Ordinary is inappropri-
gate given the high level of distinction required to become a Fellow.

The phrase Ordinary Fellow is defined in the Society’s Law 1, and referred
to again in Laws 29, 39 and 48. Appendix II lists those existing Laws
and alongside them the changes approved.

6. Election of Council and Other Office Bearers for the 228th Session

Lord Wilson reported that all Fellows entitled to vote had been sent a
ballot paper. The returned papers were examined by the scrutineers,
Professors Jan McDonald and Andrew Ranicki. All those proposed were
elected either unanimously or by an overwhelming majority. The Presi-
dent congratulated the newly-elected Council members and thanked all
those who were standing down. Membership of Council and the
Executive Board for the next Session would be:

Council

President
Lord Wilson of Tillyorn KT

Vice-Presidents
Professor Jean Beggs CBE
Professor Hector MacQueen

Treasurer
Mr Ewan Brown CBE

Ordinary Members
Professor Cairns Craig OBE
Professor Iain Halliday CBE
Professor Sheila Rowan

General Secretary
Professor Geoffrey Boulton OBE

Mr John McClelland CBE
Professor Wilson Sibbett CBE

Fellowship Secretary
Professor Peter Holmes OBE

Professor Anna Dominiczak OBE
Professor Sue Manning
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Executive Board

General Secretary
Professor Geoffrey Boulton OBE

Curator
Professor Duncan Macmillan

Programme Convener
Professor John Richardson

Young People’s Convener
Professor Mary Bownes OBE

Treasurer
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International Convener
Professor Sir David Edward KCMG, QC, PC

Research Awards Convener
Professor Alan Miller
B. FUTURE LEADERS ACADEMY

Professor Holmes presented the following paper which was then discussed and welcomed by the meeting as an initiative that should be progressed.

1) Why should the RSE create this new body? What are the “issues” we are seeking to address?

The RSE Council believes that it is timely for the RSE to examine how it can interact more effectively with and support early-career researchers, scholars and professionals. One way of addressing this issue would be to create within the RSE a structure which supports this group and provides them with a forum in which to undertake a range of activities. The working title for this development is Future Leaders Academy. (The term ‘Young’ in the title is not favoured. Another possible title is Early Careers Academy, but a range of other titles are being considered and suggestions from Fellows would be welcome).

Acting in this way would be in keeping with a growing interest by European national academies in developing ‘Young Academies’. The first was formed in Germany in 2000. This led to the development of one in the Netherlands five years ago and more recently in Austria, Turkey and Hungary. A number of other national academies in Europe are now actively discussing the creation of their own ‘Young Academies’. These countries include Belgium, Sweden, Finland and Switzerland.

2) What are the benefits?

The Council believes that the creation of the Academy would demonstrate to Government and the wider community a vibrant RSE which is addressing the issues of younger scientists/scholars/professionals and stimulating inter-disciplinary exchange, and that the RSE wishes to provide ongoing support for research fellowship-holders during and beyond the tenure of their fellowship. There would also be a strong alignment with the government priority of sustainable economic development.

The development of a Future Leaders Academy for early-career researchers, scholars and professionals would provide considerable benefits to (a) themselves as individuals, (b) their careers, (c) the RSE and (d) the country more widely.
Activities to achieve the above benefits:

(a) will be achieved through social interactions – e.g. social gatherings, personal development events, shared e-mail lists, web-based social networking, etc.

(b) will be achieved through professional interactions – e.g. meetings aimed at understanding one another’s research and seeking opportunities for collaboration (both intra- and interdisciplinary), self-help sessions, facilitated professional/career development events, etc.

(c&d) will be achieved through involvement with experienced representatives of various relevant groupings – e.g. senior researchers, senior university academics, government representatives (both politicians and civil servants), leaders of industry, entrepreneurs, etc.

These interactions would be in both directions – permitting the opportunity for the member to better understand the complexities of the organisations upon which they depend and to influence and shape decisions and policy development.

3) What will the Academy do?

The Academy will provide:

(i) a forum and focus for younger researcher/scholar/professional activities; an opportunity for early-career research and professional leaders to generate networking and/or mentoring contacts and exposure to those in very different disciplines and professions to foster interdisciplinary exchange;

(ii) a structure for young researchers/scholars/professionals to organise symposia, conferences or activities on topics of current interest (whether purely academic or policy/ethical/cross-discipline);

(iii) the opportunity for young researchers/scholars/professionals to provide independent advice to the RSE, government and other national bodies on issues pertaining to young researchers/scholars and policy more broadly, and provide a pool of disciplinary expertise, opinion and assistance to the RSE, and for government or media to tap into;

(iv) empowerment of younger researchers/scholars/professionals as a defined group within Scotland and the opportunity to
provide a defined ‘voice’ of younger researchers/scholars to media and policy makers on national issues;

(v) participation in RSE functions at all levels, providing a balancing influence on decisions and actions;

(vi) promotion of outreach and provision of links between younger researchers/scholars and society; highlighting research conducted by young researchers to the media and society;

(vii) inclusion of inputs from young researchers/scholars/professionals on all RSE policy consultations and expert documents;

(viii) inclusion of young researchers/scholars/professionals on the Young Peopple’s Committee, the Meetings Committee and other committees;

(ix) possibly a programme of “young leaders” meet “old leaders” networking and dinners and have formal inclusion in RSE events – meeting politicians etc.

4) What will be the relationship to the RSE?

The Academy will be closely linked into the RSE and its management group will include RSE Council members and senior officials who, initially at least, have control of what the Academy does. It will be administered by the RSE. It is important to stress that the RSE Council is not seeking to create a ‘Junior Fellowship’ although it is expected that, since the membership of the Academy will consist of highly able people, many of them will later become potential candidates for election to the Fellowship.

5) Academy membership

It is proposed that the membership of the Future Leaders’ Academy should embrace younger researchers, scholars and young professionals across the wide range of disciplines covered by the Fellowship of the RSE and who are based in Scotland.

The criteria for selection will be refined by the RSE Sectors and Sectional Fellowship Committees. Initially each of the fou Sector Committees will be asked to identify up to a maximum of up to 50 possible members. Although the criteria may vary between the Sectors, they will all strive to nominate high quality individuals in the suggested age range of 30-40 years, with a good gender balance and geographical spread across Scotland.
A sub-committee of the Fellowship Committee will review the nominations and recommend a short list to the Council of those to be invited to join the Academy. Members will serve for between three and five years. This will allow the Academy to be established with a modest initial membership (perhaps about 60 in the first year) building up to a steady state of about 200.

The criteria for membership are likely to include those who have been successful in existing competitive research fellowship schemes conducted by bodies such as the RSE, Research Councils, the Royal Society and the British Academy researchers. For others, it would require young professionals who have been identified as ‘rising stars’ by their firms and professional organisations.

6) **What will it cost and how will this be funded?**

Supporting the work of the Academy will require £30k-£50k per annum, inclusive of staff costs. The RSE will raise this additional funding before the Academy is launched.

We will not be seeking Government funding for the Academy, although we hope the Government will be supportive to its aims.

It is anticipated that the members will pay an annual subscription, but careful consideration will need to be given to the level, so as not to be a disincentive to membership.

7) **What are the main risks to RSE and how will these be mitigated?**

The RSE Council recognises that the creation of the Academy carries some risks. These include; reputational risk if the Academy is not a success or if it becomes very controversial in its policies; and financial risks if insufficient levels of external funding can be raised initially and maintained in order to sustain the Academy. The Council believes that by maintaining close links with the Academy the former risks at least can be mitigated.

8) **Timescale for implementation.**

The purpose of this paper is to seek endorsement from the ASM for the Council to move forward with plans for the Academy. The launch of the Academy will be dependent upon the identification of adequate external financial resources. It is hoped that these can be secured in the next six months and the Academy can be launched during 2011.
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Discussion

Professor Andrew Miller: I do hope it is possible to go ahead with this. The group we are talking about are very active academic and professional people and are the people we really want to connect to the Society. It must, however, be clear that we are listening to them. It would be interesting to know what they think would be in it for them and what do they feel they could give to the Society by being a member of such an academy. The only criticism I can give is that there are too many ideas. Why don’t we canvas that group and ask them what they would like to see coming from such an academy.

Mr Jonathan Mills: the paper didn’t mention the age group. I assumed that it was 30-40 years, but there will be some people who are very advanced in their careers at the age of 25 and there will be people who are very immature very much at the beginning of their career at the same age. Do you have any sense of an upper age limit and lower age limit? I think both are very important. Professor Holmes replied that under current legislation it would be very difficult to say nobody younger than 30 and older than 40, but in reality it would be what might be called “early-career academics and professionals” and they are likely to fall into that age range.

Professor Rona Mackie: can I just make three specific points? The first one is establishing if the potential members of such a group feel they have time to participate. For example, it is a very productive time in the life of medical researchers, although I am sure they would be keen and willing to give sometime to do this sort of thing. Secondly, there must be an exit strategy. Thirdly, to what extent do you foresee that in the future this would be the entry route to the RSE Fellowship? Professor Holmes replied that the Academy would need to offer very high quality activity because of the enormous pressures / demands potential members are already under, but that initial ‘market testing’ had produced a positive response. On exit strategy, the feeling is that the membership should probably be restricted to possibly four or five years in order to get due turnover, and that is the kind of pattern that seems to be evolving within Europe. Whether the alumni stay connected is a possibility, but its important there is a limit on membership and that it is not a fast track into the RSE Fellowship. It is not, however, unreasonable to think that members will be very high quality people and in time some of them will come forward as candidates for RSE Fellowship, but there is no connection to be made between a member of the Academy and an RSE Fellow.
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Professor Murray Pittock: there is a lot to be learned from the Dutch and German experience, but the situation in the UK is significantly different. Firstly what universities here are already doing to promote and develop early career researchers, so that there is no duplication of effort. Secondly, to resonate with Research Councils and similar other career awards. My own view would be if someone possesses such an award they should automatically gain entry to the junior academy. Another thing that struck me was the extent we talked about age group and so on. How far do you want to specify other careers as such in terms of Research Councils UK language? Should this be consistent or should it depart from that and if so why? A further issue concerns focus. One thing it could focus on, which I think is particularly pertinent to the strengths we have here in Scotland, is exchange with others. Professor Holmes replied that universities have to some extent woken up to this, particularly aided by the Roberts money, and they are doing more in terms of generic skills training. What happens after the Roberts money dries up is another issue for universities, but it’s something that we shouldn’t duplicate and we should speak to the Research Councils. Taking prestigious fellowship-holders as a kind of criteria would be an easy way in and we would probably expect people to have that type of award. The problem is that Scotland has a lot of these and we would be way over 60 into the 300+. We have to develop this, including how we identify and select young lawyers and young business people as members.

Mr Ian Ritchie: you are right about finding young lawyers and so forth, but it would probably be more difficult to find young artists, young creative people and young musicians and poets, who are also important. I was surprised to hear a limit of 60–200 members. There is an enormous amount of talent out there and obviously the way professional institutions are calculated is that the fellows are the elite of a much bigger group, say 10% of a bigger group, and I suppose you must have thought of whether you wanted to go that way and have, say, about 20000 members and the fellowship would be the elite of that. Is that something you’ve considered? Professor Holmes replied that it had been considered to some extent. Some countries have huge numbers and call them a forum, but it was felt that we should be more restricted, starting with 60 members and building up to 200. If membership is for 4-5 years, this phased approach is needed.

Professor Robin Knops: it does seem to me that there’s slight confusion over the objectives that you’re trying to specify. One of them is that membership should be in some sense honorific and this takes up what
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Ian Ritchie is saying that perhaps in some of the objectives, namely networking and all the rest of it, it would benefit all the relevant community, not just those selected for this particular activity. Secondly, maybe if this is successful, and hopefully it will be, in the right format it will take on a life of its own and start to set its own agenda and actually present some sort of competition to the established society. Professor Holmes replied that we must be selective and have very high quality people who are motivated and create disciplinary mix. It could be that it organises events, which perhaps spread to a much wider group. A key issue is how much freedom it should have. The intention is a lot because it has to set the agenda. On the other hand there’s a reputational risk to which we always have to be sensitive.

Professor John Laver: I am very pleased to see this initiative beginning to move forward in this promising way and want to offer two points of view. First, it would be extremely helpful, I think, for recruiting people of the right calibre and the right sorts of research interests and so on, if there was some tangible benefits immediately available, for example, being able to tap into some restricted portion of the Society’s funds, for example, travel abroad to begin to negotiate cooperative interdisciplinary projects with other members of the young academies in Europe. Secondly, you have repeatedly said there is not a connection with a direct route to becoming a RSE Fellow. I think if you are going to be successful with the Future Leaders Academy there will be an inevitable organic growth towards that and indeed it would be absurd if some people didn’t emerge rather quickly as potential candidates for RSE Fellowship. I wonder whether it is possible to be quite so absolute about no connection whatsoever. Professor Holmes replied that there cannot be any promise that being in the Future Leaders Academy will mean members automatically become RSE Fellows, but it is not an unreasonable expectation that many members would in fact move forward and may be identified at an earlier stage. Tangible benefits, such as travel grants should also be considered, as well as the funding implications of these.

Sir Brian Ivory: on further reflection I would drop the word ‘future’ as I think the development element is covered by the word academy. It’s slightly presumptuous saying we’ve selected the future leaders. I think we should just call it the Leaders Academy; they are after all leaders and hopefully will be or are already the leaders of their own generation.

Professor Andy Walker: I was involved in the early days of this and am very pleased to see how far it has progressed. We have heard about
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Scottish Crucible, which brings together a very dynamic group of selected individuals for around Scotland. I’ve seen it operating and indeed, I had a good opportunity to bounce this idea off them at a session that we had earlier and the response was very positive. There were some very interesting comments. They wanted to know more about us and I do think it’s a very sensitive area that we have got to get right.

Professor Ian Halliday: we do have to be a little bit careful about how we label such people in the future and I am just a little nervous. In Scotland “academy” has its one meaning, in Europe it has a different overtone altogether. If the members are so good, I am also a little nervous about giving them money. I think the attraction for them will be being able to engage with issues, decisions and high level people that their everyday activities don’t facilitate. This is certainly the attraction in Germany and I believe in Holland.

There being no further comments the President thanked all those who had attended the meeting and contributed to the reports and discussions, and declared the meeting closed.

Lord Wilson of Tillyorn KT GCMG .......................... 3 October 2011
President
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Major General Simon Mayall, the current Assistant Chief of the General Staff, opened the series with an insightful examination of the war in Iraq, taken from the perspective of both a scholar and an experienced military commander.

General Mayall began his presentation with a critical analysis of the concept of Jihad, assessing its philosophy and development since the shattering of the Ottoman Empire and creation of nation states within the Middle East. He discussed how the interpretation of Jihad has been altered over time and, more recently, how it has been manipulated at the hands of militants and extremists. Closely connected to this problem, General Mayall assessed the political and historical situation of Iraq, noting the confluence of religious, ethnic, and cultural ‘fault lines’ within the country, and how the Coalition’s invasion unleashed many of these latent tensions.

General Mayall then proceeded to give a strategic view of the war,
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noting the many mistakes made by the Coalition: a brilliant military campaign, but a woefully ineffective occupation. General Mayall noted the comparative strengths of the insurgency at this time, among them a sense of general opposition to the invaders, a sense of paranoia, and influx of foreign fighters, observing that this combination brought the country to the brink of civil war. General Mayall moved on to compare the admittedly dire situation of the first years of the occupation to the recent past, focusing on the positive effects of the ‘Surge’ – a much misunderstood strategy which has included not only a rise in troop numbers, but also a coordinated increase in economic development, reconstruction, reconciliation, and transferal of responsibility to the Iraqis themselves. General Mayall concluded that, despite many initial mistakes, much progress has been made, and the future for Iraq looks promising.

Major General Mayall’s presentation exhibited both a deep understanding of the history and politics of the Middle East and a wealth of first-hand knowledge and experience of the region.

Professor Carole Hillenbrand OBE FRSA FRSE

Images of Saladin: Past and Present

10 December 2008

The first non-Muslim to be awarded the King Faisal Prize for Islamic Studies, Vice-President of the British Society for Middle Eastern Studies, and Islamic Advisory Editor at Edinburgh University Press, Professor Carole Hillenbrand shared some of her broad knowledge and experience about the image and reputation of Saladin throughout history.

Professor Hillenbrand began by attempting to separate the ‘myth’ from the ‘reality’ concerning the great military leader who, having united the Arabs behind him, recaptured Jerusalem from the Crusaders. A young noble of Kurdish origin, Saladin was the protégé of the successful commander Nur ad-Din. He built on his master’s success, and proceeded to construct a strong powerbase through conflict and intrigue against his fellow Muslims. Professor Hillenbrand then discussed the darker sides to this charismatic and passionate figure, whose sense and awareness of image extended to the employment of two ‘spin-doctors’.

Saladin’s reputation in the West, both during and after the Crusades, was discussed at length.
Professor Hillenbrand noted the adoration and esteem with which authors such as Dante and Scott regarded Saladin: portraying him as the paradigm of heroism and Christian chivalry. Contrasted to this was the disdain and fear which was shown towards Islam and the Arabs, concurrent and seemingly contradictory to such adulation of their leader.

The image of Saladin in the Middle East was then discussed, and it was noted how his reputation was rekindled remarkably recently by Christian Arabs translating texts for their Muslim neighbours. From there, Professor Hillenbrand exhibited a number of intriguing examples of the image of Saladin being usurped for the attainment of modern political currency: stamps from Jordan, films from Egypt, bank-notes from Iraq, all using the resonance of Saladin’s image to glorify the current regime.

Professor Hillenbrand concluded that Saladin’s role in recapturing Jerusalem, an emotive city for Christians and Muslims alike, was the definitive act which secured both his fame and his mystery, and ensured that his name would live on through the ages.

Having lectured on Islamic art for over 30 years at some of the world’s most prestigious institutions, serving as the Editor of leading journals in the field, and widely regarded as the world expert on Islamic art, Professor Robert Hillenbrand was ideally placed to deliver an introduction to this diverse, fascinating, and much misunderstood subject.

Professor Hillenbrand began by calling for the audience to ‘leave their baggage behind’ when contemplating Islamic art, and to jettison all preconceptions that medieval art must be figural and religious, and that it privileged easel painting and sculpture. He went on to demonstrate, through a richly illustrated presentation, that Islamic art, by contrast, found its most apt expression in more practical manifestations: textiles and carpets, bowls and candlesticks, buildings and book painting.

Moreover, Professor Hillenbrand discussed the roles of architecture as a means of conveying complex power-relationships within society: from shared features in mosques from Spain to India, to megalomaniacal city plans.
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employing concepts from astrology and geometry to produce impressive displays of wealth and control. Allied to these architectural statements were commissioned paintings and illustrations which depicted the rulers and their courts living in considerable luxury and decadence.

Professor Hillenbrand proceeded to consider the commonest forms of expression in Islamic art – geometry, vegetal themes, and calligraphy – in their many manifestations. These achieved an unusual intensity in the hands of medieval Islamic craftsmen, well-versed in mathematics and studies of the natural world, using contrasts of colour and texture, light and dark, solid and void, as well as employing devices of rhythm, repetition, echo and symmetry to secure effects of abstraction and concentration.

Throughout his lecture, Professor Hillenbrand used the artwork which he was discussing to analyse medieval Islamic society, providing penetrating insights on its conception of religion, politics, and the Cosmos.

Professor Hillenbrand’s presentation provided both a uniquely entertaining and accessible introduction to such a specialised subject.

Professor Mona Siddiqui FRSA FRSE
Islam and the Day of Judgement
12 February 2009

Professor Siddiqui is currently the Professor of Islamic Studies and Public Understanding, as well as the Director and founder of the Centre for the Study of Islam, at the University of Glasgow. She also provides numerous consultancy services to Government, and publishes and broadcasts extensively in the national media. An expert on Islamic theology and thought, Professor Siddiqui delivered her thoughts on the Day of Judgement, as envisaged within Islam.

Professor Siddiqui’s lecture drew on descriptions of the Day of Judgement as presented in the Qur’an, as well as on the works of medieval theologians and modern scholarly commentators, in an exceptionally well-researched address. Simultaneous to this was a close reading and deep analysis of the Qur’an, combined with an evident spirituality which also, on occasion, served as a powerful and personal interpretive tool.

The lecture was concerned not only with the Day of Judgement itself, but also dealt with such philosophical issues as divine
agency, free will, the nature of God, and the position and role of man within God’s world. Professor Siddiqui’s thorough knowledge of Islamic, Christian and Judaic theologies was exceptional, with many comparisons between the basic tenets of the three monotheistic religions being made at various junctures throughout the lecture.

A particularly lively question and answer session expanded on Professor Siddiqui’s understanding of the precise nature of the after-life, and questions of ‘salvation’, ‘sin’, and ‘forgiveness’, as explored within the Qur’an, were abundant.

Professor Siddiqui, in characteristic fashion, managed to distil a considerable amount of expertise and knowledge into a clear and comprehensible lecture.

Professor Robert Hoyland

Writing the First Qur’ans: Running the Early Islamic State

12 March 2009

Professor Hoyland, Professor of Arabic and Middle East Studies at the University of St. Andrews, discussed his latest research into the use of Arabic both before and during the early Islamic conquests.

Beginning with the Islamic conquests and early empire, Professor Hoyland examined and challenged assumptions that the Arabs, in their first period of expansion, did not implement their language within the machinations of empire. Professor Hoyland discussed the initial private usage of Arabic, confined to supplicatory and funerary inscriptions, as well as in numerous copies of the Qur’an, which begin to appear from the latter half of the seventh century. Soon, however, Arabic began to be seen on coinage and in bilingual administrative documents: with such sophistication as to indicate a long tradition of writing, influenced by the Graeco-Roman World in style and content. A bilingual administration began to be deployed at this time, coupled with an increasing involvement of Arab officials in the everyday lives of their subjects.

In the second half of his address, Professor Hoyland considered the pre-Islamic use of Arabic, beginning in its oral form around the middle of the first millennium BC. Professor Hoyland discussed numerous examples of Arabic being written in local scripts as early as the first century AD, before noting the emergence of a recognisably Arabic script only...
one hundred years or so before the advent of Islam, in a number of bilingual documents, alongside Greek.

Professor Hoyland accounted for the emergence of a distinctive Arabic script with the development of incipient state structures among the Arab peoples, which were created by an increasing interaction with the Roman and Persian empires. The effect of regular contact with Christian missionaries was also noted as a potential stimulus for the development of an Arabic script.

Professor Hoyland concluded with a discussion of the importance of Arabic in the Qur’an, noting the many references in the Qur’an not only to itself, but to parchments, scriptures, and tablets, as well as the self conscious nature of the Book as being written in Arabic, for Arabic speakers, as the language of the Arab people.

Professor Hoyland's lecture, richly illustrated with inscriptions, parchments, and papyri, coupled with an evidently deep knowledge of the Arabic language, provided a stimulating insight into a topic on which still very little is known.
For nearly 200 years the Bell Rock Lighthouse has helped protect mariners around the great firths of the Tay and Forth. Its design and construction were triumphs of engineering and human determination. Mr McIntosh, whose career has been dedicated to maintaining and building lighthouses, explored the origins and history of the elegant stone tower and why it qualifies as an engineering wonder of the world.

The engineering challenge was to build a lighthouse of great strength, largely by hand, on a small rocky reef that was twice-daily submerged beneath five metres of swirling and hostile sea. In the 18th and 19th centuries trade from Scotland’s great ports was on the increase but sailors, ships and cargoes were all at risk from its coastal hazards, especially years of great storms such as 1782. As far back as the 10th Century there are records of the monks of the Isle of May lighting beacons as a warning to vessels. Purpose-built structures began appearing in the 16th and 17th centuries but were small and inefficient, relying on coal fires to cast a powerful enough light to guide distant ships.

Improvements came in the 1780s when new technology, developed by Thomas Smith, that used parabolic reflectors to boost the power of lights – and was already providing gas street lighting in Edinburgh – was employed by the Northern Lighthouse Board to establish a string of new lighthouses.

According to Mr McIntosh, it was an urgent task. The structures at Kinnaird Head, the Mull of Kintyre, Dennis Head on North Ronaldsay, and Eilean Glas on Scalpay, were completed in around two years, even though only one site was served by a road. Smith was also stepfather of Robert Stevenson, of the great civil engineering family, in whose footsteps Mr McIntosh said he felt privileged to follow.

“Robert Stevenson learned the craft of civil engineering in general and lighthouse construction in particular under the instruction of his stepfather, and he was the founding father of this dynasty of engineers, and as such was responsible for the construction of some 15 lighthouses between 1811 and 1833. He started in Arbroath with what was possibly his most famous, the Bell Rock.”
The project was necessary because in the early 19th Century there was so little help available to mariners. There were just three lighthouses round the firths of the Tay and Forth – and ships did not even have the benefit of the background lighting to illuminate the coast that comes from today’s coastal villages and towns.

The Bell Rock, 600 metres long and 12 miles out to sea, was in direct line of Dundee and Edinburgh shipping, making it an important place for a light and also an incredibly difficult place to reach, let alone build a 36 m high tower. It was a location so dangerous, that centuries before a bell had been placed upon it to warn vessels to keep away.

When work began in 1807, a wooden beacon house was built to keep the blacksmith’s forge above the tide and which would later provide safe accommodation for workers. Labourers also started to cut circular foundations 12.8m in diameter and 60cm deep to take the base of the tower and prevent it being washed away. One of the jobs that kept the smith busy was re-sharpening the picks used to chip away at the rock. Each time the tide receded the hole had to be pumped out, reducing the working day to a few hours.

Stevenson had spent some six years working on the design of the lighthouse, for which although loosely based on the trunk of an oak tree, adopted the cycloidal curve tapering upwards so waves would sweep round it, minimising their impact on the stonework. Every piece of the tower was individually planned so the stones would connect to each other like a jigsaw. “The yard established in Arbroath was the land base and focal point for the construction works. Every one of the stones was cut, shaped and dovetailed there before it was shipped out to the rock.” Only once the third and fourth courses were complete were the workers above the tide and such was the need for strength of construction that the first 10m of the tower are entirely solid. One indication of the quality of workmanship is that the cast iron railway completed in 1809 to allow the easier landing and moving of 1,000 tons of stone has survived to the present day despite the ferocity of the ocean.

Despite the enormous care that went into the preparatory work, the challenges of the job meant that many pieces of equipment were developed or refined as work progressed. One piece of equipment that resulted from the project, variously attributed to Stevenson or his junior engineer, was the balance crane which is now used on construction sites worldwide.

Stevenson was determined that 1810 should be the last season of
construction work and the final stone was laid on 3 August.

During the project, Stevenson had won the admiration of the workforce. Mr McIntosh said: “His drive and enthusiasm was greatly respected. He was always concerned about safety on the ships and on the rock and for looking after the men if they were injured, or their families if they lost their main breadwinner. He was well-known for his strong religious beliefs but almost more so for his belief in the need for the project to succeed and for mariners to be protected from the hazards of the Bell Rock.”

There was great relief when the light finally went on 1 February 1811, using parabolic reflectors to increase the power of the lamps, which were fuelled by sperm whale oil.

Stevenson had used winter months away from the rock to experiment with the best colours and settled on alternating red and white.

While Stevenson’s name is most closely associated with the feat, it was John Rennie who held the title of chief engineer, and disagreement continues over the amount of credit each should be awarded.

Once operational, Bell Rock became workplace and home, for shifts of a month at a time, to generations of lighthouse keepers. Their conditions were cramped but their work in maintaining the lights and winding the clockwork mechanism every 45 minutes was vital.

Over the decades, the light itself was changed and upgraded to use rape seed oil, then paraffin, followed by acetylene lamps from Swedish company Aga when the site was first automated in the 1980s. Nowadays, it has electric lights powered by large batteries with a diesel generator, and maintenance work is carried out by NLB Engineers flown in by helicopter.

Mr McIntosh described how technology has transformed the job of providing hazard lights, showing pictures of a small solar-powered unit with LED lights that he was involved with creating on a small island near Skye.

There are some 80 Scottish lighthouses which are listed buildings, in recognition of their architectural or historical importance.

But after long and valuable service they are now occasions when, as a result of consultation with users, a few of the lighthouses are identified as no longer required by the mariner. Questions are being raised about their future – not least because many are remote and finding new uses could be difficult but at this stage the users still use lighthouses as part of the Aids to Navigation system. Mr McIntosh said the
Review of Sessions 2008/09 and 2009/10

Northern Lighthouse Board would continue looking after its lighthouses so long as funding was available.

In closing his talk he pointed to the continuing role of the Board in ensuring the safety of mariners and quoted its motto – In Salutem Omnium – For the Safety of All.

The Northern Lighthouse Board operates under statute – the Merchant Shipping Act 1995 – and is the General Lighthouse Authority for Scotland and the Isle of Man. The Board currently operates: 209 Lighthouses, 162 Buoys, 37 Beacons, four Differential Global Positioning System Stations, 27 Racons and one eLoran. The Board is funded entirely from the General Lighthouse Fund, sourced by “Light Dues”, a levy paid by shipping. The Board receives no direct funding from the Exchequer or taxpayer. The other General Lighthouse Authorities are the Commissioners of Irish Lights (Republic of Ireland and Northern Ireland) and Trinity House (England, Wales, the Channel Islands and Gibraltar).

Following the lecture, the Chair of the session, Professor Sue Black OBE FRSE, thanked Mr McIntosh and led a question and answer session.

As ships make increasing use of GPS, rather than relying on lighthouses, Professor Black asked if there were moves to safeguard the future of the buildings that are such an important part of our heritage. Mr McIntosh said the Board is looking at a system to grade properties in terms of importance to try to ensure the preservation of good examples from each era.

Asked if there was a role for councils in the future of lighthouses, Mr McIntosh said authorities had taken differing approaches to getting them listed. He said that while listing brings protection it also creates restrictions, as special consent has to be sought for major changes to the buildings.

Professor Black asked if ship owners now argue that in the age of GPS they should no longer have to pay a levy for lighthouses. Mr McIntosh responded that this was the case, but that lighthouses act as a standby in case the GPS system fails. He added that there is a move away from using them to mark coasts to a situation where they alert mariners to hazards in difficult areas.

Mr McIntosh was asked why the lighthouse levy falls on commercial shipping, which often doesn’t use lighthouses, rather than leisure craft. He responded that there is a commitment to the principle that the user should pay, but that no effective mechanism has yet been designed for charging leisure crafts.
Asked about the power of the lights, Mr McIntosh said that hazard markers are normally visible for 11 miles and full-intensity lighthouses could be seen for 23 miles. Early lights were hundreds of candlepower in strength, modern ones are in the millions.

Arbroath Academy headmaster David MacDonald ended the session with a vote of thanks for Mr McIntosh.
Definition: Broadly, regenerative medicine is the umbrella term for innovative medical therapies which allow the body to repair or regenerate damaged or diseased cells, tissues or organs. This includes technologies which use stem cells’ capacity to ‘grow’ into the different cells of the body.

Introduction/Summary
Writing in the 17th century, Joseph Glanvill, a founding member of the Royal Society, said that one day grey hairs might be restored to ‘juvenility’ and that ‘exhausted marrow’ might be renewed without a miracle. Almost 350 years later these lines were quoted at the RSE, this time by Dr Brendon Noble, a scientist who is helping to make them come true. He and colleagues at Edinburgh University’s Centre for Regenerative Medicine – which had been launched officially earlier that day – are using stem cells to regenerate bone and cartilage, work which will potentially revolutionise treatment for people with conditions including arthritis and bone fractures.

The RSE event, supported by Edinburgh Beltane, one of the UK’s beacons for public engagement, asked what regenerative medicine was and what it might do. Three distinguished speakers – Dr Noble, Dr Anna Krassowska and Professor Hamish Simpson – gave short presentations, then the bulk of the evening was made up of discussion and questions.

Dr Anna Krassowska, formerly research manager with the UK Stem Cell Foundation, gave an overview of the current state and potential of stem cell research.

Dr Noble described some of his laboratory-based research, which is working with stem cells to grow bone and cartilage and make them into therapies.

Dr Simpson, an orthopaedic surgeon, spoke of how such technologies could benefit patients in practice – and, importantly, said some could be available in the next few years.

A number of challenges were brought out during the discussion, including the need for a strong, well-funded research base in Scotland and the importance of a regulatory environment which is robust and safe, but does not stifle innovation. The importance of engaging the public with the
issues was emphasised throughout.

**Dr Anna Krassowska, former Research Manager, UK Stem Cell Foundation**

Dr Krassowska described how regenerative medicines, including stem cell technologies, have potential in many different chronic conditions which are caused by the loss of specific cell types. These include diabetes, where there is a loss of insulin-secreting cells, and Parkinson’s, where the dopamine-secreting cells are lost. Others include spinal cord injury, osteoarthritis and heart disease.

“The idea is that one can take damaged cells and replace them by transplantation or encourage endogenous cells to replenish,” she said. There were several areas with proof of concept – the first real evidence that something works – including a Canadian study where insulin-secreting cells were transplanted into patients with diabetes, who then became less dependent on insulin. There were challenges, however. For example, the diabetes study required cells from 2–3 donors for just one patient, which would hinder large-scale treatment programmes.

She described the different types of cells which had the ability or potential to develop into other cells in the body. In particular, she spoke about the stem cells which come from embryos, and which are particularly flexible in terms of the type of cells they can grow into. She also spoke about adult stem cells, which are less flexible, but have potential in a number of therapeutic areas.

Stem cells can be taken from a person’s own body – for example, from bone marrow or (with planning ahead) from umbilical cord blood – which lessens the risk of the body rejecting them because of an immune response.

But Dr Krassowska also described allogeneic treatments, where a bank of cells is created and stored at hospital sites to be used when needed. Again there are challenges, including making sure the stem cells grow into the right thing. “You don’t want bone growing in the heart,” she said.

“Although there is promising research, for example in heart disease, it is still early days.”

**Dr Brendon Noble, MRC Centre for Regenerative Medicine, University of Edinburgh**

Dr Noble began by describing the mythical Hydra – the creature which grew two heads for each one that was cut off – calling it an early experiment in regenerative medicine. His work in Edinburgh, however, is concerned with bone rather than monster heads.

He talked about mesenchymal stem cells, which are found in bone marrow and which have the potential to grow into bone and cartilage, among other cells.
Although work in the lab has been relatively promising, he said there is a need for a ‘reality check’. Persuading the cells to survive in real patients is more challenging, partly because they are going into a harsh environment – the previous bone or cartilage cells didn’t like it there, so why should the new ones? Rather than send in the new cells unarmed to a hostile environment, his scientists are trying to find a way of protecting them. This can involve a protective, bioactive scaffold which keeps the cells alive so that they can do their stuff.

In Edinburgh, Dr Noble and his team have been testing different materials to see which ones the cells will be happy with. Early results have been promising, he said, with bone growing where it wouldn’t have done and authentic-looking cartilage being produced.

If successful, some of Dr Noble’s work will be placed in a clinical trial in two years time.

**Professor Hamish Simpson, Scottish Centre for Regenerative Medicine and Professor of Orthopaedics and Trauma at the University of Edinburgh**

Following on from Dr Noble’s description of the work being done in the laboratory, Professor Simpson gave an overview of what it could mean for patients.

He described the great clinical need for more effective treatments for bone injury and disease, talked about conditions which might benefit from stem cell technologies then gave his assessment of how soon treatments might be available. He also emphasised the importance of translational medicine, which is taking discoveries from the lab bench to the patient bedside and back again.

And he spoke about the human side of musculo-skeletal problems, including a patient who had to undergo years of treatment, losing his job and marriage in the process.

Hip and knee replacements had been a great boon, he said, but did not suit everyone and were difficult to repair. Better alternatives were needed.

Similarly, although 95 per cent of fractures heal well, the remainder, the ‘non-union’ ones, fail to heal. He described work which has been done to ‘regrow’ bone to fill gaps left where bone has died and had to be removed. He is optimistic that treatment will be available within a very few years to repair small, localised defects in cartilage, which affect some 2,000 people in the UK each year. Similarly, ways of dealing with non-union fractures should be available in the short term. Using stem cells to treat osteoarthritis and large bone defects are long-term ambitions, however.

He spoke of the challenges in clinical trials, including developing
objective outcome measures and finding enough similar patients to take part. Getting cells of sufficient quality and winning ethical approval can also be difficult.

Discussion
The discussion session was chaired by Professor Mary Bownes, Vice-Principal for Research, Training and Community Relations with the University of Edinburgh, who also heads the Edinburgh Beltane. She opened with a short explanation of the work of that project, which includes all the higher education institutions in Edinburgh and other organisations including the RSE. One of six UK beacons of public engagement, its aim is to help scientists engage more with the public and vice-versa, changing cultures, improving understanding and influencing policy.

The involvement of Edinburgh Beltane proved topical, with more than one member of the audience asking for more information and engagement.

The questions ranged from the personal and specific to more general points.

The recently reported case of the operation performed on a woman in Spain to replace her windpipe was raised several times. Asked about its relevance to regenerative medicine, Dr Noble explained that the patient had been given a trachea which had her own cartilage-forming stem cells added. Professor Simpson added that the trachea, which had been taken from a cadaver and had had all its own cells removed, would have acted as a kind of mechanical strut to allow the stem cells to grow.

One member of the audience asked if the development of regenerative medicine would put people under more pressure to have treatments or if perhaps they would choose to terminate their lives earlier.

The panel responded that, in effect, it was just another medicine or therapy, which people would have the right to refuse, so it didn’t change the current situation. Professor Simpson added that new therapies might be more about improving the quality of life, not extending it in all cases, and that this improved quality might change people’s minds about whether they wanted to undergo treatment or not.

One questioner asked about collaborative research across universities, remarking that Scotland appeared to be leading the way with regenerative medicine. Dr Noble said that the Scottish Stem Cell Network was a fantastic way of promoting collaboration and networking and Professor Simpson said that trials involved many centres.

Asked if stem cell therapy might be used in birth defects, such as
those related to thalidomide, Prof Simpson said that would be a bigger challenge because it would involve growing muscle as well as bone. But Dr Noble said that treatments for even genetic conditions were not ruled out. One woman in the audience offered herself up as a guinea pig for Dr Noble’s research and asked what was being done to make GPs aware of new developments. She also asked if steps forward in treatment would be patient-driven or if she had to wait for her GP.

Dr Noble said it was too early to say which patients would be suitable for trials and Professor Simpson said that patients would probably be recruited from orthopaedics clinics, so it was important that colleagues knew where trials were happening. He defended GPs, saying they had a lot to keep up with so wouldn’t necessarily know about possible future trials. Asked about the difference between adult and embryonic stem cells (to which some people have an ethical objection) the panel said that while they could be used for many of the same things, embryonic cells could develop more cell types. However, Dr Noble said that he was convinced that patients would be informed about the origin of the cells.

Asked about the main policy issues, the panel mentioned several, including funding, the regulatory environment – getting over the various hurdles to run trials and licence treatments – and the importance of keeping a workforce with expertise in Scotland. Professor Bownes asked how much regenerative medicine would cost. Dr Noble said it would be similar to other drug discovery – expensive to develop and bring to market, but less expensive later.

Dr Krassowska has a vision of ‘off the shelf’ products, such as heart cells which have been frozen in vials and used to treat people who come into hospital needing urgent therapy. Professor Simpson pointed out that current treatment for a person with severe bone trauma can run into hundreds of thousands of pounds.

Asked if it would be possible to grow large organs like hearts or lungs, Dr Noble said that while this was not possible at the moment it might be one day. "Who knows?" he asked. Professor Simpson said it was difficult to get the interconnectivity right – the liver has to hook up to several vascular systems, for example. Talking about the regulatory environment in the UK, Dr Noble said that although it involved hurdles, he was glad it was there. Dr Krassowska said clinics in other countries are offering expensive stem cell therapies which have not been proven and could be dangerous, to vulnerable, desper-
ate people. “There’s no long-term follow-up, nobody is learning anything,” she added.
The audience was keen for the public to learn more. One said medical meetings should be opened up. The panel said that the public could attend many medical meetings and that patient interest groups and charities were a good source of information. Dr Krassowska said that many of her scientific colleagues regularly gave talks to such groups.
Professor Bownes said that this is the sort of thing that the beacons of public engagement are trying to promote. The debate wasn’t closed with the end of this meeting, she said, and asked that anyone who had further points or suggestions get in touch with the Edinburgh Beltane.
James Clerk Maxwell became a Fellow of the Royal Society of Edinburgh in April 1856 when he was aged twenty-four, having presented his first paper to the Royal Society of Edinburgh at age fourteen (or rather Professor Forbes, FRSE, the Professor of Natural Philosophy at Edinburgh University presented it on Maxwell's behalf as Maxwell was considered too young!).

James Clerk Maxwell, FRS, FRSE is revered today as Scotland's greatest scientist. His 'mathematisation' of Michael Faraday's field concept and his creation of 'Maxwell's equations' are fundamental to physics as they unify the forces of electricity and magnetism. By means of these equations, Maxwell established the theoretical foundation for the existence of a whole spectrum of electromagnetic radiation of different frequencies. The mere mention of light of different colours, wireless, micro-waves, mobile-phones, radio-astronomy, x-rays, gamma-rays... illustrates the profound significance for mankind of the progressive discovery of the extent of the electromagnetic spectrum.

Maxwell's work on this and many other aspects of physics is today recognized as work of genius. We celebrate today the historic occasion of the unveiling of the statue of James Clerk Maxwell in George Street, Edinburgh.

Introduction
The President of The Royal Society of Edinburgh: Lord Wilson of Tillyorn, KT, GCMG, PRSE

There is something particularly pleasing about gathering to celebrate the achievements and legacy of somebody who was both a genius and a man of modesty. That James Clerk Maxwell is not a household name in the UK cannot be due solely to the complexity of his work, as many who know the names of Einstein and Newton would lay no claim to understanding their equations. Clerk Maxwell's self-effacing nature and antipathy to self-promotion may offer clues to his relative obscurity. Perhaps today's conference will offer other answers. It is a remarkable fact that James Clerk Maxwell is represented on postage stamps in Mexico and has a crater named after him on Venus yet, until
today, there has been no monument to Clerk Maxwell in Edinburgh, the city of his birth.

At Sir Michael Atiyah's instigation, The Royal Society of Edinburgh was much engaged in collaborative efforts in 2006, the 175th anniversary of Clerk Maxwell's birth, to raise his profile here in Scotland. With valuable input from the James Clerk Maxwell Foundation, a great deal was done towards achieving this. In an obituary notice, Professor Peter-Guthrie Tait, who was General Secretary of the Society (1879-1901) and James Clerk Maxwell's contemporary at the Edinburgh Academy and at Cambridge, referred to the “imperishable writings of Clerk Maxwell”. As James Clerk Maxwell’s work on electromagnetism is the basis of all the relevant technology, his legacy is indeed enduring, in the form of computers, mobile phones and other crucial elements of modern-day life.

Using red, green and blue filters, he produced the first colour photography of a tartan ribbon, and so also paved the way for today's colour photography. It seems extremely fitting that The Royal Society of Edinburgh, of which James Clerk Maxwell was a Fellow, should commission a lasting monument to this great man in what the Sculptor, Alexander Stoddart, has called “deathless bronze”.

Many people have been involved in the production of this statue. Our thanks are due to all of them. But I should like to single out two individuals. In a spirit of genuine modesty, befitting Clerk Maxwell himself, Sir Michael Atiyah would not countenance any reference on the statue’s plaque to him as the statue’s “Patron”, nor any acknowledgement of his being the driving force behind this commission. He could, though, rightly be described as both. Without Sir Michael’s commitment to this endeavour; without the great energy that he put into fundraising for it; and without his steadfast confidence that, through much effort and goodwill, the statue would be in place by November 25th, we would never have had this very fine statue. A mathematician of worldwide renown and my immediate predecessor as President of the Society, I offer my congratulations to Sir Michael on this legacy.

Individual praise too is deserved for the Sculptor, Alexander Stoddart. In recent years, he has already made his mark on Edinburgh with the statues of David Hume and Adam Smith in the Royal Mile, as well as the Robert Louis Stevenson memorial in Corstorphine. Whilst he would be quick to credit a large cast of characters who played a part in this project, it is inspiring to reflect that he has done the vast majority of the work single-
handed. I am delighted that Sandy Stoddart, who is increasingly regarded as Scotland’s National Sculptor, has created this monument to the man who was arguably Scotland’s greatest scientist. In 1865, Clerk Maxwell described the Royal Society of Edinburgh as a “very sociable body, most of them good speakers as well as sensible men”. I hope that James Clerk Maxwell would feel that today’s event lives up to that characterisation and that you will agree.

Preface

Sir Michael Atiyah, OM, PPRS, PPRSE

The unveiling of a statue of James Clerk Maxwell in George Street at last gives due recognition by the City of Edinburgh to its greatest scientist. The Royal Society of Edinburgh, whose premises are only a short walk from the location of the statue, is proud to have been the body responsible for commissioning the statue, raising the funds and organising the unveiling ceremony.

As President of the RSE for the past three years, I have taken a strong personal interest in this project and I am delighted that my successor, Lord Wilson of Tillyorn, joins me to celebrate this great occasion. We have been fortunate to have had the enthusiastic support of many individuals and organisations, without which the statue would never have been erected on such a prominent site, and in such a short time. It is a tribute to the genius, humanity and modesty of Maxwell that we have had such universal backing.

Our sculptor Sandy Stoddart always said that he hoped to produce a statue of Maxwell for Edinburgh to follow the statues of those other icons of the city’s history, David Hume and Adam Smith. He was only waiting for the order to be given, and the outcome is the fine sculpture which we can now admire. He has fulfilled all our expectations and has worked long hours to complete the task in record time.

His lecture at the celebratory conference will chronicle and illustrate the progress of the work, and the exhibition organised by David Forfar will embed the statue project in a larger historical context. On the scientific side, Malcolm Longair, formerly Astronomer Royal of Scotland and more recently from the Cavendish Laboratory in Cambridge, is lecturing on Maxwell’s science and has also been involved in advising on the design of the friezes on the plinth. The statue will very appropriately be turned into a hologram, based on the technology of light-waves, as will be explained by Andy Walker, who has worked very hard to fit into our tight schedule. Our final lecture today will be from our
American colleague Lew Terman of the IEEE, who will turn our attention to the future.

The financing of the statue is a task which I felt it was my duty to oversee, not only as the then President of the RSE but also as a former Master of Trinity College, Cambridge and a former President of the Royal Society of London. Maxwell belonged to all these bodies and it was highly appropriate that they all contributed to this project.

The full list of the major financial sponsors is recorded on the plinth of the statue and a fuller record of all contributions, both personal and institutional, is contained in a book placed in our Clerk Maxwell Room. Perhaps, from among our sponsors, I can single out three for special mention. First there is the Edinburgh World Heritage Trust, who joined us at the very start and gave us the respectability that opened many doors. The other two I want to mention are the David and Elaine Potter Foundation and Standard Life, both of whom gave very generous financial backing. David Potter was, like Maxwell, a physicist and a Fellow of Trinity, and he built up a very successful company exploring technology that rests ultimately on Maxwell’s electromagnetism. Standard Life is both a major financial institution based in Edinburgh and has offices in George Street just opposite the Maxwell statue. They are very kindly hosting the drinks reception on their premises that will follow the close of today’s conference. The City of Edinburgh has throughout been supportive of the project. Both the present Lord Provost and his predecessor Lesley Hinds have given their backing and the officials involved in the planning application were most helpful.

Many members of the Scottish Parliament have, in recent years, pushed for appropriate public recognition of Maxwell and one of these, Alex Fergusson, now Presiding Officer of the Scottish Parliament, has agreed to unveil the statue. To cheer the procession from the RSE to the statue, bagpipes from Edinburgh Academy, Maxwell’s old school, will lead the way.

Finally, I must record the hard work put in by the RSE staff in connection with the whole project. Special thanks are due to Stuart Brown, our former Public Relations Manager, and William Duncan our Chief Executive.
Delivering the Bruce Preller Prize Lecture, Professor David Porteous set out his vision of how the new genetics has the potential to transform our health. He spoke about the Generation Scotland project, where volunteer families are helping to build up a picture of the importance of genetic history. And he made particular reference to how mental health problems can be addressed through genetics.

Professor Porteous’ lecture added grist to the mills of those who want to blame their parents for everything – but quickly made it clear that it’s not all mum and dad’s fault. Family history has an important role in determining our health, he said, but it isn’t the whole story. There’s a balance, of nature and nurture. Our genetic inheritance probably accounts for about half our risk of developing a given disease, but other factors, including lifestyle, environment and what we do for a living, account for the other 50 per cent.

In the Bruce Preller Prize Lecture, Professor Porteous set the scene by showing that we are living longer than ever before. From the situation early in the last century, where only a very few people reached what we would now call a ripe old age, we’re heading for a time where the number of people in their 60s and 70s outstrips those in any other age group. This ageing population brings with it a growth in chronic disease. The west of Scotland has a particularly grim tale to tell in that respect, with high rates of heart and lung disease and cancer.

Nature and nurture have roles to play in whether we succumb to these diseases. Professor Porteous described the “role of the genetic dice”, which determines our genetic likelihood of developing disease.

Our greater understanding of DNA – the stuff of life – has revolutionised our understanding of our genetic inheritance. From the solving of the structure of DNA in 1953 to the mapping of the human genome in 2003, our knowledge of this area has moved on tremendously in the last few decades. What we have learned, among many other things, is that we’re all pretty much 99.9 per...
cent the same; it's that 0.1 per cent which accounts for individual variation and whether we're at risk of getting diseases.

The hunt for genes implicated in disease has also moved on apace. More than 2,400 genes for single gene disorders – such as cystic fibrosis – have been found. These tend to be rare, however, affecting only small numbers of people.

In the same period, more than 100 genetic risk factors have been found for common disorders, including cancer and mental illness. These affect far more people and rates will continue to rise as populations age.

The technology has moved on so much that it has become cheaper, less labour-intensive and much quicker to sequence or read human genomes. We are almost at the point where an individual can get an entire genetic printout for $1,000, with results on the same day. Advances have moved hand-in-hand with computer technology, however, which is essential for storage of information, for example.

Professor Porteous showed a slide which gives a vision of a future where patients receive medicine which is personalised to them, depending on their genetic make-up. This should revolutionise treatment and help move away from the current system which means that only 30 per cent of people benefit from the drugs they are prescribed, with 10 per cent suffering serious adverse effects.

Having outlined the current position and the potential benefits of genetic research, Professor Porteous went on to describe Generation Scotland, a pioneering, family-based study which aims to cast new light on how and why we develop diseases. Generation Scotland (www.generationscotland.com) involves all four Scottish medical schools and is supported by a number of other organisations including Scottish Enterprise and the Scottish Government.

Scotland is a good place for such a study, he said, partly because of our high levels of ill-health, but also because the population is relatively stable and supportive, which makes family-based research possible. Scotland also punches above its weight academically and has a strong background in clinical and other research. The NHS, with disease registers and cradle-to-grave health records is also a valuable resource.

Those taking part in the research are all volunteers. The process involves filling out questionnaires about the history and health of individuals, as well as clinical testing to build up a biological picture. The aims include identifying genetic risk factors, understanding the origins of
disease, devising new approaches to treatment and prevention, finding new (cheaper and better) medicines and making better use of existing treatments.

As an example of the huge potential benefits of using genetics to help solve health problems, Professor Porteous looked specifically at mental illness. Around 450 billion people – 10 per cent of the global adult population – are affected by mental disorder and in the UK it is estimated that one in four will experience mental illness during their lifetime. Mental ill health is a huge burden, both personally and globally, in terms of years lost to disability and its use of NHS resources, yet there are no laboratory tests to diagnose it. Drugs such as anti-depressants and anti-psychotics have been great steps forward and do save lives, said Professor Porteous, but aren’t good enough. Some people don’t respond, or respond badly and there are significant side-effects. A new approach is needed. He looked particularly at schizophrenia, explaining that the biggest risk factor for developing the condition is a family history of it. Professor Porteous described research he conducted in Scotland with colleagues, which has identified genes implicated in schizophrenia.

The most important of these is DISC1. Those with a damaged version of that gene have a ten-fold raised risk of schizophrenia or bipolar disorder and also are at more risk of major depression. Although the research was dismissed at first, it has since been backed up by studies worldwide and has provided valuable information about the biology behind the conditions. It appears that DISC1 is active at the point of our brain where connections are made and where learning and memory take place. In other words, damage to the DISC1 gene suggests our memories work in a disrupted way. Professor Porteous described DISC1 as the conductor in an orchestra of the brain: if it isn’t working, the music won’t sound the same. The hunt is now on to find other leading players, such as the ‘first violin’, or other genes which are involved in the pathway. Some promising genes have already been found.

Professor Porteous widened his orchestra analogy to the rest of the mind and body, describing mental and physical health as a ‘long orchestral performance played out by nature and nurture’. There is hope, he said, and work being done through Generation Scotland and elsewhere is helping to make his vision of the next generation of predictive and preventative medicine a reality.
Middle Kingdom, Middle Class

According to James Kynge, the challenge for the Western world is not to make China become more like us or measure its development according to how ‘democratic’ it is but to welcome the progress that China is making — and be more humble about our own ‘broken society’ instead of criticising one of the world’s greatest civilisations...

The figures may vary, but the rise of China’s middle class is truly spectacular. Some observers estimate that there are already 300 million ‘middle-class’ people in the ‘Middle Kingdom,’ expected to double by 2025. More conservative estimates talk about 120 million middle-class people today, rising to 150 million over the same period.

The definition of ‘middle-class’ also varies. Some commentators use the ‘Big Mac Index’ (comparing incomes in terms of how many Big Macs to the dollar) while others use ‘purchasing power parity,’ but whether you multiply by 2.5 or 4.5, the disposable income of the average family in China is increasing fast, with 300 million people in households earning the equivalent of up to £40,000 a year.

Add to this the Chinese people’s attitude to education, with children spending up to 14 hours a day in school and extra lessons, and the future is anyone’s guess...

James Kynge, who has spent most of the last 25 years in China, working for the Financial Times and the Pearson Group, approached the big issues by painting a portrait of the typical middle-class family in China. ‘Mr and Mrs Wang’ earn £1,700 a month (equivalent to over £4,000), out of which they manage to save 10 per cent. They have one child (who loves watching the Teletubbies) and two cars (Mazda and Chevrolet). Their modern apartment is worth about £158,000 and they borrowed the deposit for the 20-year mortgage from relatives, paying it back at 6% interest a year. They have furnished their apartment from Ikea, and have China-made products for home use and foreign-brand products for show. Education used to be free but is getting more costly, largely because of the extra tuition in subjects such as English, Chinese and Maths.
This growing middle class is a ‘force to be reckoned with’ as it integrates with the global economy, but what are the political implications? Do China’s middle classes want more democratic rights or do they think it’s better not to rock the boat?

Echoing the mantra of the early USA, “No taxation without representation,” Kynge borrowed the title of his lecture from a car number plate spotted on the worldwide web, to investigate whether Joseph Schumpeter’s idea that “modern democracy is a product of the capitalist process” rings true for modern China.

During the ill-fated Tiananmen Square demonstrations in 1989, a few of the new class of entrepreneurs helped the students, said Kynge, but the “transmission mechanism from capitalism to democracy” did not transpire, and even though there are thousands of protests every year, these are mainly organised by farmers, not the urban ‘elite’ who benefit from China’s pragmatic and adaptable one-party system. Kynge also suggested that the higher-income groups don’t even discuss democracy much and think it is best to stay silent – rather than confront the People’s Liberation Army.

Later, in response to an audience question, Kynge said there was no ‘powder keg’ about to explode in rural areas. The gulf between the rich and poor is widening, but ownership of land provides security to farmers, while the middleclass now have their pensions. There may be some unrest, but no-one wants to overthrow the government or make it change its policies. Dissenters tend to focus on the minor details, not the big issues.

People may be learning to exercise their property rights, for example, but private-sector businesses work hand-in-hand with government, and many entrepreneurs are also members of the Communist Party, and seek to change it from within. From the outside, said Kynge, China looks like “a monolith of authoritarian rule,” but it is also adaptable and moves with the times.

Kynge even suggested that some degree of corruption can also facilitate getting things done – for example, local authorities set up thousands of ‘illegal’ investment parks over the years which the government quietly left well alone, simply because they were working. To clean up corruption would also require an independent judiciary, and this would mean surrendering too much political power. Much of what happens may be counter-intuitive, but “if it’s not broken, don’t fix it” could well be the motto of the People’s Republic, along with one of Kynge’s expressions: “Money buys freedom.”
In another example of China's adaptability, Kynge described how government came up with a novel solution to the problem of cheating in high-school exams, devolving the examination process to the provinces and introducing new technology – including cameras in every exam hall. In this way, he explained, the new technology helps China overcome the single greatest weakness of the single-party state – local versus central control. He also talked about the idea of authoritarian government at the centre, surrounded by the ‘disobedient’ provinces.

Ultimately said Kynge, critics of China should be careful when it comes to looking at cause and effect. Rather than the government having a master-plan to neutralise pressures and stimulate the economy, it has improvised many of its policies over the years and allowed things to happen, thriving in the “chaos under heaven” so exulted by Mao.

In the Q&A session which followed, Kynge also focused on the ‘pros and cons’ of democratic government in relation to issues such as carbon emissions, suggesting that although China will probably increase its dependence on coal-based power to drive economic expansion, it is also in a position to change direction more quickly and more easily than Western democracies, because it does not have to answer directly to public opinion at general elections. The Chinese people know they have an environmental problem, he added, but this may be the price of their ‘right to develop.’

Do Chinese people want democracy or larger families? Kynge even suggested that families may ‘buy’ the right to have more children. And what about Tibet? Kynge said that Western criticisms may have backfired, encouraging the ‘angry youth’ to become more assertive and nationalistic than the older generation. The worst thing for a Chinese person, Kynge added, is to be seen as a traitor; supporting independence for Tibet or other regions is to side with interfering foreigners who also seek to hold back China’s economic growth.

Kynge concluded: “It’s about time the West just accepted China for the way it is and recognised the improvement in human rights – stopped criticising and acknowledged the progress that China has made.” Attempts to “inculcate the building blocks of democracy” are now becoming counter-productive, he added. “The challenge for Western governments is that a whole generation of young Chinese people misguidedly believe we are against them, so perhaps we should go easy on our criticisms and interventions and be more humble about the shortcomings of our own democracies.”
Scotland has a remarkable legacy as the birthplace of many great scientists. This tradition is alive and well today as the country continues to be a leader in science and technology. These are strengths of which Prof Anne Glover, who spent her early childhood in Arbroath, believes we should all be proud and on which we can build a great future. Yet the future, not just for Scotland, but for all mankind, is in dire danger from the effects of man-made climate change. The threat to the planet can only be averted if scientists, politicians and individual citizens act together to bring about real change and create sustainable lifestyles.

Science is exciting – influencing every aspect of our lives from the moment we are born. But unlike the arts, music and cultural activities it can seem distant and inaccessible. Yet, from life-saving medicines to iPods we are surrounded by the benefits that science, technology and engineering have brought.

Professor Anne Glover, Chief Scientific Advisor for Scotland, said: “Maybe my only disappointment about a life in science is I feel that science isn’t shared enough with all of our community.” She continued that its sophistication has made it seem remote and inaccessible to those without a background in the subject, when it should be something with which we can readily engage and which we celebrate. Nonetheless, independent research shows Scotland is held in higher esteem than any other country in the world for its scientific research. “That’s something I feel we should be proud of. But it will also be our future. Our economy, our prosperity and our wellbeing will depend on our excellence in science, technology and engineering, because we don’t need an economy that makes cheap widgets. If you are the cheapest at making something there is always someone out there who can undercut you, but if you are the smartest it’s very hard for others to compete.”

According to Professor Glover, the recently launched Large Hadron Collider at CERN, near Geneva, is a prime example of the importance of science. “To me this defines what it is to be a human.
It highlights the difference between us and any other species on the planet that we can build this.”

The collider is located in a tunnel 27km in diameter and is used to accelerate sub-atomic particles, heading in opposite directions, to just below the speed of light before allowing them to crash into each other. The results of these collisions can tell us about the fundamental nature of matter. This research could yield immense practical benefits. It may hold the key to advances such as nuclear fusion plants which would, unlike the fission ones of today, create energy without radioactive waste. It is helping us learn how to create medical devices that can cure cancers by targeting individual cells in areas of exceptionally sensitive tissue such as the brain. Indeed, we already have enormous benefits from the collider project, as its development demanded a whole new approach to the sharing of information across the globe – giving rise to the internet. “The Large Hadron Collider is an amazing achievement. Sadly, there is much human activity about which to be disappointed, but this has to be one of our ultimate achievements.”

Professor Glover looked at the contribution Scots have made to the world through science in the past. This included Nobel Laureate Sir Alexander Fleming, who gave us penicillin, and with it the cure to many once-fatal illnesses. Then there was Alexander Graham Bell, credited with inventing the telephone, and the founder of the National Geographical Society. Another great Scottish scientist was James Clerk Maxwell, father of modern physics, who Professor Glover said “taught Einstein everything he knew – metaphorically speaking”.

Today we continue to excel, as the home of great scientists such as Sir Ian Wilmut, whose cloning of Dolly the sheep paves the way for cures to devastating illnesses such as Alzheimer’s.

At the same time, the software behind famous computer games and the technology that gives us iPods, are all the result of Scottish ingenuity.

Scotland has also developed the world’s smallest TV screen. This is expected to lead to the development of one-way glasses that allow wearers to see programmes on the lenses in front of their eyes. Similar imaging technology is also already being used to help blind people see basic shapes and in future may allow some fully to regain their sight.

Science also has a critical role in addressing what Professor Glover described as “one of the biggest challenges we all face; rapid man-made climate change”. This is because it allows us to observe
change, explain what is happening, reduce uncertainties and identify solutions. In the case of climate change this may include carbon capture technology or the use of renewables.

To do its job, however, scientists must be allowed to carry out pure research and this will sometimes involve decades of study. The weather observations carried out in the Antarctic from the 1950s onwards did not at first sight offer any practical returns on investment. But over 20 years scientists began to see changes taking place and discovered that the CFCs, the chemicals once used in fridges and aerosols, were creating a hole in the ozone layer which protects us against damaging ultraviolet (UV) radiation from outer space. “UV radiation causes cancers, skin cancers for example, so it’s very dangerous. Ozone protects us from that and the ozone layer is very fragile. “But the really comforting thing is that the world’s population and our political leaders recognised what was happening, they understood the science, and put a ban on CFCs. “The outcome will be that hopefully by the end of this century we will have repaired that hole in the ozone layer. “So that gives us cause for optimism that we can face big problems and do something about them.”

The big problem we face now is the greenhouse effect being created as human activity causes the release of more and more greenhouse gases, particularly carbon dioxide, into the atmosphere. This traps heat rather than allowing it to escape into space. We only know this is happening thanks to rigorous scientific research. By analysing ice core samples from the Antarctic we can look at the amount of carbon dioxide present in the atmosphere in the past which became trapped as ice was laid down. This shows that it fluctuates naturally due to wobbles in the Earth’s rotation, meaning the planet shifts between ice ages and warm spells every 120,000 to 130,000 years.

Over the past million years the concentration of $CO_2$ in the atmosphere has varied between 180 parts per million (ppm) when the world is cold to 280ppm when it is at its warmest. Even though we are just 30,000 years out of the last ice age, the current levels of $CO_2$ have changed dramatically. “I hope it will shock you to learn that the present levels are over 380ppm. Never in history, as far as we have been able to go back through the ice core, has the concentration ever been that high. “And that is because of human activity.”

Since the 1950s, there has been an enormous increase in population, energy production, air travel, car use and the consumption of goods, especially plastics. “We are
-responsible for all these extra greenhouse gases. What it does is act like a fleece blanket. What we are doing is putting more fleece blankets round the Earth and that’s warming up the surface of the planet.” This causes the ice at the poles to melt, which threatens to raise water levels by six to seven metres – which would leave places such as Arbroath submerged. “If you think of much smaller rises, they would leave countries such as Bangladesh entirely underwater. That’s going to affect all of us because when that happens the people of Bangladesh have to go somewhere. All round the globe people will be fleeing from coastal regions and if you think about where our population is it tends to be in coastal regions.”

Current predictions are that the heatwave of 2003, which brought a wave of deaths in Europe, will seem like a cool summer by 2050. At the same time, new diseases such as Blue Tongue, which is already affecting UK livestock, will arrive as there are fewer cold spells to kill out the carriers of disease in the winter.

Professor Glover showed maps of how the coastline might change if worst fears are realised. Within around 40 years, low-lying areas of Scotland, such as the Old Course at St Andrews, could be swallowed by the sea and by 2100 the British mainland could be a scattered patchwork of islands.

“Why it’s different from in the past is that we fly everywhere and think nothing of it; we think nothing of driving around as a single person in a car; we demand goods and services and foods from overseas; we are not content only to have our raspberries and strawberries at a certain time of year. The only way we will be able to cope with this problem is if all of us change. And actually it is one thing where tiny acts by individuals can make an enormous difference.” This might be directly by walking not driving, or through example by holidaying in this country rather than abroad which encourages others to do the same.

Professor Glover said she is very proud that Scotland has just announced the £10 million Saltire Prize, the biggest-ever environmental prize to be awarded for the generation of a threshold amount of power from wave or tidal resource. “Scotland, a very small country, is doing something very big to address a global problem and this is displaying scientific leadership.”

The Professor called on everyone to save energy and reduce consumption. “What’s the reward if we do this? The reward is that we protect the planet on which we live. It is the most awe-inspiring planet, no matter how flashy Saturn is with those rings, there’s nothing quite like this and
we need to protect our place on the planet."

Professor Glover ended with an observation she found optimistic, but said others might find pessimistic. “We are a very young and inexperienced species and it’s very hard for us to cope. We think we are smart, we think we are sophisticated, but we are not and we are making a mess of things at the moment. It’s possible that we won’t get ourselves out of this hole. But for me the comforting thing is that if we disappear from the planet there will still be microbes, and the thing about them is they grow, they develop, they evolve.

“Maybe next time round there might be the evolution of a species of human that is slightly more considerate about the planet than we are.”

Following the lecture, the Chair of the session, President of the RSE, Lord Wilson of Tillyorn, thanked Professor Glover and led a question and answer session. Asked if she believed humans were capable of moving away from the use of fossil fuels and a consumerist society before it’s too late, Professor Glover said the choices are stark. One reason for hope is that research suggests people were happier when life was simpler in the 1950s, so we might discover we prefer another way of life.

The Professor was asked her view on the USA’s decision to invest large sums in propping up a car industry that causes pollution. She responded that we are not always good at swift changes of direction. But we do have a window of about 10–15 years during which relatively modest changes will be able to mitigate the affects of climate change.

Asked if Scotland can meet its simultaneous targets for economic expansion and major cuts in CO₂ emissions, she said both might be possible, in part because the country has 40% of Europe’s renewable energy resources. But the Professor went on to question why we are seeking growth and argued that the emphasis must be on sustainability.

Professor Glover was questioned on whether she thought the increasing inequalities in society fuelled consumerism by encouraging people to desire ever-more products and services. She responded that ordinary citizens have a role in making it easier for politicians to propose measures that will change society to make it more sustainable.

The vote of thanks was given by Dr David Keeble of the Institute of Physics, which was the joint sponsor of the event. He noted that it was the last in a successful year-long series of RSE events in Arbroath for which he also thanked the Society and its staff.
The RSE organised a series of events to mark the 250th anniversary of the birth of Scotland’s foremost poet, Robert Burns. As well as the lecture from the distinguished author and journalist Neal Ascherson, there was a concert; a Burns Supper; and a major one-day conference on Robert Burns in Global Culture.

In placing Burns in a global context, Mr Ascherson set the tone for the events – and, indeed, more broadly, for Scotland’s Year of Homecoming.

Views about the literary influence of Robert Burns diverge widely – and Neal Ascherson said he could “snowball-fight with contrary verdicts all night”. For example, while Christopher Grieve – better known as the poet Hugh MacDiarmid – contended in 1928 that Burns had “no living literary influence whatever”, biographer James Mackay said in 1992 that he was “universally recognised as one of the greatest poets of all time”. In his wide-ranging talk, Mr Ascherson discussed the difference between the influence of Burns and of his literary influence, which he contended were two different things. It is hard to think of another poet who has achieved such a colossal, global readership, yet had so little perceptible influence on how subsequent writers wrote.

He quoted Murray Pittock in 2002 saying that Burns has 1,030 clubs and societies with 80,000 members in 18 countries and statues standing across at least three continents. His books have been translated 3,000 times into 51 languages, but since the Second World War Burns has “almost vanished from the canon of what the critical academies choose to define as Romanticism”.

Burns, then, is hugely popular but has become ‘British literature’s invisible man’, Professor Pittock said. Mr Ascherson agreed with this – as far as the late 20th Century English-speaking literary criticism industry is concerned. But he said that even a hundred years before, Burns’ impact on how world writers wrote was strikingly hard to trace. Although a number of would-be ‘Burnses’ sprang up after his death, they weren’t very good and, possibly, got in the way of Scotland’s literary development. Indeed, it might be that Burns –
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writing as he was at the cusp of industrialisation – was at the end of a tradition given life by poets such as Dunbar and Ferguson.

Overseas, it’s a similar story. While Burns has been popular, it has been argued that his influence on literature is limited. Mr Ascherson quoted Robert Crawford, saying that Ossian and Walter Scott are more influential. Mr Ascherson discussed possible reasons for the paradox of readership versus influence – for example, could dialect and metre have got in the way, particularly for English-speakers (translators wouldn’t have these issues with vocabulary). Mr Ascherson believes that Burns translates with varying success – awful in French, ‘pretty good’ in Slav languages. Russia, in particular, is the greatest success story in reuniting Burnsian form and content, he said.

Burns’ importance abroad was highlighted by the worldwide celebrations of the first century of his birth. He was also written about in other countries, particularly in the French writer Auguste Angellier’s 1893 Life and Works, which argued that he should be seen as a European poet.

He was celebrated in Germany also, but the literati were unsure about whether he was an ‘artless child of nature’, or a patriot, or any one of a number of labels. Germany’s foremost poet, Goethe, was an admirer of Burns; in particular, he envied the popularitiy and currency of his work with his own people. While Goethe’s own songs were sung by pretty girls at pianos, Burns’ were sung by the ‘people’, in the fields and in the pub. In Germany, as elsewhere, Burns was admired for being a conduit for old folksongs and the rural tradition, but then was welcomed as a political ally in the liberal struggle for democracy. In particular, A Man’s a Man for a’ That, translated by Frederick Freiligrath in the run-up to the 1848 revolutions, caught on to such an extent that it is quoted to this day on a plaque off Berlin’s Friedrichstrasse.

In Germanic lands, he was also recognised as an apostle of localism – a preacher of healthy, rural farming values and thus helping to preserve people in their natural virtue. Burns was particularly popular in areas which had maintained their own dialect and, indeed, was claimed as their ally and translated into, for example, Schweizerdeutsch Zurich dialect.

Burns’s popularity was slower to take off in Russia, but again he was claimed as an ally by different groups. Translations of his work tended to be ‘adapted’ to fit political or other sensibilities – mentions of royalty and patriotism were fudged or removed, for example.

After the 1917 revolution, his status grew rapidly – he was already in the canon of socialist song and poetry for the masses,
said Mr Ascherson. In the Soviet Union the chief translator of Burns was Samuil Marshak (1887-1964) who made him what Mr Ascherson called a “not simply popular but integral part of Soviet mass culture”. Burns became a hero of Soviet culture and even Shostakovich set Marshak’s translations to music. Again, however, Marshak (as befits someone wanting to survive under Stalin) censored his translations, removing references to royalty, and, for example, not translating Burns’ (referring to Catherine the Great) mention of ‘Auld Kate’s arse’. Marshak’s monopoly over Burns set up a reaction after his death and following the fall of the Soviet Union, as his works were seen as part of the Communist culture apparatus. Burns is still one of Russia’s best-loved and best-known poets, however.

Burns’ reception in the United States was similar: “high appreciation by 19th century writers and critics, enormous popular readership and no perceptible effect on the evolution of American verse, Romantic or otherwise”. Burns was seen as a poet of liberty, but also as an ignorant poet of the poor, with self-inflicted (boozing and sex) miseries. Walt Whitman, like Goethe, appreciated Burns’ appeal to his own community, but deplored his lack of spirituality and his backward-looking fondness for Scotland’s past. Burns is very popular, however, particularly among the Scottish diaspora, with the philanthropist Andrew Carnegie, for example, “scattering 3,460 sculptures of Robert Burns across the United States”. His songs – or about a dozen of them – became popular in the US although most people didn’t even know who had written them.

Mr Ascherson concluded that Burns scarcely ever has been successfully imitated. This is not, however, because he is necessarily “inimitable” – more like “un-repeatable”, he said.

His environment – poor, but with a wide appreciation of literature; a rebel at home, a studier of liberty as it formulated across the world – was unlikely to be repeated. His passions – sex, for example – and his dignity in the face of poverty are also combinations hard to reproduce. He also never went away – as well as in the English-speaking world and Scottish diaspora he remains dear and familiar to older generations in many cultures, including Russia, Germany and Scandinavia.

“untold millions sing Auld Lang Syne, who know at most two or three of his other songs and few lines of the poetry,” said Mr Ascherson.

Burns’s poetry is popular, not because it is necessarily profound or even always good, but because in it, people recognise themselves
and their own feelings and even feel honoured. “Who else can do that, and with an air you want to whistle?” Burns’s take on equality was the thing that mattered most, said Mr Ascherson, saying that the poet believed that ordinary folk shouldn’t be patronised nor oppressed but treated with the “royal respect due to all human beings”. He concluded: “The Royalty he meant was not really about Man, but about men and women, Rob and Jean, you and me.”

Questions ranged over a wide area, from whether Burns – a lowland Scot – had been appropriated by the vision of the Highlands, to how ‘liberal’ he actually was given he planned to go to Jamaica, possibly to become a slave-driver.

On the latter, Mr Ascherson pointed out that Burns had written beautifully about the plight of the slave, but admitted that the man was “flawed and contradictory”, as well as living in an era where “everyone was doing it”.

He was asked about whether classical music settings of Burns songs had helped to make them popular. Mr Ascherson said that they were popular to this day.

Asked about Burns’ contribution to parochial ideas of Scotland of the hills and haggis, when he was writing about equality and social development, Mr Ascherson said that Burns would have, for example enjoyed Burns suppers up to a point, but wouldn’t have wanted them confined to institutionalise “bardolotry”. “He would say equality is the chance to be equally fou,” he said.

Just how much of the songs attributed to Burns, were actually written by Burns, was also raised. How many were folk songs he had ‘tarted up a bit’, the questioner asked. Mr Ascherson said that while scholars argued about it, he felt it was missing the point. Burns wouldn’t have really cared whether people thought he wrote them; the important thing was that they were out there and being sung.

The vote of thanks was delivered by Professor Murray Pittock of the University of Glasgow.
To mark the 250th anniversary of Robert Burns, the Royal Society of Edinburgh organised a number of events, including an important one-day conference on the poet’s place in global culture.

Leading Burns scholars from Scotland and around the world contributed to the event, both as speakers and in floor discussions. Topics included the role of Burns in Scotland’s image abroad, his place in history and contemporary culture and the continuing celebration of the man and his works. The audience heard about Burns statues in Canada and America, Burns’ influence on the rise and fall of the British Empire and his role in European democracy. Delegates were also shown direct evidence of his influence on contemporary American culture in the form of the recent film of Sex and the City – and heard about his potential part in the creation of Mickey Mouse.

**Theme 1: Reception of Burns in Global Culture**

**Professor Nigel Leask FRSE, University of Glasgow**

Burns creates problems for those who try to place him in a colonial context. On the one hand, he wrote beautifully about the plight of the slave, but against that, he planned at one point to emigrate to Jamaica, where his job would most likely have been that of slave-driver. Professor Leask made the intriguing suggestion that in the light of the Clan Campbell networks in Jamaica, his marriage to Mary Campbell shortly before his departure, might have been advantageous in practical terms, although of course primarily dictated by romantic motives.

Professor Leask looked in general at Scotland’s role in British empire-building, and homed in on Burns’ own particular case. Despite the inherent contradictions in Burns’ life, poetry and letters, Professor Leask contended that his work offered resources to those who wanted to resist colonial power. So Burns’ poetry influenced, for example, the thinkers behind 19th-Century Bengali nationalism, at the same time as it promoted a Scottish identity in the empire.

Without excusing Burns’ plans to go to Jamaica, Professor Leask gave them an economic context. Scots in Burns’ position couldn’t afford to have a conscience about slavery and, in any case, their chances of surviving in Jamaica were not good. As a conclusion,
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Professor Leask spoke of the contribution made to establishing the Empire by Burns’ children – while his poetry helped inspire its downfall.

Professor Ronald Jack FRSE, University of Edinburgh

Professor Jack spoke about an internet project which is helping to map and foster Burns’ international presence. The Bibliography of Scottish Literature in Translation (BOSLIT) is an online resource hosted by the National Library of Scotland. With more than 25,000 records showing where and by whom Scottish literature has been translated, the website is a useful tool for academics, writers, translators and others. Professor Jack described it as a “uniquely rich database”, but said it had faced, and still does face, challenges in getting funding. This is a shame, he said, particularly as the resource offers a valuable international perspective on Scottish literature. Burns accounts for the second highest number of records for an individual author on BOSLIT, with more than 3,000 translations in languages including German, Danish, Russian and French. Professor Jack said that the resource could pose as many questions as it answers, but that it gives interesting information about, for example, who was translating Burns and at what time. There are gaps, he said, but it is an important research tool which deserves continued investment.

Theme 2: The Influence of Burns on the Image of Scotland Abroad

Professor James Chandler, University of Chicago

The work of Burns has appeared in hundreds of films and television programmes since the early 20th Century; Auld Lang Syne has itself been played or sung in more than 170. These include renditions in classics such as It’s a Wonderful Life (1946) and When Harry Met Sally (1989) right up to last year’s hit, Sex and the City, where it is the background for a pivotal five-minute sequence. Sometimes Burns is directly mentioned as well. For example, in last year’s Made of Honour, the poet is discussed after a rendition of My Love is Like a Red, Red Rose. Professor Chandler gave some reasons for the popularity in romantic comedy of Auld Lang Syne in particular, suggesting its connections with Scottish moral sentiment in Adam Smith, and Scottish notions of sensibility in Henry Mackenzie, two writers Burns knew intimately. Burns also played a potential role in early animation, he said, citing a short Mickey Mouse film, The Plow Boy, where the hero is whistling a Burns air. Perhaps Burns, specifically To a Mouse, with its vivid imagination of a rodentine world, inspired that cartoon creation.
Perhaps the Scots invented Mickey Mouse, too, suggested Professor Chandler mischievously.

**Professor Martin Prochazka, Charles University, Prague**

Burns has traditionally been popular in Czech culture and, in the century from 1850, was the most translated of Scottish poets, admired by those with and without specific links to Scotland. Professor Prochazka talked about the importance of the poetry of Burns in helping to construct the Czech national identity. In a time when many Czech poets were censored, Burns' work appeared in translation in a number of periodicals, both highbrow and more popular. His popularity stemmed from different traditions of romantic nationalism and political radicalism. His more pastoral works were seen as part of a folk tradition, a symbol of the country’s idealised village-based past, but at the same time, his egalitarian poetry, such as *A Man’s a Man for a’ That*, expressed the strength and equality of the people. Translations of Burns could sometimes be vague and even incomprehensible; in some cases, their radical political implications were glossed over altogether. Professor Prochazka discussed some of the most important translators of Burns and pointed out that he was also the subject of literary criticism and essays. Burns is not as popular now as he might be, but Professor Prochazka blames the translations, which he says use old-fashioned Czech and do not appeal to young audiences.

**Lunch and Music**

**Sheena Wellington and Dr Kirsteen McCue** led an informal lunchtime concert, in which the audience was occasionally asked to participate. Sheena Wellington, perhaps best known for singing *A Man’s a Man for a’ That* at the opening of the Scottish Parliament, sang (unaccompanied) a number of Burns’ songs, including ‘*A Man’s a Man*’. Kirsteen McCue sang a number of Burns songs which had been set to music by composers from across Europe, emphasising his global influence.

**Theme 3: The Performance of Burns in Culture**

**Professor Robert Crawford FRSE, University of St Andrews**

Professor Crawford began by paying tribute to the poet Mick Imlah, who had died the previous week. In particular, he cited Imlah’s poem, *The Ayrshire Orpheus*, which refers to Burns – thus placing both men in a tradition of Scottish poetry. The bulk of Professor Crawford’s talk, however, concerned Burns as a European poet. When T S Eliot spoke of the “*mind of Europe*” in the early 20th Century, he asked if there was such a thing as Scottish...
literature. To Eliot, Scots were not part of the mind of Europe and, indeed, he left Burns out. This could have been because Burns was the opposite of Eliot, who was a royalist, a classicist and an Anglo Catholic. But Professor Crawford makes a case for placing Burns in the European literary tradition, saying he should be considered a poet of European democracy. Professor Crawford believes that Burns has had a lasting influence on European culture. He referred in particular to the composer Arvo Part's setting of My Heart's in the Highlands. Burns supplements the European order, said Professor Crawford, mutually enriching the way we look at his poetry and how we see European culture as a whole.

**Professor Leith Davis, Simon Fraser University, Vancouver**

Professor Davis examined Burns' use by creative writers in the last 150 years. She suggested that Burns, more than any other poet in the English-speaking world, has been read through the lens of his biography. This tendency was already there in early reviews of his work, but it was made official policy in James Currie's *Works of Robert Burns* (1800). Fictionalised accounts of Burns' life began after the Centenary celebrations and continued with such works as John Drinkwater's *Robert Burns* (1952), the “Immortal Memory” novels of James Barke (1946–53) and Lawrence and Lee's *Annie Laurie* (1954). These popular renditions, coupled with a critical move away from biography, have combined to exclude Burns from academia.

**Theme 4: Graduate Students and Burns**

The relevance of Burns to academia today, from his bawdy poetry to the way he is commemorated in North America and Canada, was underlined in the conference. The last session of the day provided concrete evidence that research into Burns is taking place in Scotland's universities. Four graduate students described their projects in a discussion chaired by Dr Gerry Carruthers of the University of Glasgow.

**Pauline Gray**

Burns’ bawdry is a legitimate area for study, although it was seen as taboo until recently. His bawdy songs contain discussions on the themes of gender, religion and politics, which make them ripe for critical appraisal. Ms Gray spoke about gender in particular, and exposed some of the contradictions in Burns’s work. For example, he may have had a reputation as a male chauvinist, but his poetry shows genuine notions of romantic love and appreciation of women’s bodies. He uses religious language to suggest that sex is a gift from God - "divine blisses" - and also writes about women as
lustful beings with sexual urges of their own, rather than being passive objects of men’s desire. Burns acknowledges that sex is complex and often mutual and his bawdry deserves a place in the canon of his work.

Ralph McLean
This research centres on the seeds of the Scottish Enlightenment. Ralph McLean spoke about Burns’ relationship with the Edinburgh ‘literati’, describing how the poet had a “chameleon-like ability” to act in the way which would suit him best in a given situation. For example, if people wanted to see a rustic vernacular poet, that’s what he would be, although he actually wrote sophisticated verse and had read deeply. The literati were aware of Burns’ abilities but, at the same, time, Burns appreciated the literati. Indeed, Burns was at the heart of the Enlightenment, which spread through all levels of society in a myriad of ways.

Catherine McBay
Are Burns statues erected abroad to honour the man and his poetry or as an expression of Scottish identity? Catherine McBay is trying to answer this question with a study of statues in Canada and the US. In particular, she is looking at the inauguration speeches, as reported in local newspapers, as well as who was behind the building of them. She is also looking at how he is represented, and has concluded that people want to feel they have the best and most authentic representation of the man. It may be that Burns statues are there for reasons of nostalgia – a permanent memorial of devotion to Scotland from generations of emigrants.

Jennifer Orr
Jennifer Orr described Burns’ influence on the Ulster poets, a group of labouring class poets in what is now Northern Ireland. In particular, she is interested in Samuel Thomson (1766–1816) who wrote verse epistles to Burns. “Anything but a bardolet” as she describes him, Thomson nevertheless puts Burns into a succession of Scottish poets and pits him against English poets of the time, such as Alexander Pope. She outlined how Burns’ work had an influence on Ulster poets writing in the vernacular Scots tradition. There’s a clear need to study the influence of Burns on political circles throughout the British Isles, she said.
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Burns Supper
22 January 2009
A special Burns Supper held in honour of Robert Burns’ 2009 celebration. Contributors included Mr Clark McGinn and the renowned Scottish singer/songwriter Gill Bowman one of the finest interpreters of Robert Burns’ songs performing today.

Concert - Lament for Mary Queen of Scots
The Haydn Trio Eisenstadt, Lorna Anderson, Jamie MacDougall.
23 January 2009
Featuring Harald Kosik on piano, Verena Stourhz on violin and Hannes Gradwolh playing cello the Haydn Trio Eisenstadt is one of Austria’s leading chamber music ensembles. Since 2002 the trio have worked closely with the renowned Scottish Singers Lorna Anderson (Soprano) and Jamie MacDougall (Tenor). The Royal Society of Edinburgh and the University of Edinburgh was delighted to be able to bring to Edinburgh, for one night only, Jamie, Lorna and the Haydn trio Eisenstadt and to watch all five performers breathe new life into Haydn’s Scottish songs.
An exciting link up with one of Scotland’s pre-eminent composers of this generation James MacMillan FRSE added another dimension to the evening as the five performed his newest, as yet untitled, Scottish themed piece of work.
The forum was introduced by Lord Wilson of Tillyorn, President of the Royal Society of Edinburgh, who thanked Professors Jan McDonald FRSE and Adrienne Scullion FRSE for their work on the National Flagships seminar series, and handed over to the Chair for the evening, Professor Duncan Macmillan FRSE of the University of Edinburgh, who is also chief visual arts critic of The Scotsman, and former Curator of the Talbot Rice Gallery, the University of Edinburgh.

Professor Macmillan introduced the debate by drawing attention to the recent controversy over the raising of funds to keep the Titian painting Diana and Actaeon on public display in Scotland. He quoted the view of Iain Smith MSP, Liberal Democrat Culture spokesman, that the painting is hardly worth saving for Scotland, because it has no real Scottish connection. “It’s not even as if it was by Jock McTitian”, the MSP was quoted as saying. Professor Macmillan said that this controversy reminds us of the questions faced daily by those responsible for running ‘national’ galleries and museums in the 21st Century, who often find themselves at the cutting edge of debates about national identity and culture. Professor Macmillan then introduced the four speakers. He pointed out that Belfast-born John Leighton, Director-General of the National Galleries of Scotland (NGS), is the first trained painter to occupy that post for many decades, and outlined his career before he took over at NGS in 2006, which ranged from student years at Edinburgh University, Edinburgh College of Art and the Courtauld Institute, to periods at the National Gallery in London, and the Van Gogh Museum, Amsterdam.

Enrique Juncosa, Director of the Irish Museum of Modern Art (IMMA), was born in Majorca, and has previously worked in Valencia, and at the Reina Sofia Museum in Madrid. Dr Gordon Rintoul, Director of National Museums Scotland (NMS), is currently presiding over a major refurbishment of the Royal Museum building in Chambers Street. And Neil MacGregor, Director of the British Museum, was brought up in Glasgow, before studying for the Scottish bar, and moving into the world of fine arts via the University of Edinburgh, the
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Courtauld Institute and the University of Reading. He was Director of the National Gallery in London before moving to the British Museum in 2002. Professor Macmillan said that many of the exhibitions Neil McGregor has presented at the British Museum have shown a strong sense of topicality, including the current exhibition on *The Remaking of Iran in the Early 17th Century*. Professor Macmillan added that in his view, culture is the essential element from which politics grows, and that politics is only a function of culture. He therefore felt that the approach to national culture of those running major national museums and galleries is of profound importance, and looked forward to hearing the views of such a distinguished group of speakers on a subject so critical to our future.

**John Leighton**

John Leighton began by pointing out that the National Galleries of Scotland are approaching an important birthday; they are due to celebrate their 150th anniversary in March 2009. He said that when the galleries first opened in 1859, there was general agreement that there was a compelling need for the public in Scotland to have access to great works of art; but there was no great consensus – if any at all – about what the content of the collection should be. There was a feeling that the gallery should be not only a force for encouraging artistic achievement within Scotland, but also a potent sign of distinction to the nation. *The Scotsman*, at the time, said that the purpose of the collection should be “to teach art and elevate taste”; but added that in these respects, the existing collections were “quite useless”.

Initially, the galleries had little or no acquisition funding, and depended almost entirely on gifts and bequests. The aim, though, was clearly to acquire the finest examples of international art that could be bought or gifted; the remit became more complex later, with the general growth of nationalism, and of indigenous Scottish schools of painting. Early directors were soon complaining that the prices of ‘old masters’ were becoming prohibitive, so the debate on acquisitions and spending priorities began early. There were also strong class attitudes in the early management of the galleries. Directors used to employ extra security staff on public holidays, when the working classes might be expected to visit; and in every sense, the lower orders received only a ‘guarded’ welcome from management.

Nowadays, of course, things have moved on. John Leighton is concerned that it should be clear that these are not the ‘National Galleries of Edinburgh’. He is interested in the mission of creating galleries “without walls”, whose collections become visible
and accessible throughout the country. The gallery, he said, should not be a “self-contained treasure chest”, but should form part of a wider network across the nation and beyond. He hoped to see more collaborations with other collections, both in Scotland and elsewhere.

He felt that the Galleries are, in the broadest sense, educational institutions, and that a continuing relationship with contemporary Scottish art should be one of the foundations of the Galleries’ work. They also play a crucial role in supporting the nation’s tourist industry.

Mr Leighton said, in conclusion, that questions of national identity are always challenging, and should be so. The temptation is to try to use institutions such as museums and galleries to simplify national identity, and define it in narrow ways. The duty of the institutions is to resist that, and to insist on the complexity of their role, and of the culture they record and reflect. And he added that he is delighted by the purchase of the Titian painting, which he described as “a sign of ambition, as well as a great work of art.”

Enrique Juncosa

Mr Juncosa began by observing that people often use the term ‘nationalism’ in a pejorative way, and always of others, never of themselves. He said he is also wary of the “same everywhere” culture in modern art, where similar exhibitions move around a fashionable circuit from Berlin to Paris to London to New York, and seem to have no real identity. He argued that the easiest way to have a distinctive identity is to put some emphasis on the national dimension of a collection, and said that at IMMA, he aims to assemble the best possible collection of contemporary Irish art, in a good international context. The general collection can be excellent, but the Irish one can reasonably aim to be the best in the world.

The Irish Museum of Modern Art was founded in 1991 with a very small acquisition fund, and in its early years tended to use this to buy contemporary art from outside Ireland, along with some contemporary Irish work. Mr Juncosa has tried to fill in the gaps, updating the collection with neglected Irish material created between the 1940s – the terminal date of the collections in the National Gallery of Ireland – and the 1990s. He also observed that when he was appointed to his post in 2003, one newspaper article was published objecting to his appointment, and saying that it was disgraceful that a foreigner should hold such a post. But that was the only hostility he encountered, and he has found the Irish arts community very supportive.
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He is currently collecting mainly Irish artists, including those with Irish connections who live elsewhere - Northern Ireland, North America, etc. Mr Juncosa noted the paradox that while people in Spain see England, France and Germany as the essence of Europe, British people seem very reluctantly European. In Ireland, though, people are responsive to the European dimension and enjoy making European links, and Mr Juncosa has also linked Ireland through exhibitions to other ‘new’ or recently independent countries, including India and Pakistan. A museum in Ireland, he concluded, has to be Irish; and it also has to be much more than that.

Gordon Rintoul

Gordon Rintoul began by observing how wide-ranging the National Museums Scotland's collections are, and how this reflects the history of Scotland, and the importance in our national story of Empire, science and technology. He argued that national storytelling is always fraught with different viewpoints, and that there are pitfalls in telling a story through artifacts. There is, for example, not much about William Wallace in the National Museum of Scotland, because there are no objects in the collection relating to him; at the time of the opening of the Museum, the current First Minister had made vigorous comments about the relative lack of a focus on Wallace. History is a contested place. When Australia's National Museum opened in 2001, there were so many protests and disputes that a government commission had to be appointed to investigate, and the row led to the departure of the Director.

Dr Rintoul therefore felt that, in the first place, it is essential for a national museum, particularly in a small country, to engage in the continuing debate about the history of the nation, and to provide a forum for that discussion. It should offer not just the story of an imagined past, but an opportunity to understand the past through a range of different voices, including those recorded through oral history and on film.

Secondly, the national museum should have a role as a national resource, with a vigorous loans programme to other museums and institutions across the country. The National Museum currently has more than 2,500 objects out on loan to various institutions, and is particularly pleased that the collection known as St Ninian's Treasure has recently returned to Shetland for the first time since its rediscovery in the 1950s.

Thirdly, the museum should be involved in supporting and enabling others, particularly smaller museums across Scotland. Fourthly, the institution should be
mindful that being national means being international, if Scotland’s story is to be told in full. International exchange and linkage is of central importance. Dr Rintoul said that he hoped the revamped Royal Museum building would reflect this international perspective very strongly - for example, there was an exhibition in 2008 called *Extremes*, about the Hudson’s Bay Company of Canada, featuring 250 items, many of them brought back from northwest Canada by Scots involved in the history of the company. The exhibition coincided with a land claim by the Tlicho people of the area around Yellowknife, whose representatives visited Edinburgh during the exhibition; the whole event was particularly moving and well received.

And fifthly place, Dr Rintoul argued that being national should mean being a centre for the creation and sharing of knowledge, particularly through research around the museum’s substantial science collection. Research activities could range from straightforward history of science to contemporary research in natural sciences, using the museum’s collections as a resource, and there are exciting possibilities in this area.

Dr Rintoul concluded that national status and national funding also bring national responsibilities, and that national institutions such as National Museums Scotland should seek to act as a force for good, both nationally and internationally.

**Neil MacGregor**

Neil MacGregor used historical and contemporary images of the British Museum to illustrate his speech, and began by reflecting on the values and ideas which helped inspire the museum’s foundation at Montague House in 1753. He showed an image of the steeple of St. George’s Church, Bloomsbury, close to the museum, with its statue of King George I at the very pinnacle of the steeple, and reflected that the museum was founded at a time when people were determined to strengthen and consolidate the idea of the nation – the question of “which nation?” had after all been tested as recently as 1745.

Mr MacGregor showed a particularly powerful picture of the public execution of Jacobite lords at Tower Hill following the rebellion of that year, and said that in the 1750s, the great and the good of Britain were essentially saying “Here are the ideas we will promote, and here are the much larger group of ideas we will not mention, in order to be able to live together.”

The museum was created by a vote of Parliament, not by Royal Charter, and was to be run by independent Trustees, not royal appointees. The mood in Parlia-
ment was of the need to create a society and forge a nation; Mr MacGregor reflected that interest in the idea of a national museum often comes from the sense that we have a notion of how we want our people to be, and want a museum that in some way reflects that story and that aspiration. The real purpose was to create, not recount, a national story, and it is striking that the Trustees were not to be part of government, but free and independent. They were to be funded by government, but not controlled by it. At the time, a Royal institution would have excluded everyone who was Nonconformist, Catholic or Jewish, and the foundation of the British Museum was an important step away from that.

In the years since 1753, the nations of Britain have changed dramatically, but the objects assembled in the collections still allow us to tell different and competing stories about our history and our society. The idea is that different populations within the nation can look at all the stories in one place, and begin to get a sense of how they fit together. This is the work that any national museum has to embody, and national museums must resist any “nationalism” that makes that coexistence difficult. A good example lies in attitudes to Africa, which has gone from being patronised as a primitive backwater to being recognised as the mother of all human cultures, partly through the study of fine artifacts found there.

In Neil MacGregor’s view, the objects are there in the museum precisely in order to allow different narratives, and resisted narratives, to be presented; and the civic value of that process is very great indeed. He said that in London, one person in 20 is now of sub-Saharan African origin and that this is the fastest-growing part of the city’s population. He showed a memorable picture of an African study day at the British Museum, featuring a huge crowd of people, including thousands of Londoners of African origin, gathered to hear music and presentations in the museum’s main courtyard. “Our job,” said Mr MacGregor, “is to complicate narratives, and to remind people of how complex they are.”

He added that museums need the resources to make collections available throughout the country and beyond. The idea that the British Museum should bring together artifacts ‘native and foreign’ was enshrined in the original Act of Parliament founding the museum, and today the collection should be consultable world-wide. Mr MacGregor said, in conclusion, that these remain great ideals, and that both the history and the potential of the British Museum help to demonstrate what such a collection could achieve in the civic realm.
Questions and Answers

Professor Sir Alan Peacock FRSE opened the discussion, from the audience, by pointing out that the idea of a “national” institution implies some continuing public debate about the organisation’s purpose and priorities. He welcomed the fact that museums and galleries have become more interactive in terms of the experience of visitors, but wondered how that need for wider public debate and participation could be expressed in the governance of institutions.

He also questioned whether some of the activities of museums are not taking on a political education role which could become dangerous. Is it not possible, for example, that the current Iran exhibition at the British Museum is running this risk?

Neil MacGregor said that there is no question of proselytising, either in the Iran exhibition or in any other aspect of the British Museum’s work. The public receive the information, and literally informs itself through the experience. The idea is to try to understand contemporary Iran through its past. The response or conclusions depend on the individual visitor.

Dr Rintoul said that there is no intention of telling people what to think. His intention is rather that the NMS should act as a forum for debate. Participation and interaction must be good for the institution, and there is now a far broader range of ways in which members of the public can become involved with the work of the museum.

Mr Juncosa said that there is not a simple canon of work which had to be shown, and that it is a matter of complex narratives.

Duncan Thomson, former Director of the National Portrait Gallery, then asked whether modern museums are speaking the language of inclusion, but failing to practise it. The museums themselves have become more accessible, but structural participation is being phased out – there are no longer trade union representatives on boards, for example.

Neil MacGregor said that the British Museum Board are Trustees, not representatives. They are there to defend the interests of the public, born and unborn. They need to be strong, so that they can fight government if necessary.

John Leighton pointed out that boards of trustees do not run museums – directors are responsible for the operations. Museums Boards have the responsibility to monitor and approve the broad strategy, policy and business plans and if they get too closely involved in the day-to-day operations then “all hell usually breaks loose”.

Gordon Rintoul said there are many ways of encouraging
participation, for example through open meetings. It is important to offer the public a range of ways of engaging with the work of the museum.

The question was raised of the still rather forbidding image of formal galleries. Why do people still think only of official gallery spaces, when it comes to displaying art or artifacts?

John Leighton said that he is very interested in this issue, which was why he had talked about the idea of the “gallery without walls”. There is a strong tradition of public sculpture in Britain, and of art in the environment at various sites. Mr Leighton felt that all of these developments help to make art more accessible and less intimidating.

Mr Juncosa said that the Irish Museum of Modern Art has an extensive programme of lending work from its collection to small towns across Ireland, some of which are using informal exhibition spaces such as garages and shop-fronts. The ‘national programme’, as it is called, is an increasingly important part of the IMMA’s work.

The question was raised of whether it is right to remove artworks from the places were they were created, and to keep them in other cities and countries. The questioner recounted the strange experience of seeing an ancient Persian temple reconstructed in a museum in Berlin, and wondering what on earth it was doing there. John Leighton said that he thinks works of art acquire a resonance through being exhibited in a certain place, over time. It would make us much poorer, for example, if we could only ever see Venetian art exhibited in Venice; it should also be seen in other lights. There is also an element of surprise or disjunction – like the questioner’s experience in Berlin – which can be revealing and enlightening.

Neil MacGregor suggested that the real question is about how we understand objects. The comparative method is a very powerful tool of understanding, and collections such as the British Museum are founded on it. He argued that we cannot understand the world, and how different geographical areas and traditions relate to one another, unless objects are brought together for comparison. Cultures are contiguous, like a form of trade. They are shaped by contacts and exchanges, and unless we can see objects side by side, those relations will not be clear to us. The questioner wondered, though, whether the people of Benin feel like that about their bronzes, which have become the property of the British Museum and other galleries in the west.

Another questioner wondered how much sense of ownership
people have in relation to their national galleries and museums, and how that could be fostered.

Gordon Rintoul said that the NMS has carried out substantial outreach work, for example with groups of women from the Chinese and Indian communities in Glasgow, although ethnic diversity is obviously not so strong a thread in Scottish life as it is in London.

A final questioner asked the speakers to reflect on the importance of private collectors who donate works to national galleries and museums. Among those mentioned were the Rockefeller, Burrell and Bridgewater bequests.

John Leighton said that he agreed that it is easy to forget that the stewardship of heritage is, and always has been, a public–private partnership. Many countries have national collections based on old royal collections, which have been nationalised or appropriated. But our royal family still has its own collection, and the national institutions have built up their own holdings through a combination of purchase, and generous gifts and bequests.

Gordon Rintoul agreed that the generosity of private donors is of huge benefit to the national collections, and recalled a Japanese company with a plant in Scotland generously donating a hugely valuable silicon ingot for a recent NMS exhibition.

Professor Macmillan then closed the formal debate, and invited Professor Jan McDonald to give the vote of thanks. She said that the discussion had been fascinating, and had made it clear that national galleries and museums have a very complex contract with the nations they serve. In a sense, they are there to help create a nation that can only exist if we suspend our disbelief, and allow ourselves to become something more than an imaginary community. She thanked all four speakers, and Professor Macmillan, for an outstanding debate.
Science to the rescue
Professor John Beddington, the Chief Scientific Adviser to HM Government and Head of the Government Office for Science, believes that science and technology must play a critical role in tackling the many global challenges facing humanity through the 21st Century – and that the economic downturn is no time to be taking our foot off the accelerator for the investments required…

Listening to Professor Beddington set out these challenges, you may be forgiven for thinking the future is cancelled. He presents a stark picture of complex, interacting problems, and of transformational changes to be managed alongside these.

- World population is expected to rise from six billion at the start of the century to nine billion by 2050 – an increase of six million people per month, mostly in developing countries.
- Urbanisation will accelerate. Last year, urban population overtook rural.
- More than a billion people live on less than 50p a day.
- Demand for food is projected to increase by 50% by 2030, according to the United Nations.
- World grain reserves are at an all-time low of 14%, down from 35% in 1986, and 75% of the major marine fish stocks are either depleted, overexploited or being fished at their biological limit.
- Demand for energy is projected to increase by 45% by 2030 in a BAU scenario.
- Demand for water may increase by 30% by 2030. One in three people already face serious shortages in the form of physical or economic water scarcity. Potentially forcing more countries to introduce charges and with the possibility of increased tensions and conflicts.
- The acidity of the oceans is accelerating, with Ph expected to drop by approximately 0.4 by the end of the century, due to rising CO₂ emissions.
- Economic migration has increased from less than 80 million in 1960 to around 200 million by 2005.
- The world's mega deltas are particularly vulnerable to climate change, and every year there is already around a 75% chance of one of the world's major 136 port cities being inundated with a one-in-a-100-year flood.

Even some of the good news is bad. Beddington highlighted recent research which suggests that banning aerosols may have led to an increase in deforestation of the Amazon rainforest, due to an increase in droughts.

He explained too how economic growth projected for the developing world, lifting millions from poverty, would at the same time increase exponentially the demand for energy, water, food and other resources. More prosperous populations, centred increasingly in mega-cities and aspiring to the lifestyles of affluent Western nations, will require servicing often by a rural community declining in at least relative terms.

Looming over all of this is climate change – and other unpredictable phenomena such as terrorism and natural disasters. It's no good having a healthy economy if the planet is killing itself – for example, a 5º increase in temperature would cause a catastrophic rise in sea levels and devastate agricultural production.

Unfortunately some of our most pessimistic forecasts may not be pessimistic enough, said Beddington. For example, even the worst-case scenario for the rate of Arctic melting turned out to be not as bad as actual observations. Further research and data will be key to understand whether short term fluctuations or more fundamental trend factors are the cause. In many areas the full impact of the changes being experienced or which are predicted, such as rising sea temperatures, is still not well understood by scientists.

Whilst spending much of his RSE lecture describing the problems, he talked too about solutions. Beddington remains optimistic that science and technology can rise to the challenge, if we have the political will and invest adequately in research and in its effective exploitation. An economic downturn may not seem the best time to argue for increased investment, but Beddington believes that there are profits to be made from the crisis, and that we have no other choice.

Beddington welcomed the inauguration of President Obama, because the new administration is already taking climate change more seriously, including the appointment of two Nobel Prize winners with an interest in climate change to the team of scientific advisors.

Our prospects may look bleak, but Beddington seems to agree with the idea that every crisis means an opportunity. And he is very clear what this will mean: “We need
significant investment in science and engineering solutions to complex inter-related issues.”

For example, the developing world will inevitably use its massive coal reserves to generate energy, but new carbon capture and storage (CCS) technologies will not only help cut emissions but also mean profits for the companies who successfully develop and market their solutions. And cleaner electricity and transport are two of the most critical issues.

Reducing emissions by 80% by 2050 in the UK may seem an impossible challenge, but Beddington is confident we can reach our targets by using smart science and technology, especially if there are strong international agreements.

Beddington compared a range of solutions in terms of cost-benefits, suggesting that some technologies and policies are more cost-effective at reducing emissions than others. For example, better home insulation would be the cheapest and highest-impact solution, since households alone contribute about 45% to total emissions. Nuclear energy is another “no brainer” for Beddington, who described it as “break even” in terms of return on investment, while other options such as sugarcane biofuels generate savings. CCS is still an unproven solution which appears more expensive at the moment, but Beddington agrees that it will play a crucial role in substantially lowering emissions from coal in the decades to come. For many promising technologies, a medium to long-term view of the value of investments is needed. Other positive options are reforestation, combined heat and power plants, biomass and other renewables such as wave, wind and tidal power.

To promote these solutions, we don’t just need money and technological innovation, but also behavioural changes, said Beddington, helped by incentives. Carbon trading may work at a national level, but individuals need more persuasion.

Increasing food production by 50 per cent in the next 30 years, at the same time as reducing agricultural energy and water consumption and managing pesticides and fertilisers more sparingly, may seem impossible, but there are grounds for hope. Grain reserves are so low that our total reserves are literally at sea at any given moment. But if we could eliminate crop losses and other wastage through the food chain, food production and food security could increase substantially, even on less land with fewer resources. At the same time, genetically modified crops he saw as another key technology option with the potential to make a significant contribution.
Similarly, better water management like recycling “grey water” and improving irrigation using new technologies (including nanotechnology) may mitigate the worst effects of future shortages. Some ideas like “fertilising” clouds and giant sun shades orbiting the Earth may seem like pie in the sky, but Beddington has great hopes for fusion power and other breakthrough concepts such as growing algae to increase absorption of carbon dioxide. He saw an important role too for climate models, to improve progressively our understanding of future climates. He noted at the same time the difficulties in interpreting such models, which are inherently chaotic, Beddington explained. Even tiny changes in inputs can lead to dramatic variations in results. The models also currently leave “major uncertainties”, including potential impacts on monsoons and El Nino phenomena.

Dwelling for a moment on a more administrative aspect of his role, Beddington revealed that every government department has a chief scientific advisor, with the exception of the Treasury. Just as with the changing economic climate however, there are no quick fixes with science. Asked about birth control, for example, Beddington described how rapid changes in population can have a negative effect on an economy – while many religions oppose contraception completely. Rather than legislating for the bedroom, societies are better off educating women, said Beddington. When it comes to climate change and other global problems, what we need is a much more holistic approach, including better communication and engagement with people.

Finally, asked if it would be “madness” to reduce our investment in science and technology, despite the financial constraints of the credit crunch, Beddington answered resoundingly: “Yes!”
UK–Taiwan Workshop on Tidal Current Energy
Organised with the National Science Council of Taiwan,
in cooperation with the University of Edinburgh
24 February 2009

Islands linked by science
The UK and Taiwan may be islands on opposite sides of the planet, but the workshop on tidal current energy highlighted how much they have in common in terms of the energy challenges they both face, their renewable resources and the science required to develop commercial solutions. And ultimately, this may lead to ‘powerful’ partnerships between the two, involving industry as well as academic researchers.

Several themes emerged during the workshop to emphasise these common interests:

1. As well as the need to develop renewable sources of energy, while reducing emissions and dependence on carbon-based fuels, both the UK and Taiwan have enormous resources around them – particularly the power of the sea.

2. In Taiwan, scientists are focusing on a phenomenon called Kuroshio – an ocean circulating current which runs in one direction up the east coast of Taiwan, capable of producing 60GW of power. In the UK, we have similar resources, with biodirectional tidal currents in the Irish Sea, the Pentland Firth and around Orkney, where projects are already underway, including the world’s first twin-rotor tidal current turbine – SeaGen.

3. Both are also concerned about the environmental impact of developing renewable resources, and are working hard to ensure that we not only have greater knowledge of long-term effects but also minimise potential damage.

4. Within the UK and Taiwan, partnerships are key to the success of renewable energy projects, because they tend to be multi-disciplinary and require close cooperation between so many different interested parties, including government, the general public, universities and business.

5. Similarly, international partnerships will help to accelerate progress at national and global levels by sharing the results of our experience and avoiding duplication of effort.

Even though the UK and Taiwan are surrounded by water, when it
comes to solving our energy problems, neither can afford to be an island, and the workshop was a powerful demonstration of this, as well as a great demonstration that everyone involved was willing to share ideas and form strategic partnerships – and friendships which the organisers hope to renew in the very near future.

WORKSHOP PAPERS

Energy Research and the Kuroshio Power Plant Project
Professor Chen Falin, Institute of Applied Mechanics, National Taiwan University
Professor Chen set the scene for the workshop by mapping out the energy challenges faced by Taiwan, then describing plans to tap the Kuroshio – an ocean current which runs up the east coast of Taiwan which could provide 60GW of power, using the next generation of turbines. He also revealed that Taiwan’s National Science Council will launch a new National Energy Program this summer, investing about £100 million a year in academic research and industrial projects over the next five years.

According to Professor Chen, Taiwan’s “inconvenient truth” is that an island one eighth of the size of the UK with a population of 23 million people relies almost entirely on imported energy, in particular oil, coal and gas. Wind and solar energy are simply not practical options, and nor is hydro power, due to geographical and weather conditions, while nuclear energy currently provides only eight per cent of the total.

Taiwan is also a major industrial player, and, as a result, its greenhouse gas emissions make it number 22 in the world in volume terms (one per cent of total emissions) and Number 18 in emissions per capita, growing faster than most others at a rate of five per cent a year. Clean coal, carbon capture and gasification will be major priorities in coming years, spending £4 billion to replace all 18 coal-fired power plants over the next 20 years, at the same time as developing the nuclear sector (if there is political backing) and boosting the renewables sector.

Professor Chen said that Taiwan will face a huge energy problem in the future if it does not act now, and that is why the National Energy Program will focus on three major issues:
1. energy security
2. greenhouse gas reduction
3. development of a new energy industry

As part of this programme, Taiwan also recognises the need to work with international partners to develop its renewables sector, including photovoltaic cells, wind power, biofuels and LED. It is already successful in the photo-
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voltaic industry, with 30 manufacturers (number four in the world) and LED lighting (number two in the world). Biofuels are now a “hot issue,” said Professor Chen, but Taiwan is relatively new to wind turbines, with a capacity of 347MW.

The Kuroshio Project is potentially the most important part of the equation, however – and also the greatest technological challenge. Scientists have already identified the best location for a power plant, in a 100km-wide stretch of water near the east coast of Taiwan, which is not just easier to access but also more reliable in terms of predictable flow. Even with a tidal flow of only two metres per second, however, the “Black Current” has 100 times more power than the Amazon and could provide Taiwan with 60GW of energy – more than it uses today.

Scientists have already started surveying the area with a view to building new power plants and installing turbines, exploring the environmental risks and archaeological implications, as well as likely costs.

One problem is that most existing tidal current turbines are designed for shallow waters, and the turbines required are still artist’s impressions. The design of the turbines will therefore be a critical factor – with each one capable of generating 2MW of power. “We need to invest in manufacturing,” said Professor Chen, “and we are looking for international technologies, including new mooring and anchoring systems.”

Marine Energy Research and Development in the UK
Professor Robin Wallace, Institute for Energy Systems, University of Edinburgh

Professor Wallace provided the British perspective on marine energy, focusing on the R&D environment in the UK, discussing recent progress with new technologies and infrastructure, the research challenges and opportunities for collaboration.

He recognised and applauded the significant progress in the sector, noting that in the last five years several technologies had completed the journey “from artist’s impressions to the real thing” – deploying devices at sea. For example, he described the Wavegen LIMPET, an oscillating water-column shoreline wave energy converter deployed on the island of Islay, and plans for a 4MW offshore breakwater device. Other technologies highlighted by Professor Wallace included the Ocean Power Technology power buoys, the Pelamis Wave Power wave energy converter (deployed in Portugal and UK waters), the Open Hydro tidal current turbine in Orkney and MCT’s SeaGen project (described in detail later in the workshop).
These new wave and tidal-current generators are full-scale prototypes with generators plugged into the national grid, demonstrating the UK’s achievements in research and development activity, device construction, open sea testing and deployment – and actual power production from the sea.

Like Taiwan, said Professor Wallace, the UK faces an “inconvenient truth,” including the fact that most population centres were established above the coalfields in the south, with the electricity supply network following the east coast, while the greatest potential resources are found in the north and the west – abundant wind and marine energy.

To exploit its rich marine resources and help solve its energy problems, said Professor Wallace, the UK needs to proceed with “a joined-up campaign of development and deployment and strategic and prudent investment in the network, to ensure that good ideas are translated into real-world solutions, not only taking account of the technical challenges and constraints but also the economic realities. It’s a long way from dreams to deployment, and important to learn from experience,” he added. Above all, said Professor Wallace, it’s important to ensure continuity of funding for winning ideas and technologies from concept to deployment. Technology evolution and learning by doing generally reduces costs as volume deployment increases, but sometimes there can be a challenging funding gap in the journey to commercialisation – what Professor Wallace called the “valley of death.”

Professor Wallace then talked about the world-class research and development going on in many universities; some of them part of the SuperGen Marine Energy Research Consortium. He also highlighted the 1/10th scale tidal test facility at NaREC and the EMEC wave and tidal test sites on Orkney.

Collaboration is key to success, said Professor Wallace, and many energy research programmes in the UK are collaborative efforts, with £200 million invested in sustainable power generation projects involving 14 consortia, with 38 academic and 80 industrial partners. The Energy Technology Partnership (ETP) is another example of “outward-facing collaboration,” he added, by pooling the resources of 250 academics and 600 researchers in Scottish universities – the biggest partnership of its kind in Europe.

There are many research challenges, said Professor Wallace, including the development of better testing facilities, increasing the size and number of devices and moving into deeper water.
further offshore, but there are also many exciting opportunities for collaboration as the industry evolves in the next few years into second- and third-generation solutions.

Establishment of a CODAR System to monitor Ocean Surface Currents around Taiwan. Dr Yang Wen-chang, National Applied Research Laboratories

If Taiwan is going to take full advantage of its marine energy resources, it is vital to understand as much as possible about the ocean which surrounds it, and Dr Yang's organisation will play a key role in that process, in the process helping in the drive towards sustainable development and better understanding of the full effects of climate change.

Set up last year, the Taiwan Ocean Research Institute (TORI) is carrying out a four-year project to monitor the Western Pacific using a CODAR system and a fleet of research vessels to establish a comprehensive database and information network, including hydrographic, geological, geophysical and biological data, etc. It will also develop new ocean exploration technology, including deep-sea ROVs (remotely operated vehicles) and has commissioned a new 2,700-ton research vessel expected to be operational in 2012.

With a staff of 66 researchers, including 17 with PhDs, TORI will also look at seismic activity and the ecology of the ocean, mapping the habitats and distribution of deep-sea organisms, as well as studying storm surges, coastal erosion and the movement of sediments, coral reefs, water quality and atmospheric conditions.

The CODAR real-time observation equipment includes site data acquisition systems plus transmitter and receiver, with a range of 220km. The ultimate aim is to cover an area approximately twice as big as Taiwan itself with a network of intelligent buoys, and installation is scheduled for completion in 2011.

Tidal Current Characterisation
Professor Ian Bryden, Institute for Energy Systems, University of Edinburgh

Professor Bryden started by declaring that tidal currents are a mechanistic process that is well understood and relatively easy to mimic, using computers and wave tanks. Tides are also easy to predict because they are determined by the push and pull of the Solar System. He also explained that the North Sea is like a semi-enclosed basin, and that tides produce kinetic energy in a similar fashion to waves or wind. To tap this power, we need the right coastal topography, but many countries have accessible “hot
spots” where this can be found, including the Pentland Firth in north–east Scotland, where tidal currents can reach speeds of up to six metres per second. Even though the hot spots move around in the Firth, there are enough stable locations where energy capture is a practical option, and a channel roughly 1,000 metres wide by 40 metres deep is capable of producing enough electricity to power large cities such as Glasgow or Edinburgh.

After showing a “scary” film of the tide in the Pentland Firth moving at less than two metres per second, to illustrate the huge amounts of energy available even in relative calm, Professor Bryden then explained that kinetic energy is only part of the story. Friction and potential changes in the sea surface level can produce twice as much power as tidal currents. The extraction of energy from a tidal flow also alters the underlying hydraulic nature of the flow, and this may affect the environment, he added.

Professor Bryden then explained that if we extract 25 per cent of the kinetic flux in a current, the energy in the current actually increases rather than decreases, but he also cautioned that there is an absolute limit on the amount of energy that can be extracted, based on the laws of physics, and that because tides are turbulent, it is better not to interfere too much with nature or there may be undesirable effects on the environment.

Current Developments in Taiwan Ocean and Coastal Engineering. Kung Cheng-Shan, Senior Vice-President, Sinotech Engineering Consultant Ltd

Dr Kung described a number of marine and coastal projects in Taiwan, including five harbour development schemes, modeling Typhoon Wave and storm surge analysis. He also talked about how Taiwan exploited its deep-sea resources, tapping water from 300 to 1,000 metres under the sea surface for use in cooling processes, as well as for drinking, aquaculture and mineral extraction. He then described how Taiwan has established its first offshore wind farm project, and has learned from UK experience and adapted that to local conditions (such as typhoon and earthquake). The jacket-type foundation will be the most suitable for future projects.

Taiwan is also seeking to achieve the right balance between nature and human activities, said Dr Kung, monitoring the effects of offshore industrial estates as well as trying to design the most suitable dykes to protect the coastline without damaging its appearance.
SeaGen – Moving Tidal Turbines into Deeper Waters. Professor Peter Fraenkel, Marine Current Turbines (MCT)

One of the highlights of the workshop was the talk by Peter Fraenkel describing the development of SeaGen, “the largest rotating device in the sea,” which the delegation visited later in the week, in Northern Ireland.

Warning of the risks of “getting into deep water,” Fraenkel started by outlining his four conditions for marine energy projects:

1. scale – the device should be able to generate at least 1MW to be economic
2. access – it should be close to land so it is easy to service
3. reliability – to minimise the need for repairs/intervention
4. life – it should last for several decades

Then having outlined these conditions, he stated that “few technology developers are anywhere near to meeting these criteria.”

Moving on to the technology itself, Fraenkel then said that the design of the rotors was not the big challenge. The simple rule is to use the least amount of material over the greatest area. When it comes to location, he added, “the seabed is not the place to go,” because 75 per cent of the energy is found in the top 50 per cent of the water column.

MCT, said Fraenkel, has deployed three of the five tidal turbines now being tested in the UK, with output ranging from 300kW to 1MW. He also said that MCT was the first company to achieve commercial viability, with SeaGen’s twin 16-metre-diameter turbines producing up to 1.2MW of power – and strong enough to carry three double-decker buses. Early versions developed by MCT, such as the world’s first tidal current turbine (deployed in Loch Linnhe in 1994) which produced 15kW, or the more recent Seaflow (deployed in 2003), with a rated power of 300kW, were experimental prototypes.

Fraenkel then described the installation of SeaGen in Strangford Lough, including the design of a new “Quadropod” – a temporary platform used for construction. Even though SeaGen was up to full power by December last year, Fraenkel said that it would be another year or two before MCT would have a reliable system.

As well as power output, MCT’s investment has accelerated over the years, rising from about £350,000 from 1992 to 1995 to £3.4 million in Seaflow and over £20 million in SeaGen. The next step for MCT will be to deploy an array of turbines in the Irish Sea by 2011, capable of generating 10MW, and this will need a further investment of about £52
million, said Fraenkel. Above all, he added, MCT has been able to learn so much from its experience that the risks should be less and the costs should be lower – ultimately leading to a lower cost per megawatt than wind turbines.

Looking to the future, Fraenkel said that second-generation designs will need more reliable power units, and will have to be capable of scaling up and down, with 24-metre-diameter rotors the maximum size, deployed in arrays with a surface area of 1,5000 square metres, as compared to SeaGen's 400 square metres. He also talked about deploying horizontal arrays, incorporating six rotors, and floating vertical arrays, submerged in deep waters, which could be the solution for the Kuroshio Power Plant Project in Taiwan.

A Contra-Rotating Marine Current Turbine. Dr Cameron Johnstone, Energy Systems Research Unit, University of Strathclyde

Following the discussions of rotors and mooring systems, Dr Johnstone described his "revolutionary" design for a second-generation tidal current turbine which would not need a solid structure for support in the water, thanks to the use of two dissimilar rotors (one three-blade and one four-blade) which turn in opposite directions, thus counter-balancing each other and stabilising the turbine.

Dr Johnstone then explained how the design had evolved from research into wind turbines. What makes tidal current turbines different, however, is that they operate in a very different environment, and if they could float in the water, tethered to a single-point mooring, this would cut roughly 40 per cent of the cost – the cost of the solid structure usually used as foundation (like SeaGen).

The other advantages of contra-rotation are a reduction in torque ("zero-reactive torque"), which makes the turbine more stable, a longer lifetime, greater power-capture area, and a reduction in the turbulent flow downstream of the rotors. In addition, because it is possible to pack more into any given area, you don't need bigger rotor blades to increase power output – simply more rotors.

According to Dr Johnstone, the "unique selling points" of contra-rotation are higher power output, reduced environmental impact, lower maintenance costs and no need to construct expensive seabed foundations. Add these together, and the new design fits the requirement for deep-sea deployment, with the added bonus of reduced system and operational costs. The new device also generates power using a direct-drive alternator, which eliminates the need for a gearbox, while the open-to-water design enables natural cooling, at the
same time as eliminating the need for complex seals to protect the power equipment.

The development of the prototype has already moved on from 1/30th-scale testing to 1/7th-scale testing to sea trials in the west of Scotland (Kyles of Bute and Islay). The results of these trials have confirmed the low deployment and maintenance costs (six minutes to deploy and eight minutes to recover) and proved the viability of single-point mooring. The flexibility of configuration for different depths and resistance to marine growth also make it suitable for deep-sea deployment in a wide range of climates.

**Geochemical Dynamics and Anthropogenic Impacts of Estuarine, Coastal and Shelf Waters of Taiwan.**

Professor Wen Liang-Saw, Institute of Oceanography, National Taiwan University

To underscore Taiwan’s concerns about environmental impact, Professor Wen described his comprehensive study (from 2000 to 2003) of the estuaries and coastal waters surrounding Taiwan. The focus of his study was on water quality and the balance of nutrients found in the water, analysing how the land interacts with the ocean. The results of the study have widespread implications, not just when it comes to measuring the impact of future marine energy projects but also to establish present conditions, to help with plans for sewage treatment, industrial pollution, aquaculture and agricultural run-off.

After explaining that Taiwan has 118 rivers and streams, and that 24 of them provide about 85 per cent of the water supply, Professor Wen then outlined the different conditions affecting the estuaries and coastal waters of Taiwan, not just because of rapid industrialisation and urbanisation but also because of its sub-tropical climate and historical problems with waste-water treatment. Professor Wen also revealed that despite covering only 0.024 per cent of the surface of the planet, Taiwan produces 1.9 per cent of estimated global sediment discharge. And to illustrate the scale of the problems it faces, it is only today that the capital city, Taipei, has adequate sewage facilities – a few years ago, less than 60 per cent of households had proper sewage and even very recently, 10 per cent were still without modern facilities. According to Professor Wen, old industries also cause problems – with disused outlet pipes buried from view still responsible for some degree of pollution.

Professor Wen’s study covered a number of factors, including water quality, precipitation, water temperature, salinity, particulates, turbidity and dissolved oxygen,
phosphates, carbon dioxide, nitrogen, copper and silver. One of the findings was that household pollution is a more pressing problem than industrial effluents, with traces of silver (used in domestic disinfectant) betraying the scale of the problem. Professor Wen is confident, however, that the silver pollution has a negligible global impact.

As a result of the study, the government has closed down the pig farms on the banks of the river, due to excess copper flowing into the water from the cleaning agents used on the pig farms. Measuring the effects of sewage has also driven policy changes, and over the last two years, nitrogen levels have decreased by 50 per cent.

“Economic growth over the last 50 years has brought prosperity and rapid development,” Professor Wen concluded. “This had serious environmental consequences – and now we are trying to fix it.”

Environmental Monitoring in Strangford Narrows. Dr Graham Savidge, Queen’s University Belfast

After describing the advantages of Strangford Narrows for tapping tidal current energy, such as tides of four metres per second, easy access from land and good shelter, Dr Savidge then explained the possible down side – the lough (lake) is an area of major conservation interest and several agencies are concerned about the danger to wildlife posed by the construction of SeaGen and its giant rotors.

The environmental monitoring programme managed by Queen’s University Belfast and St Andrews University’s Sea Mammal Research Unit was not just designed to satisfy the Northern Ireland Environmental Agency (NIEA) and the Maritime & Coastguard Agency (MCA), but also European agencies, the general public – and MCT itself. As well as praising MCT for being so willing to support the programme, Dr Savidge also stressed that it was important to get input from all stakeholders, to avoid missing anyone out who may raise a concern, especially considering the damage which could be caused by media images of damage to wildlife. He also pointed out that there were risks for MCT, since one of the conditions of the programme was that in the event of a “significant environmental impact,” the turbine could still be shut down. By welcoming the programme, however, MCT was clearing the way for future projects by establishing the environmental facts right from the start, rather than waiting for something to happen and dealing with it after the event. “This will soften the pressure on developers,” said Dr Savidge.
The study looked at the impact on common harbour seals, cetaceans, birds and benthos (seabed creatures such as hydroid turf and sponges), including tagging seals with GPS tracking devices, visual observation, acoustic monitoring of porpoises and sonar to detect approaching creatures in the water, which could even be used to shut down the turbines automatically (in about four seconds). Seals are intelligent and inquisitive animals, said Dr Savidge, but little is known about their ability for close avoidance of hazards, so the researchers went to great lengths to minimise risks to the seals at the same time as closely observing their movements.

The researchers also monitored changes in the flow pattern of the Narrows to measure the impact of the turbines on currents. The data gathered covers the two years before SeaGen was constructed and the two years following deployment. The objective is to establish the environmental impact on factors such as long-term population and short-term behaviour of wildlife. In the process, said Dr Savidge, the researchers learned more about seals than expected, including the discovery that they behaved more individually (in some cases swimming long-distance, alone) and did not always stay in the Narrows in groups.

The divers also took a lot of risks to examine the benthos, Dr Savidge explained, in their attempts to capture images of life on the seabed, in the 10-minute calm between fast-moving, turbulent tides.

The results so far indicate some degree of impact but no significant damage. Benthic surveys show little change. Seabird diving has increased in the wake of the turbines, but no major changes have been noticed in activity patterns. Porpoise activity has reduced in the area near the turbines, but SeaGen is already becoming part of the landscape.

**Wave and Typhoon Activity in the Western Pacific. Professor Kao Chia-Chuen, National Cheng-Kung University**

The Kuroshio is a natural phenomenon with the potential to power the whole of Taiwan, but what is provided by nature with one hand is taken away with another. The island is located in an area of sometimes spectacular weather conditions which could play havoc with future energy projects, and mean that the design of any turbines will have to be extra strong to survive. Taiwan is in the firing line for several typhoons a year and some of the waves observed in coastal waters are as large as Tsunamis, according to Professor Kao, whose work involves measuring waves and other oceanic phenomena.
using a network of 12 solar-powered wireless buoys.

In addition to *in situ* observation and analysing the data produced by the buoys, Professor Kao’s department uses numerical modelling and remote sensing to keep a close watch on the ocean – particularly tides, waves, winds, pressure and surface currents. The data is provided to a number of agencies, including the marine weather bureau, the water resource agency and the tourism office. During major storms or typhoons, the equipment is capable of taking measurements every minute, to avoid missing any large waves, using X-band radar to monitor the sea state. And his equipment has monitored waves as high as 30 metres, with the highest recorded wave in October 2007.

**A Review of the Tidal Current Power Plant of the US. Chang Sen-Tsun, PhD Student, National Taiwan University**

Mr Chang described his study of the various tidal current energy projects underway in North America, ranging from Alaska all the way to Nova Scotia, via San Francisco’s Golden Gate. Taking into account a number of factors such as local topography, cable installation, structural elements, grid connections and the design of the turbines themselves, Mr Chang’s research was designed to compare the cost of installation and the cost of electricity over the long term. His basic conclusion was that the Minas Passage in Nova Scotia has the greatest potential to generate power. Tidal current energy is reliable and predictable, said Mr Chang, but his study was also concerned with the large variations in power over the course of a day, and the critical gap at certain times between power generation and demand.

**Wake Effects of Tidal Current Turbines. Matthew Topper, PhD Student, University of Edinburgh**

Just when you thought that you understood something about tidal currents, along comes Mr Topper with his mathematical theories about the complex interaction between the surface of the ocean and the turbulence created in the wake of turbines – or “decomposing power curve free-surface effects.” This is important, because it helps to understand why power generation is so variable with full-scale tidal current turbines, and the problem for Mr Topper is that the numerical models used to analyse these highly complex effects are not good enough – one model may be very good at understanding surface dynamics while the other may be very good at analysing turbulence, but neither can cope very well with the interaction between them. “There is more than one type of physics
going on at the same time,” Mr Topper explained, describing the fact that a wind turbine produces a steady wake while a tidal turbine produces an unsteady wake because it interacts with the free-moving surface (i.e. waves in the water). Mr Topper uses the boundary element method to model free-surface problems, studying the flow and interactions, but said we don’t know much about the turbulence effects in high-energy tidal channels which flow at a rate of three metres per second, such as the Pentland Firth and Strangford Narrows.
Public Discussion Forum and Full-Day Conference
*Alcohol – Our Favourite Drug: from Chemistry to Culture*
26 and 27 February 2009

Introduction/Summary
As the Scottish Government prepared to publish its far-reaching alcohol strategy, experts from around the world gathered in Edinburgh to take part in two events to discuss what the RSE calls ‘our favourite drug’.

On Thursday evening, Lord Wilson of Tillyorn, President of the RSE, set the scene for the events by talking about Scotland’s ‘love-hate’ relationship with alcohol.

Broadly, the speakers covered two main areas: the science of addiction, including genetic components and, secondly, the role of alcohol in our culture. Over the two days, participants heard about young ‘determined drinkers’ in Manchester and the habits of people in urban and rural Scotland, many of whom are drinking far too much but think that they don’t have a problem.

The audience was also told of new research from Australia which has started to map the social costs of drinking – not just to the drinker but to those around him or her. They learned about how heavy drinking has a disproportionate effect on poorer populations, both at our country level and worldwide, and heard a call for a global framework convention for alcohol policy.

On the more scientific side, advances in imaging and other techniques are helping to improve our understanding of addiction – and hence leading to new modes of treatment and prevention. Those present were informed about the role of genetics and the complex interplay with environment and lifestyle factors and found out at first hand about the huge burden of alcohol-related disease on our health services, which is costing us all – individuals, families and societies – so dearly.

The events were supported by the Alcohol Education and Research Council (AERC) and Scottish Health Action on Alcohol Problems (SHAAP)
Thursday 26 February
Public Discussion Forum

The public discussion forum heard in particular from three of the speakers who were also to give presentations at Friday's full-day conference.

In summary, Professor Anne Lingford-Hughes spoke of the biology of addiction, and described how advances in scanning of brain function and chemistry, for example, are improving our understanding of what alcohol is doing in the brain, and how this is leading to new treatments.

Dr Fiona Measham sounded a note of optimism, saying that the alcoholic excess of the last 15 years in particular may be levelling off, (although figures reported were only for England), but gave a valuable insight into the reasons why alcohol consumption has been increasing for the last half century.

Professor Robin Room outlined research which showed the indirect cost of alcohol – ‘passive drinking’ – in its effects on people other than the drinker, including families and society in general.

The discussion was chaired by Dr Bruce Ritson, Chairman of Scottish Health Action on Alcohol Problems (SHAAP). He asked whether there is something ‘special’ about Scotland and its relationship to alcohol – after all, it is possibly the only country to have given its name to a drink (Scotch). Scotland has a drinking problem – as evidenced by a visit to any town or city centre on a Friday or Saturday night. But are we passive victims, he asked, or can we do something about it?

Professor Anne Lingford-Hughes, Professor of Addiction Biology, Imperial College, London.

As an addictions biologist and a psychiatrist who, until recently, was treating addicted patients in Bristol, Professor Lingford-Hughes sees the value in learning more about the effects alcohol has on the brain. Alcohol is well-known to rot the brain, but modern brain imaging techniques such as PET and MRI are showing us more specifically how the substance acts on the brain.

For example, PET scans show us that alcohol acts on different pathways, which may lead to clues about the best form of treatment, prevention and how to stop relapse. This includes the use of new and existing drugs and treatments, some of which might replicate the desired effects of alcohol, but less harmfully, while others may help repair the damage already caused by the drug. For example, for people who like the endorphin rush of alcohol, exercise might be an effective substitute.

She showed slides which indicated that even where the brain has
been damaged by alcohol, some of the damage can be reversed by a period of abstinence. In the addicted drinker withdrawal from alcohol also carries health risks, however.

She also sounded a warning about drinking in young people. Because the adolescent brain is still forming, alcohol damage at that stage might well ‘hard-wire’ damage into the brain, which could last for the rest of a teenager’s life.

More details on Professor Lingford-Hughes’s work can be found in the conference report below.

Professor Robin Room, Director, Centre for Alcohol Policy Research, Australia

Usually, the cost of alcohol is calculated in terms of the individual – we’re told how much money it costs to treat alcohol-related health problems and the money lost to the economy because the drinker does not turn up for work. That’s not the whole story, however. Professor Room described research carried out in Australia looking at the people around the drinker and the effects that a person’s drinking has on them. This, he says, gives a wider picture of social costs of alcohol.

‘Passive drinking’ can affect people around the drinker in a variety of ways. This can range from someone being disturbed by rowdy behaviour to becoming a victim of a drunken assault.

Professor Room’s team carried out a national phone survey, which involved interviewing 2,649 people. This found that a significant number (17 per cent) knew a heavy drinker and had been negatively affected. The drinkers included family members and co-workers. A small amount of those questioned had suffered sexual or other assault and children had also been mistreated by heavy drinkers. The research revealed that there was a significant amount of social harm – two thirds said a drinker had disrupted a social occasion such as Christmas – and also community harm. For example, 13 per cent of those affected by the latter had called the police.

Australia is a country not unlike Scotland, and he said that these other costs should be factored in when drawing up alcohol policy – in much the same way as the costs of passive smoking had been a driver for change.

Dr Fiona Measham, Senior Lecturer in Criminology, Lancaster University

Dr Measham sounded a note of optimism in the title of her talk, *The Turning Tides of Intoxication*. She put alcohol consumption in an historical context – for example, although our drinking has been rising in the last 50 years, it has not reached the highs of the Victorian era. And although consumption in the under-16s has
doubled in recent years, it appears to be levelling off now, giving some hope that the tide may be turning again.

She described some of the reasons for what she called the ‘carnival’ of excess in the last 15 years. New types of drinkers – including women and young professionals – are attracted by new-style pubs and bars. New, sweeter, alcopop-type drinks have drawn in new drinkers and now have a significant market share. The way we drink is changing, with men and women of the same age drinking together, rather than in mixed age, same sex groups. Getting drunk is seen as the aim on a night out, usually at weekends – with the notion that young people in particular feel they ‘deserve’ it after a hard week at work. As well as the ‘pull’ factors drawing people to the pub, there are also the ‘push’ factors getting them out of the home. There’s a trend of extended adolescence, she said, with young people staying at home with their parents for longer. Where else is there to go but the pub? For more detail on Dr Measham’s work, see the conference presentation report below.

**Questions/Discussion**

Questions ranged from whether there is a gene for alcohol addiction to habits and perspectives in different parts of the world – on drinking, law-making and treatment. From the floor, Dr Francesca Ducci explained that although there is no single alcoholic gene, there was a genetic component in addiction. “It’s not a yes–no phenomenon, but some people are more likely to develop disease,” she said, adding that it is a complex interplay between genetics, environment and lifestyle factors.

Asked about a possible north–south divide in drinking habits and attitudes, at a global level, the panel agreed that even within Europe there are differences, with the Protestant northern countries tending towards a weekday restraint/weekend excess model while Mediterranean countries tend to drink a little wine with meals daily. But Dr Measham and Professor Room said this is changing, with young people in France, for example, choosing to drink beer and condemning red wine as something drunk by ‘alcoholics or their parents’.

One questioner asked why alcohol isn’t banned, when other drugs are criminalised. Professor Room responded that alcohol is part of our lives. While smoking is now essentially a poor people’s habit, drinking is familiar to newspaper editors, politicians and professionals. Dr Measham pointed out that drugs such as opium used to be available legally but suggested that the historic power of the alcohol industry may have contrib-
uted to keeping it legal. Professor Lingford-Hughes said that society endorses some risks, but not others – for example, horse-riding. One student in the audience asked about teenage drinking, saying that in his experience the students who get wild and drink too much when they come to university are those who have previously had no experience of alcohol. Dr Measham said that the American students at her university, unable to buy drink until they are 21 at home, “think it is Christmas” when they come to the UK.

The topical issue of a doctor who reportedly ‘cured’ himself of alcoholism by taking a muscle-relaxant was also raised. Professor Lingford-Hughes said she had used the muscle-relaxant baclofen in treatment – and stressed that there were more pharmaceutical products available which might prove useful once they had been fully evaluated.

Friday 27 February
Conference
Chairman’s Introduction
Professor Harry Burns, Chief Medical Officer, Scottish Government

Professor Burns compared alcohol today with tobacco 10–20 years ago. “Tobacco used to be our favourite drug, but we’ve left smoking behind and have moved into an era of alcohol addiction”, he said. “The harm to health caused by alcohol-related disease is ‘shocking’” he said – adding that there was no doubt that something needs to be done.

Session 1: Science
Professor Anne Lingford-Hughes, Professor of Addiction Biology, Imperial College, London

Brain Mechanisms of Intoxication, Dependence and Damage

Understanding the biology of alcohol addiction helps us treat and prevent it, says Professor Lingford-Hughes. Recent advances in imaging are helping us see more clearly how alcohol affects the brain. We know that it is a ‘rich’ drug targeting many different chemical systems in the brain and we know that it rots the brain, but now we are able to see the specific vulnerable areas of the brain it affects. Recent advances, for example, in PET (position emission tomography) and MRI scanning, allow us to get a fuller picture of how alcohol acts on the brain.

In her talk, Professor Lingford-Hughes outlined some of the pathways activated by alcohol and other drugs of abuse. For example, drugs, including alcohol and cocaine, increase the concentrations of the ‘pleasure’ chemical dopamine. This chemical is released through what you might call ‘natural’ pleasures, but also mediates the ‘high’ of drugs, she
said. Addicts hit the system so hard that it stops working so well, she said, which can lead to taking more of a drug to try to get the same effect.

The dopamine system is modulated by other neurotransmitters, and they might be targets for possible treatments. For example, the GABA system is the brain’s ‘brake’ on dopamine cell firing. Drugs which increase GABA levels – such as the muscle relaxant baclofen – are increasingly being used to treat addiction in specialist settings and trials in the Europe have been promising.

Other brain systems – such as the opioid receptors – also appear to play a fundamental role in addiction and possibly craving, again providing a useful pharmaceutical target. Drug treatments, both new and existing, may help treat addiction and prevent relapse. They may also help mitigate some of the adverse effects of alcohol addiction, such as memory loss and can therefore help to make it easier for those trying to give up drinking to function in day-to-day life.

Although some damage caused to the brain by alcohol will be repaired by abstinence, withdrawal in itself can be dangerous. However, it’s an exciting time in addiction biology and treatment, with a greater understanding of the mechanisms leading to new modes of treatment.

Dr Francesca Ducci, Institute of Psychiatry, King’s College, London

Genetics of Addiction

Addictions can be inherited and about half a person’s vulnerability is genetic, said Dr Ducci, but it’s a complex disease and no single gene can be blamed. There is specific gene involvement, however, with different genes implicated in different people.

In her talk, she described some candidate genes where differences make a carrier more likely to develop alcoholism and related psychiatric illnesses. She focused on the monoamine oxidase A (MAOA) enzyme, which appears to play an important role in the amount of serotonin (the ‘happiness’ chemical) in the brain. People with a variation in the MAOA gene are more likely to develop alcoholism and antisocial personality disorder. Environmental factors are important too, and may interact with the genetic differences. For example, a study of women who had experienced sexual abuse showed that those with the MAOA variation were more likely to develop alcoholism and antisocial personality disorder. The research findings suggest that the gene influences sensitivity to stress.

The task now is to look for more genes which could in turn provide more targets for treatment.
Dr Alastair McGilchrist, Department of Gastroenterology, Royal Infirmary of Edinburgh; Dr Lesley Graham, Public Health, Information Services Division, NHS National Services Scotland

Scotland’s Liver Disease Epidemic: What’s the Story?

Drs McGilchrist and Graham spoke about what the former called ‘an epidemic of liver disease of frightening proportions’. While Dr Graham explored the reasons behind this, Dr McGilchrist set the scene by talking about liver disease – and alcohol’s role in it. He showed how liver damage happens, comparing pictures of a healthy liver, with one which has become infiltrated by fat, then progressively through alcoholic hepatitis to cirrhosis. The process can take years and can often be ‘silent’ or without serious symptoms. With the complications of cirrhosis, the results could be liver failure or cancer. Alcohol is one of the three most common causes of liver disease, the others being viral hepatitis (both B and C) and obesity. He described the risk factors for alcoholic liver disease, including how much is drunk, what is drunk, how often and how – for example, risk increases if it is taken without food. Individual susceptibility is also important. Drinkers who have other risk factors, such as diabetes or obesity may have increased risk, while hepatitis C leads to a more rapid progression to cirrhosis.

Dr Graham described the current position in Scotland. While chronic liver disease rates and deaths from cirrhosis are falling in most of Western Europe, Scotland has among the fastest growing rates in the world. Scotland’s chronic liver disease and cirrhosis death rates among 45–64-year-old men have increased dramatically in the last ten years and are twice as high as in England and Wales, with rates for women in Scotland higher than those for men in England. While liver disease attacks all sectors of society and rates have risen across all socio-economic groups, the rise has been more acute in the most deprived, (with, for example, men in the most deprived groups 16 times more likely to die than those in the most affluent groups), so contributing to health inequalities. She presented evidence to show that the main driver of the epidemic to date has been alcohol.

She also looked at the figures behind alcohol consumption. At UK level, having fallen in the beginning of the 20th Century, particularly during the two world wars, it has more than doubled since 1950, with a particularly noticeable increase since the early 1990s. Recent revised estimates from the Scottish Health Survey (SHS) suggest that people are drinking more than previously
Reported. For example, 40 per cent of men and 33 per cent of women are drinking twice the daily limits and almost two thirds are drinking over the daily benchmarks. The picture could actually be even worse than this, as the SHS tends to be completed by healthier people, particularly so in deprived areas. Evidence from work with prisoners suggests that there is very heavy drinking in deprived groups. Industry sales data also shows that Scotland is drinking almost two litres of pure alcohol per capita more than England and has the eighth highest consumption of pure alcohol in the world.

Other contributing factors to the high levels of liver disease in Scotland could include smoking rates, which are higher in Scotland than England, and the type of alcohol drunk – Scots drink more spirits than English people, for example.

Wider environmental changes may also account for higher mortality rates, such as the liberalisation of the licensing laws in Scotland in the 1970s and the increasing affordability of alcohol. She considered whether Scotland has reached a ‘tipping point’ where a small change in consumption had made a big difference in mortality, then asked whether something could be done to make a similar change in a positive direction.

A reduction in population consumption of alcohol would lead to a reduction in mortality from liver disease, with a rise in price being one of the most effective ways of reducing consumption. An effective alcohol policy has to be multi-faceted and include targeted approaches as well. Hepatitis C and obesity also need to be tackled.

Panel Discussion
The speakers from the morning session took part in a panel discussion. Issues raised included the importance of co-factors, such as hepatitis C; the interplay between genetics and environment; and how soon effective new drugs would be available.

Asked about whether alcohol policies should be selective – ie, targeted at individuals at most risk – or population-based (eg, through increasing price), Professor Lingford-Hughes said there was a debate to be had. Dr Graham said that brief interventions are cost-effective and that both population-based and targeted approaches in combination were most effective (as recommended by the World Health Organisation, WHO).

A member of the audience pointed out that targeted approaches tended to be more popular with the industry and with most governments, partly because they didn’t want to be seen as ‘nanny’.

Asked about the availability of specialist services and the possibil-
ity of new drugs, Professor Lingford-Hughes said it was an exciting time with many potential treatments, but that it was a complex process to decide what to give and when.

Session 2: Culture
Chairman’s Introduction: Dr Magnus Linklater
Dr Linklater said that drinking and drunkenness had moved from being a private and furtive activity and state. Now they are not only done openly, but are actually celebrated. While it was appalling that town centres were seen as ‘no-go’ areas on Friday and Saturday evenings, he said there was a struggle to find the right policy approach. Indeed, politicians tended to veer between standing back from the problem and being interventionist.

Dr Peter Anderson, Consultant in Public Health and Alcohol Policy, Ministry of Health, Catalonia
Alcohol, Inequalities and Health
Dr Anderson focused on socioeconomic inequalities and looked at what alcohol meant for policies based on a single country, both Europe-wide and globally. For each, he considered alcohol consumption, alcohol-related deaths, the impact of bad policy and the potential impact of good policy.
People in lower socioeconomic groups are less likely to drink, but those who do are more likely to drink heavily and suffer alcohol-related harm – compounded by social deprivation and social exclusion. Bad policy – such as reducing taxes on alcohol – tends to result in everyone drinking more, but affects those in lower socioeconomic groups more. Good policy, on the other hand, is likely to reduce negative alcohol-related socio-economic inequalities, he said.

The current economic crash, he said, could have good and bad effects. It is potentially positive because it may reduce affordability of alcohol so people may drink less. It is potentially bad, because changes in social dislocation and cohesion may increase problem drinking. He said there was a need for strengthened alcohol policy, which reduces the affordability and availability of alcohol.

At a European level, there are alcohol-related health inequalities between eastern and western Europe and, in particular, between the Baltic States and the rest of Europe. This means there is a particular need for strong alcohol policies in these areas – coupled with dealing with issues of cross-border trade (which has led to lower alcohol taxes). Globally, Dr Anderson pointed out that poorer countries are hit harder by a given level or pattern of drinking than more affluent countries. This can be due to a variety of factors – for
instance, poor street lighting making drink driving incidents more likely and because poor nutrition might lead to worse outcomes in liver disease and have a role in communicable diseases such as TB. Increasingly, he said, the alcohol burden will be dominated by the burden in low to middle-income countries.

He said there was a need for a global framework convention for alcohol policy and that action was needed to counteract the activity of the alcohol industry, particularly in poorer countries. He gave the example of a government alcohol policy in sub-Saharan Africa, which was industry-friendly and which actually turned out to have originated from industry. Effective alcohol policy within and between countries is likely to reduce alcohol-related health inequalities, he concluded. This could be needed even more in times of economic turmoil, where although consumption might decrease, the potential for harm is different.

Dr Fiona Measham, Senior Lecturer in Criminology, Lancaster University

*The Turning Tides of Intoxication*

Dr Measham has conducted research on the frontline – in the pubs and clubs of Manchester. In so doing, she has witnessed the environment in which people, particularly young people, drink and has also observed the factors which have contributed to increased consumption. For example, as well as various happy-hour-type discounts, she found one venue where free vodka is served for a specific period. She has also asked young people about their drinking as well as looking at the overall epidemiological evidence.

She shared some of her findings at the conference, and speculated, with some optimism, that we might be seeing the end of the last 15 years of excess – the ‘carnival’ she called it – and said that while the rise in young people’s drinking was levelling off, she was detecting that drunkenness might be going out of fashion.

First, however, she looked at the factors leading to more drinking. These include the ‘pull’ factors, encouraging people to drink, such as new-style pubs attracting new drinkers and drinks such as alcopops. She also spoke about the environment and policies of pubs and clubs which encouraged drinking – such as no seats, the availability of table service, the fashion for ‘shots’ (often unmeasured) and the high price of soft drinks.

She also spoke about the ‘push’ factors – the period of extended adolescence which means that young people live at home longer and want somewhere to go.
While accepting that binge drinking is a problem, she said it isn’t new, giving the example of the 19th century gin shop. She also suggested that it is a particularly northern European Protestant pattern of working hard during the week then ‘letting go’ at weekends, in comparison to traditional Mediterranean drinking habits of a little wine each day with meals. In the last 15 years there has been normalisation of binge drinking – among young men and women – she said, and also a normalisation of determined drunkenness. She hopes the tide is turning, however.

Susan MacAskill, Institute for Social Marketing, University of Stirling and the Open University

Consumption Norms: Hidden Problems, Complex Solutions

It is acknowledged that alcohol consumption and alcohol-related harm are increasing, but the media, public and policy focus has been on the young ‘binge’ drinker. Many people in Scotland are drinking too much, however, and that includes people from all age groups and social classes. Marketing and media contribute to the pervasiveness – and normalisation – of drinking. The industry makes drinking easy and attractive and the media underlines its place in our lives – for example by setting so much action in soap operas around the pub.

At the same time, when the media portrays drinking problems it concentrates on extremes, such as drunken violence, which makes it easier for many people to distance themselves and not see their ‘normal’ way of drinking as a ‘problem’ – in a sense it is hidden as an issue.

The Institute of Social Marketing at Stirling University carried out some qualitative research which looked at drinking in both urban and rural settings and among the advantaged and disadvantaged populations. Researchers questioned 172 people and found high levels of consumption across the board. Key findings were that there is no single drinking behaviour; individuals can drink a lot without recognising a problem, people have their own ‘sensible’ drinking strategies and there is media and marketing awareness. People’s drinking habits change with age and with life stages and motivations vary too. For example, people can drink to relax, to celebrate or even just to get drunk.

She gave two examples: an affluent urban woman in the 40–55 age group, who drinks every day, adding up to 55.9 units per week. She did not realise she was drinking so much. The other was a woman in the 18–30 age group in a rural deprived household who can drink 40.75 units – in a single night – but nothing the rest of the week.
The research found high weekly consumption among affluent drinkers – many of whom drink every day – and heavy episodic drinking among poorer people. People mostly distanced themselves from the totals recorded, for example, saying it hadn’t been a typical week and blaming ‘young people’ and ‘alcoholics’ for the ‘problem’. Self-perceived ‘sensible’ drinking included being aware of personal limits and ensuring plenty of time to recover before going back to work. People were aware of the concept of units, but they were felt to be difficult and impractical to apply in a drinking session, and so were easy to ignore. One quote from a rural affluent man in the 31–59 age group was: “How many pints is 20 units? Ten pints a week! I spill more than that!”

She concluded that people may be heavy drinkers but that they don’t see themselves as such and think ‘others’ are the problem. There’s a need to reframe the problem so that it connects with people and makes it harder for them to distance themselves. Multi-faceted approaches are needed as there is no one Scottish drinking behaviour. She believes the lessons from marketing – including understanding of target groups – need to be learned. Action is needed at an individual and population level, including promoting positive (sensible drinking) options, addressing price and availability of alcohol and challenging current definitions of problem drinking. Challenging cultural drinking norms and developing an environment supporting sensible drinking is also important, she said.

Panel Discussion
Questions covered issues including labelling, the possibility of ‘shock’ advertising and the risks to an ageing population. While it was important to learn the lessons from marketing, Ms MacAskill said there were no easy solutions. She was not particularly in favour of ‘shock’ pictures of diseased livers on wine bottles, but would like to see more done to emphasise the positives of not drinking too much – for example, weight control. Dr Measham said it was easy to evade shock messages: for example, people sometimes use stickers to cover warnings on cigarette packets. Dr Measham was questioned about her ‘optimism’ when the disease burden in Scotland is far more pessimistic, with alcohol-related death rates continuing to rise. She said that while she is optimistic, her feeling was based on work done in England and that in any case drinking levels are still too high.
Summary Closing Talk
Professor Robin Room, Director, Centre for Alcohol Policy Research, Australian (this talk was supported by SHAAP)

Choices for a Society in Reducing Drinking Problems

Professor Room described the conference as a 'rich day, with a rich tapestry of presentations and discussions'. He offered a few closing thoughts about the way forward in Scotland and in the world generally.

Scotland, he said, had the potential to be bold with its proposed new alcohol legislation, which would tackle pricing, marketing and displays and the age at which people could buy alcohol. The rest of the world would be watching.

He said there were risks with whole-population approaches, with politicians in particular nervous of being accused of creating a nanny state. But there were dangers with targeted approaches too, including the ethical problems of how to select and how to intervene. Governments need to pay attention to evidence and then evaluate policies so that others can learn from them.

Capturing people's hearts and getting them on board is also important – not giving the technocratic point of view only. Community groups might help do this, just as the actions of the temperance movement had far-reaching effects which last to this day.

This is a 'fateful moment' for Scotland, he said, and will be watched in the rest of the UK and the broader world arena.
Dr Colin Urquhart, winner of the prestigious Gannochy Trust Award for Innovation, which carries a £50,000 prize, invited a captivated RSE audience to don their 3D spectacles and view the revolutionary technology which is making a big impact in facial surgery, orthodontics and even the entertainment industry.

From the zombies in Hollywood blockbuster 28 Weeks Later to burns units, psychology labs and orthodontic practice, the technology of Dimensional Imaging Ltd is making itself felt. The Scottish company has sold its products to customers around the world and is continuing to develop new and exciting technologies.

Chief Executive Officer, Dr Colin Urquhart, 2008 winner of the Gannochy Trust Innovation Award of the Royal Society of Edinburgh, described how the company was set up to exploit the technique of passive stereo photogrammetry, which is used to derive accurate, high resolution, three-dimensional surface images from stereo pairs of images captured by standard digital cameras. The company's DI3D (TM) system, the first commercial application of its type, is being used in diverse fields ranging from the medical and psychological to entertainment.

But it didn’t start out like that. In an engaging lecture, Dr Urquhart took the RSE audience through a whistle-stop tour of the history of using stereo images to allow depth to be perceived, which was first described by Charles Wheatstone in 1838. This work was then refined by Dr David Brewster in 1849, who invented the prism stereoscope and went on to develop the technology further. Dr Urquhart used this example to explain the difference between invention and innovation. Innovation is more about entrepreneurship, he believes, because it probably means introducing an invention to market. While Wheatstone invented the stereoscope, Brewster was the innovator. The Victorians realised they could take measurements from stereo photographs – a process called photogrammetry. A century later, in the 1970s, neuroscientists became interested in taking this further because they wanted to understand how we perceive
depth. They used tools such as random dot stereograms, as
developed by Dr Bela Julesz, which helped to show how depth is
perceived by the human brain. The advent of computers meant that
theories could be tested more easily. But in 1989, when Dr Urquhart
was working for his Masters degree, it still took days to
compute images and the technology didn’t work with natural
images, possibly because they didn’t have enough texture. Dr
Urquhart and his supervisor, Dr J. Paul Siebert, developed active
stereo photogrammetry (ASP), which involved projecting random
patterns on to the same images, and was able to capture a three-
dimensional model. Dr Urquhart described how he and his supervi-
sor were very excited about this, so published their findings. Had
they patented them, things may have taken a different course, he
said ruefully. Unlike traditional methods of creating 3D pictures,
which use lasers and can take up to several seconds to scan an
object, ASP was instantaneous; indeed, its applications are still in
use today.

In 1995, Dr Urquhart worked with facial surgeons at Canniesburn
Hospital and helped to develop a technique which involved combin-
ing the ASP technology with x-ray, to give a picture of hard and soft
tissue. Again, this technology was probably patentable; but again, Dr
Urquhart and his colleagues chose to publish instead.

Further developments were made to the ASP technology, including
the addition of colour, but attempts to commercialise it were
unsuccesful. Around this time, however, at the turn of the
Millennium, digital camera technology was moving on apace.
Returning to Glasgow University, Dr Urquhart and his former
supervisor used two high-
specification Kodak cameras to
create 3D surface images which
were even higher resolution and
better quality than those previous-
ly achieved with ASP. There was no
need to capture a second image
and colour was ‘built-in’. This was
to become passive stereo photo-
grammetry, which definitely had
commercial possibilities.

Following Proof of Concept
funding from Scottish Enterprise,
Dr Urquhart and colleagues
developed a demonstration reel,
which showed how real people
could be turned into virtual
characters. Their target was the
video games market, with the idea
that life-like 3D images of anyone
– be they celebrities or ordinary
punters – could be dropped into
games. A company, then called
Virtual Clones, was formed in

Dr Urquhart showed the compa-
ny’s development from its very
early stages, with particular
reference to financial challenges.
He believes it was the right approach that he and his co-founder set up the company, rather than the university. Entrepreneurs should set up companies, he believes, because they will drive it forward.

The chosen market – entertainment – was not to prove fruitful at first, however. In August 2003, they made their first sale, but it was to the Glasgow Dental Hospital and Southern General – users of the previous ASP technology. A change of focus followed, and the young company turned its attention more closely to the medical market. The move was successful. Since then, the technology has been used to create ‘virtual patients’, on whom techniques can be tested and measured. It lets maxillofacial surgeons observe precise images of patients before and after surgery and measure outcomes objectively. ‘It allows them to see, measure and assess what they are doing – they can capture the patient at all stages of treatment,’ he said.

In 2005, the company name was changed to Dimensional Imaging, which better reflected the medical focus. At the same time, the company was able to exploit advances in digital camera technology which, as Dr Urquhart put it, meant you could get more pixels for your pound. Cameras are getting cheaper and higher resolution all the time, and Dimensional Imaging can use these advances to provide ever-better products.

Other applications have since been developed. These include using the technology to treat facial burns – where previously the patient would have to undergo an unpleasant plaster-casting of the face, probably involving an anaesthetic, the DI3D system allows a highly accurate ‘mask’ to be made without even touching the patient.

The technology is also of interest to psychologists, who use it to morph the shape and appearance of a number of people into a single image – a technique very useful in the growing discipline of facial recognition, where applications include witness identification.

And finally, as if to come full circle, the entertainment industry has been knocking at the company’s door. As well as being used to create some of the zombies in 28 Weeks Later, Dimensional Imaging systems have now been sold to major UK and US video games companies. ‘Our original business plan wasn’t wrong – just five years ahead of its time,’ he smiled.

Last year the company made a profit for the first time and Dr Urquhart plans to invest the £50,000 Gannochy Prize in Dimensional Imaging to help it to develop new technologies and to
continue to innovate. He aims to use any future returns from the investment of the Prize to help support other young innovative Scottish companies.

Dr Urquhart finished with a brief description of the company’s latest innovation, which adds the fourth dimension – time – with the use of video cameras. This can capture three-dimensional sequences of dynamically changing surfaces, which allows even very subtle changes to be captured accurately. In facial surgery, for example, the data can be used to measure facial function, while in video games it creates more realistic facial animation. It’s a novel technology on the world scale and is revolutionising our ability to track temporal changes.

In conclusion, Dr Urquhart summed up some of the lessons he has learned. Innovation is harder than invention, he believes. It’s tough, but satisfying, to see products that embody technology you have developed sold across the world. You can innovate with existing technologies – arguably his innovation is based on an invention from 160 years ago.

Cash is king – and so is the customer: talking to and getting feedback from those who use the equipment is vital to development. And you have to adapt to survive. His company started with a focus on entertainment, moved to medical applications, and this financial year so far, a third of the sales have come from entertainment. He ended with an advert – anyone interested in the technology should contact him for a chat.

http://www.di3d.com/
They said it couldn’t be done. For years, the prosthetics industry focused on delivering incremental improvements to a pincer-like hand design that was not a true reflection of a human hand. The concept of a hand with articulating fingers was considered too great an engineering challenge for prosthetic device companies. While the industry stood still, a small company from Scotland was tearing up the rule book and forging ahead with the development of the *i-LIMB Hand*, the world’s first bionic hand. That company was *Touch Bionics* and this is their story.

**Advanced design**

*Touch Bionics* is the first company to offer commercial availability of a true bionic upper-limb product. Both the *i-LIMB Hand* and *ProDigits* have been fitted to many different patients at a number of leading prosthetic and orthopedic clinics both in the US, the UK and in another 28 countries around the world.

The modular construction of the *i-LIMB Hand* means that each individually -powered finger can be quickly removed by simply removing one screw. This means that a prosthetist can easily swap out fingers that require servicing and patients can return to their everyday lives after a short clinic visit. Traditional devices would have to be returned to the manufacturer, often leaving the patient without a hand for many weeks.

**Controlling bionic devices**

The *i-LIMB Hand* relies on some of the most advanced control software yet seen in the prosthetics industry. This software provides speed and grip-strength control to the device, while patients generate signals to control the device in a way that does not differ from how traditional devices operated in the past. Two small metal electrode plates, which detect the minute electrical signals generated by the remaining muscles in the limb stump, are placed against the skin to pick up signals. Traditionally one electrode is placed on the top of the forearm and the other on the bottom.
Patients usually have a sensation that their hand still exists despite it being amputated, something often referred to as ‘phantom’ feelings. When encouraged to generate a strong signal, the patient is often asked to move and flex their missing hand to generate a strong control signal. Before too long, these reflexes become intuitive.

Feedback from early patient studies identified that software adjustments can allow patients to perform simple tasks and improve functionality. An example of this is thumb parking, instructing the thumb to close down against the side of the hand to allow a jacket to be put on. Another is a completely new grip function for prosthetic hands, the index point, whereby the hand grasps into a fist whilst leaving the index finger extended. Patients have found this very useful for operating computer keyboards, telephone dial pads, ATM cash machines and a host of other everyday requirements.

**Advances in cosmesis**

Cosmesis is the flexible skin covering that covers the *i-LIMB Hand* and *ProDigits*. By applying in-house expertise and partnering with companies that specialise in cosmesis, *Touch Bionics* has achieved major breakthroughs in the aesthetic appearance of its prosthetic products. The *Touch Bionics* products are the first prosthetic hands to imitate the true movement and life-like accuracy of a human hand. The challenge has been to find materials that can move and flex in the same way that human skin does.

This has been addressed in two ways, in order to support two distinct patient preferences. Some patients, mainly military personnel, particularly love the robotic nature of the uncovered *i-LIMB Hand* and prefer not to wear it with a cosmesis glove. However, because of the need to provide a grip surface and to protect the hand from dust and water, *Touch Bionics* has developed the *i-LIMB Skin*. This is a thin layer of semi-transparent material that has been computer-modeled to accurately wrap to every contour of the hand.

Other patients wish their device to blend anatomically with the rest of their body, and have a life-like covering for the *i-LIMB Hand* and *ProDigits*. As these products are more anatomically correct than any currently on the market, which not only allows for increased functionality but also a vastly improved cosmetic appearance, the challenge has been to find a high-definition cosmesis of superior quality. *Touch Bionics* has launched with custom cosmesis products from two of its cosmesis partner companies.

Full report available: ISBN No 978 0 902198 80 7
“Prisons sometimes do good but they always do harm” was how Dr Andrew McLellan concluded his lecture on the problem of finding realistic alternatives to prison for young offenders. And to grasp the opportunity for change, he declared, we need to realise that these young offenders belong to us all…

Dr Andrew McLellan may talk himself out of a job as Her Majesty’s Chief Inspector of Prisons, but nothing would give him more pleasure than to see our overcrowded jails emptied of inmates, because rather than viewing our prisons as a cure for society’s ills, he believes they are one of the causes.

His started and ended his lecture with six thought-provoking quotations, from a wide range of people including Albert Einstein and former First Minister, Henry McLeish:

1. We should do all we can to keep people out of jail.
2. We can’t reverse the damage done to children if there’s an absence of nurture beyond age two or three.
3. Prisons can’t solve the problems of Scotland.
4. Most offenders are “daft lads and lassies,” not villains.
5. Insanity is doing the same thing again and again and expecting different results.
6. To halve the prison population, everyone must “grasp the opportunity for change.”

Einstein’s definition of insanity echoed McLellan’s description of the typical cycle experienced by many young offenders, who commit crimes again and again and are institutionalised again and again, then carry on doing the same when they’re older. That’s why prisons are not the solution, he said. Housing, education, better healthcare and employment, as well as drug and alcohol treatment, are the keys to success, and what happens after release matters much more than prison itself.

The crime–prison cycle can sometimes seem impossible to break, but taking inspiration from Barack Obama, McLellan thinks that “yes we can” can transform Scotland’s all-too-common attitude of “no we cannae.” He also thinks that if we want to bring hope, not despair, “it’s now
or never – the opportunity won’t come again in our generation.”

McLellan then described a few examples of programmes which do make a difference, including the Venture Trust, Columba 1400, The Duke of Edinburgh Awards, Includem and the Motorcycle Project. Like the Airborne Initiative, these projects challenge young people emotionally and socially, and “powerful learning takes place,” said McLellan.

Young people get more confidence through gaining a sense of achievement and working as part of a team, and drug abuse tends to reduce at the same time as the rate of offending behaviour. The projects are also fun, said McLellan – a far cry from typical prison conditions. And the lesson which McLellan draws from all of these projects is that if politicians want to reduce crime, they should pay more attention to youth groups, and invest more in probation and community services, both of which are now “hopelessly under funded.”

Some new programmes offer considerable hope for the future. For example, in “Routes out of prison” young offenders are mentored immediately after release by a former offender who knows how they feel and can speak the same language. The mentor not only offers advice but accompanies the person to appointments at job centres and housing offices, etc, to make sure offenders stay focused on trying to rebuild their lives, instead of drifting back into their old ways.

What we need for young offenders, said McLellan, is what social workers call, “wraparound support” including a new approach to probation, integrated with health care, education and help with employment and housing. All of this would cost a lot of money, he admitted, but how much do we value our young people – and how much do we spend on our prisons already? Why is it, he asked, that we question the value of punishment in the community much more than we question the value of prisons?

To put a human face on these ideas, McLellan then invited the audience to “Meet Danny” – a young man who has been in and out of the Young Offenders Institution in Polmont three times already this year. Like 90 per cent of the inmates, Danny is a repeat visitor, and he sometimes returns in a matter of days, a victim of his own alcohol problem, which started when Danny was just eight years old.

Conditions in Polmont have improved significantly in recent years, but there is no escape from some things, such as the lack of privacy and overcrowding. There are programmes to help with addiction and relationship
problems, including a course to help young offenders become more aware of the consequences of their own actions. But despite all the good work that Polmont and other institutions may do, McLellan very strongly believes that it cannot provide all the answers. And the statistics confirm this – the 575 inmates have committed 4,508 offences between them, or an average of seven per person, and the figures will only get worse unless we change our attitudes to treating young offenders.

Finally, McLellan added, we need to change our attitudes to the young people themselves, and realise that “prisoners are not them – they are us.”
Introduction and Summary
As populations age, the need to find safe and effective treatments for diseases which primarily afflict older people becomes more acute. There are, however, challenges in making this happen, not least the current status of the pharmaceutical industry, where a massive investment into drug discovery has been accompanied by a dramatic fall in the number of new therapies introduced per annum. The conference heard about the current state of play in treatments of diseases affecting the elderly, as well as hopes for the future. The morning session focused on Alzheimer’s disease and dementia, while the afternoon looked at heart failure. In the evening, exciting potential treatments for age-related macular degeneration – the most common cause of sight-loss in the over-60s – were discussed, along with industry’s approach to drugs for dementia and the push towards personalised medicine, tailored to individuals.

Session One: Alzheimer’s
Chair: Professor Leslie Iversen, Department of Pharmacology, University of Oxford
Alzheimer’s disease is the most common form of dementia and the number of people suffering from it is predicted to increase dramatically as the population ages. There is no cure, but a number of potential therapies are in the pipeline. There are challenges, but personalisation may help provide some answers.

Translational Medicine and the Crisis in Drug Development
Professor Garret FitzGerald, Director, Institute for Translational Medicine and Therapeutics, University of Pennsylvania
Professor FitzGerald called for a new model of drug development, which he said would benefit patients as well as the pharmaceutical industry. This new model would include more partnerships with academia and better investment in ‘human capital’ – the scientists and clinicians who can bring treatments from the bench to the bedside. He spoke of the
Review of Sessions 2008/09 and 2009/10

crisis in pharma, with only 17 new drugs approved by the FDA in 2007 – the lowest number since 1983. Previously, high prices for prescription drugs have insulated the pharmaceutical industry, but now they recognise that they have a broken business model.

He spoke about the potential benefits of personalised medicine, bringing in the example of Vioxx (rofecobix), which was withdrawn from the market when found to increase the risks of cardiovascular disease. If companies knew which patients would react well or badly to a drug, that knowledge would increase safety and improve effectiveness. He said there is a need to combine quantitative measures of drug response with genetic information, and then relate these to clinical outcome. He described the current ‘broken’ model as one where there is massive and quite effective investment into drug discovery but poor translation to new products.

There are also two ‘cliffs’ facing pharma, relating to patents and generic drugs. Some calculate a decline in revenue stream of up to 40 per cent, due to patents expiring. Increased use of generics – now 60 per cent of prescribed drugs in the US – is also hitting profits. Pharma is trying to cope with these challenges in various ways, including mergers which allow for efficiencies (i.e. job losses), but Professor FitzGerald suggested some other solutions.

Academia has talented physician scientists with access to patients, but traditionally these have been resource-starved. Often too, they are poorly educated in pharmacology, which may hinder the drug development process. There are few incentives for ‘team science’ – which brings expertise together – and huge competition for grants, which is helping to keep younger applicants out. On average, physician scientists are now in their 40s before getting the funding which makes them independent, making academia unattractive as a career.

Professor FitzGerald suggests more collaboration between academia and pharma, but also advocates a changed approach to trials. There is pressure to get into Phase 3 trials, at the expense of selecting doses and understanding how a drug works, he said. Currently, Phase 3 trials assume one dose works for everyone, ignoring the potential benefits of personalisation.

He suggests a new discipline which develops quantitative biomarkers which can be used to measure response and use these to come up with the optimal doses for people with different phenotypic responses. He would like academia, industry, funders and regulators to work together to develop a unitary nomenclature
and agree core competencies. He’d like funding to be revised and to be focused on longer term and more heterogeneous portfolios. He’d like more emphasis on Phase 2 trials, including on personalised doses, and he would like more people with good knowledge of pharmacology to be at the centre of the process.

The Elderly in Scotland and their Health

Professor John Starr, Department of Geriatric Medicine, University of Edinburgh

Professor Starr gave an overview of the current state of health of older people in Scotland and, based on evidence, made some predictions about the future. Life expectancy is going up and the number of over-65s is increasing. By 2031 the 60–74 age-group will have increased by 40 per cent, while there will be 91 per cent more people aged 75 and over. This is likely to have an impact on health and social care.

Professor Starr looked at what it means to be healthy, including how people feel about their own health and what society says health means. He also described some of the conditions suffered by Scotland’s elderly, including osteoporosis, dementia and depression. As the population ages, rates of these conditions are likely to increase.

Professor Starr looked at what’s being done now to look after older people. Based on current trends, he said that Scotland’s elderly are likely to live longer, spend a longer time with disability (particularly women), and have improving physical, but worsening mental health. Life satisfaction is unlikely to change. Based on a survey carried out in Scotland in 2000, a man aged 65 now can expect to live another 17.2 years and a woman 19.9 years. Both sexes could look forward to about 10 years of good health and a further five years of modest ill health while the remainder of between two and five years would be spent with a considerable incapacity.

Demand for hospital admissions and care at home and in care homes increase when people reach 65, although the number of GP visits remains about the same. Older people use more prescription drugs than younger age groups, but many are prescribed inappropriately. Adults over 60 years have 3.6 times more prescriptions than younger adults and up to 80 per cent of elderly people receive inappropriate treatment, he said, with some being hospitalised due to adverse drug reactions. Importantly, some drugs which are commonly prescribed will have an effect on cognitive abilities.

He concluded that there will be a substantial increase in numbers of older people, living with and
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without disability; that there will be changing patterns of disease, increasing numbers or prescriptions and increasing risks of adverse drug effects. The impact on health and social services is difficult to measure.

New Drugs for Cognitive Decline

Professor Alistair Burns, School of Medicine, University of Manchester

Professor Burns looked at dementia now and in the future. He summarised current and potential treatment strategies and also considered prospects for prevention.

Dementia affects 700,000 people in the UK and this figure is expected to rise as the population continues to age. Public awareness has never been higher, partly due to a number of official studies and documents which have been publicised and partly as it becomes a pressing political and economical issue. According to a King’s Fund report, for example, incidence of Alzheimer’s disease (AD) (the most common cause of dementia) will increase by 61 per cent between 2007 and 2026, with costs projected to rise from £14.9 billion to £34.8 billion over the same period.

There are known treatments for AD. These include the cholinesterase inhibitors, (donepezil, (Aricept), galantamine (Reminyl), rivastigmine (Exelon)) and the glutamatergic agent memantine. While the former can be prescribed on the NHS for ‘moderate’ disease, the latter is only available as part of a clinical trial. Other treatments including antidepressants, antipsychotics, and novel interventions, including aromatherapy, are also used in the management of dementia. The economic case is difficult to make for these drugs.

A number of drugs are being developed with the aim of slowing down the cognitive decline in dementia. These include those which tackle the amyloid plaques, which develop in a brain with AD, and the tau protein, which is implicated in the neurofibrillary tangles characteristic in AD. There are a number of vaccines and other products in the pipeline, including the possibility of the use of a Rember, which appears to act on tau, although this work has yet to be published.

Other possibilities include the use of a non-selective antihistamine (Dimebon) and even a food supplement, Souvenaid.

Public interest in AD is high and every week, it seems, a new paper is publicised, but nothing definitive has emerged as yet. There is also public interest in prevention of dementia, and there are known risk factors. These include sociodemographic factors, education level, habits, genetics and medical history and treatments, in addition to age. Hypertension and
high cholesterol levels are risk factors, so it is possible that reducing these might help prevent AD. Keeping the brain active and participating in social networks may also be protective.

Professor Burns concluded that public interest in dementia has never been higher, that current treatments are safe and effective and that there are real and realisable prospects for prevention.

Session Two: Management of Heart Failure
Chair: Professor Henry Dargie, Department of Cardiology, Golden Jubilee Hospital

Heart failure is a serious condition which affects young and old but is more common in the over-75s. There is a vast array of drugs available, but recent advances have included device therapies, such as implantable defibrillators. It’s a common, complex and lethal condition, said Professor Dargie.

Essential Clinical Standards for the Diagnosis, Treatment and Long-Term Management of Chronic Heart Failure
Dr Martin Denvir, Consultant Cardiologist, Royal Infirmary of Edinburgh

As well as being a consultant cardiologist working with patients, Dr Denvir is clinical advisor to NHS Quality Improvements Scotland (QIS) and is involved in drawing up clinical standards for the management of heart failure. This is part of a large body of work, which included Scottish Intercollegiate Guidelines Network (SIGN) guidelines on chronic heart failure published in 2007, and draft standards on the prevention and treatment of coronary heart disease more widely, which were published in February of this year. Dr Denvir described some of the process in drawing up standards and guidelines, and also said that implementation of the SIGN guidelines had been variable. Cardiologists were more familiar with the guidelines than GPs, although the majority of heart failure is treated in primary care.

The clinical standards may be a way of ensuring more consistent implementation of guidelines, which include recommendations on diagnosis, pharmacological treatment, a multi-disciplinary approach to care, the use of device therapies, and supportive and palliative care at end of life. Standards should be clear, measurable and evidence-based, he said. They should be small in number and achievable, but stretching. Dr Denvir accepted, however, that there were many demands on doctors and health boards, so the aim is to make complying with the guidelines, and with audit and monitoring, as streamlined and painless as possible.

Management of heart failure will be continually assessed, however,
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under the Scottish Patient Safety Programme. The national heart failure audit will include six to ten measures or indicators to show how well patients are being managed.

He concluded by saying that the evidence was out there and the guidance written; the standards of care are agreed and implementation and measurement of the quality of care must be linked in a clear process that everyone understands. They should promote care which is effective, safe, timely, efficient and patient-centred.

The Efficacy of Intracardiac Devices in the Management of Sudden Cardiac Death and Ventricular Dysfunction

Dr Neil Davidson, North West Regional Cardiac Centre, Wythenshawe Hospital, Manchester

As well as drug therapies for heart failure, the meeting heard that other interventions, including specialist nurses and electrical devices such as pacemakers, had made a big difference to treatment, quality of life and survival.

Dr Davidson described the history of implantable devices, talked about their benefits and disadvantages and discussed emerging and possible future technologies. Intracardiac devices have been in use for some 50 years, beginning with the simple pacemaker. More recent developments have included resynchronisation devices and internal defibrillators. Much of the progress in intracardiac devices has been driven by technical advances outside medicine, as batteries and processors have improved dramatically.

The UK lags behind much of the rest of the developed world in its rate of implantation. There could be a number of reasons for this, including affordability – more devices are implanted in healthcare systems which rely on the number of procedures for payments – and lack of awareness of the benefits among health professionals.

There is also the question of acceptability to patients: some do not like the implantable cardiac defibrillator (ICD), for example, because it works by delivering a ‘shock’ when it senses cardiac arrhythmia in patients at risk of sudden cardiac death due to ventricular fibrillation. Sometimes it is activated in error and there can be psychological side-effects for patients.

While electrical devices show good results, resynchronisation devices, for example, help improve heart function and lead to better quality of life – but they are expensive and aren’t getting cheaper. Resynchronisation devices cost around £6,000; when combined with a implantable
cardiac defibrillator, the cost goes up to £15,000. Dr Davidson said that the manufacturers did not focus on producing cheaper models, but instead kept prices constantly high by adding ‘bells and whistles’. He drew attention to the way mobile phones have become ever more complicated but no cheaper.

In the future, he believes there will be further useful refinements. For example, information from the blood flow in the patient’s individual cardiac chambers and major blood vessels (haemodynamic monitoring) using ‘wireless’ devices with no leads might be used to adjust medication.

He concluded by saying that electrical devices had improved quality of life and that they should be used more. In his view, technological advances should be focused on cost-effectiveness.

**Which New Medicines Produce Heart Failure and Which Alleviate It?**

**Professor Allan Struthers, Department of Clinical Pharmacology and Therapeutics, Ninewells Hospital and Medical School, Dundee**

There have been a number of successful drugs for heart failure introduced since the 1980s and ‘90s, including the neurohormonal therapies of ACE inhibitors and beta-blockers. Since then, however, the major advances in treatment have been the use of specialist nurses and of intracardiac devices, such as CRTs and ICDs. Professor Struthers outlined the current strategies for finding new drugs. These include looking for other neurohormones to target, following the success of ACE inhibitors, and there have been trials of a number of possibilities, including testosterone. Another strategy has been to re-examine inotropic drugs, which was where the so-called ‘smart money’ was before ACE inhibitors proved more effective. He described two inotropic drugs which might be promising. Other potential therapies could involve those acting on the cardiac metabolism, or antiarrhythmic drugs, such as fish oils.

There is also a suggestion that drugs in use for other conditions, for example Viagra, might have an application in heart failure. The twist, however, is that some drugs, which have been introduced for other diseases, seem to cause heart failure. These include some anti-diabetic drugs and the cancer drugs doxorubicin and herceptin. In the case of herceptin, the heart failure seems to be reversible when the drug is stopped. However, an understanding of the detrimental action of these drugs on the heart muscle might provide clues to potential therapy targets. Professor Struthers said that there are hopeful new drugs around,
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but that more research is needed to see if they provided clinical benefit.

Session Three: The Future of Personalised Medicine

Chairman: Professor David Lawson, Honorary Professor of Medicine and Therapeutics, University of Glasgow

The evening session of the meeting looked at potential therapies for the disease often known as ‘Alzheimer’s of the eye’ because it is so common in older people. It also heard about industry’s approach to treatments for dementia, and learned how, in the genomic age, personalised medicine could be coming into its own.

Future of Therapies for Macular Degeneration

Professor Peter Coffey, Ocular Biology and Therapeutics, Institute of Ophthalmology, University College London

Professor Coffey described new and emerging techniques for treating one of the most common and distressing conditions relating to getting older.

Age-related macular degeneration (AMD) is often called ‘Alzheimer’s of the eye’ – not because it has anything to do with the disease, but because of the vast numbers of older people it affects. AMD is the most common cause of sight loss in people aged over 60 and occurs when the cells of the macula become damaged. The macula is in three layers: the retina, the choroid, and, in the middle, the RPE layer (retinal pigment epithelium). It is the RPE cells which seem to age and die first, affecting the retina’s ability to ‘see’. Professor Coffey is director of the London Project, led by UCL, which aims to find a cure for AMD. This involves using stem cells to halt and reverse loss of sight.

So far stem cells have been used to create healthy RPE cells which have been used to replace those in animal models, most recently in a pig. The possibility of ‘personalised’ treatment exists because a person’s skin could be used to obtain stem cells which could then be used to create RPE cells which could be used in the treatment. This is likely to be an expensive option, however, although the technology might help find new targets for drug treatments.

Stem cell technology is likely to have major advantages over existing treatments. At the moment, the biological drug Lucentis is the main (and controversially expensive) treatment for ‘wet’ AMD, which accounts for around 10 per cent of cases of AMD (with ‘dry’ AMD accounting for the other 90 per cent). Treatment with Lucentis involves injecting the patient in the back of the eye every few weeks at a cost...
of between £1,000 and £1,500 per injection.

There are other possible treatments. Professor Coffey showed videos of patients, one whose central vision had been improved by a surgical technique moving RPE cells from the periphery of the retina to the centre. In another, a retinal flap of healthy cells was rotated to replace the diseased tissue. These techniques take up to three hours, however, so would not be suitable for an outpatient or day-case procedure, compared to 40 minutes for the stem cell operation carried out on the pig. Professor Coffey hopes that techniques using stem cells will be in clinical trials shortly.

**Industry’s Approach**

**Professor Leslie Iversen, Department of Pharmacology, University of Oxford**

Professor Iversen, who for many years held a senior role with the pharmaceutical giant Merck, described industry’s approach to Alzheimer’s disease therapy.

Every pharma company is involved in research and development in the area of dementia, which is seen as a huge marketing opportunity by industry, he said. There is a large amount of unmet need, which will grow as the population continues to age, and current therapies are seen by industry to be making large amounts of money. Global sales of *Aricept* were $2 billion in 2008.

He described the beta-amyloid hypothesis – essentially that too much of this protein in the brain causes ‘plaques’ present in the brains of people with dementia – which has dominated scientific thinking about Alzheimer’s disease in the last 30 years. It is only now that drugs based on this theory are emerging, and so far, they have not been very successful. There are also, however, known genetic factors which increase the risk of AD. For example, there are mutations which promote formation of beta-amyloid and others such as the nature of Apo-enzyme E alleles 1 to 4 which effect the age of onset and the overall severity of the disease.

Currently cholinesterase inhibitors (such as *Aricept*) are the only approved medicines. Other approaches in the pipeline include inhibitors of beta-amyloid synthesis, drugs that may prevent or reverse formation of plaques or vaccine or antibody treatments. There has also been a suggestion that inhibiting aggregation of the tau protein (which leads to tangles in the brain associated with AD) might provide an answer. Cholinergic treatments such as *Aricept* are only moderately effective and many people do not respond. It could be that genetic factors determine who will respond. Beta-amyloid synthesis inhibitors have not proved successful in trials so far, but at
least six other drugs are in development.

Vaccines have looked promising but one trial was halted because the drug caused inflammation in the brains of some patients. There are several other vaccines in development. Another novel approach involves using monoclonal antibodies to clear the disease from the brain. Although successful in animal trials, a Phase 2 clinical trial of one antibody (bapineuzimab) showed positive clinical benefit only in a subset of patients (without the Apo-enzyme E4 allele.)

Professor Iversen said it was too early to write off the beta-amyloid hypothesis, although trial results had been disappointing so far. Most of the trials to date have involved moderate to severe AD patients, where it might be more difficult to see a benefit. Personalised medicine may be a way forward, although industry is naturally concerned about the commercial effects of the stratification of disease, each with a different treatment splitting the market for the individual products.

Phase 3 trials of bapineuzimab will include patients with and without the Apo-enzyme E4 allele — a form of personalised medicine. Post-hoc analysis of earlier trials which is not accepted as evidence by the regulatory bodies, suggests that this division will show some of the new amyloid attenuating strategies to be successful in those without the E4 allele.

He suggested new approaches to clinical trials, including identifying and including patients at an early state of disease and making better use of neuro-imaging and improved tests for cognitive function.

The goal, he concluded, is to improve quality of life for the future. His hopes for the future include seeing the first effective treatment for AD within ten years, and also the use of stem cell therapy to replace damaged or missing nerve cells in the same timescale. He would also like to see ways of identifying suitable people to treat with preventative medicines.

Personalised Medicines: Coming of Clinical Age

Dr Geoffrey Ginsburg, Director, Centre for Genomic Medicine, Institute for Genome Sciences & Policy, Duke University

Dr Ginsburg began by outlining some of the reasons why we need a different sort of medicine. There are safety issues, with some 6.7 per cent of patients suffering adverse drug reactions in hospitals alone. Serious reactions in small groups of patients have led to drugs being withdrawn, for example Vioxx. And there are efficacy factors: even commonly prescribed drugs are ineffective in a substantial numbers of patients.
There are many reasons for a push towards personalised medicine. These include advances in technology and disease understanding on the one hand – including the mapping on the human genome – but on the other hand also including pressure from consumer demand, demographics, health policy makers and industry. Personalised medicine means getting better at knowing who, how and when to treat, and there are a number of ways of doing this.

You can look at risk factors for disease, said Dr Ginsburg, and make predictions. It’s known that risk factors for developing heart disease include smoking, increased cholesterol and high blood pressure, so people with these conditions might be considered for preventative treatment. He cited a paper from 1961, showing that these ideas had been around for some time.

Medicine and biology have moved forward in the last half century from observational to molecular science and, now, to genomic or digital science. The sequencing of the human genome and other advances, such as gene expression profiles, are revolutionising drug discovery and the way we define disease.

Genomics can be used to predict risk and also response to treatment. This is hugely important because it can help develop tailored treatments for diseases which have many forms, for example, breast cancer. Genomics can help us refine prognosis, make better use of available drugs and develop personalised therapies.

Cancer drugs tend to be designed for groups, not individuals, he said, but different people will react differently. For example, although most people who have surgical resection of early stage 1 non-small cell lung cancer will be fine, around 30 per cent will have a recurrence and die. If it was possible to identify that 30 per cent, they might benefit from adjuvant chemotherapy.

A study is being carried out which seeks to use gene expression analysis to predict high risk, with these patients being randomised to chemotherapy or observation (which is the current standard treatment). Gene expression data from tumour samples may also be used to identify which patients will respond to different drugs. Designing clinical trials to do this – so-called trial enrichment – could lead to savings in clinical trials and better identification of the patients who would benefit. The personalised approach to cancer care would therefore involve using genomics to predict recurrence, which would identify whom to treat, and then predict chemotherapy response, showing how to treat.
There is a strong public policy move towards personalised medicine. The Food and Drug Administration (FDA) is behind it, and President Obama, when a senator, introduced a medicine act to ‘secure the promise of personalised medicine to all Americans’.

To illustrate how genomics is moving on, Dr Ginsburg shared his own profile, obtained from one of the many companies which will now provide a read-out for a price. There are concerns about the reliability of such information, however, as well as public concerns about ethics, and the fear of discrimination by insurance companies and others.

Much needs to happen to make personalised medicine a reality, including building better infrastructure, improving information-sharing and getting the right workforce in place. Medicine which is science-based is patient-centred, he said, but pharma cannot achieve this in isolation. Academia, health care systems, federal agencies and others will have to contribute and work together.
The Higgs boson: what, why, how?
A panel discussion organised jointly by the RSE and the International Centre for Mathematical Sciences (ICMS)
21 April 2009

Questions, questions, questions...
In 1964, Peter Higgs came up with an idea which turned the world of physics upside down – a theory which helped to explain how the universe came into being and why it does not fall apart. The critical component of Higgs’ revolutionary theory was a mysterious sub-atomic particle called the “Higgs boson,” but 45 years later, no-one has been able to prove it exists.

At the RSE in April 2009, Professor Higgs was joined by Professor Edward Witten and Professor David Saxon to discuss the missing piece in physics’ jigsaw – and the Large Hadron Collider (LHC) at CERN which is seeking to find it. The panel discussion which ensued was chaired by Sir Michael Atiyah, OM, FRS, Past President of the RSE.

Professor Higgs described how the concept was born, Professor Witten (Institute for Advanced Study and European Organisation for Nuclear Research) discussed the modern theory of the boson and what’s being tested at CERN, and Professor David Saxon (University of Glasgow) outlined the experimental challenges.

The focus of the panel discussion was “what, why and how?” But as the evening developed, it seemed more a question of “when?”

Introduction
RSE President, Lord Wilson of Tillyorn, introduced the discussion by saying it was part of a series of special events, jointly organised by the RSE and the International Centre for Mathematical Studies, to celebrate the 80th birthday of his predecessor as RSE president, Sir Michael Atiyah. Describing himself as a mathematician who had become “a pseudo physicist” later in life, Sir Michael then explained that the focus of the evening was to ask “what’s going on” with the Higgs boson, posing the question to a panel who, between them, covered the whole spectrum of physics. He said that he also looked forward to hearing what is happening at CERN – or what isn’t happening at CERN – as scientists investigate one of the great ‘mysteries’ of fundamental physics...
Professor Peter Higgs – The historical background (what?)

Invited by Sir Michael to talk about ‘where it all started,’ Professor Higgs modestly suggested that he had only been invited because his work “has interesting mathematical connections” with the topic. He then said the idea of the Higgs boson arose from thinking about “spontaneous breaking of a symmetry” – which he said was about “the consequences of having a ground state of a quantum system where the underlying dynamics respect some symmetry under a group of transformations.”

“If the ground state of the quantum system is asymmetric, then that has an interesting impact on the behaviour of the states of the system,” said Higgs. According to quantum theory, he continued, electromagnetic and other fields “come in lumps” or packets of energy which behave like particles – or photons. “Such systems can have an asymmetric ground state or a vacuum,” he continued, “and when the ground state is asymmetric, then the asymmetry spreads into the excitations which are the particle states and you have a broken symmetry.”

Before 1960, the concept of spontaneous symmetry breaking was originally developed in condensed matter physics – e.g., ferromagnets and different kinds of crystal lattice in which matter condenses in various ways, “breaking the continuous translational symmetry that’s in the underlying dynamics.”

No-one took these theories very seriously, Higgs said, until the theory of superconductivity was developed by Bardeen, Cooper and Schrieffer in 1957, describing how the charged particles in a superconductor move about like a superfluid, without friction. In 1960, Yoichiro Nambu expressed this in the language of quantum field theory, and Higgs explained that his role was to “fill in a gap” in the theory.

Another key figure was Jeffrey Goldstone, who expressed the theory of symmetry breaking in more “easy-to-understand” terms, including a model often referred to as the “wine bottle” potential which helps to visualise the various phenomena. “What happens is that the ground state of the system, which classically is just the state of lowest possible energy, is where the value of the field sits – somewhere in the bottom of the wine bottle, instead of on the axis which would be the symmetry point,” Higgs explained.

The trouble, said Higgs, was that in Goldstone’s and Nambu’s models, there were particle excitations which had a mass of zero. These were easy to understand in Goldstone’s language because they corresponded to
excitations of the field around the bottom of the trough where you don’t need to put in any energy to get it to go in another direction in that two-dimensional space, and the Goldstone Theorem was formulated “as a necessary consequence of trying to combine a relativistically invariant quantum field theory with spontaneous symmetry breaking.”

Higgs then explained that the flaw in Goldstone’s axioms was the insistence on manifest Lorentz invariance, and that there was an exception well known to that rule of transformations – the class of gauge theories. “The potentials in the Maxwell theory are ill-defined up to what is called the gauge transformation,” he continued, “and that is the feature which drives a hole through the axioms in the Goldstone Theorem.”

According to Higgs, Philip Anderson said that if you put together the so called Yang–Mills theory (a generalisation of Maxwell’s theory) and a system with spontaneous symmetry breaking, their apparent difficulties would cancel one another out. “But he failed to say why there was anything wrong with that theorem,” Higgs then explained.

Higgs and other physicists then studied what actually happens when you combine a Maxwell type of theory with spontaneous symmetry breaking, and all independently showed that you give mass to the quanta of the Maxwell type of field as a result of spontaneous symmetry breaking.

“So finally, where’s the Higgs boson?” asked Higgs. “There is at least one system in which the Higgs type of excitation has already been detected, and that’s in a superconductor.”

And that is why there’s something for the LHC to look for…

Edward Witten – The theory (why?)

Edward Witten put things in context by saying that particle physics is a modern name for something much older – the quest to understand the laws of nature. In the 20th Century, Witten continued, physicists discovered that subatomic particles play a key role in this quest, and there are “crucial parts of the puzzle” that we can only learn by using an accelerator such as the Large Hadron Collider.

Witten then described how particles are accelerated and how their orbits are bent into circles by powerful magnets. Then, as they go round the ring – two miles across – they collide. The accelerator has to be large, he explained, and use very powerful magnets, to ensure that the particles reach very high speeds so that when they collide, they produce a lot of energy. When Witten was a
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graduate student, the highest energy for two colliding protons was about 30 times $mc^2$ but today the LHC studies protons at 2,000 times $mc^2$. When you go to higher energies, collisions are rarer, said Witten, so the beams have to be more intense. The events also become more complicated, so you need much better particle detectors, which produce vast amounts of data.

Many fundamental questions have already been answered, said Witten, including what holds the nucleus together, but equally big questions still “tantalise” physicists. “Some of these are old riddles,” he continued. For example, why does nature have so many different “flavours” of similar particles, including muons and tau particles? There are also riddles like dark matter, he said, and “particle physics is now on the brink of a very big jump into the unknown,” because of the LHC.

The LHC will boost the energy from 2,000 times $mc^2$ to about 14,000 times $mc^2$, taking it into the terascale range — the equivalent of 14 trillion ordinary electrons with the same power as a flashlight battery.

Witten then described what scientists hope to learn from the LHC, saying that part of the answer is: “We don’t know everything that’s going to happen, because there is such a big jump in energy.” One question Witten believes we can reasonably hope to answer is why electromagnetism is “so different from the weak interactions.” We can detect electromagnetic effects (i.e. light waves) with our eyes, he explained, and modern technology is based on electromagnetism. But the weak interactions are much less familiar, he said, and we need special equipment to see them and even to know they exist.

Witten then said it was “funny” that we use the same type of equations to describe electromagnetism and the weak interactions, even though they’re very different forces. And this raises an obvious question, he said. If electromagnetism and the weak interactions are fundamentally the same, why do they look so different?

It is all to do with symmetry breaking, said Witten, and there are solid reasons to believe that the answer can be found at the terascale — at the energy range of the LHC. The simplest explanation, he continued, involves the existence of a new particle like the Higgs boson, but it hasn’t been found yet so the theory has not yet been proved. “It’s a question that’s been with us since I was a student,” said Witten, “so we’ve had the chance to dream up a lot of variants and competing theories.”

Finally, said Witten, the LHC will give physicists the chance to look
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at the terascale and find out what’s going on there – whether there’s a Higgs particle, whether there’s a more complicated theory, or whether there’s the Higgs particle plus other things. “But whatever is the nature of the electro-weak symmetry breaking,” said Witten, “we ought to find out once the LHC is operating.”

The search for the nature of symmetry breaking is also linked to many other questions, said Witten. “For example,” he continued, “it’s believed that the symmetry breaking process is the origin of the masses of familiar particles such as the electron. It’s also the origin of a crucial part of the masses of the protons and neutrons.”

The symmetry between the weak interactions and electromagnetism is what interests Witten the most, “because the origin of masses is what is perhaps most often explained, and because the symmetry breaking is very important.”

Witten then described the other big questions that the LHC might answer, including dark matter – the invisible stuff which has a major effect on the orbits of planets and stars. “We don’t know what the dark matter is made of, but there is a very interesting theory that it consists of exotic elementary particles that are part of the cosmic rays,” said Witten – particles even more exotic than muons. To really understand dark matter, an even more speculative project, said Witten, is to probe the unity of the laws of nature at a much deeper level than ever before.

“The three main forces in particle physics are the electromagnetic and weak force, the symmetry breaking and something else called the strong force,” he said, and the LHC may help to prove the unity of all elementary particle forces, using supersymmetry. Ultimately, this would update Einstein’s theory in the light of quantum theory, stating that as well as space and time, there is an additional quantum dimension in which an ordinary particle could vibrate – leading to the existence of new particles which could be produced and detected at the LHC or other accelerators now being planned, including the International Linear Collider...

David Saxon – The experiment (how?)

Saxon talked about how to detect the Higgs boson, starting off with protons – the nuclei of hydrogen atoms – then accelerating them to gain kinetic energy. There are two ways to accelerate the protons, he explained – in a straight line (rather difficult and costly) or by using a ring so the particles go round and round and return through the same accelerating element again and again, eventually leading to head-on collisions,
with 7TeV (seven trillion electron volts) hitting 7TeV coming in the opposite direction. “The colliding beam is the efficient way to destroy energy to create mass,” said Saxon – this technique was invented by Bruno Touschek, who did his PhD in Glasgow.

A head-on collision is called an event, and detecting events will help to capture the characteristic Higgs signatures, Saxon explained. Theories today are like jigsaw puzzles that we’ve almost completed, and the Higgs boson is the last piece. We already know a lot about its properties, but there’s one thing we don’t know – how massive it is – and that is critical because as the mass of the Higgs boson candidate alters, its properties vary, so to cover the range of possible masses, the detectors must be sensitive to many different processes. Production of the Higgs boson is rare – one event in $10^{11}$ – and this means different experiments (such as hunting for muons) have to run simultaneously. “You have to be alert to all possibilities all the time,” Saxon explained, with events arriving at a rate of 40 million a second.

The Large Hadron Collider is the world’s most powerful accelerator, with the most powerful detectors and the most powerful computing infrastructure, said Saxon. It also involves the widest international collaboration and uses the most innovative concepts in technology. The key to the project is the CERN laboratory in Geneva, set up in 1954. Today, it has 20 member states and eight observers, plus a budget of about £600 million pounds per annum – roughly the cost of one cup of coffee per person, per year.

The CERN collider is 100 metres below the ground and 27km in circumference, traversing the Franco-Swiss border. One bunch of the protons goes clockwise around the ring, while another bunch runs anti-clockwise, and there are collisions at four points around the ring. “There’s a huge amount of energy,” said Saxon – equivalent to 20 one-volt batteries for every star in our galaxy or $10^{14}$ times room temperature. These staggering statistics have made people worry that the LHC would create black holes, but Saxon explained that although a black hole may be created by one proton colliding with another, fortunately these black holes don’t breed – because of Hawking radiation, they die very quickly, and only produce enough energy (about one micro-joule) to swat a mosquito.

The most challenging components in the LHC are the superconducting magnets, said Saxon, and that is what broke in the 2008 start-up. The accelerator is also one of the coldest places in the universe, cooled to 1.9 Kelvin.
Saxon then described the detectors, explaining that the proton beams collide with each other every 25 nanoseconds, producing an average of about 10 interactions, out of which come particles. The detector first determines if it was a very short-lived particle, then the momentum and the energy, and finally it measures the outgoing muons. It’s constructed in a multi-layered way so that different studies can co-habit, but this means it is very complicated and as big as a cathedral – 45 metres long and 25 metres in diameter.

The detectors produce data 40 million times a second, but all this is useless without collaboration, said Saxon. The final version of the data is published only after independent analysis and there are powerful safeguards. Mistakes and disagreements are inevitable, but everyone must feel a sense of ownership over the data and overcome internal rivalries. It wouldn’t do, for example, if a Scottish group claimed to discover the Higgs boson and another group looked at the same data and said: “No you haven’t!” Saxon suggested that what holds them together is hope.

The readout system has 100 million electronic channels and 300km of cable, and involves some “tricky” engineering, said Saxon, adding that we have a good idea what a Higgs event might look like, but so far we only have an artist’s impressions.

Saxon then described the computing resources required to analyse the data produced by the accelerator. Each LHC experiment produces 10 petabytes (a million gigabytes) and this requires the processing power of about 100,000 computers, and a network of computer centres – what’s called “The Grid.” The world wide web was invented at CERN, but Saxon said The Grid is much more organised than that, because the data in themselves are valueless. “What is valuable,” Saxon explained, “is what we call the metadata – which tells you how it was measured and specifies all the conditions that it was done under, and which version of the program it was processed under.” We can’t afford to repeat calculations that have already been done in America, Saxon continued. We need all the computing resources to hand.

The Grid provides seamless access to computing power and data storage distributed all round the world. “Once the LHC starts producing for real it will be like a bicycle race,” said Saxon. “At the moment it’s like learning to ride a bicycle.” In the UK, he explained, the effort is led from Glasgow by Tony Doyle and Dave Britton – a £60 million project over 11 years, funded in part by the Scottish
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Funding Council. The idea of The Grid started in particle physics but other disciplines are now showing interest, he said – e.g. for research into DNA coding.

“Present data tell us that the Higgs mass should be between 114 and 200 GeV, based on the minimal theory,” said Saxon. But even if there’s only one piece left in the jigsaw, there could be another page missing. The standard model without the Higgs violates unitarity – e.g. the theory that if you fire 10 arrows at a target, the number that hit won’t be greater than 10 – but the difference between the theory and the model is that if you take a model up to high energy, it always violates unitarity, while if you take a theory up to high energy, it works beautifully. “We need people like Witten and Higgs to explain why that works,” he continued, “but the theory without the Higgs is incomplete – it must lead to a contradiction and to a disagreement with data. Something Higgs or Higgs-like must occur.”

Superconducting magnets were pioneered for particle physics, said Saxon, and now these are routinely used in MRI scans, with the “nuclear” component which makes it safe. “Real life is much more complicated than headline writing,” said Saxon, citing other “side-benefits” of nuclear research such as medical imaging, cancer therapy and “Seeking answers to fundamental questions about elementary particle physics in the universe – that’s why we do it,” said Saxon. There’s going to be a new era of discoveries, starting at the LHC. We’re advancing the frontiers of technology, training young people and bringing nations together through science.”

Q&A

How do you select which events to analyse?

“In the trade, that’s called triggering,” said Saxon. You capture the data and store an event for a fraction of a second, and in that time you have to do enough computation to identify two candidate electrons – with 20 to 50 triggers at any one time. “The crucial step in the game is knowing what to preserve for future study,” he said.

What about superstring theory?

Witten said that supersymmetry and string theory “grew up together,” and hopes the LHC will confirm supersymmetry. Saxon explained that in the standard model, there is the minimum Higgs, then the Minimal Supersymmetric Model, and so on. In the simplest supersymmetric model, he continued, there is not one Higgs boson but four Higgs bosons of different masses, with the same decay possibilities but different ratios. So, when you see...
something that looks like a Higgs, you have to check if it’s obeying all the standard model predictions.

*How long will it take to hand on some of this exciting physics to the young generation – given that the experiments take many years and involve so many people?*

Saxon said he was amazed the project had survived since 1990, and said that “hope” had kept it going through the years. Witten said young people are excited about large projects like the LHC because they have so many crucial sub-components which are challenging projects in their own right.

*What leads us to believe the 14 tera-electron volt scale is the right scale to look at?*

Witten re-worded the question as: “What gives us confidence that the energy of the LHC is sufficient to explain symmetry breaking between the weak interactions and electromagnetism?” He then said that an earlier collider at CERN had discovered the heavy particles responsible for weak interactions in the 1980s – the W and Z particles. “We know their masses already, and we know that the mechanism that breaks the symmetry can’t involve energies that are too much higher than that, or the model stops making sense,” he continued. “The data tells us that the standard model works if you try to complete it with the Higgs particle that weighs not more than a few tenths of a TeV – and it doesn’t work otherwise.”

*Does CERN also hope to reveal some insight into gravity?*

Witten said the LHC could “possibly shed light on quantum gravity,” but thought it less likely than the study of “symmetry breaking” and perhaps the discovery of supersymmetry – “which would combine Einstein’s special relativity with quantum

You’re firing protons at protons. Whatever happened to the promise of controlled nuclear fusion?

Firing protons at protons is one way to do nuclear fusion, said Saxon. There are large machines which get “close to ignition” – i.e. get more energy out than put in – but it is not yet “remotely economic,” he added. Witten explained that accelerators like CERN involve a lot of particles and energy, but for fusion, you need more of both – and not enough collisions for a fusion machine, even though the energy in each collision is “vastly bigger than it would be to do fusion.”

*What if you find nothing? Have you got a Plan B or will you just go on?*

Saxon said that the theory without the Higgs is known to give impossible answers, so whatever is found will be different. He also
said he wasn’t worried because half of the large accelerators built around the world were built for reasons which became out of date, and instead did something “unexpected and different.” Witten said the standard model without the Higgs particle doesn’t make sense mathematically at LHC energies, “so we’d have a kind of contradiction.”

How do you see this filtering down through the education system?

Saxon said you need a lot of vocabulary to teach undergraduates, so it’s hard to do a master class in particle physics. He recommended “hands-on practical experiments.”

Finally, Alan Walker then drew attention to the exhibition upstairs, Particle Physics for Scottish Schools, and said that a primary school in Musselburgh had invited him to take the exhibition to its school fair – a breakthrough which Sir Michael described as a good note on which to end the discussion.
Scottish Aquaculture - A sustainable future
A joint International Symposium
organised with the Scottish Aquaculture Research Forum
21-22 April 2009

Scotland is a leader in seeking to use science based policy, regulation and voluntary industry codes to increase the sustainability of the aquaculture sector within the context of increasingly focused regulation and global environmental and economic forces.

The symposium explored sustainability under four broad themes of the environment, fish health and welfare, the role of science within regulation and policy, together with the socio-economic impact of aquaculture. The symposium was organised by the Scottish Aquaculture Research Forum (SARF) in conjunction with The Royal Society of Edinburgh and The Norwegian Academy of Science and Letters, and aimed to engage delegates from a wide range of backgrounds with an interest in aquaculture, bring together the extensive portfolio of SARF-sponsored research, complemented by internationally recognised keynote speakers.

Speaker Abstracts
DAY ONE. PLENARY SESSION
Aquaculture – an EU perspective. Jean Weissenberger, DG - MARE A2 (CFP & Aquaculture)

In spring 2009, the European Commission will adopt a Strategy for the sustainable development of European aquaculture. While it is not possible to prejudge the final outcome of this initiative at this time in this abstract, this Strategy should aim at providing political impetus and addressing a number of challenges faced by the aquaculture sector. It would focus on the role of public authorities, at EU and national level, in considering some major objectives such as establishing conditions for the sustainable development of aquaculture, promoting its competitiveness and improving governance.

Sustainable development is about ensuring compatibility between aquaculture and the high European standards for environmental protection. It is also about shaping a performing aquatic animal farming industry, able to provide safe and healthy food to the consumers. Promoting competitiveness implies, among others, giving the highest priority to research, innovation and technological development.

Addressing the high competition for access to water and space, or enabling the aquaculture business to cope with market demands are necessary if aquaculture is to develop. Finally, aquaculture
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would benefit from improved governance and a better level playing field when decisions are taken by public authorities. This should be based on a proper stakeholder participation in the process, on a factual information base and should be accompanied by a reduction in the administrative burden.

DAY ONE. PARALLEL SESSION 1: POLICY AND REGULATION

Scottish Aquaculture Research Forum (SARF) outputs aid Scottish Environmental Protection Agency (SEPA) policy and regulation. Campbell Gemmell, Scottish Environment Protection Agency

Robust research outputs are an essential tool in the development of policy in connection with environmental regulation and have been used by SEPA to effect significant changes in aquaculture policy in recent years.

Expectations of changes to the regulatory framework arising from the outcome of research are high but the steps required to turn research findings into policy change are often significant and not always obvious at the start of any project. This can lead to delays in the evolution of policy or a requirement for significant additional work.

Nonetheless, SEPA is a committed partner within SARF and a strong supporter of the research projects commissioned by both SARF and other institutions. SEPA will work with Marine Scotland and other partners in seeking to continue to use research findings as a route to policy change wherever practical and possible.

Identification of risk factors in shellfish harvesting areas: regulatory and policy implications. David Kay, Centre for Research into Environment and Health, University of Wales

Bacterial fluxes from the land surface and sewerage system can impact on both shellfish harvesting waters and bathing waters. In the USA and the EU, new approaches to protection of such waters are outlined in the Clean Water Act (USA) and Water Framework Directive (EU). Both require by law a catchment perspective involving quantification and integrated policy to achieve attenuation of microbial fluxes. However, this regulatory environment assumes: (i) that we know where the pollutant are coming from; (ii) their fate and transport in the catchment and near-shore marine systems; and (iii) the uptake of faecal indicators in target species. In fact, there are many information gaps in present regulation of microbial pollution, because this area is very new and lags behind efforts designed to control nutrients, sediments and oxygen demand.

A great deal of the early UK research effort in this area was
initiated in Scotland and directed at protection of both bathing and shellfish harvesting waters. This growing empirical evidence base can inform many of the required judgement on: (a) the balance between ‘point’ and ‘diffuse’ pollution inputs; (b) the regulatory impacts of both baseline pollution inputs and short-term rainfall-driven events of peak bacterial flux; (c) appropriate targeting of sustainable land use and associated Best Management Practices (BMPs) within the farming community designed to reduce the ‘diffuse’ pollutant flux from livestock farming areas; (d) appropriate remediation of pollutant flux from sewerage systems and industrial point discharges, specifically addressing the complex temporal and spatial patterns of microbial flux from treated effluents and intermittent discharges via storm overflows discharged from combined sewage systems; and, finally diffuse pollution flux from urban and industrial areas which is proving to be an emerging problem world-wide.

This presentation provided an overview of developments in regulation of catchment microbial pollution world-wide through review of the science information base, new challenges and information gaps which require attention by the research community.

**The recovery of the seabed after fish farming. Kenny Black, Scottish Association for Marine Science (SAMS)**

Marine fish farms can cause profound changes to natural biogeochemical processes and to the benthic community. The scale of change depends on farm size, feeding efficiency, site bathymetry, ambient currents and sediment grain size. Organic matter (OM) from fish faeces and uneaten feed cause local oxygen demand as they are bacterially degraded on the seabed. This causes a change in the reduction-oxidation potential of the sediments and a shift toward domination by anaerobic processes, especially to OM degradation by sulphate-reducing bacteria. Hypoxic and sulphidic sediments are inimical to many groups of benthic invertebrates and, as sediments become increasingly anoxic, the benthic community becomes dominated by large numbers of small, opportunist worms, mostly near the sediment surface. The speed of this process depends on the degree of imbalance between the enhanced oxygen demand caused by the farm wastes and the supply of oxygen to the sediments by the overlying water, but sediments can become highly degraded very quickly (~weeks). The process of recovery once fish farming has ceased is the topic of the present talk. This process has strongly
coupled biochemical and biological components that determine the trajectory of the sediment back to biogeochemical and ecological “normality”.

**Applied epidemiology as it relates to aquatic animal health policy and regulation. Jimmy Turnbull, University of Stirling**

Epidemiology is the study of diseases, health and welfare in populations, not in individual animals. It is based on simple ideas, such as comparing affected with unaffected farms to identify differences between them, but it is supported by sophisticated maths. Epidemiology can identify causes or risks (e.g. smoking and cardiovascular disease). However, it can also improve monitoring to detect problems earlier and more cost effectively. Epidemiology can estimate the impact or cost of diseases and model their spread, allowing control strategies to be evaluated. Since the mid 1990s, epidemiology has been used successfully in aquaculture and wild fisheries. During that time several important lessons have been learned.

Epidemiology is only one of the available research tools. Most aquatic diseases are too complex for a single discipline and it is important to choose the correct tools for the job. Applied research produces understanding, but this can only be converted into practical or regulatory strategies through regular and effective interaction with stakeholders; disseminating findings once a project is complete is not enough. We are now using existing data more effectively than ever, but it is essential that we have UK-wide databases and UK-wide strategies for aquatic resources.

**What has been done to minimise uses of medicines and anti-parasitic drugs in Norwegian aquaculture? Paul Midtlyng, Norwegian School of Veterinary Science (VETH)**

For nearly 15 years, the use of antibacterial treatments in Norwegian fish farming has been dramatically reduced to a total of between 650 and 1500 kg active substance, slightly varying from year to year. The amount of 649 kg prescribed in 2007 corresponds to less than 0.8 gram per ton of salmonid biomass, which is an unprecedented figure compared to any other segment of animal production, or to antibiotic use in humans. Among the factors contributing to this favourable situation are proposed: (a) the unique government – industry initiative to facilitate vaccination against classical furunculosis in the early 1990s; (b) the continuing predominance of vaccine development within the business strategies of fish vaccine companies; (c) zoning and the spatial re-arrangement of marine produc-
tion sites to minimise horizontal spread of infections; and (d) adoption of an “all-in-all-out” production system with mandatory fallowing periods between yearclasses. Adequate legal and regulatory instruments for the continuing success of disease control in aquaculture will be discussed using examples from several salmonid farming countries. The limited use of medicinal therapeutics in industrialised aquaculture has, however, some negative aspects. One of the dilemmas is the availability of veterinary medicines that are needed to provide adequate treatment of our cultured stocks, which is important to animal welfare. The emergence of resistance to therapy is also stimulated by lack of diversity in medicinal products.

**Appropriate and Sustainable Predator Control: the use of ADDs and other measures to control seal predation at Scottish salmon farm sites.**
Simon Northridge, SMRU, University of St Andrews

The main predatory problems faced by Scottish marine fish farms involve net damage, fish kills, fish escapes and slowed growth due to stress. Most such problems are attributable to seals. Interviews and official statistics demonstrate the likely scale of this problem in Scotland. The paper discussed methods to control the problem, and describe husbandry techniques that include the use of acoustic deterrent devices (ADDs). ADDs have been criticised because of their potential effect of habitat exclusion on dolphins and porpoises which are more sensitive to such acoustic signals than seals. The evidence for such concerns was discussed and their importance was discussed in the context of European legislation. Some preliminary evidence was also presented that the reactions of cetaceans to ADDs are more complex than previous experiments have suggested. There are also some fundamental uncertainties about seal depredation at salmon farms that limit our ability to evaluate or develop predator control measures. Despite a wealth of knowledge within the industry, little structured research has yet been conducted to understand seal predation. The speaker concluded by suggesting some areas that need to be examined in more detail if we are to develop more effective, appropriate and sustainable means of managing seal predation at aquaculture sites.

**The relationship between aquaculture and biodiversity.**
Dr Tom Wilding, Scottish Association for Marine Science

Most Scottish aquaculture operations occur in sheltered sea-lochs in relatively deep (>20 m) water underlain by shelly muds/
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fine sands and frequently in relatively close proximity to rocky substrata. The effect of aquaculture on megafauna is, compared to macrofaunal, poorly understood and is the focus of this paper. The UK is a signatory to the Convention on Biological Diversity and, consequently, has assigned ‘Biodiversity Action Plan’ (BAP) status to habitats and species considered particularly important. Many Scottish aquaculture operations currently overlap the ‘Mud in Deep Water’ BAP and evidence suggests resident megafauna should be relatively resilient to aquaculture-related sedimentation and organic enrichment. However, such assemblages will not tolerate changes above a currently unknown threshold level. Preliminary observations indicate the presence of megafaunal such as the seapen *Pennatula phosphorea* (L.), in close proximity to fish cages. The impact of other salmon farming activities on the megabenthos, such as discharged chemotheraputants, are largely unknown. Higher energy sites host biotopes that are likely to be more sensitive to fish-farming and an expansion of the aquaculture industry into these habitats should only proceed where appropriate impact threshold levels have been determined. The link between aquaculture and invasive species needs to be better understood so that any consequences to native biodiversity can be established.

**Incident prevention in the Scottish shellfish sector.** Lorna Murray, Food Standards Agency Scotland

On 1 January 2005, European Commission Regulation 178/2002 came into force, laying down the general principles and requirements of food law and establishing procedures in matters of food safety. The regulation is enforced in the UK via The General Food Law Regulations 2004 (as amended). The regulation contains provisions for determining the safety of food or feed on the market and outlines the responsibilities for food and feed business operators. The Regulation requires food business operators to withdraw food which is not in compliance with food safety requirements, if it has left their control, and to recall if it has reached the consumer. The Agency’s incident response capability is governed by the Incident Response Protocol. This protocol defines the Agency’s view of an incident and details the action to be taken thereafter. Every year the Agency has noted a considerable increase in incidents. For example, in 2006 the Agency investigated 1342 incidents in the UK. This is an increase of 388 incidents from 2005, when 954 incidents were dealt with.
The Food Standards Agency in Scotland (FSAS), as a competent authority, deals with many incidents and outbreaks of food–borne disease associated with the consumption of contaminated shellfish originating from Scotland. These are due both to naturally occurring biotoxins accumulated in the flesh of live bivalve molluscs and *Norovirus* accumulated by the molluscs growing in sewage contaminated waters. With an average of 60 classified shellfish production area closures per year due to toxic events alone, we have the potential for this many incidents. In reality there are eight to ten incidents each year in Scotland, where there is evidence that shellfish not meeting food safety requirements have reached the market place. These require tracing, withdrawal, seizure, detention and destruction.

Incidents themselves are not simple procedures; the investigation is multifaceted and complex, requiring many hours of investigation by Agency staff, local enforcement officers and food business operators. The costs associated with incidents are large and many tonnes of shellfish are destroyed as a result. The Agency has therefore begun a strategy aimed at incident prevention; as part of this, Scotland is working with the Scottish shellfish sector. The main project strand intends to identify the beliefs and understanding of the shellfish community in Scotland, both harvesters and enforcers, and benefit from an understanding of the awareness, knowledge, attitudes and practices in place. In so doing, the Agency will be able to design an approach to assist reduction in shellfish-related incidents.

**DAY ONE. PARALLEL SESSION 2: UNDERSTANDING OUR ENVIRONMENT**

*Carrying capacity. Anders Stigebrandt, University of Goteburg*

Carrying capacity is the biomass of a certain species an environment can support without causing significant negative impacts to the given species and its environment. In practice, carrying capacity depends on the degree of environmental impact that can be accepted, which is expressed by environmental quality standards. The latter are established in a political process where environmental impact may be traded for economical and social benefits. Obviously, the scientific part of the problem, which is the topic of this paper, is to develop a toolbox with reliable, objective methods or models to estimate the environmental response to specified loads and sinks from aquaculture. The models may differ between countries because of differences in environmental quality stand-
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ards. Models must properly deal with hydrodynamic and biogeochemical and ecological processes, as well as with sources and sinks of organic matter, nutrients, etc., due to farm activity. Uncertainty in estimates of environmental impact is discussed. Current speed data and farm activity data are identified as two generally large sources of uncertainty.

**Carrying capacity: fit for purpose models. Paul Tett, Napier University**

‘Carrying capacity’ is the ability of that water body to support a stock or harvest of farmed animals (or plants) without long-term harm to the health of the aquatic ecosystem concerned, and in an economically as well as an ecologically sustainable manner. Carrying capacity is linked to the ‘assimilative capacity’ of the water body for the waste products of farming, as well as to the supply of needs such as food (for filter-feeding shellfish) or oxygen. It involves considerations of the scale of farming, the size of the water body, and the extent to which it exchanges with surrounding waters.

It is suggested that these capacities are best understood in a Driver-Pressure-State-Impact-Response (DPSIR) approach to aquatic ecosystem management. This approach posits knowledge of relationships between ‘pressures’ on the environment generated by aquaculture, the effects of these pressures on the ‘state’ of ecosystems, and the ‘impact’ of state changes on the ‘goods and services’ provided to humans by the ecosystem.

Mathematical models offer one way to generate such relationships and can thus enable the estimation of assimilative and carrying capacities for particular water-bodies and types of farming. This was illustrated using the ACExR-LESV model developed in the SARF012 project to estimate the capacity of Scottish sea-lochs and voes to assimilate farm waste. Reference was also be made to work completed in the EC ECASA project, and being done in the SARF012b and EC SPICOSA projects, aimed at estimating carrying capacity for shellfish.

**Environmental Standards for Aquaculture Medicines. Mark Crane, Crane Consultants**

Environmental Quality Standards (EQS) based on Predicted No Effect Concentrations (PNECs) for non-target aquatic organisms are required for a wide variety of substances released to water, including sea louse treatments and other aquaculture medicines. Companies producing medicines, the farmers who use these medicines, and the regulatory agencies charged with protecting the environment from any adverse effects cause by chemical use must
comply with a range of different European regulations which require consideration of PNECs, but which are not always consistent in the way that they apply them. These include regulations on the marketing authorisation of veterinary medicines, the Water Framework Directive, and the Habitats Directive, plus national regulations on discharge consents. This presentation we provided a critical overview of these regulations and present a case study for deltamethrin, the active substance in a synthetic pyrethroid sea louse treatment, to show how a tiered risk assessment approach can be used to balance the needs of all stakeholders, comply with necessary regulations, and safeguard the environment.

Coastal assimilative capacity: fish farm amalgamation, size matters? Martin Solan, University of Aberdeen

Intensification of fish farming activity and the amalgamation of farm units has the potential to cause an increased risk of organic contaminant pollution. Although the amalgamation of fish farm units into a fewer number of larger operations offers greater financial efficiency, concern exists over whether the discharge of nutrients and organic compounds from large scale operations may have a greater environmental impact than an equivalent spatial area distributed amongst several smaller farm units. The findings of a field survey which aimed to determine the relationship between farm size and zone of impact across a range of farms were presented together with findings based on a national analysis using SEPA’s archive, where the size of a fish farm and its environmental impact was examined. Using linear mixed-effects models, it was shown that the discernable effects of the farms investigated \((n = 50)\) are greatest at the cage edge, declining with increasing distance from the farm. The abundance of benthic macrofauna and sediment concentrations of organic carbon are both influenced by an, albeit weak, interaction between farm size and current speed, such that the magnitude of effects at farms located in areas of elevated current speeds are greater than those of similar sized farms located in more quiescent waters. Collectively, results suggest that there is a non-linear relationship between farm size and organic waste production and that such relationships depend on complex interactions that are site-specific. In order to constructively inform policymakers on the placement and design of amalgamated fish farm units, it is clear that more detailed information on farming practices and influential variables is needed.
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**Dispersion modelling of fish farm particulate wastes.**
**Andrew Symonds, ABPmer Consultancy**

An important consideration in the design of fish farms is the fate of the particulate wastes arising from the farm. Therefore this study was aimed at investigating the fate of chemical/faecal particulate wastes that arise from activities associated with fish farms and gaining a better understanding of their dispersive mechanisms and resultant environmental concentrations. A numerical model encompassing Loch Shuna and Loch Melfort was configured, calibrated and validated to provide a means of assessing the local hydrodynamic and sediment regime as well as any issues related to fish farm activities within its area. The dispersion modelling was undertaken using a layered three-dimensional tidal model with coupled sediment transport and dispersion modules. The results indicate that much of the wastes remain in suspension, with only minimal rates of deposition. The findings from the study have helped to advance the technical understanding of far-field dispersion processes of waste from fish farms and provide a means of validating existing regulatory management developed to investigate processes in the near-field/mid-field region.

**Containment and genetic impact of fish farming on wild populations.**
**Terje Svåsand, IMR Norway**

The continuing global decline of wild fish stocks has been accompanied by a parallel increase in aquaculture. In the course of the past ten years, worldwide production of farmed fish has more than doubled, with farming activities now producing half of the fish directly consumed by humans. For a species as Atlantic salmon, capture of wild fish in Europe was only 0.3% of the aquaculture production.

The potential for genetic effects of aquaculture on natural fish populations is arousing a great deal of concern among scientists, as well as the general public. The perceived risks are often associated with cultured and native fish, and the adverse effects of the interactions of escaped fish with the ecosystem. Atlantic cod reach sexual maturity in their net pens, and genetic material can even “escape” through the release of eggs by fish that spawn in the pens.

**Application of novel ecotoxicity assays in aquaculture.**
**Graeme Paton, University of Aberdeen**

Ecotoxicology has evolved greatly from the systematic testing of freshwater species to a given dose of a relevant compound. Today, ecotoxicology includes marine,
intertidal, infaunal, deep sediment and soil environments in its applications and has been extended to include trace elements and to be linked to environmental fate models. As the discipline has evolved, the interpretation of mechanistic responses has become more akin to the mature models that underpin pharmacological assays. These resultant quantitative structural activity relationships (QSAR) can be used to assess both the performance of given receptors and the suitability of the optimised assay. Furthermore they can also be used (with a degree of certainty) to understand the potential impact of as-yet-untested compounds. In this presentation we consider the evolution of QSAR for a range of trophic levels and then couple the response to a measure of the bioaccessible and bioavailable fraction of the target analyte. Coupling receptor responses to physicochemical parameters is essential if we are to be confident that adopted assays are adequately protective. A predictive capacity in this context is key, not just for dealing with the many metabolites associated with aquaculture but also for the potential of new generation compounds that may be released into the environment.

**The Scottish Marine Bill: sustainable and strategic management**

David Palmer, Scottish Government

The Scottish Marine Bill will form the basis of an improved and more sustainable management of human activities within the marine environment and increased protection of Scotland’s marine natural heritage. The proposed legislation aims to provide coherent integrated framework for marine planning, licensing and conservation. This will enhance Scotland’s stewardship of the seas, support sustainable development and provide protection for the marine environment, so ensuring that future generations of Scots will be able to enjoy the many social, cultural and economic benefits that the seas deliver.

Scottish Ministers are working constructively with the UK Government and other administrations to ensure that an integrated and joined-up approach to this new legislation and its implementation is achieved.

The development of The Marine Bill has been informed by the recently-completed consultation reports *Sustainable Seas for All – Environmental Report* (SEA-ER December 2008), and *Regulatory Impact Assessment* (RIA December 2008) that outline the five key policy areas which underpin the Scottish Marine Bill:
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- Creating Stability: Marine Planning and Integrated Coastal Zone Management
- Reducing the Burden: Licensing and Enforcement
- Securing the Future: Nature Conservation
- Understanding our Seas: Science and Data
- Managing our Seas: Marine Scotland

DAY TWO. PLENARY SESSION
Aquaculture as a new-comer in the economic and social life of coastal communities. Do we learn from experience? Bjorn Hersøug, University of Tromso

This presentation dealt with the aquaculture experience in three selected countries: Norway, Chile and Vietnam, demonstrating that industrial, marine aquaculture poses specific challenges regarding its accommodation to the economic and social life of coastal communities. The three countries have chosen different models for their aquaculture industries, and although all three have experienced considerable success, there are several challenges ahead, not least regarding industry structure and government regulations. The article discussed to what extent the aquaculture industry can be managed by planning and which aspects should be left to the market. Finally, the article dealt with the difficult aspects of institutional learning. Who are learning what, and to what extent can these lessons be implemented in new policies? These issues were discussed within a framework where aquaculture is only one of many factors presently affecting the coastal communities.

DAY TWO. PARALLEL SESSION 1: FISH HEALTH AND WELFARE
Emerging virus disease problems in aquaculture. Epsen Rimstad, Norwegian School of Veterinary Science

Viruses may be on the bright side of life in modern marine aquaculture, due to high density monoculture of hosts, numerous possible routes of transmission, and lack of effective vaccines for most viral diseases in fish. Aquaculture can thus offer close-to-ideal environments for the spread of viral diseases. Furthermore, infectious diseases do not respect national boundaries and they can have detrimental effects on both production and export of aquaculture products. Effective vaccines are available for only some of the serious fish viral diseases, leaving avoidance, or expensive compulsory “stamp-out” eradication, as the official national approaches. What can the aquaculture community do to prevent and control future epidemics? How far will the infection spread and how rapidly? When fish health officials don’t act quickly enough, outbreaks may become epidemics. The key to controlling viral epidemics is to
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block the transmission of infection. This requires that knowledge about reservoirs, susceptible fish species, shedding of virus and survival of viral infectivity outside host for each virus species ought to have a sound scientific basis. Development of highly effective vaccines offers another way of preventing and controlling future risks.

**Fish immunity: vaccine development and performance. Chris Secombes, University of Aberdeen**

Control of disease to maintain fish health is important for the continuing success of the Scottish aquaculture industry. Of the different approaches that can be adopted, it is clear that vaccination offers a prophylactic treatment with limited environmental issues, and is thus a method of choice against ubiquitous diseases accessible to the immune system. Whilst some vaccines have been proven to be tremendously successful, others have not, and ways to improve vaccine performance and to accelerate their development are needed. Over the last few years, knowledge gained about the complexity of the fish immune system has increased enormously, in large part due to the availability of sequenced fish genomes. The many immune genes discovered will allow new approaches in fish vaccine development, as highlighted in this talk. The potential to boost vaccine performance, to manipulate the immune system in a more controlled fashion and to measure more precisely the type of response being elicited, are examples of ways in which these molecules can now be used to the benefit of fish health.

**Development of diagnostics: challenges and opportunities. Sandra Adams, University of Stirling**

The application of biotechnology in aquaculture has enabled the development and improvement of a wide range of immunodiagnostic and molecular technologies, and reagents and commercial kits have become more generally available. Recently method development has increased exponentially as techniques developed for clinical and veterinary medicine are adapted and optimised for use in aquaculture. Careful consideration needs to be given to selecting which rapid diagnostic methods to take forward and apply in aquaculture pathogen detection methods need to be robust yet sensitive. There are many innovative techniques that may fulfil these criteria and provide valuable diagnostic tools. It is also important, however, that useful diagnostic methods already developed are standardised and fully validated, and that new technologies do not supersede...
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these just because they are novel methods. The cost, speed, specificity and sensitivity of assays are all extremely important to end-users. This paper looked at some of the opportunities and challenges for the development of rapid diagnostics for aquaculture.

**Investigation and control of rainbow trout gastroenteritis.** Jorge del Pozo, University of Stirling

Disease has a significant economic impact on the UK rainbow trout industry and during the last decade several new important diseases have emerged, including rainbow trout gastroenteritis (RTGE) and red mark syndrome. Scientific research produces understanding that can be turned into effective management strategies through dialogue with end users. This talk presented RTGE as an example of how multidisciplinary approaches may lead to the development of management strategies. Epidemiology, histopathology and microbiological molecular tools were used to study RTGE. Two types of epidemiology study were employed: a cross-sectional survey examined the prevalence of RTGE in the UK and the risk factors associated with affected farms and a longitudinal prospective design was used to describe the impact, pattern of spread and risk factors for RTGE within affected sites. The pathogenesis of RTGE in affected fish was investigated using histopathology, electron microscopy and blood biochemistry. Finally, molecular tools were used to examine the association of *Candidatus arthromitus* with RTGE-affected fish. The findings of this project were used to develop management strategies for RTGE, based on feeding and movement controls, these have been circulated to rainbow trout farmers in the UK.

**Biosecurity in aquaculture: a UK perspective.** Andy Shinn, University of Stirling

Biosecurity presents continuing challenges for the aquaculture industry and its stakeholders. Disease introductions are a threat through both intentional and accidental movement of aquatic species and products. This presentation provided an overview of UK biosecurity considerations, from a local scale, e.g. disease transfer within a single farm, to the global, e.g. risks associated with common water sources and national trading networks. These considerations were illustrated within the context of three aquaculture environments: a marine fin-fish cage facility, a shellfish site and a freshwater trout farm using examples of anthropogenic and ecological threats to biosecurity. Key on-site biosecurity considerations include diagnostic capability, stage of the production cycle, and the robustness of routine health
management, surveillance and communication procedures. Livestock movements and harvest practices must be designed to include health-screening and disinfection procedures to avoid the transfer of pathogens through water. Larger-scale considerations include the use of risk assessment (e.g. network analysis, Import Risk Analysis) and risk management (e.g. HACCP). Improved biosecurity also depends upon the development of good communication and information management systems including cross-border cooperation, complemented by well-parameterised epidemiological and other models, which together assist the assessment of risks and the implementation of improved risk-reduction strategies.

**Genetic evaluation of disease resistance in farmed fish – challenges and future prospects. Jørgen Ødegård, NNFES**

Genetic evaluation of disease resistance in farmed fish is commonly based on challenge testing, for which medium to high heritabilities are often estimated. Analysis of such data is often based on survival (often at 50% overall mortality). However, accounting for time to death may improve accuracy of selection. Due to disease prevention reasons, tested individuals are normally culled after testing, and selection is thus limited to between-family, imposing restrictions on accuracy of selection as well as selection intensity. Thus, methods allowing individual selection among untested individuals would be especially advantageous in selection for improved disease resistance (i.e. selection for identified QTL, genomic selection, or indirect selection based on traits correlated to resistance). For diseases characterized by chronic infections, survival may be a poor indicator of resistance, making other supplementing indicators necessary. Furthermore, a population may contain a fraction of individuals being non-susceptible to specific diseases. If so, forced termination of the challenge test (e.g. at 50% overall mortality) or genetic evaluation based on time until death will be suboptimal. Vaccination programs may also complicate selection for improved resistance, as indicated by an estimated low genetic correlation (0.3) between resistance to furunculosis in vaccinated and unvaccinated salmon. Current research projects are now addressing these challenges.

**Optimisation of on-growing of marine finfish – a welfare perspective. Herve Migaud, University of Stirling**

Management strategies developed to combat the problem of early maturation in marine aquaculture are species-specific. Regarding Atlantic cod, photoperiod manipulation is the preferred
management approach; however, there are welfare concerns as to its application in commercial conditions. In this project, work has investigated the impact of traditional (metal halide) and novel (green cathode) lighting systems on welfare and light sensitivity in the species. Results have revealed that the application of such lighting does not induce a significant chronic stress response (plasma cortisol and glucose analysis) or non-specific immune response (lysozyme activity), suppress feeding behaviour or severely damage the retina. Melatonin analysis did, however, indicate that even under constant lighting (LL), cod perceived the overlying ambient photoperiod. Consequently, a longer term outdoor study is currently being conducted to investigate the perception of day/night light intensity ratio in cod under LL in combination with shade netting to suppress the intensity of ambient illumination.

Overall this project is intended to improve the competitiveness and sustainability of the marine aquaculture industry within the UK by refining photoperiod manipulation in Atlantic cod farming and enhancing their growth potential. This work is supported by SARF, the British Marine Finfish Association and Intravision Aqua AS.

**Can we get the upper hand on virus diseases in aquatic organisms?** Borre Robertsen, NFH, University of Tromso

The current disease situation in Atlantic salmon aquaculture suggests that large gains in the control of virus diseases can still be made through classical combat principles. Improved and enforced strategies for avoidance of viral pathogens by breaking horizontal transmission have given encouraging results both for ISA-virus and PD-virus. More emphasis should, however, be put on possible vertical transmission of viral pathogens. Atlantic salmon possesses a very well developed interferon system, which is a main component in the first line of defence against viruses. Salmon have high resistance against IPN and PD virus in laboratory experiments and interferons protect host cells against infection of these viruses. In contrast, these viruses cause high mortality in salmon farming. Accordingly, avoidance of production conditions that result in suppression of the immune system should be another primary effort in aquaculture. Interferon does not protect cells against ISA virus, however, which confirms that ISA must be combated by avoidance and vaccination. Breeding of virus resistant fish also shows promising results. Finally, development of more effective viral vaccines will be
crucial for a sustained control of virus diseases. To effectuate the above combat principles, it is important to educate highly competent health personnel to the aquaculture industry. In Norway, this is accomplished through a five-year integrated MSc program in Aquamedicine.

**DAY TWO. PARALLEL SESSION 2: SUSTAINABILITY**

**Aquaculture management in Norway. Magnor Neirheim, Ministry for Fisheries and Coastal Affairs, Norway**

The presentation was on how the Norwegian government is regulating aquaculture and how it is working to achieve sustainable growth in aquaculture. The development and growth of Norwegian farmed Salmon has been a success story over the last 30 years. This is partly due to favourable natural conditions, but also to strict regulations. In the current work to define more precisely the requirements for sustainable growth in aquaculture production five areas have been identified which must be given attention:

- Genetic interaction
- Effects on water quality
- Diseases
- Access to coastal waters, and
- Fish feed

**Streamlining the environmental impact assessment procedure for aquaculture. Richard Slaski, Federation of Scottish Aquaculture Producers**

The Environmental Impact Assessment Directive was published in 1997, and for the marine fish farming industry this was transposed to Scottish legislation as the Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999. From that point, there was a perception by the industry that it was being required to produce full Environmental Statements, at significant cost, for a very large percentage of the applications it made for development consent. This perception was backed up by evidence provided by the then Office of the Deputy Prime Minister. Recognising the burden of the EIA process for the industry, in 2007 the Scottish Aquaculture Research Forum commissioned a study into the subject, with a view to producing a Guide to good practice in the use of the EIA regulations. This was completed, but a steering group of public bodies and industry recognized that a further step was required: the preparation of easy-to-use templates for all three stages of the EIA process, based upon the best practice Guide. This was seen as being in keeping with the Guidance and templates being used for Strategic Environmental
Feed sustainability: current status, future prospects and consumer attitudes. Paul Morris, Skretting

The sustainability of fish feed is being addressed from multiple perspectives. Firstly, in the light of limited annual availability of fishmeal and oil, fish feed compounders have directed enormous effort towards finding alternatives to these two commodities. Secondly, given that fishmeal and oil will remain highly desirable feed materials (primarily as sources of long-chain omega-3, polyunsaturated fatty acids (PUFAS)), the industry is engaging with stakeholders in the fishery and reduction sectors to secure sustainably fished and processed marine feed materials. This has led to the adoption of numerous codes of practice and rigorous selection criteria throughout the fishing, farming and retail chain. Thirdly, feed compounders are engaging with the suppliers of agricultural commodities to assure that they too are responsibly sourced. Over-arching these activities is the principle that fish farming is fundamentally resource-efficient, due to the low feed conversion ratios (FCRs) achievable by fish. However, there is scope for further improvement, and feed producers and farming companies devote considerable attention to maximising returns per unit of feed fed. The UK and

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Assessment in Scotland. This presentation and paper described the process of, and objectives for, creating EIA templates.

Review of marine fish farm environmental impact assessment (EIA) thresholds - scope for change and application of permitted development rights

Suzan Bennett, Xodus Group

The need to examine the possibility for a change in environmental impact assessment (EIA) screening thresholds and the application of permitted development rights to marine fish farming, was identified during a consultation exercise on Extending planning controls to marine fish farming, carried out by the Scottish Government in 2004. Following this, research was commissioned by the Scottish Aquaculture Research Forum to examine current screening thresholds within the Environmental Impact Assessment (Scotland) Regulations 1999, with respect to fish farming. The results of the review of current thresholds, including similar thresholds applied to marine fish farming elsewhere were presented. Some potential approaches to establishing thresholds were explored, together with the concept of Permitted Development Rights.
Norway are very actively pursuing improvements in the fundamentals of formulation and feeding to optimise FCR and in the sourcing of sustainable feed materials. But the legacy of food and feed scares has led to conservatism in Europe and particularly, the UK, with regards what constitutes a natural feed ingredient for fish. As a result, having rejected many of the feed materials used widely in the global agriculture industry, there have been missed opportunities with regards partial replacement of fishmeal and oil in salmon and trout feeds. This conservatism is expressed largely through retailer specifications and independent quality schemes on behalf of the consumer from whom, we the feed manufacturers hear very little directly.

Tourism and aquaculture. Fiona Nimmo, Royal Haskoning

Aquaculture is an important industry for rural Scotland, in particular for the west coast and the islands. Tourism is also important to Scotland’s economy and depends heavily on the country’s landscape.

Targeted research was undertaken to assess whether fish or shellfish farming impacts tourism in coastal areas of Scotland. This was accomplished through interviews with tourists, tourism related businesses and aquaculture businesses at three case study locations: the Western Isles, Shetland and Oban and Mull.

In the sample number of 120 detailed ‘face-to-face’ interviews a large percentage of respondents (87%) had seen fish farming before, although half of these had not seen fish farming at the case study location. When asked to focus on the effect of specific aspects of fish farming, including perception of the area, impact on scenery, natural environment, recreational activities and willingness to re-visit, the majority of respondents remained neutral.

The overwhelming majority of respondents believed that:

- Fish farms contribute to the livelihoods in coastal communities;
- Fish farms do not spoil the appearance of the coast; and
- Tourists would not be less likely to visit those places in Scotland where fish farms are sited.

The research conducted that, at current levels, the presence of aquaculture operations would not affect visitors’ willingness to re-visit or affect their key recreational activities.

Environmental values and consumer behaviour: a case study of Scottish salmon aquaculture. David Whitmarsh, University of Portsmouth

Aquaculture has contributed substantially to world fish supplies, but alongside this there has been growing concern about the sustainability of many of the
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practices employed in fish farming. This concern affects public attitudes towards aquaculture, and there seems little doubt that the social acceptability of the industry is shaped by what people perceive to be its environmental performance. What is less clear, however, is how far such attitudes influence consumer behaviour. This paper reported on a survey of public attitudes towards salmon farming in Scotland, which inter alia collected data on the frequency of salmon purchases. The results showed that purchasing is influenced by both context and attribute variables, including environmental preferences. The research also has implications for the method by which preferences and values are appropriately measured.

**Social impacts of aquaculture.**

Steve Yearley, University of Edinburgh

This meeting was originally to be entitled “Sustainable Aquaculture – A Rational Approach” and that original emphasis on rational assessments was telling. Of course, no one wants an irrational approach to economic and environmental developments. But calls for rationality are usually made when the speaker (or author) is aiming to imply that other people are being irrational. The famed German sociologist Max Weber helpfully distinguished between different kinds of rationality in modern societies, including instrumental rationality (choosing the best means for a given end) and value rationality (our reasons for selecting ultimate values or goals). This presentation analyses the broad social impacts of aquaculture in relation to Weber’s work on types of rationality. Dominant approaches to assessing the impact of aquaculture characteristically operate with a limited conception of what is rational; they are usually instrumentally rational. I shall examined ways of extending the kinds of social values and goals that may be taken into account and indicated how this may lead to differing ideas of what aquaculture’s impacts are and a different assessment of those impacts.
In April 2009, the RSE presented a series of events to run concurrently with the staging, at the Lyceum Theatre in Edinburgh, of Michael Frayn’s intense, absorbing and powerful piece of theatre, *Copenhagen*. The events followed on from the 80th birthday conference for Sir Michael Atiyah OM, PPRSE at the University of Edinburgh, which included the Higgs boson discussion held at the RSE on Tuesday, 21 April.

On Thursday 23 April, the RSE presented the film *The Strangest Dream*, which tells the story of Joseph Rotblat, the history of nuclear weapons and the efforts of the Pugwash Conferences on Science and World Affairs – an international movement Rotblat co-founded – to halt nuclear proliferation. The story takes the audience from the site of the first nuclear test, in New Mexico, to Cairo, where contemporary Pugwash scientists meet under the cloud of nuclear proliferation, and to Hiroshima, where survivors of the first atomic attack are seen. Featuring interviews with contemporaries of Rotblat, members of the Pugwash movement and passionate public figures, *The Strangest Dream* demonstrates the renewed threat.

The author of *Copenhagen*, Michael Frayn, was invited to present a talk at the RSE on Friday 24 April on *The After-effects of Copenhagen*.

Following Frayn’s talk, Muriel Romanes (Artistic Director, Stellar Quines) directed guests of the RSE as they read from the papers that inspired the play *Operation Epsilon* – readings from *The Farm Hall Transcripts*.

Michael Frayn

*After effects of Copenhagen - Fiction or faction?*

23 April 2009

Frayn began by saying that one of the difficulties of writing plays or novels based on the historical record is that the record keeps changing. For example, now that the archives of the former Soviet Union are open to view, “people are discovering things about the past that they hadn’t known.”

The ground has already shifted under his play *Copenhagen*, he added, and a lot of what was solidly established is now being called into question. If he wrote the play again today, it would need to be altered in light of what we know now.

Moving on to the *Farm Hall Transcripts*, which recorded the secret conversations of the captured German nuclear physi-
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cists who had worked on the development of nuclear weapons for the Nazis during the Second World War, Frayn said that when the transcripts were made available to the public in 1992, no-one had challenged their accuracy, but they had certainly altered the historical record.

Frayn then described how he was bombarded with books after he wrote *Copenhagen* – more than he could ever conceivably read. And two years ago, he received a copy of a book called *Hitler’s Bomb* by Rainer Karlsch, which brought many things into question, including the Farm Hall Transcripts.

Before Karlsch’s book, the development of ‘Hitler’s bomb’ had been very thoroughly covered by historians, said Frayn. We knew there were two programmes, one under Werner Heisenberg and the other under Kurt Diebner. Even though Nazi Germany was highly centralised, the two teams were like “feudal baronies,” said Frayn, competing for resources, power and influence. When Heisenberg was moving his reactor away from the fighting, Diebner even tried to hijack it.

But *Hitler’s Bomb* revealed there had been a third programme trying to develop a nuclear bomb – a fact which had been hidden since the War. And the most surprising thing, said Frayn, was that the third programme had focused on research into fusion – to develop a hydrogen bomb. This was an “extraordinary piece of information,” said Frayn, which no-one had known about before. There was also a “fundamental difficulty” in believing that the Germans at that time had been so advanced, because to produce fusion you need conditions of extreme heat and pressure, and must first explode an atom bomb in order to do this. Yet, the two teams led by Heisenberg and Diebner had not come “within a thousand miles” of developing fission weapons, said Frayn, so there was little chance of making a hydrogen bomb. Karlsch’s theory was that the third team working on the hydrogen bomb (involving many different institutes across Germany) believed they could create enough heat and pressure with conventional weapons. Even though he may not be a scientist, Frayn believes this programme had really existed, based on the available evidence. The Nazis had clearly taken the project very seriously because towards the end of the War, the SS had taken it under its wing. Kurt Diebner was also in charge of the programme, said Frayn, along with Walther Gerlach, who also co-ordinated the two other programmes.

It is interesting to note, said Frayn, that neither Gerlach or Diebner referred to the fusion programme during their stay at Farm Hall, and even though it was widely
believed at the time that the German physicists were unaware that their conversations were being recorded, they may have suspected that this was the case, and “retired to the rose garden” outside the house when they wanted to talk to each other in private. When the bomb was dropped on Hiroshima, Frayn continued, the physicists seemed genuinely stunned and had no time to work out a “security response.” Yet even though we learn about the details of the fission programme, nothing is said about the fusion programme. So, were the Germans being frank and open with each other? Frayn suggested that Diebner and Gerlach may have been more “devious” than previously thought...

“But is Karlsch right?” asked Frayn, despite his claims of concrete evidence and the suggestion that the Germans had even tested prototype weapons, including an explosion in the Baltic for which there is “reasonable evidence,” and another test at Ohrdruf which is supported by “impressive” eye-witness testimony – plus corpses with evidence of radioactive damage and survivors suffering from radiation sickness (including inmates from a nearby concentration camp).

After writing *Copenhagen*, Frayn met the American physicist Jeremy Bernstein, who edited the American version of the *Farm Hall Transcripts* and put a different “gloss” on what had happened, said Frayn. According to Bernstein, the transcripts are full of allusions and “shorthand” which make it difficult to reconstruct the actual conversations, and when Frayn later introduced Bernstein and others to Karlsch’s revelations, they “dismissed the possibility” of a fusion programme during the War, and said there was “no way that any configuration of conventional explosives can begin to produce the conditions you need” for a hydrogen bomb. The tests, they said, had not been fusion but the first “dirty bombs,” using conventional weapons to scatter radioactive material over the site.

So what did the fusion programme really achieve? Frayn said that even if they did not build a workable weapon, the test would still have been very impressive, and this may explain the Nazi government’s strategy in the final days of the War. Instead of their refusal to surrender, being “crazy,” the high command may have believed they were about to get a “wonder weapon” to halt the Soviet advance. This may not seem practical, but to “desperate people” this may have appeared a possibility, said Frayn. This may also explain why the SS moved resources to the test site at Ohrdruf, perhaps for a desperate last stand.

A lot of information landed on Frayn’s desk after writing *Copen-
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*hagen* (which described the uncertainties surrounding the meeting in the Danish capital between Niels Bohr and Werner Heisenberg in 1941), but he also suggested that the play itself has also had an impact on the historical record, because the controversy after its initial performance led to the release of new material, including the so-called ‘Bohr letter’ – originally intended to be kept under wraps until 50 years after Bohr’s death. Frayn’s knowledge of the meeting between Heisenberg and Bohr had, until then, been based on what Heisenberg said, with Bohr’s views only known via indirect sources. The letter, said Frayn, had been addressed to Heisenberg but had never been sent, and Bohr had written several drafts over the years, describing his account of the fateful meeting in Copenhagen. Even though Bohr’s account “dissents” from Heisenberg’s in some respects, said Frayn, what they agree on is more interesting, establishing the fact that Heisenberg did talk about developing nuclear weapons. This was amazing, said Frayn, because Bohr was half-Jewish and “notoriously anti-Nazi” and would have been considered as an “enemy alien.” Bohr was also in touch with people in the US and Britain, and had helped several physicists escape from Nazi Germany, so one implication is that Heisenberg may have been trying to alert the Allies to the Nazi’s nuclear programme.

Following a performance of *Copenhagen* to celebrate Heisenberg’s centenary, the German physicist Hans-Peter Dürr, who worked with Heisenberg after the War, revealed that Heisenberg had been “obsessed” with the meeting – and why Bohr had seemed so angry and ended their talks. The suggestion was that Heisenberg was naïve to think the two men (no matter how close they had been in the past) could simply sit down for a chat, ignoring the historical circumstances and the fact that his visit to occupied Denmark would be viewed as unwelcome and even “embarrassing.”

So what did Heisenberg hope to achieve? Was he seeking technical or moral advice? Or did he simply want to talk things over and rehearse his arguments?

What is fact and what is fiction? Frayn left these questions unanswered when he said that putting events into narrative form “changes our attitude to the events,” and concluded by paraphrasing Einstein’s idea that just as theories may determine observations, “often the narrative determines events.”
War of the Words

Nuclear weapons are an ethical dilemma for all thinking people – particularly the scientists who build them. Should nuclear physicists have worked for the Nazis, refused to follow orders or even sabotaged the project? Should the bomb have been dropped on Japan – and should civilians have been targeted? What about the arms race now – and in the future?

Sir Michael Atiyah kicked off the discussion by saying that many of the scientists constructing the atomic bomb in Los Alamos may have had qualms about what they were doing, but only one of them resigned on moral grounds.

Robert Oppenheimer (‘the father of the bomb’) did express misgivings later on, but the only scientist who actually resigned was Jo Rotblat, who went on to form the first Pugwash movement, in a bid to control and eventually eliminate nuclear weapons.

John Polkinghorne said that Los Alamos saw the greatest concentration of high scientific talent ever assembled for a single common purpose, adding: “With the honourable exception of Jo Rotblat, nobody really asked themselves what they were up to, until they actually saw the test explosion in the New Mexico desert.” And according to Polkinghorne, “that was too late.”

Scientists involved in this kind of research have two roles, said Polkinghorne: they are indispensable experts and morally responsible citizens. Pure science gives us knowledge, and that is a good thing, but the “lusty offspring” is technology, which turns that knowledge into power,
“and that is a much more ambiguous gift,” he continued, because not everything that can be done should be done.

We therefore need another gift, said Polkinghorne – the wisdom to choose good over bad. Scientists also have to make such decisions, but they have no unique expertise in that respect. The hymn says “every calling has its snare,” he continued, and the snare of the scientific calling is the “technological imperative,” the excitement of discovery and doing new things, even though the next thing may be something that we shouldn’t do.

That is why there has to be a dialogue between scientists and the general public, when society tells scientists to think about what they are doing and the consequences of their actions. Scientists can’t always be their own judges, he added. They should never forget that they also have a community role.

It’s always hard to reach the right decision, said Polkinghorne, especially when ethical discourse is so often about “the clash of single-issue pressure groups.” While one group howls “X is terrible,” another group is saying “X is wonderful!” And it’s very unlikely that either is right, he continued, because “X” will be good for some things and bad for others, just as nuclear reactions are ‘bad’ for bombs and potential-ly ‘good’ for power production. That’s why we need public forums in which scientists participate but do not monopolise, not seeking what the media love (the conflicts which make “really good television”) but a “measured, truth-seeking, wisdom-seeking debate.” Scientists have to contribute, he said, but they have no unique role to play.

The “slightly pessimistic” Michael Frayn said that the control of nuclear weapons is like “the balloon problem” described in Ian McEwan’s novel Enduring Love, when a balloon breaks loose and several people grab the ropes to hold it down, but then someone drops one of the ropes and it becomes in the interest of everyone else to drop the ropes before they fly away with the balloon. Unfortunately, however, one of them is carried off and falls to his death. And for Frayn this symbolises the idea that renunciation of nuclear weapons only works if it is universal.

“It seems extremely unlikely that it’s going to be universal,” he said, “because there is always a living to be made by some group as a predator.” The only way to control nuclear weapons, he added, “is by extremely elaborate, tiresome and complicated agreements between great powers to join together to resist any minor power or private interest who tries to seize the advantage by becoming a predator.”
Frayn also thought it was unlikely that renunciation of nuclear weapons could ever be completely successful, but hoped it would be “largely successful.” Sir Michael agreed there is some room for hope, but also conceded “it’s tough.”

Richard Holloway described the two days of drama as “a kind of narrative of the fall of science,” with the invention of the bomb as “science’s original sin.” We gained “astonishing but dangerous knowledge” by inventing the bomb, he explained, and lost our innocence as a result.

These terrible weapons may have prevented war between “advanced” nations, said Holloway, so there is “a weird kind of evil grace in the invention.” The danger is that the bomb will fall into the hands of people who do not have the same restraint.

Describing the “ambiguity of science,” Holloway said we may be very clever, but scientific knowledge often outstrips ethical considerations and there’s a lag between what we can do and what we ought to do, which the bomb demonstrates. He also said we have a “duty” to deal with this dangerous knowledge.

Fifty miles away, Holloway added, there are submarines in Holy Loch with “enormous predatory nuclear weapons” that the government is about to renew, at a cost of £20 billion, in the midst of an “apocalyptic financial crisis.” Maybe the RSE should look at the morality and economics of the renewal of Trident, he said, as its “next piece of drama.”

John Finney mused on the suggestion that was raised that Heisenberg might have been “something of a German Rotblat,” and said that Rotblat’s short-term goal was the abolition of nuclear weapons – and his long-term ambition the abolition of war. And “there is certainly no Heisenberg uncertainty” in that, he declared.

Rotblat did some very fundamental work on nuclear fission, said Finney. He was one of the first people to calculate how many additional neutrons are produced by uranium fission, and saw as a result of that the possibility of a nuclear bomb. “He joined the Manhattan Project because of the possibility that Germany would develop a nuclear weapon,” said Finney, “but he left it when it was clear Germany was not developing the atomic bomb.” He went into the Manhattan Project believing in deterrence as a theory, but at the end of his life, he no longer believed this, said Finney.

After quitting the Manhattan project, Rotblat spent most of the rest of his professional scientific career looking into the medical uses of nuclear physics, and indeed built what appears to have been the first X-ray scanner. He
also signed the Russell–Einstein Manifesto, calling for the abolition of nuclear weapons, and co-founded Pugwash in 1957. And while Rotblat was the President of Pugwash, the organisation and Rotblat himself were awarded the Nobel Peace Prize.

Finney then described Pugwash (named after the small town in Nova Scotia where the first conference was held) as an international network of scientists who are concerned about the social impact of science – and want to do something about it, including preventing the “misuse” of science. Initially, the focus was nuclear weapons, but that brief has since expanded. Because it works behind the scenes, a lot of its achievements are not public knowledge, but after the Cold War, Gorbachev confirmed it had had a major effect through keeping communication channels open during the Cold War. It had a critical influence on many arms control agreements, but Finney wondered why we have outlawed biological and chemical weapons but not nuclear weapons.

Pugwash today remains focused on nuclear weapons, trying to help resolve conflict through dialogue – e.g. “very interesting discussions with senior Iranians in the last 12 months.” The Pugwash nuclear disarmament agenda has in the last two years moved into the political mainstream, with ‘getting to zero’ seen as a viable aim by many politicians, including President Obama. The Americans and Russians could get down to 500 weapons, said Finney, “without any problem,” but getting down to zero would be harder, and we’d need complex agreements to do so.

Finney also emphasised that the Pugwash movement is also concerned with other issues where scientists can play a positive role, including problems of climate change and the ethics of science, where the idea of a Hippocratic Oath for scientists has been developed by the Student/Young Pugwash organisation.

Q&A

*How do we ensure that this knowledge (about nuclear weapons) will always reach people in an unbiased way? Via drama? Or more education?*

Polkinghorne was concerned that the general public do not have a good understanding of science, while Finney said that the decision to renew Trident has both political and technical aspects. The design lifetime of the submarines is 25 years, he explained, but experts in the US argue that this lifetime could be extended by ten or more years, which would allow a decision on replacement to be postponed while international efforts towards nuclear disarmament continue. “But there’s a
disconnect in being able to get that information into the policy process,” said Finney. “There are no easy mechanisms in the UK for feeding independent scientific advice into government,” partly because we don’t have many independent scientists who haven’t signed the Official Secrets Act, unlike in the US where scientists who have been previously active within government can raise technical issues from the outside.

Today’s Guardian said it’s likely to cost £80 billion to renew Trident. Is it possible to “dis-invent” nuclear weapons – like South Africa? And what’s the French position on disarmament?

Finney replied that France has said it is prepared to join in negotiations when weapons reductions have reached a certain (unspecified) level, and that it is reducing its number of weapons to about 350, although it’s still building improved warheads. “They’ve also opened up some of their military fissile material production facilities for inspection,” he said, “but there is no pressure within the French population for nuclear disarmament.” There’s a disconnect, he added. People in France appear to accept that nuclear weapons are important and will even protect them from terrorists, but there hasn’t been much of a public debate on the issue.

Holloway said: “Just because you have a group of experts giving politicians advice, it doesn’t follow that they will accept it,” for political reasons and to keep the media happy. In Scotland, he said, a majority oppose renewing Trident, and it should be possible to start a good debate, especially given the fact that we could save £20 billion by not renewing Trident.

We have had over 60 years of peace in Europe as a result of deterrence, whereas in other countries, “monstrous acts continue.” So, does deterrence work?

Atiyah pointed out that even though we have had peace, the causes are much more complicated: “The idea that deterrence solved all our problems in the past and we should have more of it – that doesn’t work, I’m afraid.”

Is there any “narrative” that will link things like climate change, nuclear disarmament and the financial crisis?

Frayn replied that we can’t assume that all human beings have the same aim or could have the same aim. “It’s always in the interest of someone to break ranks,” he said. Polkinghorne believed proliferation would continue and that one of the drivers is the fact that the powerful nuclear states have the most powerful weapons, which encourages more states to acquire their own weapons, “almost in self-defence.” We need to look at
these issues in a different way, he added, “but how do we make it possible for politicians to shift their positions?” One of the answers could be attempting to mobilise “international civic society,” Polkinghorne continued, even if this may be “pie in the sky.”

What about Pakistan, with the Taliban 60 miles from Islamabad? Finney said the situation in Pakistan is “very worrying and grave,” and expressed his concern about other areas of the world where if something went wrong, it could go very, very wrong, because of the presence of nuclear weapons – e.g. the Middle East and North Korea. “I have no easy answers,” he said. The people there have to solve their own problems, he added, with whatever assistance they can get from outside. Because a conflict might escalate into the use of nuclear weapons, these are areas where Pugwash is making particular efforts to try to help find ways forward.

Should we have a Muslim forum for scientists? And communication between scientists with different ideological backgrounds?

Atiyah pointed out that many scientists from Muslim areas, including Pakistan, are involved in Pugwash, and said it is a serious mistake to believe that the Muslim world is a hotbed of extremist views. “We’ve got to get rid of that simplified view of the world,” he added.

Some of us do not share your views on nuclear weapons. I believe they’ve been an unfortunate blessing. I wish that they would go away but you can’t reinvent them. And how do we address the problem of proliferation in less “sophisticated” countries?

I was shocked by the suggestion that the balance of nuclear powers prevented the Third World War. Do you think this changed after the Cold War ended?

Polkinghorne said the situation has changed for the worst, because of proliferation. Not only are more states acquiring nuclear weapons, but there is also a large black market for terrorists. “It seems like we’re in a more dangerous place now than we were 30 years ago,” he added. Holloway “kind of agreed” that deterrence had worked, but said that some things only work until they stop working, “so there’s never any actual proof that they are working.” Some states are probably not interested in deterrence because they’re not bothered about mutually assured destruction. “I think that’s the new world enemy,” he added.

Atiyah then described how, at the end of the Cold War, the Russians and Americans who had been involved in the Cuban Missile
Crisis exchanged information about “what they knew and what they didn’t know,” about each other at the time. “The outcome was extremely chilling,” said Atiyah, because they found out how much they had been misinformed by their own governments, and how poor the intelligence was. “They very nearly stumbled into a thermo-nuclear war,” he continued, “without even knowing it.” Robert McNamara, who became very active in Pugwash, said that the longer we have nuclear weapons, the more likely it is we will make a mistake, because “the fallibility of human beings will guarantee an accident.” So if anyone still believes that nuclear weapons can ever be a permanent source of stability, Atiyah continued, they should study those events.

Finney said that nuclear weapons were initially developed to deter a possible German attack. Afterwards, nuclear weapons were justified on the grounds that they would prevent a conventional attack by the Russians, who were thought to have superior conventional forces. When the Cold War ended, “we moved from a bi-polar world to a multi-polar world,” said Finney, and we had to rethink how to keep the peace. Even if you believe that nuclear weapons actually worked in a “bi-polar world,” can you extend that theory to a world in which there are 100 states with nuclear weapons?

According to Finney, the Nuclear Non-Proliferation Treaty was a bargain between the recognised nuclear weapons states – France, the UK, US, USSR and China – and the other signatories that recognised the right of all countries to access nuclear technology for peaceful purposes if they agree not to develop nuclear weapons. And as part of that grand bargain, the five nuclear weapons states agreed to work towards the elimination of nuclear weapons. Unfortunately, said Finney, the nuclear weapons states haven’t fulfilled their part of the bargain, and the danger of nuclear weapon proliferation has increased. India and Pakistan haven’t signed the NPT, Israel doesn’t officially acknowledge it has nuclear weapons (even though everyone knows that it does), and North Korea applies the same argument in favour of developing a nuclear weapon capability as we do for retaining ours, saying its weapons will deter other states from attacking it – an argument that every other state could also use to justify possession of nuclear weapons. And that is why “there’s no way forward but to get rid of the damn things,” said Finney.
To stop proliferation, stop testing and get everyone to sign a comprehensive nuclear test ban treaty, including the US. What does the panel think about that?

Finney explained that the US has signed the Comprehensive Nuclear-Test-Ban Treaty (CTBT) but it hasn’t been ratified yet by the Senate – and this requires a two-thirds majority. The treaty is high on the new administration’s priority list but there is still a lot of work to do, he added.

There’s been a lot of talk about the ‘advanced’ and ‘sophisticated’ nations with nuclear weapons, but if I lived in a country which has been on the receiving end of the behaviour of these ‘morally superior’ nations, I might find it harder to get so worked up about the prospect of terrorists gaining the same kind of power.

Holloway explained that he had used the word ‘advanced’ not in any moral sense but in the sense of developed technology, and agreed we are not morally superior. “I think we are all pretty mixed,” he said.

Most of the panel appear to agree about nuclear weapons and are also happy about nuclear power. But as long as there’s nuclear power, there’s always the potential to make nuclear weapons. Do you see any optimistic way forward?

Finney said there are serious technical issues that still need to be solved in relation to inspections by the International Atomic Energy Agency to be able to ensure that nuclear technology is only being used for peaceful purposes. The problem, he continued, is that it is relatively straightforward for a country with a nuclear power infrastructure to make a further step and develop a nuclear weapon. So we need “some sort of trip wire” to alert us to when the line between having nuclear power and developing a nuclear weapon capability has been crossed. But the problem is not “insoluble,” Finney said, but agreeing that if there were no nuclear power, it would be easier to prevent weapons development.

CLOSING REMARKS

Frayn: “It’s not a question of morals or sophistication – it’s always going to be in the interests of smaller powers to retain a trump against the massive powers.”

Holloway: To build ‘a narrative of hope,’ Britain could re-think the renewal of Trident. “I don’t know if that would render us any less safe,” he said, “but it would be an enormous spiritual and moral gesture and save us a hell of a lot of money.”

Polkinghorne: “If we gave up our nuclear deterrent tomorrow, what effect would that have on North Korea? Not very much, I think.”
Finney: “We certainly can’t dis-invent nuclear weapons, but that is not to say we can’t abolish them. We need to mobilise international civic society.” Rotblat believed that in addition to its traditional “behind the scenes” work, Pugwash had to convince people nuclear weapons are not the way forward. “It’s no good Obama wanting to get rid of nuclear weapons, if he can’t take his population with him,” Finney added.

Atiyah: “Most of our scientists agree that although our science produces problems, knowledge is important.” And part of the trouble, he said, is that politicians and the general public are not well informed. “On a more hopeful note,” Atiyah pointed out that the former Chairman of Pugwash, John Holdren, has been appointed scientific adviser to President Obama.

“We didn’t solve the problems of the world,” Atiyah concluded at the end of the evening, but perhaps the renewal of Trident would be a good topic for next time…”
The Robert Cormack Bequest Meeting, supported by the Cormack Bequest Fund and the Scottish Universities Physics Alliance (SUPA), was held on Monday 27 April, hosted for the first time by the University of Dundee.

The aim of this annual meeting is to bring together astronomers, space scientists and those interested in astronomy, mainly post-graduate level students and post-doc researchers, to share their work and discuss the latest happenings in Scottish astronomy.

This year’s meeting opened with a welcome from co-host Dr Steve Parkes, of the University of Dundee’s Space Technology Centre. He also gave the audience an insight into the dynamic research being carried out in the Space Technology Centre.

The opening lecture, entitled Sizing-up extra solar planets, was given by Professor Andrew Collier-Cameron from the University of St. Andrews. His fascinating presentation provided an overview of the latest research in the area of exoplanetary science, including some of the more unusual planet discoveries. Professor Cameron also presented the history of the UK Wide-Angle Search for Planets (WASP) which has become the world’s most successful survey of bright transiting planets.

The welcome and opening lecture were followed by a series of contributed talks, by PhD Students and Researchers from across Scotland:

- The physical and chemical environment of a star-forming bright-rimmed cloud - Alison Craigon (University of Strathclyde)
- Stellar Encounters: A Stimulus for Disc Fragmentation? - Duncan Forgan (Institute for Astronomy, University of Edinburgh)
- Silicate, ruby and opal in the atmospheres of Brown Dwarfs and planets - Christiane Helling (University of St. Andrews)
- NIR and optical luminosity distributions and functions in MGC/GAMA - David Hill (University of St. Andrews)
- Cosmological Perturbations and Instabilities in Coupled Dark Energy and Dark Matter Models - Brendan Jackson (Institute for Astronomy, University of Edinburgh)
- Extrapolating Coronal Stellar Magnetic Fields - Colin Johnstone (University of St. Andrews)
- University of Dundee involvement with the ExoMars mission - Mark McCrum (University of Dundee)
Fragmentation in Molecular Clouds and its Connection to the IMF - Rown J. Smith (University of St. Andrews)

The Nature and Clustering of Star-forming Galaxies at z=0.84 - David Sobral (University of Edinburgh)

The temperature structure around Quasars during Reionisation - Eric Tittley (Institute for Astronomy, University of Edinburgh)

A new SMBH Mass Function for the Local Universe - Marina Vika (University of St. Andrews)

Testing the stability of dwarf ellipticals in MOND - Xufen Wu (University of St. Andrews)

Posters on a variety of topics, including the first non-linear force-free Vlasov-Maxwell equilibrium and the development of comprehensive Lunar South Pole maps using a planetary surface simulation tool, were presented in a poster display:

Gráinne Costigan (University of Dundee)

Martin Feix (University of St Andrews)

Scott Gregory (University of St. Andrews)

Emma Grocutt (Institute for Astronomy, University of Edinburgh)

Julia Kennedy (Institute for Astronomy, University of Edinburgh)

Primates Mallik (University of Glasgow)

Dr. Thomas Neukirch (University of St Andrews)

Jennifer Noble (University of Strathclyde)

Hamish Reid (University of Glasgow)

David Sobral (University of St. Andrews)

The meeting closed with the presentation of the following prizes:

Cormack Undergraduate Prize – Mr William Simpson (University of St Andrews). Coronal Null points and Solar Flares: a study of the topology of Active Regios AR0486 during the time of the X17.2 Flare.

Cormack Postgraduate Prize – Ms Jenny Richardson (Royal Observatory, University of Edinburgh). An HCTIACS view of the inhomogeneous outer halo of M31

Prize for Best Poster – Ms Jennifer Noble (University of Strathclyde). Probing the chemistry of molecular cores: 2.5 - 5 micro Prism spectroscopy of B35A

The meeting was followed by a tour and drinks reception at the Mills Observatory, Dundee, the only UK Observatory to have been built with the sole aim of encouraging public understanding of science.

This year’s meeting attracted a total of 65 participants, from five Scottish Universities, as well as members of the Dundee Astronomical Society and the Mills Observatory Advisory Group.
Review of Sessions 2008/09 and 2009/10

Stem Cells as Therapy. Where have we been; Where are we now and where are we going (and how fast?)
Caledonian Research Foundation Conference
30 April 2009

Stem cells may well hold the key to finding treatments for previously incurable conditions. But they tend to divide populations. While many are excited about their possible therapeutic applications, others see them as an ethical affront and are uneasy about their use. Stem cell research has, however, been one of the fastest growing areas of biomedical science in the last decade. The recent election of US President Barack Obama – who is in favour of stem cell research – is likely to accelerate that further. Leaving aside the ethical debate, just how close are we to turning dreams of a range of stem cell therapies into clinical reality?

This conference, organised by the Royal Society of Edinburgh and the Caledonian Research Foundation, brought together some of the world’s leading figures in stem cell research to discuss the scientific barriers which must be overcome.

Taken in three sections, the conference heard about achievements to date, reviewed the current state of research and took a look into the future – including developments in the regulatory framework which governs the field. Significant questions and hurdles remain, but there was a sense of optimism that, given the right policy and research environment and backing, stem cells may one day become routine therapy.

Session One – Where have we been?
Sir John Gurdon FRS. Wellcome Trust/Cancer Research UK Gurdon Institute, University of Cambridge.

Nuclear reprogramming in eggs and oocytes
Described as a ‘father figure’ in the field of stem cells because of his pioneering work with frog cloning in the 1960s, Sir John introduced the day with an overview of nuclear reprogramming. In nature, cells do not change from one pathway to another – once they have started developing, they will continue to become the specific adult cells they started out to be. But experimental nuclear reprogramming can be used to encourage other, unrelated, cells to grow. This works most efficiently where the nucleus of a somatic cell is transplanted to an egg which has had its own nucleus removed.

The advantage of this process is that it is natural and highly efficient and does not require new
genes. The disadvantages are that human eggs are hard to obtain, so, realistically, it would not be possible to obtain enough.

The long-term aim is therefore to identify the mechanisms and substances with reprogramming ability, then use them to improve the success rates of creating replacement cells from easily obtainable tissues such as skin or blood.

He asked three questions: how efficient is reprogramming by eggs and oocytes? What causes the failures of nuclear transfer? And what mechanisms are used by eggs and oocytes for reprogramming?

Using nuclear transfer to eggs to switch between cell types is around 30 per cent efficient. Unsuccessful reprogramming may be due to epigenetic memory, whereby the cell ‘remembers’ what it was supposed to be in the first place.

This may be explained by the presence of histone H3.3, which appears to be required for epigenetic memory. If this is removed, it is possible to make the cells ‘forget’ what was once their destiny and happily become different types of cells.

Sir John then discussed some of the specific mechanisms which may lead to efficient transfer. Chromatin decondensation seems to be necessary to ‘switch on’ pluripotency in cells, so could be the first crucial step. The DNA has to be demethylated (which essentially means having its memory taken away) for epigenetic reprogramming. Sir John said that although you might think that transcription factors would be required, they are not. Also, it is important to switch processes ‘on’, but not ‘off’.

The egg is a remarkable thing and a better understanding of how it works will help us make more efficient the switches for reprogramming and cell replacement.

**Professor Roger Pedersen**
MRC Cambridge Centre for Stem Cell Biology & Medicine, Cambridge.

**Mechanisms of pluripotency and differentiation in human pluripotent stem cells**

Pluripotent stem cells are capable of generating all body tissue and are potentially a source of important new therapies. Understanding how human embryonic stem cells (hESC) maintain their pluripotent state may be the key to translating stem cell research to therapeutic applications.

Comparisons between mouse and human stem cells are helping us to understand more about how they work. There are significant differences between mouse ESCs and hESCs. Unlike in mice, pluripotency in hESCs is maintained by the growth factors Activin and Nodal. Differences between the mouse and human
cells have a developmental, rather than a species, origin, and human stem cells (including induced pluripotent stem cells) represent the state of pluripotency in the pre-gastrula stages of mammalian embryos. Activin/Nodal inhibition in hESCs induces neuroectoderm differentiation. The question is how does Activin/Nodal signalling regulate the cell fate decision between pluripotency and neuroectoderm differentiation?

Professor Pedersen discussed research which is taking forward our understanding of the biological mechanisms of stem cells. This has included analysis of the roles of the Smad proteins and their binding partners, as well as isolating and studying relevant growth factors.

Other research has looked at the role of Activin/Nodal in Nanog expression (a critical factor in cell pluripotency) and has found that it depends on the growth factors, while Nanog transcription is regulated by Smad2 and Smad3 binding sites. This is important because Nanog over-expression maintains pluripotency in hESCs. Therefore, Activin/Nodal signalling maintains pluripotency through its regulation of Nanog expression and Nanog activity will inhibit neuroectoderm differentiation.

He also discussed the role of SIP1, which promotes and accelerates neuroectoderm differentiation in hESCs. But Activin/Nodal signalling represses SIP1 expression through Nanog and OCT4 and also directly by Smad2 and 3, while SIP1 is activated by SOX2. All these factors affect cell fate decisions and help determine pluripotency, and improving our understanding of them in the lab will accelerate the development of new stem cell therapies.

Professor Robin Lovell-Badge FRS. Head of Division, Division of Stem Cell Biology and Developmental Genetics, MRC National Institute for Medical Research

**Many ways to pluripotency – embryonic, adult and inducible pluripotent stem cells**

Embryonic stem cells are pluripotent, that is, they have the ability to become any of the differentiated cell types in the adult body. But there are ways of obtaining relatively stable stem cell lines from a number of sources, including blastocysts, teratocarcinoma tumours and early (post-implantation) embryonic or foetal tissue. Adult stem cells have been used for therapy for many years – for example in bone marrow transplants and skin grafts – but they tend only to give rise to the same cell type.

Adult and embryonic stem cells can also be encouraged to pluripotency by using genes such as SOX2, so that they become induced pluripotent stem cells. These stem cell genes are required for the establishment and mainte-
nance of tissues, to permit or encourage self-renewal and confer the ability to differentiate into one or more cell types. Looking for these genes and seeing how they act in different types of stem cell is providing valuable information about how cells work. For example, SOX2, OCT4 and Nanog are thought to regulate many genes that define the embryonic stem cell state, and SOX2, OCT4, KLF4 and cMYC can reprogramme fibroblasts to ES-like iPS cells.

Professor Lovell-Badge talked about the role of SOX9 in the generation of neural stem cells – the number of neurones and oligodendrocytes, for example, is reduced if SOX9 is removed. SOX2 marks several stem cell types in adults and is also expressed in several differentiated cell types, but its regulatory region is very complex.

There are a number of ways to induce or improve pluripotency, but questions remain, not least around safety. Professor Lovell-Badge concluded by saying that robust assays for pluripotency, or proxies for this, are needed, especially for human ES and iPS cells.

These should include organised and consistent in-vitro differentiation assays; teratoma assays; chimera studies (except in humans); and profiling to look for activity of both the pluripotency gene network and chromatin status.

**Session Two – Where are we now?**

**Professor Ian Duncan CorrFRSE**
Professor of Neurology, University of Wisconsin, USA

**Repair of myelin disorders using stem cells; exogenous vs endogenous strategies**

Myelin, the protective layer which surrounds nerve cells, is an important target for treating neurological disorders. Of these, the most common disease is multiple sclerosis (MS), where the myelin degenerates (demyelination). There are also a number of serious inherited disorders where myelin does not form. There are no current treatments which promote the repair or formation of myelin, but Professor Duncan described various strategies by which stem cells might be used to build or replace this insulating or protective sheath, providing potential cures.

In his talk, Professor Duncan concentrated on MS, a chronic, demyelinating condition, which is particularly common in Scotland, is pathologically complex and for which there are treatments but no cure.

One of the hallmarks of the disease is demyelination of the brain and spinal cord (CNS), to which, in the early stages of the disease, the CNS appears to respond with a partial remyelina-
As the disease progresses, however, the CNS seems to lose its ability to respond.

Myelin arises from a well-studied cell, the oligodendrocyte. Understanding the lineage of these cells, from the earliest stages of embryonic differentiation to the production of oligodendrocyte progenitors, may provide clues about the best way to provide therapies.

Professor Duncan described two approaches: exogenous treatment, where cells are effectively transplanted to replace myelin; or endogenous, where existing cells are ‘recruited’ and persuaded to repair the myelin loss. The latter method may well avoid the risks of immune reactions, but may have other risks, and, in any case, the recruitment process is not sufficiently understood as yet. The former has shown more promising results so far in animal models. Research to date may not have been conclusive, but has suggested that both methods are promising. It might be, said Professor Duncan, that the two techniques could be used together to provide a better outcome.

There will be challenges, however, in translating the animal model findings into humans, not least because the human brain is much larger.

**Professor Paul Sharpe. Department of Craniofacial Development, Dental Institute, King’s College, London**

**Tooth morphogenesis: from embryonic development to postnatal tooth regeneration**

For thousands of years, man has replaced lost teeth. Today we tend to use dental implants, involving a metal substitute for the root – not so very different from an iron peg found in the mouth of a Roman from 2,000 years ago. It’s all been about inert substances, not biology, said Professor Sharpe.

All this could be about to change. He described the development of a biological process to use stem cells to create replacement teeth. This could have huge quality-of-life benefits; could revolutionise treatments for people with diseases such as osteoporosis (who may lose teeth and the bone in the jaw) and could also provide important clues for how best to use stem cells to replace other organs.

Professor Sharpe said it was important to understand the development of the tooth. He took it right back to the epithelium and mesenchymal cells which form an embryonic tooth primordium. The idea was to identify the cells, start the process, and then you should get a tooth, he said, adding that while the idea is simple, doing it is more difficult.
Using mouse models, they have found cells (both embryonic and adult) which will form tooth primordia and then develop into complete teeth when transplanted into the mouth.

There is a need, however, to identify human cells – and also find a source of these. Professor Sharpe described how dental stem cells are a ‘fantastic’ mesenchymal cell source – one of the reasons why commercial companies are now ‘banking’ ‘baby’ teeth which children lose naturally. But there remain challenges, including a relative lack of knowledge about these cells, where they are found and how they function. In order to improve this understanding, Professor Sharpe is using mouse models to determine the genetic processes involved in the repair of damaged teeth – the idea being to learn more about the mesenchymal cells believed to be in adult molars.

Professor Olle Lindvall. Section of Restorative Neurology, Wallenberg Neuroscience Centre, Lund University Hospital, Sweden

Stem cell therapy for neurological disorders

While there is some evidence that stem cell therapies for some disorders of the brain would work in principle, Professor Lindvall urged a cautious approach, pointing out that there was still a lot to learn. Stem cells have possibilities, he said, but it would take time to develop ‘roadmaps’ to the clinic. In particular, he warned against ‘scientifically ill-founded’ trials in patients and said more research was needed to get a better understanding both of the diseases themselves and how potential treatments worked.

Professor Lindvall made special reference to Parkinson’s disease (PD), where there is proof-of-principle that neuronal replacement can work. But he said there were many issues to be considered. Any stem cell therapy would have to be clinically competitive, in that it would have to be better than existing treatments for PD. Specific cell types, for example, dopamine neurones, would have to be generated; good animal models would be needed and the biological mechanisms underlying the observed functional effects would have to be understood.

Trials using human foetal dopamine neurones are promising, but have limitations, he said. For example, there is a limited availability of human foetal tissue. There is also the question of whether the grafted tissue is likely to become affected by the disease. Research so far suggests that patients will be fine ten years after treatment, but that disease will progress in some in 16 years.

To make a successful treatment, a good supply of standardised dopamine neurones would be
needed. There have been recent interesting developments in animal models, but there are risks. For example, stem cell therapies (as tried on rats) could be tumour-forming. There is also a question about what type of stem cell would be best and research should be carried out on each in parallel. There is also the possibility that the brain could be stimulated to produce new, healthy cells of its own.

Challenges include making treatments more effective – improving survival of neurones is a major goal, he said. Minimising unwanted side-effects is also vital.

In summary, Professor Lindvall said that stem cell therapies for neurological disorders were possible, but were a long-term prospect. More information is needed on the mechanisms of the disease and on the biology underlying the functional effects. Research on exogenous and endogenous stem cells should continue to work in parallel, and potential problems should not be underestimated.

**Professor Keith Muir.** Division of Clinical Neuroscience, University of Glasgow

**Taking stem cells into clinical trials**

Professor Muir described the development of what will be the first clinical trial on stroke patients using foetal-derived stem cells. He started by saying that, as a clinician, stem cell treatments had seemed a ‘distant possibility’. Now they are closer to hand, but hold a number of challenges, not all of them clinical. Stroke is a good starting point, he said, because it is a single, focal brain injury, is common and causes disability with limited recovery – there is a huge clinical need for effective treatments.

The trial will involve injecting foetal-derived neural cells directly into the brains of stroke patients, in the hope that they will differentiate into brain tissue, neurones and other tissue and lead to repair, either directly or by stimulating the existing cells and connections to repair themselves.

There have been enormous challenges in designing the trial, which received approval from the Medicines and Healthcare Products Regulatory Agency (MHRA) in January 2009. These include choosing patients – and there is a big variety in stroke patients and most are older people with other diseases. There are also problems with recruitment of patients, as many are automatically excluded, for reasons ranging from a lack of ability to consent, to clinical suitability. There are also challenges around finding methods of showing if the treatment is working – it is not possible to ‘mark’ the cells to see what they are doing – and in ensuring safety. There are questions around control groups, whether patients...
should be immunosuppressed and about length and type of follow-up. The proposed solutions for the first trial would probably change in future trials, he said.

Professor Muir also described regulatory hurdles, with two distinct bodies overseeing scientific review at present (MHRA and also the Gene Therapy Advisory Committee). Another pressure is media interest – and dealing with public expectation. Desperate patients and their families have contacted him saying they would sell everything and move to Glasgow just to be part of the trial.

**Professor Alan Colman** Singapore Stem Cell Consortium, (A*STAR), Institute of Medical Biology, Singapore

**Translational applications of pluripotent stem cells – hESC and iPSC**

Cell therapy has reached some interesting milestones and there are promising therapies in development, but there is still some way to go and the challenges should not be underestimated.

Professor Colman outlined the potential uses and pros and cons – as we know them so far – of human embryonic stem cells (hESC) and induced pluripotent stem cells (iPSC). He also gave some examples of how they are being used in research.

Proposed uses for hESC include drug screening and allogenic cell therapy and also, possibly, for autologous cell therapies. He described some current research, including the work of Coffey and others in London to ‘cure’ age-related macular degeneration (AMD) – a common cause of sight-loss – by using stem cells to make replacement macular cells.

Cells could also be made and used in drug screening, which should improve safety and avoid situations where drugs have to be withdrawn because they are causing harm in some patients.

Prospects are less good for autologous therapies, however, partly because it is difficult to make the right cell type in sufficient numbers.

Adult stem cells or iPSC have the potential to be created in far greater numbers – which might make them more suitable for autologous treatments. Here the limitations include finding ways of getting the cells to the affected site without causing problems. These cells make it possible to create an almost unlimited amount of material for drug screening and for research to study the biology of diseases. But a major challenge will be growing and ageing them quickly enough so that they are of use in examining late-onset diseases, such as motor neurone disease.
Panel Discussion
Asked if the mechanisms in Europe for getting new therapies to the market are counter-productive, and if it could be done more quickly and safely, Professor Muir said he felt that regulatory processes are still developing and need a rigorous review. Rigorous regulation is important, but the current process could be improved.
Professor Lindvall said he felt that stem cell therapies are moving too quickly into the clinic and that they should be developed in a responsible way.
From the floor, Professor David Baird said that moving forward in a rational way has the potential to stifle innovation. IVF has been developed in a ‘chaotic’ fashion, he said, and the more it has become regulated, the more innovation has decreased. He said more account should be taken of consumer groups and of patients willing to take risks. Professor Lindvall said he had been a clinician for 30 years and his first ambition was to do something good for his patients. But he warned against rushing into treatments, for example, for Parkinson’s disease, for which there are existing therapies. If a stem cell treatment causes a tumour, for example, it could kill stem cell research for 25 years.
Professor Muir added that one problem is that while patients are willing to take part in trials, nobody wants the placebo – patients are willing to take risks.
Session Three – Where are we going? (and how fast?)
Professor Sian Harding. Professor of Cardiac Pharmacology and member of the Nuffield Council on Bioethics, National Heart & Lung Institute, Imperial College, London
Translating research into reality
Reality, said Professor Harding, has been ‘messier than planned’, when it comes to translating stem cell research into clinical treatments. Although clinical trials using cells derived from autologous bone marrow and skeletal muscle cells have been taking place for over ten years, and some results have been promising, there are still a number of challenges to overcome before the treatments become a clinical reality.
The heart can be subject to many different kinds of damage, and the high incidence of heart disease makes it an important therapeutic target. Damage can be caused by a single event, such as a heart attack, or by a reaction to prolonged toxic stimulus, and a process leading to heart failure is likely to set in. Heart failure has a poor prognosis and sufferers have a reduced quality of life, and transplant is still the only option for a cure.
What we are looking for is repair of the contracting muscle of the
heart, and stem cell technology is a possible way forward. But what kind of stem cells?

There have been trials using skeletal myoblasts, which showed some early benefit, but also suggested that there was a risk of the unwanted side-effect of arrhythmia. One trial, the Myoblast Autologous Grafting in Ischaemic Cardiomyopathy (MAGIC), was stopped early because there was no evidence of benefit, although the treatment appeared safe and may have had positive secondary effects.

Bone-marrow derived cells have produced modest improvement with no safety issues, but act indirectly rather than by creating new muscle.

Many questions remain around the efficacy of bone marrow stem cell treatment for heart disease. For example, are the trials using enough cells? Could paracrine factors do the same? Are the cells from patients impaired, and is this impairment actually a factor in the progression of the disease?

Embryonic stem cells have been shown in the lab to produce contracting myocardial muscle cells, but are more difficult to translate to clinical situations. There are hurdles to overcome in terms of immune reaction, tumour formation and potential arrhythmias, as well as ethical issues. It may be that patient-specific embryonic-like cells from skin or other areas might be an answer to some of these problems. Alternatively, using or stimulating the intrinsic cardiac progenitor cells might produce a greater benefit.

For the cardiac area, we are at a stage where the first reliable clinical trials are informing and directing progress, but a consensus has not yet been reached on cell type, or even whether extrinsic application of stem cells can be replaced by stimulation of the natural repair process of the patient.

**Dr John Connolly.** Health of Cell & Gene Therapies, Department of Health, London

**Regulation of stem cell therapies in the UK**

Dr Connolly outlined the current regulatory and legislative framework which governs stem cell and gene therapy research in the UK. He described recent developments – such as publication of a UK regulatory route-map, which provides a one-page picture of the regulatory process – and he stressed that regulators are willing to listen and trying to learn.

The current system is complex – as evidenced by the route-map – but so is the science. The different regulatory bodies, including the Human Fertilisation and Embryo Authority (HFEA), the Gene Therapy Advisory Committee (GTAC) and the Medicines and Healthcare products Authority (MHRA), have shown a willingness
to work together in order to improve the overall regulatory environment in the UK.

Regulation can be a good thing, said Dr Connolly, as it can improve the quality of research. There is a general acceptance that the process is evolving and can be improved but there are barriers to making that happen quickly – not least that there is still considerable scientific uncertainty surrounding the clinical application of stem cells and that most policies require Pan-European agreement before they can be taken forward.

He said that regulators are not risk averse and are willing to discuss research proposals to help find the best way forward. There are other helpful documents, including a handbook published recently by the International Society for Stem Cell Research. This publication is also helpful in combating ‘stem cell tourism’ – where patients are enticed into taking part in ‘trials’ which are ethically dubious, not based on evidence, and usually cost the participants a great deal of money. In some cases, even if the ‘trials’ are advertised as ‘free’, they can involve the individual paying vast amounts for travel and accommodation costs. Although regulators and others are working to tackle the purveyors of such treatment, patients can be desperate and may accept some extreme risks, financial and otherwise. It only needs one apparent success to make a media story, he said, and vulnerable patient groups are being targeted.

Sir Ian Wilmut OBE FRS FRSE.
Scottish Centre for Regenerative Medicine, University of Edinburgh

A surfeit of opportunities: which cell is best?

Stem cells provide new opportunities but it’s a distraction to ask which cell is best; we need them all, Sir Ian suggested. As well as opportunities for new therapies, stem cells have the potential to give us a better understanding of disease and may accelerate drug discovery.

Many inherited diseases have no treatment. Stem cells may offer an answer, not only in leading to potential therapies but in helping us to study the cause of the disease and to find new drugs.

For example, family history is known to be a factor in ten per cent of cases of motor neurone disease. Mutations in the SOD1 gene cause 20 per cent of the cases of inherited MND, but it may be that deposits of an abnormal protein, TDP43 actually cause many cases of the disease. Drug development is lengthy and expensive, but it could be possible to accelerate discovery using stem cells from human patients with the disease in appropriate mouse models. This could be optimistic, however, as symptoms typically
show at the age of 50 – so it would take a long time to see the effects.

Use of stem cells in drug testing may also help prevent development of dangerous drugs with unexpected side-effects. Late withdrawal of a product is very expensive – it is estimated to cost the pharmaceutical industry $8 billion a year. If this could be reduced by creating high throughput screening using induced pluripotent stem cells, then it could produce safer drugs, more quickly and more economically. He also spoke about the possible use of stem cells to help the liver to repair itself, leading to the aspiration of a stem cell therapy for cirrhosis.

Looking to the future, stem cell technology provides real opportunities, but there are still many unanswered questions and points for debate. A way forward would be to bring together all those who are involved in stem cell research to create collaborations which pool expertise and lead to the best chance of advances in the understanding of and treatment for disease.

Panel Discussion and Close

Dr Connolly was asked how the complex regulation road map compared with that of other countries. He responded that the UK was the only country which had mapped it out. He acknowledged that it is complex, but said that he is open to suggestions about how it could be improved – and stressed that regulators are approaching the issue with a degree of humility.

Asked if the wealth of regulation put people off researching in the UK, in favour of going somewhere less regulated, Dr Connolly said it is a mixed picture. While some may be put off, others find that the quality of regulation in the UK is helpful, because, for example, investors see regulatory approval as a positive thing.

Asked whether there should be more focus on potency and purity of stem cells, Professor Harding said that in cardiac terms, purity is not possible, because a number of different cells would be needed.

Professor Haites wound up the event by thanking the organisers and the speakers and all those who had contributed.
As Secretary-General of the European Convention, Lord Kerr helped to draft the EU Constitution from 2002 to 2003, and in this year’s inaugural MacCormick European Lecture, renamed to commemorate the former MEP Sir Neil MacCormick, the ex-diplomat said what is needed in Europe is not just more debate but more Neil MacCormicks…

**Introduction**

To commemorate the late Sir Neil MacCormick, Michael Russell, Minister for Culture, External Affairs and the Constitution in the Scottish Parliament, introduced the lecture now named in his former mentor’s honour with some warm words of praise for his “learning, experience, kindness and knowledge,” highlighting Sir Neil’s contribution to the RSE and Scotland and also his passion for Europe. Russell began by quoting the English writer John Aubrey, who wrote in *Brief Lives*: “When a learned man dies, there dies a great deal of learning with him.” But in Russell’s view, this is not the case with Sir Neil, since in dying he left his learning and his passions with us, including his passion for Europe. “At a time when most people in Scotland are showing little if any passion about the European elections,” Russell concluded, “it is the passion he had for the things he believed in that will distinguish this lecture and future lectures.”

In his opening remarks, Lord Kerr echoed these sentiments, describing Sir Neil’s endless encouragement, optimism, enthusiasm and passion, adding that what we need in the debate about Europe is “a lot more MacCormicks.”

**Europe matters**

Even though the title of his lecture implies that the EU has run out of steam, Lord Kerr made a passionate call for debate about Europe – not just more logical and better informed but also recognising how much it matters to the UK and Scotland as well as to countries beyond.

Lord Kerr wore his passion on his sleeve from the start, saying that we only need to look at our war graves to see that the EU makes sense: any political construct that prevents such slaughter happening again must be good. Having served in the UK Embassy in
Moscow in 1968, he described being moved when the Czechs, and other East European and Baltic states, showed how keen they were to be members, after the break-up of the Soviet Union, and said that it is “worth getting passionate” about an entity which reinforces freedom and makes dictatorship impossible in member countries.

“There is passion,” he said, “but we are not good at expressing it.”

He then described the findings of a survey which suggested that most British people think that the EU is “bad for jobs” and a “raw deal” for the country, and said this is “demonstrably absurd”.

The creation of the single European market and the correction of original budget imbalances, both successes won by Mrs Thatcher, mean that the UK now gains a lot in terms of employment and makes a fair contribution to the budget.

“Why leave a club when we are winning?” he asked, noting that English is now the main language of the EU institutions. “Why leave when the tide has turned?” he added, noting that the old idea of power steadily accruing to the centre is out of fashion, along with dreams of a big EU budget and laws which fail to take account of national interests.

“The tide turned in the 90s,” he said.

The EU Constitution, which Lord Kerr helped to draft and insists is not a constitution but a treaty, is a “tombstone” of the old ways of thinking, he said. It confirms that the EU may not raise taxes or borrow money, make peace or war, or even decide who its citizens are. “All that is left entirely to the nation-states,” he said. The Lisbon Treaty is a bargain between states, with no ‘constitutional’ claim to a legitimacy arising directly from the people. Lord Kerr also believes that the EU would, if the Lisbon Treaty were ratified, become more democratic, clearly recognising the sovereign role of national parliaments, as well as taking due account of population in its own voting procedures. UK voting weight would increase by almost 50 per cent, he said.

Lord Kerr then quoted William Hague, saying that the Treaty of Lisbon is “all about institutional aggrandisement.” Not only is this not true, he said, it is the reverse of the truth. He also stressed that it is more important than ever to uphold the principles of the single market, at a time when economic pressures lead some politicians to argue for national protectionism – e.g. for the car industry. “Protectionism protects only decline,” he said.

When it comes to immigration, he added, we should also be more aware of the facts, recognising that northwest Europe has an
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ageing and stagnating population which will have to be renewed by immigration from the faster-growing south and east. “Our choice,” he said, “is whether to import workers or outsource work.”

EU elections, Scottish independence and the Euro

In the second half of his lecture, Lord Kerr (in his own words) “insulted” one by one the Conservative Party, the Scottish National Party and the Labour Party, starting with the Conservatives and their negative approach to the forthcoming EU elections (June 4).

Noting that turnout is likely to be less than 33 per cent of the electorate and that the election is “a mid-term referendum on an unpopular government” in the UK and some other countries, he expressed concern that the Conservatives appear to be more “anti-Europe” or “Euro-sceptic” than ever and plan to form a new alliance with parties who oppose the very idea of the EU, even potentially finding themselves in the same camp as the BNP and UKIP.

“How can you stand for election to an assembly of which you don’t want to be part, to pass Europe-wide laws of which you disapprove, and – as a first task – approve a new European Commission whose powers you reject?” he asked. Not to be part of any of the big Strasbourg groupings, Lord Kerr suggested, means being committed to “impotence,” since the work of the Parliament is done in committees and power in committee lies with the Centre-Right, Centre-Left and Liberals, who make up nearly 80 per cent of the Parliament. “The Conservatives have had real influence via the EPP (European People’s Party),” he said, “but now seem to be giving this up. It makes no sense to decide to have no influence. If you don’t want to get things done in Strasbourg, why stand for election?”

As for Tory talk of forming a new Euro-sceptic grouping, Lord Kerr thought they might well succeed, but only by embracing “some rather odd bed-fellows,” largely from Eastern Europe, very socially conservative and very opposed to agricultural reform. “Was Mr Klaus from Prague or Mr Gorski from Warsaw a natural ally for the party of Sir Alec or Lady Thatcher?” he asked. And did it make sense to reject alliances with Chancellor Merkel and President Sarkozy, in favour of such “fringe figures of the far Right”?

Turning his attention to Scotland, Lord Kerr had a warning for the SNP. “Unlike many in England, we Scots know it’s not a zero-sum game; you can be both a good Scot and a good European,” he said. But this should not blind us
to the fact that “selling our independence in Europe would not be easy.” Spain has the Basques and Catalans to think about, he explained, and along with four other EU member states also facing minority separatist movements, has refused to recognise breakaway Kosovo.

Lord Kerr also wondered what would happen to the Treaty of Accession if Scotland became independent, and how easy it would be to renegotiate the budget rebate won by Mrs Thatcher. An independent Scotland would not face insurmountable EU obstacles he added, but “part of the debate about Scottish independence should be about Europe, and how to overcome them,” he concluded.

Lord Kerr then pointed out that the Euro, now 11 years old, is used by 15 countries, the world’s most widely used transactions currency, and the world’s second reserve currency. The economic effects of adopting the Euro are complex, he said, “but it has probably increased trade flows.” Perhaps it is time to debate again “whether our isolation is really so splendid”? The UK has effectively been able to devalue the pound by 30 per cent, he explained, but Mr Brown did not argue 11 years ago that we must reject the Euro in order to retain the right to devalue; rather, he told us that the days of “boom and bust” were over.

The UK’s credit rating is now threatened with down-grading by Standard & Poor’s, said Lord Kerr, even though our government borrowing is less, for example, than France, Germany or the United States, who are not yet threatened. “Why the difference?” he asked. They have the benefit of having reserve currencies: 27 per cent of international reserves are now held in Euros, with only about four per cent in Sterling. “Alas, neither Tories nor Labour seem willing to revisit the debate,” said Lord Kerr. “The silence is deafening.”

“The EU is a good idea which works,” Lord Kerr concluded, but we still need to have a debate, particularly if we are to have an independence referendum in Scotland. It isn’t right to let Europe’s critics get away with slogans and prejudice. “We need more debate, logic and passion, and less fear, ignorance and cynicism. We need more articulate advocates. Neil MacCormick is greatly missed.”
The evolving field of Gravitational Wave Astronomy

Gravitational waves are ‘ripples in space-time’ caused by the acceleration of large masses in the universe. They carry information about what is happening deep in the heart of some of the most violent events in Space. It was Einstein who first postulated that they exist in his General Theory of Relativity in the early part of the last century. Almost 100 years on, they have never been directly detected by scientists, although there is indirect evidence of their existence. Professor Hough explained the nature of gravitational waves and the research being carried out around the world to detect these elusive signals. He said that establishing proof of their existence would confirm Einstein’s theory and, more importantly, would open up a new kind of astronomy that would add to our understanding of the universe.

According to the theory of relativity, gravity is the result of the curvature of space-time. As two objects orbit each other, their acceleration causes disturbances in space-time which move outwards like ripples across a pond. However, these strains, as they are known, are at extremely low levels of the order of one part in a thousand billion billion. That is equivalent to a change in the separation of the Earth and the Sun by less than the diameter of an atom. Detecting them has proved to be one of the most challenging problems in experimental astrophysics.

Little interest was shown in carrying out experiments in this field until the work of Joseph Weber in the 1960s. That encouraged other research teams to become involved, leading on to the developments of recent years. Professor Hough said this work was designed to answer some important scientific questions including:

- What are the properties of gravitational waves?
- Is Einstein’s theory of general relativity the correct theory of gravity?
- How does matter behave under extremes of density and pressure?
- What is the history of the accelerating expansion in the Universe?
- Where and when do massive black holes form and how are they connected to the formation of galaxies?
- What happens when a massive star collapses?
- What is the history of star formation in the Universe?

Professor Hough said that up to about ten years ago scientists thought they were close to understanding everything about the Universe. However, it was then discovered that the Universe is expanding, with its outer part accelerating away as if gravity was acting as a repulsive force. No one could understand what was causing this to happen. It is believed to be due to something called dark energy, but that is another phenomenon that is not understood. Professor Hough said that detecting gravitational waves will help scientists measure what the Universe is doing in a totally different way and begin to get an understanding about what is causing this acceleration.

A large part of Professor Hough’s lecture was devoted to the technical challenge of detecting these minute signals from faraway in space. It will need huge masses accelerating very strongly to produce waves that are capable of being detected from Earth. This will come from events such as black hole formation; neutron stars coalescing; rotating neutron stars such as pulsars; and from general noise background from sources such as cosmic strings which are thought to be like elongated black holes. To a non-specialist, the challenge seemed not dissimilar to designing and deploying equipment in Edinburgh that could detect a leaf dropping from a tree in Ecuador.

The technology being used to detect gravitational waves is the laser interferometer. The interferometers used for this work have two arms down which the laser light is fired, with reflecting mirrors at the ends of the arms. The light travels inside stainless steel tubes which are kept evacuated. The arms need to be up to four kilometres long and built on the surface of the earth (with the mirrors isolated from seismic disturbances by being hung as pendulums), to make them sensitive enough to pick up the wave signals. The laser light inside the tubes is the measuring tool. The laser light is first split into two beams by a beam-splitter, and after travelling to the ends of the arms and being reflected back, the two beams then combined to interfere with each other. This creates a form of ‘telescope’ that can ‘see’ these signals from space. This system is incredibly sensitive and can be affected by the smallest vibration, sound or Brownian Fluctuations of its
mirrors. Professor Hough said a great deal of experimental care is needed to isolate the equipment from all these influences to ensure that pure measurements are obtained. Animals living in the surrounding area can exert a gravitational pull that can affect equipment and even passing clouds have a gravitational influence. All this has to be taken into account in designing and operating the interferometers.

A network of interferometers is currently in operation around the world. Professor Hough’s team is involved with colleagues in Germany on GEO 600. This uses a novel technology known as Signal Recycling, which feeds the signals that try to come out of the interferometer back into the system to make them bigger and more measurable. It also suspends mirrors with pure glass fibre to reduce fluctuations in movement (Brownian Fluctuations) caused by the system being at room temperature. Other detectors exist in the United States (the LIGO experiment), Italy (the Virgo experiment) and Japan (the TAMA experiment) and there are plans for an additional interferometer in Australia. The Scottish and German research teams have joined together with their US colleagues in the LIGO scientific collaboration to pool their knowledge and work together. This involves some 500 scientists from 55 institutions. Five science runs have now been completed with the detectors in this collaboration but, so far, nothing has been found. Professor Hough said this is not surprising given the current limitations of the existing instrumentation, which cannot reach far enough out into the universe to pick up potential measurable events. The LIGO system is currently being enhanced by a factor of two and there are plans to run the systems again this summer. At this improved level, LIGO might be able to detect two events a year.

The real promise for the future lies in developing advanced detectors that will have 10–15 times the sensitivity or range of current interferometers. This will allow scientists to reach further out into space and increase the number of large-scale events that potentially can be detected to 500 a year. An advanced version of the LIGO detector, based on the British and German technology, is expected to be fully installed and operating by 2014. The Italian-based detector is to have a similar upgrade. In Japan, an interferometer – called the Large Cryogenic Gravitational Telescope – is planned to be built underground in a disused mine to reduce seismic and gravitational fluctuations. It will also be cooled to cryogenic temperatures to reduce Brownian Fluctuations. Professor Hough described this as
quite an undertaking, but predicted this would be the first phase of the next generation of experiments where cold systems are built underground.

Scientists are also looking beyond advanced detectors to build the third generation of instrumentation. This would have ten times the sensitivity of the advanced detectors and a design study, funded by the EC, has already begun to assess the building of such a detector, which has been given the name of the Einstein Telescope. Professor Hough said the technological challenges involved will be significant, but the spin-offs from this work will have benefits for industry around the world. The timescale for starting building is around 2020.

There are also proposals from an American and European team to take experiments into space. This is known as LISA and would involve creating a space-based laser interferometer, consisting of three spacecraft orbiting the earth connected in a triangle by laser light. A demonstrator mission LISA Pathfinder is being prepared for launch in late 2011 to test the potential of this proposal.

Professor Hough said there is a whole network underway which he is confident will be able to guarantee detection of gravitational waves sometime after 2014, although it is possible that something will be seen before then. It offers nothing less than the prospect of a whole new astronomy, leading to a host of new and totally unexpected events and phenomena to be observed in the future. Astronomy, he said, has been exciting since man first looked up at the stars. More recently, infra-red and gamma-ray astronomy, together with cosmic microwave background scanning, have increased our understanding of the universe. He is confident that with the detection of gravitational waves, another new chapter is about to begin.
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Professor Charles Godfray FRS
Department of Zoology, University of Oxford

Malaria, Mosquitoes and Models
Joint Lecture with the
International Centre for Mathematical Sciences
17 June 2009

Although there are excellent ways of controlling malaria now, there is a real risk that these will break down. We therefore need new strategies to save lives in the future. Professor Godfray described some of the exciting possibilities currently being researched – and alluded to the important role being played by mathematical modelling in trying to combat this deadly disease.

Malaria is a major problem, causing at least a million deaths and up to 500 million clinical episodes a year. About 60 per cent of cases and 80 per cent of deaths occur in sub-Saharan Africa. There are good and effective ways of combating malaria – although poor health infrastructure in developing countries challenges their implementation – but there will always be a need for new strategies. Professor Godfray’s lecture was, as he said, not so much about saving the lives of children in Africa now, but about providing possible means of doing so in the future. There is a need to have ‘things on the shelf’ for the day when current methods fail.

Professor Godfray began by describing the life cycle of malaria and of the mosquito, a vector which transmits the disease. He outlined the scale of the problem and current control methods, before going on to look at novel control measures. These include ways of stopping mosquitoes transmitting malaria and causing early death in the mosquito itself, thus reducing the opportunities for transmission.

He also spoke about the importance of an inter-disciplinary approach to the problem, making particular reference to the role of mathematical modelling. Malaria is caused by a single-celled microorganism called Plasmodium, and is transmitted only by female mosquitoes of the Anopheles genus. The mosquito injects malaria sporozoites into the human when taking the blood meal essential for successful reproduction. This then reproduces in the (human) body, causing illness and possible death – and passing the disease on when the mosquito bites again.

Current strategies include insecticide-treated bed nets and indoor residual spraying – where the
walls of huts are sprayed with a long-lasting insecticide which kills off the mosquito, a creature which will often ‘rest’ on the wall while maturing her eggs prior to laying them in suitable water bodies. There are also effective drug treatments which act against the pathogen, particular the recently-introduced drug artemisinin and its derivatives. There are several problems with both strategies, however, in that health infrastructure of countries afflicted by malaria is variable and often poor, so getting control methods out to populations is a challenge. In addition, mosquitoes and malaria itself are good at becoming resistant to insecticides and drug treatments respectively, making it a constant struggle to keep ahead.

As well as making current strategies work better – particularly by improving health infrastructure – we have to look to the future, said Professor Godfray. “There are good current strategies and we can save children today, but we have to prepare for these strategies failing,” he said. “We need to have other things on the shelf.” Researching new methods requires significant investment in molecular biology and biochemistry, and mathematical modelling plays an important role in deciding what are the most promising strategies.

Strategies on which people are working include new drugs and possible vaccines, but also novel ways of tackling the vector – the mosquito itself. Professor Godfray outlined some novel anti-mosquito tactics. These include driving genes through the mosquito populations which make them unable or less able to transmit disease, and causing the mosquito to die before it can transmit malaria.

Researchers have created a refractory mosquito – one which cannot pass on malaria – but how do you “drive” this gene through a wild insect population? As was first realised by Austin Burt at Imperial College, homing endonuclease genes (HEGs) are a promising avenue of research. These are selfish genes, found naturally in single-celled microorganisms, that are able to spread rapidly through a population by cheating Mendel’s laws – ensuring they are over-represented in the next generation. A useful gene, such as one that interrupts mosquito transmission, can be attached to the HEG and hence driven through the population. Alternatively, the HEG can be engineered to spread in a manner that knocks out a gene in the mosquito essential to the malaria pathogen, or for the mosquito itself. In the last case the aim is to drive down mosquito population numbers. Mathematical modelling has been and is an important tool in predicting how these different strategies would work and in
finding the best ways of making it possible.
HEGs can also be used to cut or ‘shred’ the X chromosome, which means there would be significantly more males (XY) than females (XX). Mathematical models show this can significantly reduce population densities and hence disease spread. Although it has been demonstrated in the lab that this technique works in mosquitoes, one problem is that currently it works too well (X chromosomes in offspring are also shredded), so means of modifying X shredding activity are being explored.
Parasitic bacteria use is another promising approach. Professor Godfray described research into *Wolbachia pipiens*, abundant intra-cellular bacteria, found in around 20 per cent of all insect species, including some mosquitoes. Females who are uninfected with *Wolbachia* cannot use sperm from infected males, again cutting down on reproductive chances. There has also been research into, for example, using the bacteria to carry a useful gene and spread it through the mosquito population. This is possible in principle, but we can’t yet get genes into *Wolbachia*.
Another strategy is trying to reduce the lifespan of the mosquito. Only a small fraction of the insects live as long as ten days – the life cycle of malaria infection – so anything that can speed death reduces transmission. This has been confirmed by mathematical modelling.
Work on the fruit fly has shown that some *Wolbachia* can cause what is colloquially known as ‘popcorn’ in the brain – essentially damaging it and causing early death. Getting ‘popcorn’ into the brains of malarial mosquitoes could shorten their lives, but we’re not there yet, he said. This would have the advantage, however, of not involving genetic modification, which opens up ethical and regulatory dilemmas.
Another approach would be using fungi as an insecticide. Again, mathematical modelling provides answers on the optimum way to do this, including getting the balance between efficacy and avoiding the development of resistance. The disadvantage is that it doesn’t kill immediately, but does accelerate senescence. Professor Godfray concluded by stressing that there are excellent ways of saving lives and controlling malaria now, although getting the health infrastructure working remains a major challenge. There is, however, a real risk of current control measures breaking down, so novel methods are needed. Many exciting ideas are being explored – both GM and non-GM – and mathematical modelling is essential to these research programmes.
As Deputy Governor of the Bank of England from 2006 until February this year, Sir John was responsible for financial stability and was a member of the FSA board. He was welcomed to the RSE by Jeremy Peat, Director of the David Hume Institute, and Gavin McCrone FRSE, who chaired the event. Both said the lecture was taking place at an extraordinary moment. The Chancellor of the Exchequer had just made a keynote Mansion House speech about the financial crisis, the Governor of the Bank of England had declared that sermons are not enough, and President Obama had announced far-reaching measures in the United States. Sir John emphasised that world-wide action is needed to restore the financial sector and ensure that similar problems cannot happen again. He also argued for a rethink of macro-economic strategies and argued that the greatest threat to sustainable recovery is not over-reaction but inertia.

Quoting Hume’s claim that “either the nation must destroy public credit or public credit will destroy the nation”, Sir John pointed to the current build-up of public debt as one of the major results of the credit crunch. Whilst hoping that the last quarter of 2008 and the first of 2009 will prove to be the low point, he added that much remains to be done to pull the economy out of its tail-spin. Pointing to similarities between the path of the current crisis and the Great Depression, he is hopeful that recovery is on the way. This is likely to be a slow process, as Western governments and consumers need to build up savings, whilst many other economies are export driven and will have continued difficulty finding markets.

Even though we are still in the midst of the crisis, Sir John argued that we already know enough to start drawing conclusions – and that these are far-reaching. He said: “This crisis calls not just for emergency measures, but for major changes in our longer-term approach to policy. And this isn’t just about banking and regulation, because the financial crisis also brought the worst world recession for 80 years. This has also been a failure of macro-economic management. So we
need to go back to the drawing board, not just on financial regulation, but on macro-economic policy, and, in my view, on macroeconomics itself.”

Sir John pointed to features of the crisis which were similar to previous booms and bust. The property price boom of recent years, the ensuing rise in interest rates, the credit squeeze, and the eventual bursting of the bubble were all familiar from the 1970s and 1990s. Yet the scale was of a new order, resulting in the worst collapse of financial confidence since 1914 and the first drop in global output since World War II. Nonetheless, he said, “I still think it’s a bit of a puzzle why an old-fashioned property boom and bust should lead to a global meltdown in financial markets.”

There was also the issue of why no-one saw it coming. Much of the problem lay in financial innovations, with the growth of derivatives obscuring real risk levels. “I think banks and their regulators thought that a lot of it was sustainable and that the hedging of their balance sheets through the use of derivatives was reducing their vulnerability to a downturn. That was a critical and shared misjudgement.” The ultimate outcome was that when a downswing came, no-one could be sure of the extent of losses or where they lay. The third special feature of the crisis has been its global reach, and the speed at which it took hold after its emergence in the USA – a result of the integrated nature of the financial system. Checks and balances were in place that could cope with a certain level of instability but, like other complex networks, it had a tipping point after which it plunged into catastrophe. In this case after “the point of no return’ institutions needed government support to raise large amounts of capital very fast, and help in funding when no-one was prepared to lend.

The first lesson Sir John drew was that much greater weight must be given to the systemic links throughout the network, rather than just watching the outliers. At the same time, there is a need to recognise that there are some actions which are rational and sustainable for an individual, but not for a whole system. Sir John listed a number of necessary reforms – from ensuring the quality of capital, to tackling bonuses, and moving more trading onto exchanges – for which there is already a consensus. Yet he argued that it would be a serious mistake to implement these and return to business as usual. Instead he identified four areas for fundamental change. These were under the headings of:

- Market mood swings
- Moral hazard
- Regulatory capture and group-think
- International inertia.

As the banking system is central to the world economy, Sir John believes it must be cushioned against market swings; something that can be achieved by insisting that banks hold greater insurance. His recipe for stability included more capital, greater liquidity and smaller balance sheets. At the same time the economy needs protection from the banks, which can be achieved by direct measures to dampen the effects of the cycle in the financial sector. “The way I believe we can most easily do that is to adjust capital and liquidity requirements as a proportion of assets in good times and reduce them in bad. That would create bigger buffers to absorb losses.” It would also dampen the pace of expansion and contraction in the banking market.

With regard to moral hazard, Sir John said the government has dispelled any creative ambiguity about how far it is willing to allow financial institutions to suffer by introducing a safety net for banks. This brings short-term gain by encouraging inter-bank lending, but it can store up problems for the next upswing by spurring rapid expansion and risk taking. Signs of problems are already emerging “with fierce competition between the investment banks … to collect the best staff with offers that include guaranteed bonuses for several years – displaying what we thought were features of a boom.” This is happening at a time when we have just seen the failure of self-regulation by banks. There is, therefore, a need for firm public regulation and to rebuild market discipline. Sir John recommended the development of special insolvency regimes for larger and more complex banks, and higher capital and liquidity requirements for the biggest firms. If these are not enough, it may be necessary to limit the size of banks and the business they can do – though this was not his favoured option.

Sir John considered the approaches taken to regulation by a variety of countries, saying no one approach was clearly better than the rest. Nonetheless, the financial crisis has demonstrated the need to be alert to the dangers of regulatory capture and “group-think”. The problem is not that banks pull the wool over the eyes of regulators, but that they share common misjudgements. While supervisors can identify abnormal or unusual behaviour, it is difficult to question common behaviour which has built up over the years and has previously been seen as acceptable. One option is to rely less on discretion and more on rules. There is also a powerful argument for the system to be
scrutinised by “a second pair of eyes” from outside the day-to-day running of the banking system.

On inertia, Sir John said: “As people feel there are green shoots, we are beginning to hear and see some reduction in the pressure for reform; there are calls for caution.” While acknowledging that a bad situation can be made worse, he added that the risks from over-reaction are outweighed by those of inertia.

He cited examples of reform proposals that had become bogged down for decades, meaning that avoidable problems had been allowed to occur. Sir John praised the EU’s calls for tighter rules, a strong body to oversee systemic risk (which is separate from the regulator) and effective control of implementation by nation states (so countries don’t fear they will lose a competitive edge because others fail to follow the rules). However, he added that reforms at national or EU level are not enough, they must be implemented by the G20, or globally, to prevent financial institutions from undermining them by shifting operations to the least regulated areas.

Turning to economic policy, Sir John said in the dozen years up to 2006 we had achieved stability, growth, low inflation, low interest rates and falling unemployment; “it seemed like we had reached the Promised Land”. There was consensus between practitioners and academics that so long as a low-inflation regime was maintained, then market forces were powerful enough to haul cyclical variations back into equilibrium.

Macro economics became reduced to monetary policy, and monetary policy was just interest rates. Fiscal policy and regulation were seen as a micro-economic function. Interest rates were set according to whether inflation was above or below a target and whether economic activity was above or below sustainable levels. The “Greenspan doctrine” – from former Chairman of the US Federal Reserve, Alan Greenspan – also held sway. This stated that it was “better to mop up after asset price bubbles than to prick them in advance,” because the authorities were ill-suited to identify bubbles and pre-emptive action risked distorting a state’s entire economic policy. “The last few years have proved the limitations of that approach.” Limitations in policy were compounded by the fact that conventional indicators failed to show that trouble was on the way: accelerating inflation or the growth in the output gap gave little sign that we were heading for a precipice.

Sir John drew four conclusions for economic policy:

- New Keynesian models failed to forecast the problems.
- They also failed to cope with the
challenges thrown up by the credit crunch, such as self-sustaining departures from the equilibrium.

- Inflation levels and output gaps, and mopping up when bubbles burst, do not represent an effective macro-economic policy.

- Interest rates alone cannot guarantee stability, and more than one policy instrument is needed. Liquidity provision, quantitative/credit easing, capital requirements and fiscal policy are essential factors.

On top of this, he suggested that a complete separation of roles in which central banks care for stability, finance ministries for equity and efficiency, and regulators supervise, is obsolete. Overlap and interdependence have already emerged and will continue, though Sir John warned against the concentration of functions in one pair of hands as a retrograde step. He called on university economists to help in the process of rebuilding by rethinking their most fundamental assumptions in the light of recent events, and help in the process of charting the way forward.

In summing up, Sir John re-emphasised that radical measures are necessary if similar, or worse, economic crises are to be avoided. “The experience of the last few years has important lessons for regulation and the way we do economic policy and for economics itself. We must not allow the emphasis on reform to weaken and I conclude with the thought that inertia, particularly international inertia is a far greater risk than over-reaction.”
Was the Scottish Enlightenment Scottish?
Professor Tom Devine believes the flowering of genius in 18th-century Scotland was influenced by several key events and ideas, including Calvinism and capitalism, centuries of “intellectual networking” all around Europe – and “the death of politics” after political union with England. But why are we the only nation in the world to turn a universal event into an object of national pride?

The Scottish Enlightenment, Professor Devine declared at the start of his lecture, was “invented” by the philosopher WR Scott more than 100 years later in 1909. Today it’s a “totemic and iconic” badge of honour, but it’s only been during the last 30 years that the Scots have moved away from a “victim” perspective (dwelling on disasters such as the Darien Scheme, the Clearances and the Glencoe massacre) to trumpet the achievements of our great 18th-Century thinkers – sometimes even daring to claim that Scotland invented the whole modern world.

One reason why the Scottish Enlightenment was neglected for so many years, he later suggested, was that Scottish historians were living in “a glen of tears,” appalled by the horrors of industrialisation which seemed to flow directly from the economic theories and inventions of the period, and obsessed with the dark side of Scotland.

The puzzle, he said, is why the Enlightenment happened at all. At the end of the 17th century, Scotland was still persecuting witches and hanging blasphemers (including Thomas Aitkenhead in 1697 for comparing the Bible with Aesop’s Fables). There was widespread poverty, and trade was being strangled by protectionist tariffs and war. The “vengeful Presbyterians” despised any form of deviance. We were a small nation, living next door to a giant, prone to parochialism and introspection.

Yet within 50 years, the Scottish Enlightenment was already emerging into the light from the darkness of “fanaticism, prejudice and the tyrannical influence of tradition,” promoting tolerance and “violent disagreement that did not end in violence.” Scotland was one of the “hot spots”
of Enlightenment in Europe. There was a commitment to learning and the world of the mind, with a strong interest in the use of reason to explain human behaviour and a belief that improvement was possible through rational intervention.

The Enlightenment was not unique to Scotland, said Devine, but the Scottish Enlightenment was distinctively Scottish, “looked at through a Scottish lens,” and – unlike other countries – based in universities (Edinburgh, Aberdeen and Glasgow).

It also had extraordinary cohesion, said Devine, and encompassed every discipline – like the Royal Society of Edinburgh, a child of the Scottish Enlightenment. But above all, he added, it was a “Christian Enlightenment,” deeply influenced by Calvinism, and most of its pivotal figures were content to embrace Christian values (at least, in public) and believed in a propertied, enlightened oligarchy, “going with the flow” rather than promoting atheism and democracy. They were also Anglophiles – not Scottish patriots but citizens of the world.

The big issue, Devine said, was how this great phenomenon had flowered so quickly in such “barren soil,” and his argument was that the roots of the Enlightenment were incubating long before 1700 – fertilised by several key events in the first half of the 18th Century. Even though the country was poor, Scotland was not an intellectual desert, said Devine. Scottish academics “served their time in Europe” from the 13th Century onwards and were the first to teach Newtonian science. The great “virtuosi” were also leaders when it came to law, biology and medical science.

Scotland also took a systematic approach to the funding of schools, including special taxes and, after the Reformation, everyone was encouraged to read so they could read the Bible for themselves. Devine then described how Adam Smith’s *Wealth of Nations* was first read by 14-year-olds, already fluent in Latin and attending school 12 hours a day, five and a half days a week. “No other ethnic group in the British Isles could compete,” said Devine, giving rise to the notion of “Scots on the make.”

The Scottish identity is inextricably linked with Calvinism, according to Devine, and the Calvinist obsession with morality was one of the precursors of the new social sciences, while the urge to “understand God’s design” was also a driver of science. “People could reflect and think for themselves,” said Devine, and even though some people feared that this would lead to anarchy, it also led to breakthroughs in philosophy, science and the arts.
Religion was also less orthodox after the Union of the Parliaments in 1707, while the Patronage Act also boosted secular influence. The Church of Scotland was also becoming more liberal, and the Secession reduced fundamentalist power.

Devine also suggested that after Union, “politics did not exist in Scotland.” There were no ideological divides, so intellectuals did not need to take sides and could debate issues free of constraint. The crushing of the Jacobite rebellion was also welcomed by most intellectuals in Scotland, as urbanisation began to accelerate, fuelled by the linen and tobacco trade, the Clearances and Empire.

But history does not move in straight lines. Professor Devine later suggested that the Scottish Enlightenment had not completely triumphed in the end over its Jacobite rival, since the “great tartan monster” seems to have hijacked the national character, even though most people in the lowlands treat “Highlandism” with contempt.

But above all, Devine said, there is no escape from the fact that Calvinism changed the “shape, nature and stamp” of the Scottish Enlightenment more than any other internal or external factor.

Was the Scottish Enlightenment Scottish? “Wha’s like us?” may be the only reply.
The Enlightenment – An 18th Century Revolution of Thought
Edinburgh International Festival
15 August 2009–3 September 2009

In partnership with the Edinburgh International Festival, Nature and the Wellcome Trust, the RSE presented a series of twelve discussions and talks exploring various aspects of the Enlightenment, as part of the Edinburgh International Festival in 2009. Forty-four eminent experts took part in the series, either speaking or chairing the events; all twelve events were well attended by lively and participative audiences.

The twelve topics covered were:
Visual Art and the Enlightenment; Scotland Exports the Enlightenment; Islam and the Enlightenment; The Ages of Optimism and Pessimism: Utopian and Dystopian Ideas; Science and Tolerance; Music and the Enlightenment: Classical and Vernacular Traditions; On the Dark Side: Witchcraft and the Theatre; Science and the Enlightenment; The Face of the Enlightenment Moral Universals and Moral Progress: the New Science of Good and Evil; The Enlightenment and the Academies; Political Economy: Adam Smith and Others

The following are summary reports of each of the events. The first four reports were prepared by a young person who worked with the RSE during the summer on a work experience project. Eade Hemingway was a pupil at Hills Road Sixth Form College in Cambridge and obtained 10 grade As at GCSE level before coming to Edinburgh in August 2009. Whilst here, not only did she celebrate her 17th birthday but she also received the results of her AS levels in Maths, Economics, Philosophy and Art, for which she was awarded A, A, B and A respectively. She went on to study for her A levels, also in Maths, Economics, Philosophy and Art. When writing to offer her services to the Society she stated “I would like to offer my insights – as a young person, pre-university but post-compulsory education …. For example, I note that there are a number of talks and debates in August; maybe I could attend some of these and offer some feedback from a young person's perspective”.

Eade attended the first four of the Festival events and prepared the summary reports, which were edited by an experienced freelance report writer, Peter Barr, whom the RSE employs on a regular basis. Peter also prepared the reports on the remaining eight events.

Introduced by Lord Wilson of Tillyorn KT GCMG, President of the Royal Society of Edinburgh, His Grace The 10th Duke of Buccleuch and Queensberry spoke at the first event and made an introduction to the series.
Review of Sessions 2008/09 and 2009/10

The Enlightenment – An 18th Century Revolution of Thought

Introduction to the series by
The Duke of Buccleuch and Queensberry FRSE
15 August 2009

The good, the great and the noble

The Duke of Buccleuch reflects on the Enlightenment and the role of his distinguished forebear – the third Duke of Buccleuch and the first President of the RSE...

It was highly appropriate that the 10th Duke of Buccleuch introduced the first of The Enlightenment discussions, since Henry Scott, the 3rd Duke of Buccleuch, was the first President of the Royal Society of Edinburgh – not just a child of the Enlightenment but also a sponsor of the series of talks, in partnership with the Edinburgh International Festival, Nature and the Wellcome Trust.

It was also appropriate that the Duke focused on a portrait of his forebear which hangs in the RSE at 22 George Street, since the theme of the first talk in the series was Visual Art and the Enlightenment.

The current Duke’s ancestor held his position from 1783 until his death in 1812, despite the fact he was not a scientist, nor even “a practitioner of the arts or literature.” But his appointment “tells us something of the spirit of the civic humanism abroad at the time,” said the Duke, “and the wish to make the RSE a forum for the nation.”

The Duke also suggested that the conversations taking place in 2009 reflected many aspects of that earlier era of which we should not lose, including the image of the “intellectually good and great rubbing shoulders with the financially and socially good and great, and the very best minds of the professional elites mingling with, enriching and being enriched by the amateur thinkers.”

As well as being open to newcomers, added the Duke, the good and great did not converse “in the rigid silos of arts and sciences, self-absorbed and self-referential,” but in open debate, without boundaries – “debate that was, if not revolutionary, at least unorthodox and maybe a little radical.”

The 3rd Duke also had another interesting connection with one of the leading figures of the Enlightenment. In 1763, the young Henry Scott went on the Grand Tour to Europe, accompanied by Adam Smith, who wrote to David Hume of his companion:
“I flatter myself, that I shall spend the rest of the time we are to live together not only in peace and contentment but in gaiety and amusement.” According to the current Duke, their friendship endured for the rest of their lives, and Smith would sometimes spend weeks with the family at Dalkeith Palace, engaging in “serious pragmatic discussion across a huge spectrum of subjects.”

Henry Scott, his son and his grandson also enjoyed a close relationship with Walter Scott (who also became President of the RSE), receiving “torrents of letters on every subject under the sun – from sawmills to schoolmasters to monumental stones.”

The Duke then talked about “one of the most remote and godforsaken corners of the Duke’s eventual inheritance,” the mining village of Wanlockhead, high in the Lowther hills, where the public subscription lending library was founded in 1756 – only the second in Scotland. “The library is still there today,” said the Duke, “and if you browse the shelves and early catalogues, it is humbling to take in the diet of philosophy, theology, Greek and Latin that was read by flickering candle in the hovels that were homes.”

The founders of this remarkable institution had a sense of duty and were generous in their support of the library, “whose inspiration and rationale was so deeply embedded in Scottish cultural and intellectual values” – the same values that helped send Robert Burns and Thomas Carlisle on the road to Edinburgh.

As the Duke travelled the same road that morning, grumbling about the rain, he was struck by how spoilt we are now and how easy it is for people today to enjoy “all the ingredients of wonderful civilised conversation, stimulated by a thoughtful and eclectic cast of speakers,” like those on the panel for the opening talk.

Like his forebear, he added, he also felt “a sense of pleasure and of duty” to be present at such an occasion, and hoped that others felt the same – suggesting “that with the material rewards of our century there go responsibilities for engagement and participation in the conversations that enrich civic society.”

Having earlier referred to the “rather nondescript portrait” of the 3rd Duke of Buccleuch which hangs in the RSE, the Duke then revealed how Walter Scott had it “cobbled together to fit a gap of the RSE’s own making.” According to a “perhaps apocryphal family story,” the RSE had first been offered Thomas Gainsborough’s portrait of Henry “in relaxed woodland setting, with his arms around a most huggable Dandie Dinmont dog,” but this
was rejected by “the starched shirts then in charge as lacking gravitas” for such a great institution. “Their loss, our gain,” said the Duke. “It hangs today at Bowhill.”

Perhaps the moral of the tale, the Duke concluded, is “not to be too serious or portentous,” and to remember those common-sense words of Adam Smith about spending time “in gaiety and amusement.”

Visual Art and the Enlightenment

Alexander Broadie FRSE
Professor of Logic and Rhetoric, University of Glasgow

Sir Timothy Clifford FRSE
former Director-General, National Galleries of Scotland

Juliana Engberg
Curator of The Enlightenments exhibition

Duncan Macmillan FRSE
Art critic, The Scotsman; RSE Curator

15 August 2009

Seeing is not always believing

In the opening event of The Enlightenment series, the four speakers highlighted some of the diverse opinions about what really happened in 18th Century Scotland – and whether the visual arts matched the achievements in science and philosophy.

Alex Broadie discussed the relationship between artists and philosophers, the influence of philosophy on art, what artists think and how their perceptions are different from most other people.

Duncan Macmillan talked about the birth of “modernism” during the Enlightenment, when artists (and other people) started to think for themselves. He also described art’s connection to other fields and the development of painting from the 18th Century until the present day.

Sir Timothy Clifford took a more critical view of the visual arts in Scotland in the 18th Century, pointing out the areas avoided – such as sculpture – but also praising the world-class achievements of Scottish architects during the same period.

Juliana Engberg talked about the Enlightenment in a more general way, discussing its influence on the development of knowledge, not just in Scotland but around the world – with an emphasis on the “New World” of Australia.

Broadie started by saying that painting is “impoverished”
without philosophy, and how we appreciate art more if we understand the philosophy behind it. After a brief introduction to the work of the 18th-Century philosopher Thomas Reid, the founder of the Scottish School of Common Sense, Broadie said that one of the great projects of the Scottish Enlightenment was the “science of man” – and the idea that to investigate human nature, we should use the same methods we use to investigate the world as a whole.

“Painters have special ways of looking at the world,” he said. They paint what they see, he continued, but the question is: “What do they see?”

Broadie then explained that adults may see a table, but infants see colours and shapes. Seeing is an “idea,” said Broadie, and it is only after many years of learning that we manage to interpret colours and shapes as particular objects. Similarly, painters have to put down the “original visual appearance” and let the spectators interpret the blotches themselves. An artist paints with “ignorance” and spectators have to unlearn and “regress” to see the visual image as a child would and become “adult infants.” And this is one reason why philosophers are so interested in artists, said Broadie, because they are concerned with observation and reason.

Macmillan started by pointing out that the “modernism” of the 20th and 21st Centuries was to a great extent formed during the Enlightenment – which in turn had its roots in the Reformation, when people started to question authority and use reason in pursuit of the truth. Perception was also at the heart of the Enlightenment, said Macmillan, so painters were also of central importance.

He then said that science and art share a common pursuit. They ask the same question: “How can we describe the world if we are part of it?” Or, as David Hume said: “It’s absurd to conclude we could ever distinguish between ourselves and external objects.”

Enlightenment wasn’t just about understanding reason – it was about understanding the limits of reason and what lies beyond. So, while scientists had to ignore the problem outlined by Hume, assuming we could be objective, artists could acknowledge the problem and make attempts to understand the world despite it.

Thomas Reid developed the idea that our thoughts are intuitive not intellectual, that feeling not reason is the key to morality. Just as the information we receive on our retinas must be read like a language, so painters “record the sign, not what it signifies” – which may produce a more accurate picture of the world.
Reid’s ideas also influenced artists like Monet, said Macmillan, and the Impressionists.

Finally, Macmillan talked about Marcel Duchamp, one of the “heroes” of contemporary art. According to Macmillan, Duchamp cut out the “messy creativity” and said that art is simply an act of subjective will. This rejects the whole Enlightenment concept, making every artist a “statement of identity” and killing the notion of a common pursuit. Macmillan then suggested we have already turned our backs on what really mattered in Enlightenment thought, so perhaps we are worthy heirs to the work of artists like Duchamp…

“So far,” said Clifford, “we’ve been talking about philosophers and the Enlightenment and portraiture, but it’s broader than that.” Rather than praise the accomplishments of the Scottish Enlightenment, he focused on the areas avoided and the lack of achievement. He also pointed out that the Scottish Enlightenment wasn’t a unique phenomenon – it had been around since the 17th Century. He also thought the ideas of the Enlightenment “didn’t get through” to the visual arts in Scotland.

On the other hand, Clifford believed that Scotland in the 18th Century produced the greatest ever architects in the UK – “by miles.” Architecture was fundamen-
Melbourne has marvellous architectural features such as Corinthian columns, as well as democracy and a health system for all. And it all started here...

She also brought greetings from the Kulin nation – an alliance of five indigenous peoples who lived in Australia 35,000 years before the Europeans arrived. And Engberg said this helps her realise that the Enlightenment “is not a bell jar” but a continuum – we are the product of an ongoing process not a single event in the past.

Engberg also commented that fundamentalism and superstition seem to be on the rise, along with religions such as Buddhism. “Self-Enlightenment” is becoming more important than Enlightenment, she added.

Communication is a key aspect of the Enlightenment, Engberg also suggested, mentioning the letters that passed between nations and philosophers, connecting the most brilliant minds so they could share their ideas and build on them.

She summarised the Enlightenment as a great “hybridisation” of thought and style. It gave us tools to build more – the foundations of progress.

**Scotland Exports the Enlightenment**

Arthur L Herman
author of How the Scots Invented the Modern World

Ong Keng Sen
Artistic Director, TheatreWorks

Tom Devine OBE FRSE
Professor of Scottish History, University of Edinburgh

16 August 2009

The conversation continues...

Arthur Herman talked about what the US imported from Scotland during the Enlightenment, including the “common sense” ideas of Thomas Reid and their influence on the “creator of modern American culture,” John Witherspoon.

Ong Keng Sen discussed the links between his country (Singapore) and Scotland. And instead of talking about Scotland “exporting” the Enlightenment, he was more interested in the contributions of different countries, helping each other to achieve mutual greatness.

Tom Devine said that without Europe there would have been no Scottish Enlightenment. He also traced the influence of Scotland on America, focusing on church and universities, the middle class,
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the Clearances, the “Atlantic Superhighway” – and the key role of “a Scotsman on the make.”

Herman began by discussing Scotland’s “gifts” to America, focusing on Scottish philosophers, including the common sense theories of Thomas Reid and his idea that our interaction with the world is between a thinking subject and objective reality – in other words, we are not passive recipients of sense perceptions, as John Locke proposed.

One of the main questions posed by Locke and others was: “How do we know what, if anything, is real?” Reid thought we can tell what is real by using our judgement and that it is the power of those judgements that makes us fully human. Our judgements are also based on certain principles, which Reid called “the principles of common sense.” Every rational human being has these basic principles, so in theory we all know what is real and what is not, what is right and what is wrong, etc. We are also “built equipped to understand the world.”

Herman then talked about the “creator of modern American culture” – John Witherspoon, the President of Princeton University for 25 years and tutor to a future US President as well as many other influential American figures. Witherspoon’s teachings were based upon Reid’s common sense ideas, although Witherspoon also felt he was due some of the credit for developing the theories, later taken on by another Scottish philosopher, William Hamilton.

Witherspoon also had a liberal attitude to his acceptance of students, taking the best candidates from all towns, including Native Americans and black students.

Herman concluded by mapping the line from Reid through Witherspoon to Hamilton, and on to pragmatism. In Herman’s view, the key idea is that there is a real world out there and our job is to go out and find it. And if Witherspoon and colleagues had developed a slogan, it would probably be Nike’s “Just do it!”

Ong explained that he had learned about the Scottish Enlightenment during a three-month residency in Edinburgh. At that time, he also became more aware of the Greek and Roman influence that still leaves its mark on the city, which got him asking: “What is Scotland today?” and “What was Scotland then?”

Ong described how, at the time of the Enlightenment, many different elements all came together at the same time, in the same place – something still reflected in Scotland today. He also said that he was less interested in Scotland “exporting the Enlightenment” and thought of it more as a migration of ideas – the migration
of soul and the migration that comes from “cultural flow.” So instead of give and take between countries, it was more about sharing.

Another issue raised by Ong was Scottish nationalism versus Scottish cosmopolitanism, and his interest in the latter. He also asked: “What is going to be the future Enlightenment?” and “Can there be one?”

Ong also emphasised the different strengths coming together, to create the best possible outcome, including travelling across the world and working with people from other cultures to achieve greatness – for example, Scottish scientists asking Chinese artists to produce drawings of birds and plants, etc. – and benefit equally from this collaboration.

Singapores connections with Scotland were something Ong had also learned about while living here, finding out for the first time how much of his own world had been influenced by Scotland.

Ong concluded by saying that Enlightenment is about transformation of sources and a growing sense of belonging to the world.

Devine said that although the Scottish Enlightenment was no doubt a great thing, there is not enough criticism of its achievements, so it’s important not to fall into what he described as “the trap of ethnic conceit.” We should put our own experience in context, he said, including the achievements of the countries around us – realising we were only “one part in a grand European symphony of ideas.” For example, if we look at Thomas Jefferson’s library, we may “arrogantly” note that a fifth of his books were by Scottish Enlightenment authors, and ignore the four-fifths written by other European authors. Without Europe, he said, there would be no Scottish Enlightenment, so why was there such a strong “Scottish stamp” on the development of North America in the late 18th century?

One reason, said Devine, was the “Atlantic Superhighway of the 18th Century,” not only helping the export of goods and services but also ideas and people, the commercial links underpinning intellectual connections.

Another reason for so much credit going to Scotland was the impact of university-trained Scots on North America as a whole, especially in the early days of colonisation. For example, between 1680 and 1780, over 800 university-educated Europeans were operating in the 13 colonies which eventually became the USA, and two-thirds of them had been educated in Scotland.

Half of all 19th-Century Canadian universities had direct Scottish origins or Scottish influence on their development.
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The simple explanation is that Scotland had a lot of universities producing lots of graduates, who had to look abroad to find work. Another explanation is that nearly everyone in Scotland was Christian, including many sons of ministers, something which went down very well in America. Devine then explained two aspects of Scottish migration that make it very different to other European countries. First, there was the export of an educated, middle class which was still a minority, but a higher proportion of the total population than in any other country. And secondly, the Highland Clearances – the major reason for Scots leaving Scotland, accounting for more than half of the total. Migration also carried on over three centuries, motivated by the search for opportunity. A Scotsman on the make, Devine concluded, was why the Scots were so influential in the 18th-Century transatlantic world, and later on in Australasia and Asia.

Islam and the Enlightenment
Dr Ibrahim Kalin
Georgetown University (Washington DC) and SETA Foundation (Ankara, Turkey)
16 August 2009

When Europe met Islam...
Dr Kalin started by asking what the Enlightenment was and quoting Immanuel Kant: “We do not live in an Enlightened Age,” said Kant, but in an “Age of Enlightenment.” Dr Kalin also said there were still a few “dark spots,” and quoted another German philosopher, Jurgen Habermas, who described the Enlightenment as an “unfinished project,” adding: “The history of reason is not yet complete; the light of reason was never fully released during the Enlightenment.”

After 9/11, Dr Kalin continued, an American historian wondered if there was any point in writing about the Enlightenment at a time when its ideas and values seemed to have ended in such brutal fashion. Kalin then explained that he didn’t mean to say Islamic culture was “unenlightened” but simply that Islam had never experienced what the West did in the 18th Century, questioning everything we thought we knew. Islam didn’t go through the same stages that created what we call “the modern world” and therefore did not feel so connected with it – an issue which Muslims have debated since the 19th Century. The Islamic concept of placing everything in a larger
context such as transcendence has little appeal in the modern world, said Dr Kalin, and Islamic religion and Islamic traditions would be compromised if that were changed.

How did Muslims create one of the most advanced civilisations and maintain it for centuries until relatively recently (the 19th Century), and why did it now seem so “backward” compared to the rest of the world? How can Muslims, Dr Kalin asked, now “catch up” with the modern world – and do so while maintaining their core values?

Since the prophet Muhammad was first called an “imposter” in the 8th Century – a popular opinion which continued throughout the Middle Ages – no Western intellectual could remain indifferent to Islam, said Dr Kalin. During the Enlightenment some philosophers were interested in Islam because they hoped it would provide an alternative religious system to compete with Christianity. They were seeking a religion without institutions – a “natural” religion that could be understood rationally – and found part of the answer in Islam. Because Islam was a “natural theology” which appealed to human reason more than superstition and myth, it spread further than Christianity. Scholars and historians of the period also praised Muhammad for his worldly achievements, and later on, a certain very famous French general, Napolean, studied the Qur’an…

However, said Dr Kalin, Christian Europe also had a love–hate relationship with Islam – it was both admired and despised. In the 17th and 18th Centuries, there were efforts to “rediscover” Islam, and also a mission to correct the Christian world’s “fanatical and distorted” views of Islam.

The Crusaders of the 11th and 12th Centuries were the first people to come into contact with Muslims and envied the advancement of Muslim society and its material achievements. The unexpected consequence of the Crusades was therefore a change in opinion, as well as the introduction of new things such as chess, ink and perfume, and Muslims were no longer thought of as “monsters.”

When the first modern encyclopaedia was written in the late 17th Century (the Historical and Critical Dictionary by Pierre Bayle) there were 25 pages on the Prophet of Islam, describing Muhammad as “an imposter and a false teacher.” Although this wasn’t meant to be a positive description, it encouraged people to find out the truth for themselves, and this had positive repercussions, said Dr Kalin, including travel to the Muslim world to witness the religious tolerance of Islam, as opposed to
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the “brutality” of many Christians when they came across different beliefs. One French historian wrote at the time: “The teaching of Islam conforms to the light of reason…and is neither gross nor barbaric.”

Jews, Christians and Muslims all believe in a divine creator, Dr Kalin continued, so how does reason fit with this? Enlightenment philosophers decided that reason was the source of truth, and this led to the start of “ideological rationalism.”

The philosophy that grew out of the Enlightenment contradicted both Christianity and Islam, and one effect of this was less hostility towards Islam. Dr Kalin also talked about the importance of reason in Islam – something which may appear puzzling because reason is concerned with truth and logic, while religion is concerned with beliefs. According to Dr Kalin, fideism – the idea that you don’t need proof to justify beliefs – was never very popular with Islam. Muslims believe that reason is used to distinguish between the self and the non-self, and even to understand “the world beyond reason” – which is why it is still so important to Muslims.

What does all this mean for us today? Does Islam need an Enlightenment? If so, what form will it take? And who will initiate it? These are just some of the questions asked by those who want the Muslim world to make peace with the “modern” world, said Dr Kalin.

Islam’s encounter with modernity goes back to the 18th Century, and since then Muslims have seen (but perhaps not acknowledged) that modernism isn’t quite so perfect. One of the consequences of the new thinking in Europe was colonialism, whilst improved technology meant better weapons, and rationalism could sometimes lead to racism.

The encounter with the modern world produced three major responses in Islam:

1. Islamic modernism – wanting Islam to “catch up” with the West
2. Fundamentalism – the opposite of modernism
3. People who thought Islam had to adjust but shouldn’t give up its traditions

There were certain traditions, Dr Kalin explained, that contributed to the Muslim world’s previous successes, producing “philosophical reflection, logical rigour and spiritual depth.” And he said that what the Muslim world needed today was a revival of those traditions.

Dr Kalin concluded that in an increasingly globalised world, the task of creating a civilised world cannot be the sole responsibility of any one nation or culture. We must rise to the challenge together, he said – which is why the
Qur’an calls on all of humankind to “fight for the common good.”
One member of the audience said that Muslim countries didn’t play a large part in shaping the UN Declaration of Human Rights and that we need common values to achieve world peace. Dr Kalin said it was a shame the Muslim countries weren’t directly involved, and wondered why the Muslim world does not have a Ghandi or a Nelson Mandela – adding that we do not always listen to such figures.
Dr Kalin also said the values of the Muslim world must be respected even though they are different. There are often double standards, he added, regarding human rights, with more powerful countries making lots of demands and often doing something very different themselves.

The Ages of Optimism and Pessimism: Utopian and Dystopian Ideas

Tom Wright
writer of the Malthouse Melbourne production, Optimism

Knud Haakonssen FRSE
Professor of Intellectual History, University of Sussex

Maggie Gee
novelist

Michael Kantor
Artistic Director, Malthouse Melbourne

17 August 2009

Enlightenment vs Endarkenment
Tom Wright talked about the impact of the Enlightenment on Australia, exploring both the positive and negative aspects – including colonisation.
Knud Haakonssen explained how Australia at one point was thought of as Utopia, and discussed the connections between optimism and Utopia.
Maggie Gee described the history of dystopias and why so many novelists write about them, tracing the plots of three of her own books.
Michael Kantor looked at the positive side of human nature as explored in Voltaire’s Candide – the inspiration behind the current production of Optimism.
Wright began by describing how he had grown up in Melbourne, at a time when dystopian works of art such as William Golding’s novel Lord of the Flies and Stanley Kubrick’s film A Clockwork Orange (adapted from the novel by Anthony Burgess) encouraged him to “mistrust human nature.”
He then described the paradox of the Enlightenment – was it like switching on a light bulb or “letting loose a plague upon the world?” For Wright, this is reflected very clearly in the founding of modern Australia, and he sees the “colonisation of the dark continent” as a product of the Enlightenment. Whilst Europeans looked out of their windows and saw a benign landscape, “the eternal verities were turned upside down” when they arrived in Australia, where nature was hostile and dark. In other words, Enlightenment means one thing in one place and something quite different when it is transplanted to the opposite side of the world.

He developed this “paradoxical” theme by describing the juxtaposition of the graveyard where David Hume and Adam Smith were buried, next door to the Political Martyrs Monument on Calton Hill – in honour of the five Scots transported to Australia in 1794 for campaigning for parliamentary reform. This was moving for anyone from Australia to see, Wright explained, because these men were more than petty criminals – they were a crucial part of what made Australia the society it is today. Wright also described how the five men were sent with a note to the governor saying that despite their “criminal behaviour” they were still men and should be well treated, and as a result they were placed on the “respectable” side of Sydney. The city itself encapsulated the idea of “light versus dark,” with the officers and gentlemen on one side of the harbour and “uneducated convicts” on the other – the template for modern Australia, with intellectuals versus the survival instinct (which makes ‘Aussies’ so good at sport!).

Wright wrapped up his talk by discussing “the problematic attitudes of encouraging Enlightenment,” and how this can lead to the feeling we have to control other people and tell them they’re ‘wrong’ – for example, saying Muslim women need to undergo enlightenment. “There is always a price to be paid,” he concluded.

Haakonssen echoed these ideas by describing how many people used to think that Utopia really existed – and imagined they would find it ‘Down Under’. However, when they reached the terra incognita of Australia, the fantasy soon changed into reality (cognita).

There is a fundamental divide between optimism and Utopia. Optimism – like pessimism – is essentially about time: our self-consciousness about the future. Utopia is stationary, unchanging, outside of time.

To bring the two together requires draconian measures – some kind of speculative theory, showing Utopia as the goal of a process of
which we are part. The idea of laws of history is one example, the idea of providence another.

Contrary to popular notions, much of the Enlightenment accepted the latter, and further, that humanity could assist providence in all manner of ways – and that was Enlightenment. Voltaire, Hume and Adam Smith rejected such ideas – but that didn’t make them pessimists.

As an author of three dystopian novels, Gee said this was one of her areas of expertise. “No-one writes utopian novels any more,” she explained.

She said the urge to write about dystopias often originated in rebellious childhood, when young people start to question authority and also feel that ‘no-one understands’ them. Gee also said that dystopian writing is a way of expressing ideas without the irrelevant details you have to include in ‘realistic’ novels. It is easier to express ideas set in a virtual world.

Every novelist is trying to highlight the fact that their experience is interesting and that they have something to say that they think is worth hearing, said Gee. And even though fiction means lies, she thinks novelists are ultimately interested in truth, but don’t always believe what they’re told.

Gee then gave a brief description of each of her dystopian novels. The first was set in the 1980s when all that seemed to matter to many people was “sex and shopping.” A couple go off travelling, leaving their kids behind, but their lives fall apart and they end up unsatisfied and lonely. The second is about climate change going into reverse, to make the point that human beings always look in the wrong direction, using environmental problems to exaggerate what she wanted to say about society. The third was written before the Iraq war, when many people thought it would not happen. And soon after the book was released, war broke out.

Finally, she said that dystopian novels are proof that some of the best things of the Enlightenment are still here – including the ability to be sceptical and realistic.

Kantor talked about his fascination with optimism, fuelled by his involvement in an adaptation of Voltaire’s novella Candide appropriately called Optimism. He then wondered how we can remain positive in face of so much bad news and things to be negative about, somehow managing to believe not only that bad things won’t happen to us but also that good things may happen.

The play, he said, unfortunately doesn’t tell us how to remain optimistic. It is in fact a satire. Voltaire is pointing out how stupid it is to remain optimistic,
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via his depiction of the character Pangloss, who witnesses extremely negative events, but somehow manages not to become pessimistic, the idea being that we have to be optimistic or “humanity goes to muck.”

Originally, said Kantor, the Malthouse team thought they would have to change a lot to fit Voltaire’s ideas in with contemporary society, but in fact they still work very well (the stage play is set on an airplane). This shows that despite the many changes since Voltaire’s time, the complexity of the human mind is much the same today. Voltaire understood that human beings need positive thought, and also need to return to the practical world, an idea expressed in the very last line of the play, when Pangloss says how great the world is and Candide replies: “That’s all well and good, but now we must tend to our garden.”

“What does it mean?” Kantor asked. For him, it is the radical idea that we need to return to more practical things. Faced with wars and natural disasters, “we need to tread lightly on the soil,” he said.

Kantor said he hated to be naïve, then concluded by saying: “It fills me with hope that there is something we can do,” despite all the problems around us.

Science and Tolerance
Baroness Onora O’Neill of Bengarve FBA
philosopher and former President of the British Academy

John V Pickstone
Wellcome Research Professor of History of the Medicine, University of Manchester

Lord Rees of Ludlow
President of the Royal Society, Astronomer Royal, Master of Trinity College, Cambridge

21 August 2009

Science vs pseudo-science
John Pickstone set the historical context by saying that tolerance was “invented” towards the end of the 17th Century. The persecution of heresy (which had been seen as endangering the spiritual health of the people) diminished, partly through war-weariness and political expediency, and partly through the promotion of individual enquiry which tested theories by arguments or experience. These attitudes remain associated with the ‘scientific revolution’ of the 17th Century, but were also
associated with developments in religious and political thought. For John Milton, one could be a “heretic in the truth” if one believed for the wrong reasons. Tolerance created the space for enquiry.

Pickstone argued that careful scepticism still remained appropriate across all fields of enquiry – from those known since the nineteenth century as science, through the wider questions which once constituted natural philosophy, and on to politics and religion. It was unhelpful to think of matters of science as now secure and as contrasting with ‘mere opinion’ or fixed faiths. Disciplined scepticism was essential to the technical and social development of the sciences; but we too easily forget that increases in gender, racial and economic equality, for example, grew more from campaigns and debate than from any particular ‘faith positions’ (or indeed from ‘science’).

Onora O’Neill pointed out that “we are the generation which has endangered the environment and trashed the economy,” yet is also more insistent on human rights and more willing to embrace diversity. She then said toleration was sometimes seen as easy and equated with indifference. Instead of saying “anything goes,” we should be more concerned with critical enquiry and focus more on evidence – “disciplined enquiry not a free-for-all.” She also suggested that we should not pay equal respect to every position, and should differentiate between arguments which rely on evidence and those which do not.

There has been a move away from older conceptions of freedom of speech, said O’Neill, to thinner conceptions of freedom of expression. Good communication or enquiry needs structure, clarity and discipline and self expression can neglect all of these. “Mere freedom of expression comes at a cost,” she continued, “and distracts from what really matters.” There is also the problem of libel and hate speech, she added, which tempts us to introduce laws to control how we talk to each other in public.

Martin Rees explained that in the late 17th and early 18th Century, medicine and astronomy were the only professional branches of science. But even though science today may be broader in scope, he continued, it is not always “optimally deployed for the sake of human welfare” – e.g. many scientists focus on weapons research and curing the diseases of the rich rather than tropical diseases. “Scientists as a tribe are fascinating subjects for anthropology,” Rees then declared.

For scientists, the path to consensus is a winding one, Rees said, referring to the “vendettas”
which sometimes exist in subjects like cosmology. When rival theories fight it out, he explained, only one argument wins, and sometimes only one piece of evidence clinches the argument – e.g. theories like the Big Bang or Continental Drift. Very strong support for a particular viewpoint can also be problematic, although, on the other hand, “we love to see a maverick vindicated.”

The general public are interested in subjects such as cosmology, as well as health and diet, but sometimes the “flaky ideas” are paid more attention than life and death issues, and this may lead to problems with the claims made for alternative medicines or the confusion about MMR. At the same time, he added, “the media should not exaggerate or gloss over the uncertainties.”

Climate change, Rees said, is another problematic area, particularly when it comes to political action. Scientists are not in charge of the world, but Rees suggested neither scientists nor politicians should make decisions alone – we all must decide. At the same time, some campaigners can get in the way of rational debate. “The global village has its global idiots,” said Rees, later adding that we also have to rise above the level of the tabloids.

Even when there is consensus, there is always a problem with measuring the scale of threats, particularly when it comes to “low-probability, high-consequence events.” For example, with Variant CJD, a scientist could say there is a one per cent chance of one million deaths, and people may panic. In reality, however, there have only been about 100 deaths. So what do you say and how do you say it?

Complex scientific questions can be social and political minefields, and must be seen in context. The moratorium on gene splicing may not have been a good idea but it made sense at the time, Rees suggested. With synthetic biology, consensus is harder, and commercial pressures make it more intense. Dialogue with politicians has enabled progress when it comes to stem-cell research, he continued; but with GM crops, the views became too polarised right from the start and the whole thing went wrong. “Scientists must engage upstream,” Rees added.

When it comes to “pseudo science” or UFOs, said Rees, it is also difficult to have a sane debate because the different sides don’t use the same methodologies, but unlike Richard Dawkins, Rees does not think astrologers ought to be sued. “The heirs to the Enlightenment should not allow intolerance,” Rees then concluded, “but we must be rational and use evidence.”
From princepal palaces to farmyard…

The Austrian composer Joseph Haydn was the focus of attention for much of the discussion, as the three speakers outlined the dramatic shifts in music during the 18th Century – including the ‘internationalisation’ of traditional Scottish airs.

Haydn’s career was a metaphor of how music changed in the course of the century. Of modest birth, he started off as a composer for the court, then later on became as famous as a pop star, moving from “servitude” and music as “simply a job” to complete artistic freedom and the joy of creativity. In the process, his music also evolved from private, religious and serious pieces to much more accessible and “recognisable tunes” enjoyed by the general public. During the same period, Haydn also evolved as a man, casting off the uniform of a servant and adopting the Masonic apron which symbolised the universal brotherhood of man. And according to Sir Roger Norrington, Haydn was “a weather vane for music in the Enlightenment,” promoting the idea that music should be entertaining and available to everyone, in the same way that education should be entertaining.

John Purser then sketched out the Scottish connections, describing the “aristocratic” composers of the early 18th Century, Sir John Clerk (described as lawyer, dilettante and Mason) and the Earl of Kellie (drank too much and died young), who according to Purser was “our own little Haydn.” Purser also talked about the Scots’ love of Italian fiddles and the drive during the 18th Century to integrate traditional Gaelic songs with classical music, “making sonatas out of old Scots tunes.” Purser also amplified the Masonic theme, describing how the Ancient and Accepted Scottish Rite influenced major composers such as Haydn and Mozart, and how the Scottish composer James Oswald wrote music of Masonic relevance.
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The starting point for Marjorie Rycroft was the founding of the Edinburgh Musical Society in 1728 by gentlemen intending to "better themselves" by establishing the city as one of the major venues for classical music on the European circuit, and the export of Scots tunes to Europe. As well as discussing the difference between folk music and high art, Rycroft described the way in which traditional tunes were translated into music which could be performed by "amateurs and young ladies" in middle-class homes, including Alan Ramsay's *Tea-Table Miscellany* and William Thomson's *Orpheus Caledonius*, the first published collection of Scots songs and airs (1725), which later inspired Robert Burns. At the end of the 18th Century, George Thomson sent Haydn 30 Scottish airs which the Austrian composer arranged for a fee of two ducats per air, eventually completing more than 200 such arrangements for voice and piano trio, many of which were set to words by Robert Burns. Rycroft also explained that Haydn, who received only the melodies from Thomson, did not set out to match words and music – the music just fitted.

**On the Dark Side: Witchcraft and the Theatre**

Julian Goodare  
Reader in Scottish History, University of Edinburgh

Ruth Little  
dramaturg and Literary Manager of Royal Court Theatre

Rona Munro  
playwright of *The Last Witch*

Adrienne Scullion FRSE  
Professor of Drama, University of Glasgow

25 August 2009

**Spellbound**

The background to the discussion was *The Last Witch* by Rona Munro, a play which was commissioned for the Edinburgh Festival, inspired by the legend of Janet Horne, a senile old woman from Dornoch found guilty of witchcraft and burned at the stake in 1727 – just before the Scottish Enlightenment officially started...

Julian Goodare kicked off the discussion by describing changing attitudes to witches in the early 18th Century, when *The Last Witch* is set. The common people may not have changed their beliefs very much, seeing witch-
craft as the work of the Devil, but during the Age of Enlightenment, the persecution of witches was becoming “old hat.” The judiciary wanted to stop executions and the torture of witches. Politicians wished no more religious wars, and the church itself was growing much more moderate. Above all, scientific sceptics swept away beliefs in demonology because they thought the world could be explained in natural – not supernatural – ways.

In the 18th Century, the theatre also went through lots of changes, said Adrienne Scullion, and women became much more active – and respectable – players. To illustrate this, Scullion described three productions of *The Douglas* by John Home, reflecting different attitudes to Scotland, women and the theatre over the decades. At the first staging of the play in Edinburgh in 1756, the famous cry was heard “Whaur’s yer Wullie Shakespeare noo?” Set in the dark and mysterious Highlands, the play also attracted considerable controversy, because there was a lot of prejudice against the theatre at that time – and against women appearing on stage. The Jacobite rebellion was also still fresh in the minds of the audience and cast its shadow over the production. In 1784, a second production starring Sarah Siddons was staged at the Theatre Royal. The theatre by then was a respectable part of city life and culture, and members of the clergy even took time out from the General Assembly to attend a performance. By 1796, the famous English actor Henry Johnson appeared in the play in full Highland dress, reflecting the fact that the Union was now more secure and Highland heroes no longer posed any serious threat. “The Enlightenment illuminated the dark recesses of theatre,” Scullion concluded.

Ruth Little talked about her interest in prejudice and scapegoating, and how witches represented opposition to authority – exemplified in modern times by a radical feminist movement of the late 1960s called WITCH – the Women’s International Terrorist Conspiracy from Hell – who tried to “hex” Wall Street. The hunt for scapegoats usually leads to a paralysis of intelligence, Little continued, and the “perfect storm” of the witch trial. She also described the idea that witches were supposed to have more “slippery tongues” and an “insatiable carnal lust” which threatened the moral establishment, and quoted the character Elizabeth Sawyer in the Jacobean play *The Witch of Edmonton*: “It’s all one to be a witch as to be counted as one.” Little then said that witchcraft was a lens through which to observe the behaviour of local communi-
Let there be Newton

According to John Henry, Newton was the driving force behind the Enlightenment and science became the “new intellectual authority,” taking over from church and religion. “Science made the Enlightenment possible,” he continued, because of the amazing success of Newton’s masterpiece, *Principia Mathematica*. After this was published, people thought that everything was solved and that the only challenge left in science was “the donkey work” of the “Newtonian programme.” As the poet Alexander Pope wrote: “Let Newton be, and all was light.”

ties and ended by saying “we are brilliant at negative definitions” of those outside society, with the witch as the metaphor of the outsider.

Rona Munro shared her experience in researching and writing her play *The Last Witch*, and the challenge of making an historical play interesting and relevant to a modern audience. As well as saying that research was sometimes a good excuse for watching Vincent Price films, she praised the database created by Julian Goodare and colleagues which provided so much useful raw material. She also said that the story of Janet Horne was more interesting because of what we don’t know rather than the so-called “facts,” and described how Walter Scott ‘rediscovered’ and probably romanticised the story 60 years later.

Because Janet Horne held her hands to the fire which would later consume her and described it as a “bonny warming,” she was either suffering from dementia or extraordinarily defiant, said Munro, and the latter was how she chose to dramatise the character, since this was what she found more interesting and closer to her personal experience. Munro also said that women like Janet Horne who alienate or annoy their neighbours seem to suffer the consequences much more than men. “If women get some power, they are often seen as being repellent,” she added, referring to the demonisation of Hillary Clinton.

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*Science and the Enlightenment*

Geoffrey Boulton OBE FRS FRSE
Professor of Geology and Mineralogy, University of Edinburgh

Dr John Henry
Director, Science Studies, University of Edinburgh

26 August 2009
No-one else made such an impact as Newton, an iconic figure who became the embodiment of the Age of Reason, said Henry. His principles were applied not only to subjects such as physics but also the study of man – a social science which was later developed by thinkers in Scotland such as Adam Ferguson and David Hume. Newton analysed morals as if he was conducting an experiment. Psychology, said Henry, also owed a lot to Newton – for example the idea that attraction (or the association of ideas) operated the same in the psychological dimension as in the physical world.

Henry then asked what made the Scottish Enlightenment so different, concluding that the reason was that Scots were very quick to adopt Newtonian ideas. And finally, he talked about the way that new branches of science emerged in the period, including chemistry and electricity, both Newtonian in origin. “Enlightenment science was Newtonian science,” he declared.

“Why did the flame of the Enlightenment burn so brilliantly in Scotland at the end of the 18th Century?” asked Geoffrey Boulton, suggesting the country had not been so bright at the start of the century. The John Knox-inspired system of education, the opportunities presented by Union with England, which opened up new markets, and the fact that so many Scots travelled abroad – these were the chief reasons Scotland progressed so rapidly during the period. Add to this so many people with so many different ideas in the same place at the same time, and the end result was an “interdisciplinary riot,” said Boulton.

So what was the role of science at this time? Boulton illustrated this by describing the careers of three leading Scots – the geologist James Hutton, the chemist Joseph Black and the inventor James Watt. Hutton was a “systems scientist” who reached the broad conclusion that the planet went through a cycle of changes similar to crop rotation, driven by internal heat and ground down by erosion. This not only brought him into conflict with contemporary scientific theory and the book of Genesis, but was frowned upon because it was associated with the “dangerous” idea of revolution. Hutton claimed that he based his theory on careful observation of objective data, using the “minimum of imagination,” but we now know that he actually developed his theory before he had gathered the facts to support it.

Joseph Black, said Boulton, engaged in a “reductionist, experimental branch of science,” concerned with latent heat and other thermal phenomena, or “analytical chemistry.” He took “enormous leaps of understand-
ing,” said Boulton, because he was “taking apart the nuts and bolts of reality.” Watt was an instrument maker who improved Newcomen’s first working steam engine by a factor of four to “power the industrial revolution”. He also owed little to science, said Boulton, who described Watt as an “enlightened technologist,” in tune with the ideas of a mechanical universe.

Boulton then subverted the idea that reason is by definition always a good thing. If these men had known the social consequences of their theories and inventions, he said, they may have “thought twice.” To explain this, he quoted the playwright Bertold Brecht, who said the aim of science “is not to open the door to infinite wisdom, but to set a limit to infinite error.” Boulton then developed this theme by discussing the modern scientific revolution ushered in by computing, “delving into the complexity of cause and effect” to produce unexpected outcomes or “emergent behaviour” which we are not “wired” to understand.

Boulton then asked: “Is our confidence in the power of human reason justified?” Is social progress a by-product of scientific progress? Or are enlightened views – such as historical progress and the “perfectibility” discussed by Adam Ferguson – profoundly flawed? “What would Watt and his fellow improvers have thought about the miseries of the industrial revolution and the industrialisation of slaughter?” asked Boulton. And is it true that social and ethical progress is fiction, while scientific progress is fact?

“If there were to be a modern Enlightenment, and we decided that human affairs should be conducted primarily through the power of reason, what would that reason look like?” he finally asked.
Appearances can be deceptive

Was the face of the Enlightenment the portrait of David Hume by Allan Ramsay (“not an easy face to paint”), a face scarred by smallpox or the head on a banknote? This was how the chair John Leighton summed up what was probably the most abstract debate of the series – trying to understand the Enlightenment by “reading” its appearance.

Leighton set the tone when he asked at the start if the face may be considered as a metaphor for the Enlightenment, or if we should focus on what we can tell from painted likenesses of people – the private and public faces of 18th-Century portraits. He also suggested that in an age of economic and political uncertainty, we may look back on the Age of Enlightenment with a lot of nostalgia.

First speaker Roger Emerson began by saying there was little agreement on what the Enlightenment actually was, or when it happened. Was it what Kant described as freeing oneself from “self-imposed immaturity,” or was it more to do with utility, as described by the Scottish encyclopaedist, William Smellie? Did it start with Voltaire in 1734 or Spinoza in the 1670s? Did it end after the French Revolution, when many critics thought it had led to the Terror? With this in mind, to talk about the “face” of the Enlightenment depends on how you define it, he said.

Emerson also said that the Enlightenment was part of a large “improvement programme” dating back to the Renaissance and the Reformation, the major difference being the ideas of the sceptical philosophers and scientists, and the application of their thinking across a number of disciplines.

The Scottish Enlightenment was not known as such until 1906, and Emerson asked if its face could perhaps be the four paintings of the Leadhills Mines
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by the Scottish painter David Allan, recently acquired by the National Galleries of Scotland, because of their association with improvement (the public library), science and technology, or the portraits of people such as Lord Alva, David Hume or Archibald Grant. Only a few thousand people were involved in the Enlightenment in Scotland, and most of them were Lowlanders. Very few were women. And ironically, Emerson concluded, the faces were more likely to be Dutch or Italian, since these were the portraits that people in Scotland bought at the time. Paul Goring decided to take the subject literally, talking about the “reliability of the face as an indicator of character,” and stating that although we think of the body as a natural constant, it is possible to study the history of the body in various ways, including the differences between the face of the Enlightenment and our faces today. At that time, many faces were marked by smallpox, despite the popular use of cosmetics, and many people’s noses had collapsed because of mercury treatment for syphilis. People then also consumed lots of sugar and dentistry was not widely available, so most people also had very bad teeth. Changing social patterns also had an impact, said Goring. Today we are the ‘Facebook’ Generation, but at that time there was a major shift in society because of the growth of public life – including coffee houses and public exhibitions. Doing business “face to face” meant that reliability was also a critical factor. Was the face a window or a mask?

Finally, said Goring, even though people were ‘performing’ in public, they also yearned for honesty, and this led to the rise of physiognomy as a respectable discipline during the 18th Century, even though it was later discredited as a science.

As a theatre director, Anne Bogart talked about how she first thought about how a stage play should ‘look’, and suggested that we are often ‘seduced by the façade’ – interested in looks rather than the impulse or the ‘energy’ behind an idea. She then declared that we are at the end of the post-modern era. There is nothing left to deconstruct, she said, so maybe we are now entering the age of the “New Enlightenment,” rediscovering stories and “new ways of meaning through stories.”

Fellow director Lee Breuer began in provocative style by declaring that all artists focus on “making a buck,” and then described the history of patronage, pre- and post-Enlightenment. Before the Enlightenment, Breuer said, artists had to go to the church or aristocracy for funding, and as a result became court “playthings” or jesters, creating work which
promoted the cause of their patrons. After the Enlightenment – with its ideas of democracy, technology, science and economics – what changed? Were we more advanced than the ancient world, when women, animals and prisoners were slaves? Breuer suggested that even though machines are supposed to be doing the dirty work now, we have replaced one form of slavery with another and all become “wage slaves.” Politicians and corporate business are the new patrons of the arts. The game has changed, he added, but the economics have not. “We may as well hitch-hike to Rome,” he suggested.

**Moral Universals and Moral Progress:**
The New Science of Good and Evil

Paul Bloom
Professor of Psychology, Yale University

31 August 2009

**Are moral judgements ruled by head or heart?**
Where do moral values come from? Do we make our moral judgements based on reason or emotion? Can babies tell right from wrong? And would babies ‘punish’ a ‘bad guy’ if given the choice?

In the 1950s, most people thought inter-racial marriages were wrong. Nowadays, the opposite is true. Meanwhile, attitudes to many other social, moral, philosophical, religious and political issues have also been turned upside down. But what has changed since then, and is this moral progress or simply a change?

Just because we are ‘disgusted’ by incest, necrophilia or the idea of eating the family pet, does that mean such ‘disgusting’ acts are morally wrong? Is it always better to sacrifice one life if that will save five lives?

Did *Uncle Tom’s Cabin* do more to end slavery in the US than thousands of essays which argued the same? Did the comedy show *Will & Grace* do more to change attitudes to same-sex relationships than years of activists demanding gay rights?

These were just some of the questions posed by Paul Bloom in the course of his lecture – a cross between a stand-up act, psychology experiment and public opinion poll, described by one member of the audience as “a master class in the art of public presentation.”

The Enlightenment may have been all about reason, but Bloom...
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subverted the idea that we base our moral judgements on reason, suggesting that emotions and the influence of ‘stories’ are more critical factors than rational arguments – based on his psychology experiments with babies and adults.

Bloom also suggested that people are ‘hard-wired’ to make moral judgements, illustrating this with his description of an incident in 1848, when a man called Phineas Gage suffered terrible brain damage after an accident, leading to a major change in character, which suggested that his physical brain played a greater role in making moral judgements than his powers of reason, which were still quite intact. This raised the question, said Bloom, of whether gut feeling or reason determines our ability to tell right from wrong.

Bloom then discussed the idea of the “foundations of a universal morality” and our altruistic aversion to the pain of others, citing his experiments with babies, observing their reactions to a cartoon which portrayed a ‘good guy’ and a ‘bad guy’, to show that the babies were ‘hard-wired’ to be capable of telling the difference and also capable of altruistic behaviour – unlike psychopaths whose lack of sensitivity makes them indifferent. (Bloom also claimed that James Bond was the perfect example of a psychopath, rather than Hannibal Lecter.)

“Instinctive empathy is universal, natural and important,” said Bloom, but there are huge differences when it comes to attitudes towards more controversial subjects such as sex and religion, and Bloom believes that this can be explained according to three types of ethics: autonomy (concerned with notions such as freedom, rights and equality); community (concerned with duty, status, hierarchy and interdependence); and divinity (concerned with purity, sanctity, pollution and sin). There are also radical differences amongst people according to their politics, with conservatives tending to be ‘disgusted’ by certain things and liberals tending to say that something is ‘OK as long as it’s fair and no-one is harmed’.

To test where people sit on the political spectrum, Bloom then presented four scenarios – incest, eating the family dog, using the national flag to clean the toilet and having sex with a dead chicken – and surveyed how the audience reacted to each in terms of right and wrong. Every situation was more complex than it appeared, and this led to complex responses – and moral dilemmas. “People struggle to find reasons to say why something is wrong,” Bloom declared, and our gut feelings tend to hold more sway than rational arguments. To illustrate this further, he presented two scenarios where we
are asked to decide the fate of several people standing on a rail track, as an express train approaches. In the first case, the train will kill five people, but we can pull a switch to divert the train onto another line, thus killing only one person. Do we pull the switch – saving five people by causing (remotely) the death of just one? Most people tend to say yes. In the second case, five people are again on the rail track as the train approaches, but this time we are standing on a bridge with a very large person – ‘the fat man’ – beside us. If we push the fat man off the bridge onto the rail track, the train will stop and as a result the five people will be saved. Bloom then explained that most people find it harder to decide what to do in the second scenario, measured with a brain scan of ‘emotional involvement’ which highlights different patterns of activity in different areas of the brain depending on the choice being made, even though it is logically the same decision – five lives versus one life. The key difference, said Bloom, is that in the second scenario, we have to actually touch the person, not just pull a switch. Bloom also suggested that how we express such dilemmas can have an effect on the outcome – for example, using words like ‘killed’ or ‘saved’ can influence people’s decisions. Bloom then quoted David Hume: ‘Reason is, and ought only to be, the slave of the passions,’ and said that his own findings also suggest that emotions tend to over-ride the rational side of the brain – for example, when it comes to changing attitudes to slavery and sexism. Bloom also said there is a big difference between our idea of moral progress and what he prefers to call “moral change.”

“What are the forces underlying moral progress?” he asked. And the answer, he suggested, was imagination and the power of stories which exploit our natural, empathetic responses to the real-life suffering of others. For example, he explained, when charities use real people to make an appeal, the end result tends to be much more successful because we find it harder to turn down a person who really exists and stories which tug on our heart strings, rather than a rational, impersonal appeal. Similarly, feeling disgusted tends to shape moral judgements, even though this is an unreliable indicator of ‘right or wrong.’

In conclusion, Bloom said, we are ‘hard-wired’ to be moral creatures, our morality is driven by gut feelings rather than reason, and our gut feelings tend to be triggered by stories. “Man will become better,” he concluded, quoting Chekhov, “when you show him what he is like.”
Back to school
Chair Louise Richardson put the discussion in context by describing how the academies of the 18th Century expressed the basic principles of the Enlightenment by trying to be independent of the church and the state, encouraging people to think for themselves and be tolerant of other people’s ideas.

Paul Wood started by defining a few basic terms, asking if the Enlightenment was a period or a cultural and intellectual movement. If it was a period, it lasted from about 1690 until 1805, when the Scottish clergy vetoed the appointment of John Leslie as a professor at the University of Edinburgh, after a century when the church had generally not interfered with such matters.

If the Enlightenment was a cultural movement, said Wood, then its leading principle was toleration – at least in theory if not in practice, as exemplified by Locke tolerating everyone except Catholics and atheists. Another pillar of the movement was the idea that tradition can’t sustain a modern way of life, and that reason, rules of evidence and sometimes utility were what really mattered. The natural sciences were also of central importance, since the ideas of Newton and Bacon provided a “proper universal method” in the search for the truth. Newton also showed us, said Wood, that truth was something that could be discovered. And “commitment to improvement” was the other major characteristic, he added, whilst we should not forget that most scientists also supported religion.

Turning to the meaning of ‘academies,’ Wood said that some institutions of that time were set up with a more practical and commercial emphasis, whilst national academies such as the RSE were closely tied to universities. Two major factors were at play in 18th-Century Scotland, he added. There was general consensus that education was a good thing because it would lead to moral and material improvement, in a country which was “culturally backward” and had suffered economic disasters and famine in recent decades. The school
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curriculum was reformed to meet the needs of the age, and this led to dramatic progress in disciplines such as medicine and even radical ideas such as education for women. Wood also set out to ‘ruffle some feathers’ by discussing academic freedom, and the fact that it did not exist in the 18th Century as we think of it today. Academics could philosophise freely but they tended to avoid questioning the basis of religion, and the establishment still ‘micro-managed’ society, via figures such as the third Duke of Argyll, who was one of the great architects of the Scottish Enlightenment – although also an enlightened and moderate man, and a good scientist. The paradox, suggested Wood, was that state control today suggests negative things such as bureaucracy, whilst then it did good things.

Stewart Sutherland began by reacting to this latter statement, saying that if you must have a despot, “make sure he’s an enlightened despot.” He then said that the Enlightenment was not a thing or event but a process, with no specific starting or end point, and that he would discuss it via three ‘vignettes’ which illustrated what was going on in Scotland during the 18th Century and beyond.

First, he told the story of the ‘perturbation of the waters’ on Loch Ness on 1st November, 1755, when extraordinary four-foot-high waves were observed. The cause of the phenomenon was the earthquake in Lisbon on the very same day, whose seismic movements were recorded many miles away. What was significant, said Sutherland, was that scientists – influenced by Newton – recorded the event and analysed the evidence, and sent a report to the Edinburgh Philosophical Society which we can still read today. “This was not a cause or consequence of the Enlightenment, but the Enlightenment at work,” said Sutherland.

The second point concerned the importance invested in education in Scotland, and the fact that the University of Edinburgh was not established by Papal Decree like other institutions, but was created by civic demand. In Aberdeenshire, he added, there were three universities in 1600, including one in Fraserburgh, also established because the community wanted it. This tied in with John Knox’s belief in the fundamental importance of education and the idea of a “school in every parish.” The church also believed that first principles and reason were prerequisites for reasonable debate – even when it came to matters of faith.

Sutherland then described how universities went out “into the world,” with Scottish influence spreading to London and
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Princeton and even to the University of Chile, whose first rector, Andres Bello (Simon Bolivar's tutor), was deeply influenced by the ideas of Scottish philosophers, including Thomas Reid and Dugald Stewart.

Finally, Sutherland said, there was a widespread belief that for reason and rationality to rule in society, we needed to educate people – starting in primary school. But today there are also two problems, he added. First, as the Enlightenment principles are institutionalised, academies take on lives of their own and it becomes increasingly difficult to resolve the competing interests of different disciplines, whose knowledge is increasingly fragmented and compartmentalised. Secondly, we should note that universities and academies such as the RSE are hugely dependent on the public purse – not always a bad thing but also not always a good thing.

Political Economy: Adam Smith and Others
James Buchan
Author of Adam Smith and the Pursuit of Perfect Liberty

Andrew Skinner FRSE
Adam Smith Professor Emeritus of Economics, University of Glasgow
3 September 2009

The conversation continues...

Gordon Brewer introduced proceedings by declaring that it was cheering to see so many people attending the Enlightenment discussions, at a time when we are being “bombarded with articles about dumbing down.” He then said that Adam Smith and his theories provided the backdrop to our current economic crisis, “a world in which the banking system has exploded and is now being propped up by taxpayers’ money.” He also said that there had been a re-evaluation of Smith since the 1980s, when it became popular to say “let the market do what it wants,” then posed the question: “What are the limits?”

James Buchan outlined Smith’s life from his birth in Kirkcaldy in 1723 until his death in Edinburgh in 1790, to describe the human being behind the great legend. Smith’s father was a customs official, a servant of the new administration set up after Union, but he died before his son was born. Smith was devoted to his mother all his life and never married, said Buchan, and was deeply affected by the death of his mother in 1784. Smith studied at the University of Glasgow (which
he loved) and Balliol College in Oxford (which he detested), said Buchan. Early on, he was engaged in philosophical enquiries, and wrote an essay on astronomy. In 1746, he returned to Scotland with no prospect of employment, no vocation or religious calling. Two years later he gave a series of lectures in Edinburgh which led to his appointment as Professor of Logic and Rhetoric at his alma mater in Glasgow, becoming Professor of Moral Philosophy the following year.

Smith was concerned with institutions such as the family, marriage and taxation, and this led to an interest in political economy and jurisprudence, and the question of why some countries are more prosperous than others – a subject which inspired *The Wealth of Nations*. Buchan then quoted Smith stating one of his central beliefs: “Little else is requisite to carry a state to the highest degree of opulence from the lowest barbarism but peace, easy taxes and a tolerable administration of justice.”

In 1759, Smith published his *Theory of Moral Sentiments* and enjoyed worldwide success, which led to him embarking on a Grand Tour of Europe in 1764 on a pension of £300 a year as tutor to the young Duke of Buccleuch. Even though he hated the idea of a Grand Tour, Smith grasped the opportunity to meet intellectuals such as Voltaire and Franklin during his travels, and returned to Scotland in 1766, taking another nine years to complete *The Wealth of Nations*, in the course of which a banking crisis rocked his patrons, the Buccleuchs. What made the book so successful, said Buchan, was that it was a new way of looking at history and society – “not moralistic and with no political axe to grind.”

Buchan then described Smith’s final years, his absent-mindedness and “worm-like” way of walking, and summed up the major factors in his career. Most importantly, said Buchan, Smith believed (like his friend David Hume) that a single principle like sympathy (the ability to put yourself in somebody else’s position) or specialisation could explain a wide range of philosophical phenomena. Like many others of his age, he was also enthralled by natural science and the theories of Newton. During his lifetime, many other factors also influenced his thinking, such as Scotland becoming more wealthy and becoming a more polite and ‘polished’ society. The supernatural was also abolished from philosophy, with a little help from Smith himself. Above all, said Buchan, Smith focused on the betterment of society and the drive for prosperity, and was anti-authoritarian as well as a republican, against the idea of either being ruled from above or below.
After describing Smith’s core beliefs (accepted standards of behaviour, rules of law, the close links between ethics and economics, etc) and tracing his philosophical career, Andrew Skinner focused on Smith’s meditations on market forces versus regulation, as well as the doctrine of unexpected outcomes and the so-called ‘invisible hand,’ and how we all live as ‘merchants’ by exchanging the fruits of our labours. Smith’s critique of the mercantile system may suggest that economic equilibrium is like a law of nature, but when should the State intervene? Smith talked a lot about high concepts such as freedom and security and dynamic global economic forces, but when it comes to more domestic issues, things become more difficult. Smith was also not a blind believer in the supremacy of free market forces. According to Skinner, Smith advocated an end to the apprenticeship system and trade guilds, believing they inhibited freedom of trade, but he also advocated taxation, and was acutely aware of the problems of the credit structure. Smith sought to create an economic environment in which individual initiative could thrive, but he also thought that government must provide public works, Skinner said, believing that the profit motive would not provide things such as bridges and roads – or education. Many areas required intervention, and government must scrutinise and regulate to protect people. There are negative and positive freedoms, said Skinner, and increased wealth can also lead to damage.
Bridges, beer and student exchanges…

The discussion forum at the RSE was part of the Japan–UK 150 series of events, organised to celebrate 150 years of friendship between Japan and the UK and encourage exchanges in culture, the arts, sport, education and science. And the five speakers not only revealed some surprising connections between Japan and Scotland in the past, but also shared their recent academic and business experiences – and their hopes for the next generation of Japanese and Scottish engineers…

Did you know that a young Japanese engineer was involved in the construction of that great Scottish icon, the Forth Rail Bridge? Did you know that a Scotsman founded one of Japan’s leading breweries? Or that Scotsmen played a key role in the founding of Japan’s first universities, shipyards and banks?

These were just some of the facts to emerge from the evening’s discussions, which focused on the links between Japan and Scotland since the mid 19th century, with an emphasis on engineering, education, science and technology – not forgetting beer.

The first speaker, Professor Alex Craik, described the emergence of modern Japan between 1853 and 1885, and the Scotsmen who played a key role in the process. Among the leading figures were Lord Elgin, who gained the first trading concessions in the late 1850s; Laurence Oliphant, who wrote a popular account of Elgin’s travels; William Keswick and Hugh Matheson (of Jardine Matheson fame), who broke the law to help five young Japanese samurai (the “Choshu 5”) sail to the UK to study. Some of these young men returned to Japan to play prominent roles in government and business, including Kikuchi Dairoku, a mathematician who later became the Minister of Education and President of Kyoto University.

One of the most colourful Scots in Japanese history was Thomas Glover, who played a “dangerous game” selling arms to the Satsuma and the Choshu clans, and founded a shipyard which was later bought by engineering giant, Mitsubishi. Glover also founded Kirin Beer, still one of
Japan’s leading brands. Other leading Scots included John Black, one of Japan’s first newspaper magnates, and numerous medical missionaries, bankers and engineers – including Richard Brunton, “the father of Japanese lighthouses” (trained by the Stevensons) who in his spare time improved Yokohama’s drainage and macadamised roads. Japan’s shipbuilding, railways and iron production also owed a lot to Scottish engineers.

Craik then described the influence of Scots on education in Japan, focusing on Henry Dyer, who became the Principal of the Imperial College of Engineering in Tokyo in 1872, recruiting many Scots and others with Scottish connections, including the geologist John Milne, inventor of the seismograph, and the physicist Sir James Ewing, who discovered hysteresis (the idea that physical systems have memories). Among the Japanese scholars with Scottish connections were Seikei Sekiya, who became the first professor of seismology at the Imperial University of Tokyo; Tanakadate Aikitsu, who visited Lord Kelvin in Glasgow; and Kaichi Watanabe, who studied in Glasgow and worked on the construction of the Forth Rail Bridge in the late 1880s.

“The Imperial College of Engineering,” said Craik, “set the scene for engineering in Japan,” and its students (mainly Samurai) enjoyed high prestige – a tradition that continues up to this day.

Sadayuki Ujihashi of the Tokyo Institute of Technology then described the links between the two countries from a Japanese perspective, and discussed the success of the exchange programme between his Institute and the University of Strathclyde.

Professor Ujihashi explained how Japan first opened up to the world, from the time Commander Perry arrived in Tokyo in 1853 with his “black ships,” until the Meiji Restoration in 1868, and beyond. In 1603, the Tokoguwa Shoguns thought that they would rule forever and banned foreign travel. The port of Nagasaki was “a pinhole” through which Japan saw the rest of the world, but the country lived in almost complete isolation for about 250 years, when foreigners including the British established relations and forced Japan to open up its ports. The British had a major influence during this period, said Ujihashi, and nurtured the talents of many young students like Yozo Yamao. When Yamao returned to Japan after his studies in Glasgow, he joined the new government and played a key role in the founding of the Imperial College of Engineering. Ujihashi also described the development of Japan after the Meiji restoration, and how the Scots had helped, including the first telegraph in 1869, the postal system (1871), the founding of
the Bank of Japan (1882) and the first telephone link between Tokyo and Yokohama in 1890. In education, Scottish influence was not just felt at university level, but also in primary schools. He also described Henry Dyer (a graduate of Anderson’s College in Glasgow) as the “father of engineering education in Japan,” and said he played a key role in developing the curriculum, including general science, where English was also taught alongside more technical subjects such as maths.

Kaichi Watanabe then came under the spotlight, with Ujihashi describing his studies in Glasgow from 1884 to 1886, his work as a foreman on the Forth Rail Bridge from 1886 to 1888 and his return to Japan, where he became an entrepreneur with an interest in railways and civil engineering. For his grand finale, Ujihashi then displayed the famous photograph of Watanabe, sitting in the centre of the cantilever model of the bridge – then zoomed in on the image of the Bank of Scotland £20 note, printed two years ago, featuring the same image of the young Japanese engineer.

Dr David Nash of the University of Strathclyde then provided an insight into the student exchange programme set up by Strathclyde and the Tokyo Institute of Technology – an agreement recently renewed until 2013. Nash himself has spent time in Japan and he and Ujihashi were the first academics to do an exchange, with the first student from Strathclyde (Dr Chris Roach) visiting Tokyo in 1994. Some students from Tokyo now spend up to one year in Glasgow, while Scottish students visit Japan for a single semester, to carry out various projects; including the development of a remote-control robotic arm designed for use in disaster recovery, biomimetic robots which mimic human behaviour, and a “human-driven snake vehicle.” The first integrated project started in 2008 and from 2009 to 2010, ten students from Japan and eight from Scotland will work as a team. Nash said that students from Strathclyde were now competing for acceptance in the programme, with 25 students applying for only five places.

Nash also said that Henry Dyer’s legacy survives in the form of in-class teaching and off-class training still encouraged today. He also quoted Dyer’s ambitions for Japan: “Knowledge should be sought for throughout the whole world, so that the welfare of the Empire may be promoted (or in order that its status may be raised ever higher and higher).”

Finally, Nash said that the programme is “all about relationships and all about fun.”
To provide the commercial perspective, Tim Ashton, Research Director of Vascutek, then described what happens when a Scottish high-tech firm is acquired by Japan’s largest medical device company, Terumo. And the plain facts are that Vascutek has more than doubled in size from about 200 to 550 people, with turnover up from about £23 million to £55 million.

The origins of Vascutek go back to 1979, when the company developed a new kind of vascular graft in a project involving Glasgow Royal Infirmary, the textiles manufacturer Coats Patons and the University of Strathclyde’s bioengineering department. Several inventions and Queen’s Awards later, the company was taken over by Terumo, and has since developed several more innovations, and gone on to acquire another company which makes porcine heart valves.

In 2002, Vascutek’s parent company got into difficulties and the Scottish subsidiary was ripe for acquisition, with several US firms keen to move in. Ashton revealed that Terumo arrived on the scene at the 11th hour, and even though it did not offer more cash, it offered better terms than the American favourites, and its bid was accepted.

Terumo wanted to be a global player and Vascutek was the first implant company it had acquired.

So what was the impact? Ashton said the first thing that impressed him and his colleagues was the President of Terumo immediately coming to Scotland to speak face to face with the staff. The President said there would be no job losses and no local management changes for at least two years, and kept to his promise. The Vascutek team carried on as usual, with a Japanese “transition manager” joining them in Scotland. Terumo people joined the board and engineers were sent out to work in the plant, along with representatives from quality control and accounts. The two companies share more technology now and Ashton said that Vascutek has had to make some “cultural adjustments” as well as learn to live with new reporting requirements. Recently, Terumo became the new distributor for Vascutek in the Japanese market, and Ashton said the company would wait to see if this arrangement works or not.

Ashton said that Japanese executives found it odd at first that British people laugh and joke at meetings and sometimes “tear into each other,” but he said that their Japanese colleagues now know when they’re being ironic. Vascutek has also retained a degree of autonomy, according to Ashton.

The bottom line for Ashton is continuing investment, technical collaboration, some extra bureaucracy, good personal
relations, higher turnover, more
staff and a new factory. Vascutek
also uses Terumo technology,
whilst Terumo engineers now split
their time between Scotland and
Japan, and the manufacturing of
some of Terumo’s vascular grafts
has transferred to Scotland. A
Terumo research team is also at
work on the development of a
new Vascutek product, and
Terumo has signed a cross-
licensing agreement which helps
protect Vascutek’s intellectual
property – not just a good
element of how to conduct global
business, but an exciting new
chapter in the story of relations
between Scotland and Japan.
Pick up any newspaper and there will be frequent reports detailing the identification of yet another human disease gene. What is the significance of such discoveries? How can we use the information to learn more about the mechanisms of disease and about possible paths to improved disease management and therapy? Our work on human eye malformations illustrates these principles.

The eye is the ultimate precision instrument. It needs to be “built” very precisely in order to fulfil its function. Charles Darwin described the eye as an ‘organ of extreme perfection’. When developing his theory of evolution, Darwin felt that the eye provided a strict test for the theory, which stipulates that an organ cannot pass through a stage where function is lost, as essential components disappear when selection is relaxed – the “use it or lose it” concept. Eyes exist in several fundamentally different designs in different animal groups; they are organised so differently that they must have evolved independently multiple times. And yet, as we shall see, a core-set of highly conserved interacting genes regulates eye development in all classes of creatures across evolution from flies to man, suggesting the re-use of common underlying components.

We have identified three major genes with key roles in eye development and function. All three work as DNA-binding transcription factors that regulate the expression of many other genes in eye, brain and some other sites. Subsequently we determined how different types of mutations cause abnormalities and were able to deduce some of the mechanisms through which such regulator genes control the complex processes of development. Each gene was found to fulfil multiple tasks in eye and brain development, and they interact with each other and additional eye and brain genes in different combinations, generating complex networks that ensure the tight regulation required for robust error-free development. Detailed analysis of how normal functions go wrong in humans and animals with known mutation-driven eye malformations has
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provided strong insight into the finely-tuned mechanisms of normal development and maintenance, as well as into the etiology of disease. Using animal models, we have also explored how the final outcome, the “phenotype”, can be influenced by environmental factors.

A brief introduction to eye development and organisation

The vertebrate eye starts to develop as an evagination of the brain, even before the neural tube is closed. The evagination balloons out and the curved surface of the neuronal precursor hemisphere touches the surface ectoderm, the outer layer of the body from which skin and also the lens and cornea will develop. The contact triggers an invagination of both the neural hemisphere and the surface ectoderm, so that a double-layered retina is formed and the lens pinches off, while the surface ectoderm reseals and eventually develops into the cornea. The double retina forms the outer pigmented retina and the inner layer becomes the soon-to-be-stratified neural retina. Photoreceptors develop on the outer curve of the neural retina, adjacent to the pigmented retina. The neural connections from the photoreceptors make connections with the visual cortex in the brain so that an exact map of retina is produced. It is not surprising that this complex developmental process occasionally goes wrong, often as a result of altered gene function.

Identification of disease genes.

Genetic eye disease is relatively frequent and often familial, partly because human societies look after people with visual impairment and they survive and reproduce relatively well. From the early 1980s efforts were made to identify genes responsible for inherited diseases. Genes were mapped using a variety of approaches to identify their chromosomal location and then candidate genes in the region were tested to assess whether they carried disease-causing mutations. One way to locate disease genes most easily then and even now, is by identifying cases where some demonstrable chromosomal rearrangement is associated with the disease of interest. The first developmental abnormality of the eye we studied was aniridia (absence of the iris) which had been previously associated with chromosomal deletions that caused two unrelated diseases because the two disease genes were co-deleted by a single event, suggesting that the genes mapped close together. Although such deletions arise very rarely, they are highly recognisable because of the co-occurrence of two rare diseases. At that time, well before the Human Genome Project had properly begun, the
search for candidate genes in a chromosomal region was a painstakingly slow process; but following extensive work internationally to map the deletions, a DNA-binding transcription factor gene called PAX6 was suggested as the candidate gene by colleagues in Texas. We set about helping them to prove that this was the gene. The process of identifying mutations in a gene was much harder in those days, but we succeeded, using both a mouse model for aniridia and collected human patient DNA.

More than a decade later, using similar chromosomal deletion approaches we identified two other transcription factors, each of which was shown to be mutated in a proportion of rare anophthalmia (no eye globe) and microphthalmia (small eye) cases. The two genes identified are SOX2 and OTX2.

The nature of the genes
All three genes are tissue-specific DNA-binding proteins, expressed in the developing eye and brain and some other tissues. Each one regulates the expression of multiple target genes important for development. The pattern of expression changes as development progresses. Each of these genes fulfils multiple roles during eye and brain development, in some other tissues too and also in adulthood.

Transcription factors (TFs) bind to chromosomal DNA at the required target sites. Access to the delicate DNA thread is modulated by chromatin conformation resulting from DNA interactions with support proteins such as histones. DNA transcription into RNA is facilitated by an open chromatin conformation. Switched off genes reside in regions of tightly-packed closed chromatin. TFs may work by turning target genes on or off. Frequently a single TF can function as an enhancer or repressor of gene expression under different circumstances. TFs work in concert with others of their kind, including some that are required for all gene expression (general transcription factors) while many, including our three eye genes, are tissue-specific regulators.

The role of PAX6, SOX2 and OTX2 in development and disease
These three transcription factors cause developmental malformations that affect the whole complex structure of the eye – the diseases associated with mutations at these three gene loci are panocular. Other TFs are associated with many different eye diseases, including retinal degenerations, glaucoma, corneal disease and cataracts.

Analysis of the expression pattern of each gene during different times in development – the spatiotemporal expression pattern
– can be very informative about the nature of the phenotypes to be assessed. For these expression studies model organisms are generally used, and the mouse is highly favoured, because it is such an amenable, manipulable model. However, significant contributions are also made using zebrafish, as well as invertebrate models such as the fruitfly *Drosophila* and the nematode worm *Caenorhabditis elegans*. This is particularly true for PAX6, which is very highly conserved in terms of both function and amino acid sequence. Indeed, PAX6 mutations are known in all of the mentioned organisms and these mutations are associated most notably with the eye phenotype, or other sensory system abnormalities in the worm, which has no eyes. Careful examination of the mouse “Small eye” heterozygotes, and the neonatally lethal homozygotes, reveals that the heterozygote is a good model for human aniridia, while the homozygotes with no eyes have severe brain and olfactory system abnormalities, which lead to death within a short time of birth. Interestingly, heterozygous mice can be shown to have mild brain abnormalities as well as the aniridia-like eye phenotype. Spurred on by knowledge of the expression pattern, and by the severe homozygous mouse phenotype, a selected group of long-term aniridia patients (all over 16 years old) was asked to participate in a research project to study their brain structure by MRI (magnetic resonance imaging), a non-invasive powerful analytical method for imaging brain structure. To everyone’s surprise, a high proportion of the aniridia patients were found to have absent or hypoplastic anterior commissure, one of the key connections between the two hemispheres. Other abnormalities observed frequently include olfactory system deficits even to complete anosmia, but this had been heralded by observations of considerably reduced olfactory bulb size in mice. Another surprise was the high frequency of cases with absence of the pineal, although no particular sleep pattern problems have been described. Finally one case with some hearing problems was seen by an audiologist, who found that each ear functions normally, but there is a problem with information transfer between the two hemispheres. Subsequently, a number of other adults and also some children were tested. Many were found to have similar auditory transfer deficits, though the children generally did not show absence of the anterior commissure, raising the possibility that the absence of the commissure is a progressive feature of aniridia.
What the details of the mutations tell us

Although classical aniridia, with absence of the iris, is generally caused by so-called null mutations where the most likely situation is that there is a reduction in protein levels because one copy of the gene does not produce protein, we do find a number of mutations which give rise to altered protein from the mutated copy. These cases, generally with a single aminoacid change (missense mutation), often have a variant phenotype, sometimes milder and sometimes more severe than the classical case. There is a general trend to specific amino acid mutations to be associated with particular phenotypes. The most severe missense mutations are actually associated with microphthalmia which is indistinguishable superficially from phenotypes that are caused by mutations at the other two loci. SOX2 mutations are frequently found in the most severe cases with bilateral anophthalmia. All the mutations, which are mostly loss of function in one copy, seem to arise anew in the germ cells of one of the parents. Until very recently no vertical inheritance of SOX2 mutations had been observed. This suggests a highly penetrant dosage sensitivity for this gene. The anophthalmia is frequently associated with brain anomalies, developmental delay and seizures.

Occasionally other associated abnormalities are also seen, such as tracheo–oesophageal joining – SOX2 is also expressed in the relevant epithelial cells, so this associated anomaly “makes sense”, although the variable occurrence is not understood. OTX2 null mutations also give rise to anophthalmia and microphthalmia which are not readily distinguished from the SOX2 phenotype. However, in this case we have seen a number of completely unaffected mutation carrier parents. There have also been differences in phenotype severity within a family. Anophthalmia and microphthalmia can be unilateral, particularly with SOX2 mutations. Recently a family with an inherited SOX2 missense change was reported with variable phenotypes some of which overlapped with Pax6-associated iris coloboma. We shall discuss the possible reasons for the phenotypic variability and overlaps observed with these genes.

Long-range regulation of gene expression

We were alerted to the existence of important distant regulatory elements outside the coding region of developmental transcription factor genes like PAX6 by several cases of classical aniridia where gene disruption arose by chromosomal breakpoints outside the gene. We showed that in the
mouse Small eye model, a stop codon mutation within the gene could only be corrected using a large genomic piece of DNA which included the intact PAX6 gene and extensive flanking sequence on either side of the gene. This led us to begin to explore the complex regulatory system of genes like PAX6 that fulfil multiple distinct roles in time and space, during development and even in adulthood. Once genomic sequences became available, it emerged very quickly that the regulatory functions are associated with highly conserved genomic elements upstream, downstream and within the introns of these genes. PAX6 has most of its regulatory region in the downstream region (relative to the direction of transcription). Surprisingly, all the downstream elements identified so far reside within the introns of a neighbouring gene called ELP4, which is apparently not affected by these elements, as it is ubiquitously expressed, unlike PAX6 with its strict expression pattern. To assess the functional capacity of these conserved elements, we have used a system known as reporter transgenesis in mice and to some extent in zebrafish. We have shown for PAX6 that the predicted regulatory elements behave as enhancers, showing tissue-specific expression of the reporter gene in a pattern that is a sub-set of the total PAX6 pattern. Each regulatory element typically drives expression in more than one tissue and the pattern changes with developmental timing. Generally each PAX6-expressing tissue is regulated by several elements – for example the brain expression is controlled by a large number of enhancers which behave in a hierarchical manner in some instances. As a result of an ancestral genome duplication, zebrafish has two different copies of the PAX6 gene, PAX6a and PAX6b. They have an overlapping but distinct expression pattern. PAX6a is more widely expressed in brain, and PAX6b has taken on the role of pancreas control; both are expressed in the eye. We were interested to find that evolutionary changes in the regulatory elements can be linked to the changes in expression pattern.

It is now considered that changes in gene regulation are a major mechanism for evolutionary change. Not surprisingly, it is also very likely that regulatory element variation is involved in many disease associated mutations. Some of these variants are likely to be implicated in the more subtle genetic predispositions to later onset common diseases. Genome-wide association studies place about half of all the recently identified disease-associated variants in regulatory regions. One of the continuing mysteries is
how all the different regulatory elements work together to bring about the complex control of individual genes and their fine coordination with other genes.

**Enhancer function and transcription factor networks**

It is clear that enhancers fulfil their role under the direction of transcription factors that bind to them. There is plenty of room for a large number of transcription factors to bind to each predicted, sequence conserved, regulatory element. It is therefore not surprising that these enhancers are controlled by multiple, often interacting transcription factors. Thus it emerged that SOX2 and PAX6 interact at the protein level by co-binding to neighbouring sites in more than one target site, including in controlling the expression of a lens crystallin protein and also in an auto- and cross-regulatory loop modulating SOX2 expression (and also PAX6 expression – target element not yet clearly identified). The actual sequences binding SOX2 and PAX6 at the two known targets are very different, probably because the exact affinity for the complex varies from tissue to tissue, where the expression levels of the two transcription factors is probably critical and very finely tuned. This is just one example of interaction between two or more transcription factors working in the same developmental path-ways. It is becoming clear that transcription factors participate within complex finely tuned networks which have nodes and some hierarchical characteristics. Network architecture, which is probably continuously evolving, is a very important determinant of developmental robustness. It is not surprising that developmental abnormalities are very often caused by dosage-altering transcription factor mutations.

In order to expand our knowledge of transcription factor networks, we have used bioinformatic approaches to predicting novel PAX6 (and SOX2) targets, using a few already defined binding site sequences in a method termed Hidden Markov Modelling. We are now in the process of validating the predicted targets using zebrafish as a model, since the predicted targets are by definition conserved between mammals and fish.

**Phenotype modulation in health and disease**

We have remarked on the significant phenotypic variation that can be associated with the same mutation between families, within families where we sometimes even see non-penetrance of disease in mutation carriers, and even within a single individual (eg unilaterality in eye disease, kidney disease, deafness etc). We wanted to explore the mechanisms that might underlie such variation. An
important pointer was work in the fruitfly *Drosophila*, where it was shown in 1998 that cryptic mutations could be uncovered if the function of the chaperone system based around HSP90 (heat shock protein 90) was perturbed. HSP90 has multiple roles in facilitating protein folding for newly produced proteins, maintaining structure for metastable proteins and helping denatured proteins to refold (or chaperoning them to their destruction). We decided to see whether the same system is also at work in more complex vertebrates and used zebrafish for this purpose. We showed that we were able to modulate eye phenotype in two zebrafish mutants, both of which turned out to be caused by missense mutations. We were also able to uncover repeatedly rare microphthalmia and anophthalmia cases in one particular strain of zebrafish, initially at low frequency, but this was increased when we inbred selected predisposed parents.

To pursue the molecular mechanisms further, we set out to identify novel interacting proteins that associate with HSP90. Interactors which turned out to belong to a family of proteins now known to be involved in chromatin modification were identified. Pursuing the function of one of these further, we have very recently found that these proteins fulfil multiple roles, by showing a presence in the cytoplasm as well as the nucleus, which is expected for a chromatin modifier. It turns out from looking further at its interactors that our protein associates with intraflagellar transport proteins and can now be identified by immunohistochemistry in primary cilia and in known ciliated tissues, such as the zebrafish lateral line structures. This is very exciting, since ciliary abnormalities are implicated in many diseases with variable phenotypes, including obesity and diabetes, kidney anomalies and developmental heart defects. It is most exciting to be able to associate the ciliary functions of environmental sensing with chromatin modification which would lead to changes in the regulation of gene expression.

**Epilogue**

It has been, and continues to be, an exciting journey from the study of human malformations to begin to unravel some of the deeper mysteries of biology and gene regulation and hopefully also to open up some possible avenues for improvements in disease management and phenotype modulation.
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Meeting the challenges ahead
Visit to the RSE by the US Ambassador, Louis B Susman

29 October 2009

On his first official visit to Scotland, the new US Ambassador to Britain, Louis B Susman, described the major issues in the world today and outlined how President Barack Obama is seeking to lead the way on several fronts, including the financial crisis, climate change and terrorism...

After praising “the independent and adventurous spirit” of Scotland, Ambassador Susman focused on the challenges facing the US and Scotland – and the rest of the world – and said that he was optimistic because we have entered “a new era of possibility and hope,” with President Obama seeking greater engagement with the rest of the world, based on mutual interest and mutual respect.

“President Obama is the single most intelligent politician I’ve ever met,” he continued, “in terms of his intellect and his curiosity.” But history will not judge President Obama by how quickly he burst onto the national scene, Susman added, or even for his magnificent oratorical skills, but by what he accomplishes, what changes he brings about and how he uses the formidable power of the US in the realm of foreign policy.

Susman said the new administration had inherited more problems than President Franklin D Roosevelt in 1933 – two wars, a global financial crisis, the constant threat of terrorism, major energy and climate issues and the need to address America’s lack of a health-care programme. In Susman’s view, the world was closer to a depression at the start of the year than many people realised, and President Obama’s first priority was to direct the US Treasury to restore stability to the US financial system, stabilise financial markets and restore confidence, helping the banks and consumers, including small-sized businesses, as well as the housing market – which at one stage was in freefall. “There is no question that this economy is still very fragile,” said Susman.

“Recovery will be slow and unemployment is way too high, but at least we have stopped the bleeding and managed to get on the right track.” We must be vigilant and recognise that this is a global recession, he added, and we still need regulatory reforms to
make sure this kind of crisis doesn’t happen again.

The US is the only industrialised nation with no national health programme, Susman continued, and the high cost of health care makes the US less competitive. President Obama’s plans for health-care reforms are still a “work in progress,” said Susman, but he was confident the Health Care Bill will be passed in 2009. The first US President to suggest that all Americans should have health care was President Theodore Roosevelt in 1912, said Susman, and President Obama was determined to be the last.

Moving on to foreign policy, Susman said the US is now implementing the concept of “smart power” not unilateral power – working more closely with its allies and “not being afraid to talk to our foes as well as our friends.” Another aim is to “dismantle Al Qaeda so they never come back to hurt us,” but Susman also stressed that US policy would not be “governed by timetables” but by the need to get it right. The aim is to bring peace and permanent stability to all the troubled regions, including Pakistan, Iran and the Middle East.

Climate change is also a priority, according to Susman, with the new administration investing $80 billion in clean energy programmes, including research. The issue is not just a question of protecting the environment or energy security but a “moral imperative,” and President Obama “will lead, not follow, on the issue of climate change,” said Susman. Education is another major issue for the new administration, which is committed to ensuring that the US has a better educated workforce to compete in the 21st Century. One of the new educational programmes is Race to the Top, with funds of $4.3 billion to “leverage change,” awarding the money to the states “who most embrace reform.” In higher education, the US aims to have the highest proportion of graduates per head of population by the year 2020. Scotland’s educational system is greatly admired in the US, said Susman, and one of our greatest gifts to the US was Andrew Carnegie, who built an estimated 3,000 public libraries in 47 states.

Susman then discussed the “special relationship” between the US and the UK, and said that anyone who thinks it has diminished is wrong – and is ignoring the lessons of history and the realities of the world today. The two countries continue to work side by side, especially when it comes to law enforcement, the economy and military matters, and “America has no better friend or more dependable ally,” said Susman. The US strongly disagreed about the decision to
release Abdelbaset Ali al-Megrahi, but the US will not let this undermine the special relationship, Susman continued, since we share too much in terms of our commitment to democracy, the rule of law and tolerance. Susman then added that the US was “eternally grateful” for the courage and the sacrifice of Britain’s serving troops, including Scottish regiments.

Finally, Susman said that President Obama had not just done a lot to improve the image of the US abroad but had also inspired young Americans to serve their country in a way that no other President has been able to do since John F Kennedy.
Professor James Moore

_Darwin’s Sacred Cause: Race, Slavery and the Quest for Human Origins_

Science and Society Book Discussion

12 November 2009

Professor James Moore, of the Open University, led an informal discussion of _Darwin’s Sacred Cause_, which he co-authored with Adrian Desmond. The event was held by the Science and Society Reading Group as part of the RSE’s year of celebrations to mark the bicentenary of the British scientist who developed the theory of evolution by natural selection.

Raised in Middle America to a Christian family who regarded Darwin as atheistic devilry – and potentially communistic – Professor Moore said he was taught nothing of the theory of evolution. During his introductory talk he described how crossing the Atlantic to the more liberal-minded shores of the UK was a revelation and an act of self-liberation. Once in this country he built a thriving academic career as a historian with the Open University, and has expressed his deep fascination with Darwin in a number of books. These include the 1991 biography _Darwin and Darwin’s Sacred Cause_, which was published this year.

The new work, which has enjoyed excellent mainstream media reviews and is on its third printing in the UK, argues that Darwin’s work, _The Descent of Man_, was profoundly influenced by the biologist’s passionate opposition to slavery. This is in fundamental opposition to an old but persistent notion that science is done in a vacuum free from social influence. With the idea of social influence, the Professor, said comes a worry that a notional “pure germ of scientific” truth is contaminated by external forces, that truth may have a history and is not as absolute as many wish to believe.

Professor Moore argued that Darwin, like all people, had his thinking influenced by the circumstances of the era in which he lived. As such his _The Descent of Man_ cannot be divorced from the forces that affected the views of its author – highly important among these was his conviction that all humanity had a common origin. This flew in the face of much contemporary thought which often sought to demonstrate that different races had separate origins.

Despite its title, much of _The Descent of Man_ is concerned with
other species, and two thirds of the book concentrates on sexual selection. Only a few chapters directly address human origins. This has led some, including Richard Dawkins, to claim it is effectively two books squeezed between one pair of covers. However, Professor Moore and Desmond reject this idea and claim that the wide-ranging content has a specific purpose. “He has a vision of life on Earth in which every plant and animal, including human beings, mind, body, society, past and future, all of this was part of one law-bound system.” Human development was, therefore, one small aspect of the wider process of evolution. Sexual selection was Darwin’s unique explanation for the natural divergence of human races and for many of their physical and mental characteristics. *Darwin’s Sacred Cause* also recognises that the biologist came from a Unitarian religious background and challenges the concept that his science was from an atheistic perspective. Instead, when Darwin was gathering his data, he believed that Creation was a miraculous work of God, but that geological evidence placed this origin millions of years in the past rather than thousands. There was a single tree of life with many branches and the races were merely the tips of twigs at their outmost extremities. Such views provided scientific support for the moral arguments against one group of humans enslaving another. Whether interpreted in religious terms or not, Professor Moore claims this sense of science as a means to prove that humanity was a brotherhood genuinely sacred to Darwin.

Following the Professor’s introductory talk, the session was opened to discussion with the reading group. A variety of topics were covered, from the levels of sales in the USA and UK to the religious and political atmosphere of the period. A key theme was whether Darwin’s science was indeed motivated by opposition to slavery. Have US readers been less receptive to the book than Britons because they still shy away from the issues raised by slavery in their own country, and are still more interested in the treatment of Native Americans?

The Professor responded that while it is the case that there is a great deal of interest in the treatment of Native Americans, the issue of black Americans was highly topical. Publication of *Darwin’s Sacred Cause* coincided with the inauguration of President Obama – who had referred to himself as a ‘mutt’, that is, of mixed race. There are also millions of Americans who are interested in Darwin, even if some think he is the Devil incarnate.
Did you write the book as a scientist or an historian?
Professor Moore explained that he and his co-author both have scientific training “but we are historians first of all. ‘Science must not be left to the scientists, science’s past must not be left to the scientists.” He added that the social pecking order means that it is accepted that a number of famous-name scientists are regularly asked to talk on historical topics, even though they do it rather poorly. Historians, by contrast, are not asked to cross beyond their disciplinary boundaries and talk on subjects such as genetics.

Why is your book seen as being so controversial?
“The subject matter had got to be controversial and we knew the book would be controversial, and the sound of breeches being loaded is heard across the Atlantic as we wait for the academic reviews to come out, but it’s fine to disagree about these things.”

But how great was the evidence that he was motivated by opposition to slavery?
The Professor said there is more evidence that Darwin was passionate about slavery than that he loved his wife, but that the latter fact is simply accepted, and it is widely acknowledged that it made possible much of what he did, and the former is seen as controversial.

You picked the title from hell because you have the name ‘Darwin’, whom to many in America is a hate figure. It’s also got the word ‘slavery’ there that the Americans are still struggling to come to terms with, and the word ‘sacred’.
The phrase ‘sacred cause’ came from a Darwin letter praising a mixed-race Jamaican magistrate for his work for ‘the sacred cause of humanity’ – as soon as the authors saw this they felt they had the title which summed up their argument.

When he used the word ‘sacred’, did he mean it in a religious sense?
Desmond believes it was rhetoric, but Professor Moore argues that the people who spoke of the ‘sacred cause’ often did feel it was somehow divinely ordained. He added that when Darwin was writing On the Origin of Species he was a man of faith, though not of Christian faith.
Where did you come up with the hypothesis that Darwin was so influenced by slavery? He was a great thinker, great thinkers get a bee in their bonnet about something, they care about it, surely that’s enough to explain what he did.

“One orthodox explanation is that this is what great scientists do because they are geniuses but if you think about it, it doesn’t explain anything. Once you say that then history ends, it’s the secular equivalent of a miracle.”

Moore continued by arguing that Darwin’s remarks on the subject of slavery demonstrate his passion over the issue. He added that it provides the best available explanation for the emergence of a young man who was prepared to develop unorthodox ideas that were so dangerous they could wreck his career. While the cutting edge of contemporary science was that the human races were separately created species, Darwin challenged it all, claiming that humans were one species, with a common origin and that the diversity of all living things could be explained by the gradual transformations engendered by natural selection.

Is it not the case that you are trying to impose 21st-Century attitudes towards race on a 19th-Century figure and that today Darwin would be deemed racist?

Professor Moore rejected this suggestion, saying the whole enterprise for an historian is to see the world from a contemporary perspective – “Darwin was racist, we make no bones about that.”

Was Darwin not influenced by the Bible in his thinking with its imagery of a single tree of life?

“Darwin took certain things for granted growing up, as we all do, such as our parents’ love – Darwin took for granted that there’s a God, a creator-God when he stepped on the Beagle.” Darwin also believed that history was moving in a direction that was objectively good and he believed in the brotherhood of the human race – these were all givens for him. At the same time he saw that creation must have taken millions of years. He had to confront issues such as the flood story, which if true meant that all the human races descended from the eight survivors in about 4,000 years. That called for an awful lot of human diversification in a very short space of time.
Charles Darwin and Abraham Lincoln were born on the same day in the same year: 12 February 1809.

The 200th anniversary celebrations on both sides of the Atlantic remind us that the American President and the British zoologist jointly helped to shape the modern world.

Questioning established hierarchies of nature, race and class, their legacy of civil and scientific liberalism still holds radical potential today.

The one-day meeting brought together three renowned speakers to explore topics which ranged from President Lincoln’s reasons for the emancipation of slaves, through Darwin’s links to Enlightenment thought, and on to the motivations which drove his development of the theory of evolution by natural selection. The speakers and audience were welcomed by Rev Canon Professor John Richardson, Programme Convener of the RSE. The conference was the first joint event to be organised by the RSE and the Institute for Advanced Studies in the Humanities, University of Edinburgh.

**Session 1: Debates over Lincoln’s Evolution**

Professor Catherine Clinton of Queen’s University, Belfast was introduced by Professor Frank Cogliano, who described her as a leading historian of the USA. He added that she has also done much to enliven the community of historians of the US on this side of the Atlantic and is a prolific author who has written or edited more than two dozen books.

It was 109 years to the day since the new US ambassador to Great Britain, Joseph Hodges Choate, gave the inaugural address to the Edinburgh Philosophical Institute. His subject was “the most American of Americans”, Abraham Lincoln, who had saved the Union from destruction and emancipated what he termed “the coloured race”. This address was in keeping with the raising of Lincoln to secular sainthood within a generation of his death – a remarkable transformation for a man who was widely reviled in his lifetime.

Choate quoted the Gettysburg Address in full, which Professor Clinton described as “American gospel, a secular prayer that symbolises the man, the moment and the power of myth to elevate
Review of Sessions 2008/09 and 2009/10

Lincoln's reputation has been built on the ending of slavery which he described as the central act of his administration and the greatest event of the 19th Century. The proclamations of emancipation were seen by Karl Marx as the most significant document in American history. It invoked the right of freedom for all, placing it above commerce, but not above the law.

Professor Clinton outlined the immense reach of Lincoln's influence, something reflected in the world-wide interest in this year's bicentenary celebrations of his birth. The coincidence that he was born on the same day as Darwin has often encouraged people to ask “who was more important, Darwin or Lincoln? Who had more influence, Lincoln or Darwin? ... Who was born first, Darwin or Lincoln?” Professor Clinton argued that the very question “who's number one?” demonstrates Darwin's primacy, as it underlines how good, better, best – the survival of the fittest – has come to frame so many of our perspectives. Yet, in terms of books published, memorials and statues erected, Lincoln far outstrips Darwin. The former is the subject of 45,000 books, the latter 20,000. There are more statues of Lincoln in Hertford, Connecticut – 15 have gone up this year – than there are of Darwin worldwide. Even in the UK they are level-pegging.

The first statue of Lincoln outside the USA was unveiled in Edinburgh in 1893, motivated by a desire to provide a suitable burial place for, and site to honour, the Scots who had fought for the Union in the American Civil War. The $6,000 memorial was coincidentally located near that of David Hume and the Martyr's Monument, and the burial place of the poet William Knox – a favourite poet of Lincoln. The statue depicts Lincoln as the great emancipator, seated above the figure of an African American (rather than Scottish) soldier clutching the standard of the 79th New York Highlanders.

Professor Clinton argued that Lincoln's life reflects a story of intellectual growth, saying “his ideas were fluid yet deliberated; fresh yet built on a foundation of intense reasoning and calculated feeling; he was a seeker who never took anything for granted”. These qualities provided him with the resources to hold together a disintegrating nation. He did not preach racial equality, but equality of opportunity, suggesting that even black women had the right to the fruits of their labour.

Lincoln's status as a champion of African American rights is much-debated. Most late 19th-and early 20th-Century biographies suggest he was repelled by slavery from an early age (influenced by his parents' Baptist connections), but
with a defining moment when he first encountered its realities on a flat boat ride to New Orleans in 1828. Professor Clinton argued for a more subtle view that upbringing and experience inclined him to empathise with all who struggled to better themselves. Lincoln visited slave-owning homes, accepting use of a slave valet, but was uncomfortable with mastery. Equally, he detached personal distaste from professional duties as a lawyer and the demands of political expediency. However, after 1854 he showed an accelerated concern about slavery and its corrupting influence. By the late 1850s he began to use terms about slavery such as “monstrous injustice” and a “national crime”. Despite the development of his views, Lincoln feared that abolition could arouse racial tensions, often towards the African Americans themselves. He believed emancipation would underscore white superiority, and in 1858 he contemplated colonisation and the separation of the races. Despite the development of his views, Lincoln feared that abolition could arouse racial tensions, often towards the African Americans themselves. He believed emancipation would underscore white superiority, and in 1858 he contemplated colonisation and the separation of the races. Lincoln publicly voiced his opposition to equal rights for blacks many times – something scholars frequently fail to mention. Nonetheless, it was ultimately Lincoln who made the dramatic and sudden decision for the uncompensated and immediate emancipation of all slaves. The inevitable question, around which there is deep disagreement, is whether emancipation was a tactic to save the Union or whether Lincoln’s supremacist rhetoric had been designed to maintain vital political support as he awaited the right time to achieve his true goals. The move to emancipation, which Prof Clinton suggested was a question of policy and law rather than principle, happened at a time when Lincoln was surrounded by change and felt an urgent need to shift the terms on which the Civil War was being fought. It was also at a time when hundreds of thousands of African Americans were fleeing behind Union lines to seize their freedom. In 1862 Lincoln felt the nation was at a crossroads, with so many dead that it must be cleansed by worthy acts. They could not rest unless purpose was given to their sacrifice. “The nation could not just be bathed in blood, it had to be baptised in blood”. Lincoln’s reputation as an emancipator rests on his recognition of the need for a Union that was worthy of preserving.

Session 2: Darwin and the Enlightenment

Dr Jon Hodge, recently retired from Leeds University, has extensively researched Darwin’s theories of creation and evolution. Chairing the session, Professor Susan Manning described him as being uniquely qualified to take on a subject as large and interesting as Darwin and the Enlightenment.
While saying that “Darwin and the Enlightenment is an impossible topic twice over,” Dr Hodge admitted that those who are retired have a certain licence to take on such challenges. In discussing Darwin, he concentrated on the formative years of 1838–39. These were “wonder years”, after his period studying medicine in Edinburgh and beyond the Beagle voyage, when he was a bachelor in London running three series of notebooks on the Earth, life and the mind. This was when Darwin was at the peak of his intellectual creativity, coming up with many of his greatest ideas.

In examining the Enlightenment, Dr Hodge focused on Georges Buffon, the 18th-Century Frenchman who published a 36-volume work on natural history. Dr Hodge argued that “if anyone is Enlightenment it’s Buffon” and that, despite profound differences in their scientific ideas, he and Darwin shared fundamentally similar Enlightenment beliefs and attitudes. Dr Hodge described the attitudes and beliefs underpinning Enlightenment thinking as based on:

. a critique of the injustices and inefficiency of the Ancien Régime;
. the valuing of education, knowledge and science;
. belief in progress and the future;
. and a commitment to action for greater prosperity and better governance.

Buffon lacks the first, as he wanted to keep his royal patronage, but exemplifies the other three elements. His central proposal was “to give a narrative for the life of the Earth and the life on the Earth”. At causal level the narrative is one of Cartesian ambitions and the new resources provided by Newton; it is about heat and gravity, and contains no miracles or Biblical structuring. Gravity is steady, heat disperses, so the history of Earth is one of cooling. In earlier days of greater heat, creatures came into existence through spontaneous parentless birth, and man is integrated into the scheme – with the exception of his intellectual capacities.

Dr Hodge moved on to Jean Baptiste Lamarck, an early protégé of Buffon and prominent in the 1790s, who rejected cooling, as the Sun maintains the Earth’s temperature. He claimed that nature could only generate simple organisms, so life forms had undergone “complexification” over time, and he proposed an ape ancestry for man. Dr Hodge then moved to the Scot, James Hutton, who believed today’s species had always been present, but that there was constant destruction and renewal of land by heat and water and that life
tried to adapt according to providential principles.

Darwin saw Lyell as superseding Hutton, and Dr Hodge claimed Darwin saw himself as the greater successor of Lamarck. And Lyell, the great geologist of the late Scottish Enlightenment, was the author with the greatest influence on Darwin. He saw individual species as going extinct and new ones arising over time. But they were formed in their original features and placed in the most suitable location. Lyell, like others associated with the *Edinburgh Review*, also opposed those who regarded the horrors of the French Revolution as an outcome of Enlightenment thinking. He kept faith with Enlightenment principles and favoured peaceful social improvement through Reform. Dr Hodge placed Darwin with “one foot in the *Edinburgh Review* and one foot in the *Westminster Review* its more radical and Benthamite competitor.

Turning to Darwin's scientific views, Dr Hodge claimed he never rejected the physical aspects of Lyell’s Neo-Huttonian views, but in other areas sided with Lamarck. Darwin came to think that ancestry rather than adaptation could be crucial to the timings, placing and extinctions of species. By 1838–39 he had developed the idea of an irregularly-branching tree of life, similar to that published in *On the Origin of Species*, with branching, adaptive divergence as the pattern for life on Earth. At this point his views on the development of species were in line with Lamarck, though soon afterwards he broke away. For Darwin, changes in habits lead to changes in species, a direction that would later lead to natural selection and transvariation.

Darwin’s notebooks show he was a materialist (mind is the workings of the brain) and, a determinist (there is no chance in nature or free will in humans), and his science assumes a deity but has no reference to the Bible. Many of Darwin’s mentors were also sympathisers of Lamarck. These included Humboldt, a German and a Romantic, who was essential to Darwin’s decision to board the *Beagle*. However, Dr Hodge dismissed any suggestion that Darwin’s views were German Romantic. Where they spoke about archetypes, he spoke about ancestors, and where they referred to the ‘soul’ of nature, he would not say that nature was mechanical or animistic. His science (a theory of matter and force) was profoundly non-Romantic.

Humans are bundles of muscles and nervous tendencies inherited from ape ancestors; there is no self.

Dr Hodge explored and rejected the possibility that Darwin was linked to other Counter-Enlightenment views, such as those of the Oxford Movement, which yearned for a return to Mediaeval
and pre-Reformation values. Likewise there was little sense that he sided with the likes of Coleridge in aiming to transcend the Enlightenment, which they regarded as putting insufficient emphasis on the artistic and poetic imagination as distinguishing features of humanity.

Ultimately Darwin was much more indebted to the 18th Century than many people have suggested. This is despite the impact on political and social thought of the French Revolution and the emergence of concepts of ‘left’, ‘right’ and ‘centre’. Even though Darwin regarded himself as a radical, Dr Hodge said this did not preclude continuity from 18th-Century values. Likewise, he rejected the idea that 19th-Century thought had necessarily broken with the past due to the Industrial Revolution. Dr Hodge questioned the validity of the Industrial Revolution concept and argued that the prime forces behind the building of the British Empire, and other major changes of Darwin’s time, were due to the established forces of landed and City capitalism. Thus there was a greater continuity between the centuries than had been supposed – and Darwin is a prime example of this being so. This in turn related to the Scottish Enlightenment thinking he was exposed to while in Edinburgh, and which Dr Hodge believes to be the main formative influence behind *The Origin*, despite what Darwin was taught in Cambridge.

### Session 3: Darwin’s Progress and the Problem of Slavery

A leading figure in the history of science, Professor James Moore of the Open University, was welcomed by Professor Charles Withers, who described his biography of Darwin, co-authored with Adrian Desmond, as possibly the greatest ever written about Darwin. Moore and Desmond have now published, *Darwin’s Sacred Cause*, which argues that his science was underpinned by a desire to oppose slavery and uphold the brotherhood of humanity.

To understand Darwin it is vital to put aside phenomena and events that were as yet unknown, to see the world as it unfolded before him, and appreciate the forces and ideas which motivated him. Liberation was so important to him that he had intended to propose to his future wife, Emma Wedgwood, in August 1838, on “the weekend when slaves were set free”. Emancipation was a cause to which the Wedgwoods were dedicated, and to which Darwin and his wife were devoted. Darwin also believed in progress and the abolition of slavery was an event that appeared to justify his hope for a future that was better than the past.

As a young man in London, one of Darwin’s dining companions
was the radical young journalist and abolitionist Harriet Beecher Stowe – so loathed by American supporters of slavery that she was threatened with lynching. The depth of Darwin's abhorrence of slavery is revealed in a notebook passage of 1838: “Animals whom we have made our slaves we do not like to consider our equals. ... Do not slave holders wish to make the black man other kind?”

Professor Moore argued that Darwin saw it as akin to the arrogance of the slave master to think that humans are unique and unrelated to the rest of life. The Creationist and slave master are comparable in the lowering of some and the elevation of themselves. He believed that such concepts could be undermined by demonstrating common ancestry and a single family tree of life.

To Darwin it was essential to argue for progressive ideas, for while he believed that progress was a rational expectation, he saw that it was not necessary, it was contingent, and could be thwarted. Simultaneously he regarded the Earth, and the life upon it, to be part of a law-bound, but ultimately progressive, universe. At a social level it was possible to identify the tendency to progress at work in developments such as the expansion of the British Empire, which he regarded as a civilising force.

Professor Moore argued that there was a profound tension in Darwin's world view, which emerged from his belief that anything which conformed to the laws of nature might happen. Slavery should pass away as a temporary evil, but might not. He was outraged when his mentor, Lyell, was prepared to tolerate the forced break up of black slave families while lamenting that some slave-owning whites failed to prosper. The unfolding of events in the USA, as it plunged towards civil war on an industrial scale, crushed Darwin's optimism. Professor Moore summed up his feelings by saying that “a man who in the name of suffering slaves damned the white man's arrogance in believing himself the God-like goal of creation could not rest comfortably in the belief that history must realise his own highest goal, the abolition of slavery.” His health suffered and he was distressed by illness and death within his family. After the victory of the Union and the abolition of slavery in the USA, Darwin's optimism returned.

During the dark years before then, there was no sense of an inevitable end to slavery. The Southern states defended the practice on Biblical grounds and attempts were made to claim that black servitude was no worse than, and could even be preferable to, the miserable conditions of industrial workers in England. At the same time a new racial science, partly financed by the slave-cotton
textile industry, was emerging, that argued for the separate and miraculous origins of the races. The movement was made authoritative by the popular Harvard professor, Louis Agassiz, whose work threatened to provide slavery with intellectual legitimacy. Darwin, said Professor Moore, "knew the way the wind was blowing; in his face."

In 1854 Darwin set out on an enterprise to tackle Agassiz's views on a global scale. First he overturned Agassiz's creation science in which plant, animal and human species were supposed to have appeared miraculously in their appointed zones. He then showed that species could be flexible enough to adapt to different circumstances around the world, with no need for divine pre-purposing. Finally he explained how human races had diverged from a single stock, replacing divine miracles with a natural mechanism. The last of these was shown to be selective mating – just as this had been used to bring about fancy varieties of animals, such as pigeons, it had yielded distinctive features among groups of humans.

Darwin's plan was to publish a huge book called Natural Selection, which would take years to complete, and would include his natural explanation for the races of man. This was in keeping with the notion that devout science led to truth. He would thus be able to dismiss Agassiz's 'heresies' through the facts alone. But Darwin then realised his ideas on evolution were at risk of being 'scooped' by Alfred Russel Wallace, so his great manuscript "was cut, crushed and rushed into print" in 1859 as On the Origin of Species. Though it contained almost nothing about human origins, that is what the book was fundamentally about.

When the American Civil War broke out in 1861, Darwin was perturbed at Lincoln's failure even to mention slavery in his call to arms and ardently believed it should be the essence of the Union's aims. He quarrelled with his American colleague Asa Gray who believed that the maintenance of the Union was the overriding objective, rather than the redemptive ambition of lessening human suffering. The depression Darwin suffered over the war and the potential survival of slavery was compounded by the continued refusal of Lyell to accept the common descent of all the races from ape ancestors.

Darwin's spirits lifted after the Union victory and a year later he wrote to Gray: "I can hardly yet realise the grand magnificent fact that slavery is now at end in your country". Darwin believed that humanity had returned to the road of progress – sometimes cruel, but ultimately producing
virtue, as ape species and human races were destroyed and some race more civilised than the Caucasian emerged triumphant.

**Session 4: Panel discussion**

The speakers and session chairs, took questions from the audience.

**Questions:**

*Was race the big issue of the 19th Century and was it the Victorian take on the 18th-Century science of man?*

**Clinton:** In the 19th Century there was a clear perception that issues of race were the centre of a truly Titanic intellectual and moral struggle. This persisted into the 20th Century when, in the 1960s, higher education institutions were still running courses on the subject of race.

**Moore:** The history of race tends to be understood in a Whiggish fashion as a direct moral line leading up to the horror of the Nazi death camps. In fact there was no straight line or obvious moral divide. Victorian scientific racism was once at the cutting edge of empirical science, claiming to be inspired by the Enlightenment. It was also informed by an anti-Semitism which desired an escape from “Jewish” views of the Bible.

**Hodge:** The discourse of race was historically consolidated through imperialism. Before that the standard point of reference was the ancients, namely Jews, Greeks and, by extension, Romans. Monogenism, whether of Christian, Muslim or Hebrew origin, was bound by its counterpart, pre-Adamism (referring to all colonised peoples).

The panel was asked whether Wallace and Darwin fitted James Clerk Maxwell’s view of two mindsets, one based on the building up of many smaller ideas and insights and the other which takes an overview.

**Hodge:** There are differences and similarities between individuals and within groups, even where people have common outlooks. What is intriguing is that two people of such different experience and upbringing as Wallace and Darwin came up with such similar theories.

**Kohn:** Both Darwin and Wallace attempted to explain themselves with the cognitive psychological explanation that they were both species men who were finely attuned to differences between specimens.

**Moore:** As a specimen collector, Wallace made his living by making fine distinctions between living organisms and the places they inhabited. He sought specimens that differed slightly from one another because collectors would pay good money for them.

**Hodge:** What Darwin and Wallace missed as their common link was that they were both closely
aligned to aspects of Lyell’s thinking and others were not. **Was the idea of evolution by natural selection simply an idea whose time had come, and if it had not been Darwin would it just have been someone else?**

**Hodge:** As a historian it’s a phrase he rejects because it fails to address the causes that lead to events and ideas. He also stressed the undecidedness of ‘scientific’ matter, which means that evolutionism happened in history, in circumstances that allow us to see it was far from consolidated at the time.

**Moore:** If Columbus hadn’t discovered America someone else probably would have, but the theory of natural selection is not something you can land on, like a continent, or even stub your toe on. While it is likely that some theory of evolution would have taken hold, it would not necessarily have been what we now refer to as Darwinism, and we would not now be calling ourselves Darwinians, we would be something else.

**Isn’t it true that all the necessary evidence was there, and the techniques and intellectual basis were in place for this theory to emerge?**

**Hodge:** It’s salutary to read the work of Agassiz from the same time as Darwin’s *Origin of Species*. He covers many of the same topics, such as biogeography and taxonomy. This was a man who was just as reputable, indeed he was better trained than Darwin, but he is hugely removed in his thinking. With hindsight we think there was only one way to make sense of the evidence around, but at the time it didn’t seem like that at all.

**Moore:** In every field of human experience and endeavour today we see that people with access to the same information regard it in different ways.

**Why is it that so long after Darwin 45% of Americans still believe in Creationism?**

**Clinton:** That has a lot to do with the way the media frames the questions that are asked, though there is certainly a Biblical Right in America.

**Moore:** Most of the Creationists I know in America are also “social Darwinists”.

**Hodge:** American attitudes may relate to the origins of white settlement by Bible-devoted Europeans who sought a new land where they could maintain a culture of religious intensity. This, combined with community control over educational curricula, has allowed Creationism to persist.

**Cogliano:** The antecedents of today’s Bible belt were not as described by Hodge, and were less religious in the colonial period than subsequently. Indeed, many
people we regard as conservative fundamentalists today hold the views of the 19th-Century people in the north of the USA whom we now see as the progressives.

*What was the distinction between species and races in Darwin’s mind?*

**Moore:** He saw that species were groups that had diverged from one another, but that the human races had only gone a very short distance from the diverging point.

*Are we less inclined to prejudice today than in Darwin’s time about the way we perceive other people and cultures?*

**Clinton:** The idea of the social construction of race is now a fertile area of inter-disciplinary study. At Harvard, Henry Louis Gates junior, head of African and African-American studies, has said “we are all Africans now”. In the 19th Century, seeking origins was hierarchical and exploitative; today people see the discovery of their origins as placing them within a global framework.

**Hodge:** The Victorian view of the history of science and religion is best summarised as: give science freedom and it will undermine religion. He also responded to a related question about the influence that the church exerts on science by answering the question of ‘who can we expect to think independently?’: ‘people of moderately independent means’.

**Moore:** Race is a biological fact as well as a matter of social perception. I think there is now precious little reason to be confident in continuing social, economic and technological “progress” (whatever that may be); indeed, we face a future in which things could get progressively worse for humans and every other species.
Dr Marek Kohn, author, journalist and Fellow of the Centre for Applied Philosophy, Politics and Ethics at the University of Brighton was welcomed by Hector MacQueen, a Vice-President of the RSE. The lecture was the culmination of a day-and-a-half of activities, organised in conjunction with the Institute of Advanced Studies in the Humanities, University of Edinburgh, that were devoted to Charles Darwin and Abraham Lincoln. It provided a modern perspective on the issues of slavery, race and evolution that were such forces in the lives of both men, whose bicentenaries this year are backlit by the election of President Obama.

“One thing is for sure, we have known this was coming for a long time. The coincidence of the births of Darwin and Lincoln was noted 100 years ago, when their joint first centenaries were commemorated. But we’ve only known for one year, with the election of Barack Obama last November, that the day of the joint bicentennial would be bathed in the afterglow of the inauguration of the first African-American President of the United States.”

All three men are transformational figures and Obama’s achievement casts new light on the other two – not always on the aspects of their lives we hold most dear. Indeed, both would have found the election of an African-American President highly surprising, given the political conditions and racial divisions of their world. And when the US writer William Roscoe Thayer looked ahead to the Lincoln/Darwin centennial he saw it in racial terms. Thayer wanted to unite the USA and Britain in a “Pan-Anglo-Saxon reunion … to feel the thrill of common hopes and common emotions, and to realise … that blood is thicker than water.”

Obama’s challenge to his nation is to move beyond race without denying its significance in American life. As Lincoln’s successor in office he led the bicentennial celebrations. He has noted that Lincoln’s views on race were “limited” but has pointed to common ground – both recognise that a house divided against itself cannot stand. Obama presented Lincoln as a man who understood the proper balance between government and people. The view
he expressed, seen with deep suspicion by many Americans, is that the state enables society to achieve what cannot done by individual efforts alone.

During the election campaign scientists were heartened when Nature published Obama’s response to the questions:

. Do you believe that evolution by means of natural selection is a sufficient explanation for the variety and complexity of life on Earth?

. Should intelligent design, or some derivative thereof, be taught in science class in public schools?

Obama replied: “I believe in evolution, and I support the strong consensus of the scientific community that evolution is scientifically validated. I do not believe it is helpful to our students to cloud discussions of science with non-scientific theories such as intelligent design that are not subject to experimental scrutiny.” He was declaring that he valued the scientific criteria of knowledge.

As a President, whose style is distinctly cerebral, Obama pursues a foreign policy based on dialogue, inclusion and a readiness to re-set relations. This is something Lincoln and Darwin would have struggled to believe in, coming as they did from a world of aggressive empire-building and subjugated peoples. Darwin’s vision, expressed in The Descent of Man, was that “the civilised races of man will almost certainly exterminate, and replace, the savage races ....”. Lincoln served in a military campaign against native Americans who were trying to recover their lands in Illinois.

The racial attitudes of Darwin, Lincoln and their contemporaries can be divided into morality, sympathy and nature, assuming different proportions in different minds. Some saw slavery as immoral, but lacked sympathy for slaves. Others saw those of African descent as inferior in intellect, yet thought it wrong to treat them as property. The British biologist Thomas Henry Huxley scorned equality, saying that “our prognathous [projecting-jawed] relative” would never “be able to compete successfully with his bigger-brained and smaller-jawed rival, in a contest which is to be carried on by thoughts and not by bites.” Huxley believed slavery should end, to cleanse the Caucasian conscience. Darwin remarked positively about the intellects of black people he met, especially the “Negro or Mulatto children” who “examine everything with the liveliest attention”. Yet he accepted a conventional view of racial hierarchy in which negroes and Australians were lower races.

Lincoln was convinced of the inferiority of Africans and stated in 1858 that he opposed them
being voters, jurors, office holders or inter-marrying with whites and even doubted that the two races could live together harmoniously. The abolitionist Frederick Douglass claimed his arguments against the extension of slavery “had their motive and mainspring in his patriotic devotion to the interests of his own race.” Quite simply, slave-owning enterprises were out-competing those which had to hire labour. Yet Lincoln delivered emancipation, and his own views changed. In his last speech he discussed votes for blacks, though confined to ex-soldiers and those deemed the brightest. The story goes that his audience included the actor John Wilkes Booth, who was planning to kidnap the President to advance the Confederate cause, but was so outraged by talk of even limited citizenship that three days later he murdered Lincoln.

Segregation remained a legal reality in the USA until the 1960s, by which time racial science had largely been discarded. Scientists became doubtful that race was of much use as a concept in their research and declared that there was no evidence of significant mental differences between races. Most importantly the Nazis had “shown that racial science was infinitely worse than useless when applied to society”.

Despite a widespread belief that science had decisively rejected racial difference, it persisted in a branch of psychology devoted to measuring intelligence. Its proponents argue that IQ tests provide reliable measurements of intelligence, that genetic factors are largely responsible for variations in intelligence between individuals, and that this genetic factor explains at least part of the gap between the average scores of black and white Americans. In 1994 Richard Herrnstein and Charles Murray published *The Bell Curve*, which purported to show that very few black people would be part of the ‘cognitive elite’ of professionals and leaders. The counterarguments emphasised that environmental factors influence test scores and pointed to political motives behind the work. One civil rights lawyer and writer claimed that Murray was using his arguments to support welfare cuts and an end to affirmative action. That lawyer was Barack Obama.

Obama returned to the subject in 2008, pointing to inferior schools as a reason for the gap in achievement between black and white students. He argued that the income gap was partly a legacy of discrimination that had prevented black families from accumulating wealth they could pass on. He spoke of material circumstances and what it is like to live in those circumstances. Obama calls for change based on the idea that everyone can and should contribute to the collective good. It is an
optimistic view of society, starkly opposed to the negative one that sees many as incapable of civic participation. He affirms human unity and insists that problems emerge from cultural, political and economic factors and not biology. The visions of Darwin, Lincoln and Obama differed greatly. Lincoln called black leaders to the White House to tell them he could not countenance the idea of equality. Now the son of a mixed marriage occupies those same offices. And yet the idea that certain ethnic groups cannot live together has a 21st-Century resonance. The differences may now be presented as cultural and religious, but they are treated as insurmountable. Darwin saw change as “the source of life’s variety” and argued for human brotherhood. Despite the apparent triumph of his science it is still rejected by many with a religious view of the world’s origins. Like Lincoln, though, Darwin would have been surprised that a man of African descent would now hold the most powerful office in the world. While race “is the obvious, insistent, nagging theme that connects the three figures” they are also linked by change. The changes have been immense. Yet Obama faces problems that are echoes from the days of Lincoln and Darwin. He seeks to tackle them in a way that upholds the best of the traditions for which they stood. And the three converge most closely in their shared belief in reason.
Before he was a guru, Charles Darwin was a disciple. John Parker revealed the scientific legacy of John Stevens Henslow that gave his favoured student the intellectual context and tools necessary to rewrite the rules of life.

The assumption that underlies most of the musings on Charles Darwin in this, the 200th year since his birth, is that the author of *On the Origin of Species* stepped aboard *HMS Beagle* in ignorance, only to stride back ashore almost six years later fully equipped to deduce the theory of evolution by natural selection.

John Parker’s research into the life and work of the Cambridge Professor of Botany, John Henslow, suggested the truth was somewhat different. Great teachers often feature in the development of great people. For Darwin, that teacher was Henslow, a man whose name has been barely mentioned amid all the bicentennial debate, yet without whom the word Darwinism would not have made it into the dictionary.

John Stevens Henslow, 1796–1861, was born in Rochester, Kent. Educated in Camberwell, he was admitted to St John’s College, Cambridge, to study mathematics, although his interests and pursuits were much broader. Henslow excelled at everything and his rise was meteoric. In 1822, a geological field map of Anglesey made Henslow’s name in scientific circles and the following year, just five years after graduating in mathematics, he was elected Professor of Mineralogy. Two years later, he was also elected Professor of Botany.

Henslow’s early research interests sound diverse, Professor Parker admitted. He explored the geology of complex regions and produced the first geological field map of the Isle of Man. He probed the mathematical underpinning of the new science of crystal structures. He carried out the first dissection of a mollusc in the British Isles and considered its whole life cycle, taking what might be described as an ecological approach. He contributed marine biology specimens to the Natural History Museum.

But it was his passion for plants that commanded the most energy. The earliest Henslow botanic specimen that Professor Parker
has been able to confirm came from his undergraduate years. It was woad, gathered and pressed in 1816. Even then, Henslow showed a consistent and systematic approach to collecting and recording. That approach let him create an unprecedented botanic database when, in 1820, he decided he would collect the entire flora of the British Isles. Henslow developed a remarkable network of 110 naturalists and enthusiasts from Shetland to the Channel Islands. Even his maiden aunts joined the project. Ultimately, he collected about 7,000 specimens himself, while his collaborators added a further 8,000, ensuring he was able to cover the 1,200 species of what Henslow considered native species.

But this was no taxonomic exercise. Henslow was driven by a desire to understand how plants developed, grew and behaved. Professor Parker explained that he was fixated with variation. The specimens in his herbarium, still kept in Cambridge, make this obsession clear. When, for example, he collected a tuft of moss from the Gog Magog hills outside Cambridge in 1821, he dissected and presented a full range of size variants. Henslow carried out the world’s first population study on a mathematical basis to define living species by the patterns of variation that they showed in nature. He looked at the natural world like a landscape of mountains. Each peak represented a species and was defined through patterns of variation. But this landscape was not unspoiled. Henslow realised that these patterns were disturbed by what he called monstrosity – isolated variants that produced unusual numbers of leaves, grew to strange proportions or exhibited some other abnormality. For Henslow, these monsters were the key to understanding plant development and they feature appropriately in his herbarium. Sadly, the tools used to explore ‘evo-devo’ today were not available in the 1820s and so he had little prospect of developing such work further.

He did, however, have a way to explore the limits of a species – hybridisation. If he could hybridise two plants and produce fertile offspring, he knew he was dealing with different varieties not species. He used this experimental criterion to test his ideas – in this sense Henslow was an experimental population biologist. He also believed that this approach gave him a way, if he could accumulate sufficient data, to establish the laws of heredity. Professor Parker noted that Henslow was wrong to make this assertion and, indeed, that mistake would manifest itself as a major weakness in Darwin’s laws.
But it is the scope of Henslow’s project that is most significant. His 14-year botanical research programme tried to understand the nature of species, all built on a bedrock of systematically collected specimens.

Among those specimens in Henslow’s herbarium are some he collected with some of his students on a fieldtrip to Gamlingay in May 1830. And with him that day was a young man who would become Henslow’s most devoted student, Charles Darwin. Darwin had arrived at Cambridge in 1828 after dropping out of studying medicine at Edinburgh. His despairing family had sent him to get an ordinary degree in theology to prepare him for a life as an Anglican minister. The young man, however, attended only one series of lectures – those given by Henslow.

By all accounts, Henslow was an inspirational lecturer, pioneering the use of illustrations, field trips and regular Saturday nature rambles. Darwin became hooked. He attended Henslow’s lecture series not once but for three years, never missed a nature ramble, enthusiastically participated in field trips and joining his teacher’s social evenings with some of the greatest names in science. So devoted was this student that to other dons he became known simply as “the man who walks with Henslow”. It seems, though, that the admiration was mutual. Henslow saw an innate brilliance in the failed medic.

In 1831, Henslow was asked to recommend someone to go on a geological surveying expedition around the world. His response was remarkable – he put forward an unknown, someone who was, in his opinion, “the best person I know for that position”. So Darwin joined the crew of the Beagle. Before he went, the teacher sent his protégé on a preparatory geological field trip to Snowdonia with his colleague, the geologist Adam Sedgwick. He also asked Darwin to bring him back some specimens of night-scented stock for the herbarium. This is the oldest known Darwin specimen, arranged to show patterns of variation as Henslow demanded.

Professor Parker noted that Darwin set off not only with the skills his teacher had taught him but also his ideas about how to understand variation. He promptly set about collecting population samples and started to see all sorts of patterns within them. He also collected monstrous forms that Henslow believed to be a key feature in natural selection. And he sent his specimens back to Cambridge, where most still reside.

On 6 November, 1835, while Darwin was somewhere between the Galapagos Islands and Tahiti,
Henslow read extracts of his correspondence to a suitably impressed audience at the Cambridge Philosophical Society. He had them printed and published. Darwin had left Cambridge as a ‘nobody’ with an ordinary degree in theology. But thanks to Henslow’s efforts, he returned as a respected scientist.

The teacher had helped shape the scientific context of his student and he was now able to help him gain the necessary level of recognition to pursue his own research. Henslow’s contribution to Darwin’s work was far greater than a letter of recommendation to sail on the Beagle. Professor Parker confidently described Henslow as “Darwin’s mentor and creator”.
In the Edinburgh Lecture, Prince Hassan El Hassan bin Talal of Jordan called for a humanitarian approach to address the problems facing the world and, in particular, the West Asia–North Africa (WANA) region. Covering areas including climate change, nuclear weapons, water and oil, he said that the human aspect must not be ignored.

Violence and disaster, natural and man-made, are daily news, but what can we, as individuals, do to prevent them or at least mitigate their effects? How can we get at the roots of what goes wrong and change what grows from them?

These were the questions posed by Prince El Hassan bin Talal in his first lecture as an Honorary Fellow of the Royal Society of Edinburgh. His talk was the RSE’s contribution to the prestigious Edinburgh Lectures series. It outlined the problems facing the world today, suggested how these should be tackled, and ended with a plea to the RSE and to Scotland more widely to work together to address them.

In particular he said the problems should be addressed from a “humanitarian perspective”, which takes into account the needs and aspirations of the whole human race, to do what we can to put right what is wrong, not just with the environment, but with humanity as a whole.

The issues facing the world include: environmental concerns; the growth in world population; the imbalance between wealth and poverty; and violence which springs from the need to defend or assert political boundaries or religious faith.

Prince Hassan described many of the groups and initiatives set up to tackle these problems; he has played a leading role in many of these projects, including the UN Independent Commission on International Humanitarian Issues, which he co-chaired in the early 1980s. Its report, called Winning the Human Race?, outlined global issues such as population, poverty and the environment. It also described the plight of the victims and looked at man-made and other disasters, including famine, desertification, nuclear power and industrial disasters.

The report recommendations included a UN code on disaster management, building global
consensus and strengthening multilateralism. As a result, the Independent Commission on International Humanitarian Issues was set up, but sadly the issues outlined in the report still remain pressing today.

Prince Hassan said that the humanitarian perspective takes into account eight elements. These are:

- Human solidarity – including respect for human life and dignity now and for future generations;
- Dialogue – between all the world religions to mobilise people to tackle shared problems;
- Security – which must be achieved through winning hearts, not by restrictive action, and by tackling the causes of conflict, such as poverty and marginalisation;
- Economy, energy and the human environment – these common issues should be addressed together, with a long-term perspective;
- Multilateralism – all parties should share a common code of conduct on security, economy and human development; issues such as arms control, reconciliation after conflict, and the environment, depend on such a code;
- Democracy and civil society – such a common code (above) would be a basis for an equitable policy on this, to allow people to feel empowered and in control of their own destiny;
- Culture and education – modern technology and communications give us knowledge about other societies, but must also give us understanding so that we can draw strength from diversity;
- Universal consciousness – globalisation is not just about economics or the spread of capitalism; it is rather about the emergence of a common global consciousness which implies compassion and altruism and where injury to one is injury to all. “We neglect the principle of the ‘Global Commons’ at our peril,” said Prince Hassan.

Shared values such as respect, responsibility and altruism have helped ensure humanity’s survival and wellbeing from time immemorial, the Prince said. The start of the 21st Century saw a change in human conflict from earlier wars between defined nations, to internal struggles, such as those in Rwanda and Bosnia. The events of 11 September 2001 changed the focus of debate from genocide to the prevention of terrorism and the risk of weapons of mass destruction. The ‘right to protect’ became a major issue discussed in a number of international fora. In 2005 it was agreed (at the World Summit) that every state has a
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duty to protect its population from crimes against humanity and that the international community must help them to do so. Prince Hassan hoped that a future UN Resolution would embody these principles.

For the final part of his lecture, the Prince moved from a universal to a regional perspective, particularly addressing the region from which he comes. “A third world country, that is my first world country, the fertile (and at times futile) crescent that embraces Iraq, Syria, Palestine, Israel and Saudi Arabia, with Jordan in its midst,” he said.

There are huge pressures on this region – which Prince Hassan calls West Asia. These include not only issues such as Gaza, but also pressures on human, natural and economic resources. Water is a major issue, which is why Prince Hassan has urged the creation of a supranational Water and Energy Community for the region.

The Prince has also established a Regional Human Security Centre in Jordan and the West Asia–North Africa (WANA) Forum, which recognises that many of the region’s problems are shared by the countries of the southern Mediterranean, in particular Egypt. He has called for the ‘greening’ of the WANA region and for a regional cohesion fund to benefit the region in the long term, not just in times of conflict. Prince Hassan said he is committed to a regional peace process based on the Helsinki model, whose objectives are threefold: economic, human and cultural. Economy includes the all-important world resource of oil. He believes a West Asian consensus would stabilise the global community and relieve tensions at the vulnerable ‘choke points’ of the oil economy. Human security depends on preventative diplomacy, he said. There must also be action to address the issues which arise from the displacement of people, including those displaced by climate change, conflict or economic circumstances.

Culture covers issues from poverty to climate change and, indeed, the impact of climate change on human society, such as its effects on nutrition and health, is blatantly apparent. A global consensus is needed “on the control of water, on agricultural priorities and on health, and policies for the containment of migration, if poverty is not to increase,” he said.

Now, more than ever, we cannot afford to squander any of our endangered assets on unproductive conflicts and war, the Prince added. He called for an official conference for security and cooperation in WANA, the remit of which would encompass a wide range of issues affecting the region. This would include a common policy on water control and a robust “composite security”
to prevent terrorism and reduce wasteful expenditure on defence. “Only then will a rule of humanitarian and international law have substance; only then will we build a ‘template for peace’ in WANA.” Prince Hassan hopes it will not be another 30 years before current problems are resolved. Indeed, he can discern at least some progress world-wide towards a new ‘humanitarian order’. “Inch by inch we have crawled forward. Unless we expand the scope of our efforts and increase the pace we may be too late,” he said. “Common understanding of these facts is now shared between the nations of the world, but we need to turn understanding into action, here, there and everywhere.”

In achieving this, he invited the RSE’s help, saying that the body was founded for the advancement of learning and useful knowledge. “West Asia is in desperate need of such support,” he said, adding that he would like to see lectures and debates in Edinburgh on the practical means of realising the goals he had outlined for West Asia. “Both our countries could benefit from an international exchange of research and enterprise.”

He concluded: “It is only by spreading learning and knowledge of the facts and needs that we can hope to win the battle for people’s minds, by which a resolution of the present problems, in which we all have an interest, can be achieved.”
Martin Wolf, Chief Economics Commentator for the Financial Times, addressed the causes of the current economic crisis and the prospects for recovery. His lecture concentrated on the UK, whilst placing it within a global context. The event was organised by the Royal Society of Edinburgh in collaboration with the David Hume Institute. Mr Wolf was welcomed by RSE President Lord Wilson of Tillyorn and Institute Director Jeremy Peat, and the event was chaired by Bill Jamieson of The Scotsman.

The global economic crisis has not only left the UK economy severely damaged, but there is no clear sign that a route to strong and sustained recovery is being charted. Mr Wolf argued that there are currently few indications that the conditions exist for a recovery led either by exports or private domestic spending.

Mr Wolf opened with three quotations which he said cast light on the crisis and its aftermath. The first was Stein’s Law which says “Things that can’t go on forever don’t”. Despite its simplicity, it is highly relevant, as so much that occurred in the early 2000s in terms of accumulations of household debt, asset prices and global current accounts, was unsustainable. It is also important for the future, not least because our swapping of immense private sector obligations for huge public sector obligations is equally unsustainable.

A second quote was from Paul Volcker, who told the Economic Club of New York in 2008: “The bright new financial system, with all its talented participants, with all its rich rewards, has failed the test of the marketplace.” Mr Wolf added that the Club is Wall Street’s meeting place and that “there were probably a thousand people there, and he told them that they were incompetent and had screwed up completely”. The third quote, from John Maynard Keynes, was that “A sound banker is … one who, when he is ruined, is ruined in a conventional and orthodox way along with his fellows, so that no-one can really blame him”. The collective failure of the banking sector, and subsequent bail-outs, has demonstrated Keynes’ point.

Addressing the nature of the crisis, Mr Wolf said the central
insight he can offer is that it is of a type frequently associated with developing countries, but at the core of the world economy. It is a classic Minsky Cycle. This began with the emergence of new opportunities – including sub-prime borrowing – which was followed by the growth of a new class of lenders and which engendered a huge spree of borrowing. An asset price bubble grew, then burst, leading to panic, as there was no way of identifying the worth of assets and, therefore, little chance of selling them.

The crisis has involved a combination of macro-economic and financial causes and ideas. This included belief in “the great moderation”, that the business cycle had been tamed, achieving sustainable low-inflation, monetary stability and stable growth. This encouraged the financial sector to underestimate risk even though investors, such as pension funds, were eagerly seeking higher returns. But the dominant factor was the burgeoning of global imbalances and extraordinary accumulations of reserves. Emerging countries, especially China, kept large current account surpluses and reserve accumulations, and became capital exporters. This capital fuelled a house price bubble in the West, made worse as consumers then borrowed against their property (with household debt markedly higher in the UK than elsewhere in the G7). The backdrop was one of accommodating monetary policies and regulatory failure.

Mr Wolf offered a detailed analysis of key causes of the crisis, arguing that the decisive element was “the scale of the growth of the financial sector itself”. Over the past 25 years its balance sheet went from c.20% to c.120% of GDP, doubling in the last decade – with the UK situation being even more extreme, reaching 250% of GDP. Even more extraordinary was the growth of aggregate assets of UK banks. This occurred within the context of a financial system which is inevitably fragile because it bets on the unknowable future.

Mr Wolf identified three characteristics which make the present crisis distinctive. These are:
- that it hit the core of the world economy
- that lending patterns were complex and opaque
- and, more positively, that the most affected economies were able to spend their way through the crisis.

Looking at the prospects for a return to stability Mr Wolf began by focusing on the massive retrenchment in private spending. This means there is a long way back to private spending-driven health and leaves us dependent on a government-driven economy. In the UK alone the cost of public sector support operations, to avoid recession turning into
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slump, has been the equivalent of 74% of GDP. At the same time bank holding write-downs are about $600 billion, half that of the US.

At a macroeconomic level the UK, like other developed countries, has reversed its position from one of spending far more than its income, to one where the household and corporate sectors have slashed spending and are building up savings. The result is that governments have ended up with deficits of wartime proportions (UK indebtedness is projected to rise from below 40% to c.90%).

A return to economic good health requires some combination of strong recovery in private domestic demand and high levels of export-led growth. Household debt levels hamper the former and a structural lack of competitiveness, plus inadequate global demand, make the latter very difficult. This creates huge challenges in cutting the public sector deficit without causing further economic damage. At present the prospects for growth in 2010 are below trend at only 1–1.5%.

Mr Wolf said there have been three big lessons for macroeconomics:

- that contemporary economic theory is in serious trouble – modern theory having been abandoned in favour of Keynesian models and ways of thinking;
- inflation targeting failed to deliver stability;
- and that we cannot handle global capital flows in a stable manner.

Underlining the second point, Mr Wolf attacked the concept adopted by central bankers that the difficulty of identifying bubbles makes it better to clear up after they burst than to try to intervene beforehand. This is because “the mess can be so large that it’s almost impossible to clean it up … it’s far better even if you don’t know exactly how big the bubble is to be roughly right than precisely wrong”. Mr Wolf expressed concern about the level of global imbalances, saying that for emerging countries to be major capital exporters is “perverse”. He characterised a situation in which “we have used the excess savings of Chinese households to build houses in the Mid-West that nobody wants” as “crazy”. A rebalancing of demand is needed and poor countries must be able to run current account deficits. This in turn demands more effective global insurance mechanisms.

Turning to whether we can fix the financial system so that it doesn’t generate large instabilities, Mr Wolf was pessimistic. Whilst we do learn from history, we soon forget its lessons. The bail-out of
financial institutions has negated one option, which is to make people more afraid of the consequences. The other main option is to find ways of controlling future problems and making the system more robust. At the moment efforts are being directed towards raising capital requirements and creating a more effective resolution regime. However, Mr Wolf doubted that these measures are sufficient. Considering a series of more radical solutions being proposed by some economists, he concluded that they either held too many dangers or were politically unacceptable. However, each points to the inherent fragility of the existing system, which is too large to be managed and contained. Even more worrying is that the response to each of the many crises over the past 30 years has been the pouring out of ever more money. Mr Wolf raised the spectres of whether the end games would be fiscal collapse or massive inflation.

Mr Wolf concluded by saying that the current economic position cannot be sustained and that it is unclear how the UK, and the world, will return to stability. “In the end I’m afraid that I don’t offer up answers to the crisis. This is a very disturbing event, and we have not resolved the crisis in any way.”
The early centuries after the death of Jesus saw the creation of many texts which have a claim to be gospels. Their contents are often very different from the four canonical works – Matthew, Mark, Luke and John. Delivering the annual BP Prize Lecture, Dr Paul Foster, University of Edinburgh Senior Lecturer on the New Testament, considered the contents and purpose of these non-canonical texts and what they can tell us about early Christian faith.

“There are also many other things which Jesus did; were every one of them to be written, I suppose that the world itself could not contain the books that would be written”. The Gospel of John ends by acknowledging that it contains just some of the traditions about Jesus. If this reflects a contemporary reality, that there were many other stories and sayings in circulation, Dr Foster said it is fascinating to consider what they were and what happened to them.

Fortunately, some early Christian stories and sayings linked to Jesus were written down and have survived to the present. There are two means by which they have been transmitted. One is through repeated scribal copying – the most common means by which New Testament and other Biblical texts have passed between times and cultures. In other cases texts have been lost or forgotten then rediscovered, sometimes by archaeological excavation.

There is a wealth of information within these “non-canonical gospels”. In considering what this term covers, Dr Foster said he preferred ‘non-canonical’ to ‘apocryphal’ because it is relatively neutral, while the latter is now seen as meaning spurious or false. The word ‘gospel’, he said, needs to be understood as it was in antiquity and not simply as referring to a work such as the four in the New Testament. It was strongly associated with the Roman Imperial cult and was often understood as the oral declaration of great events or good news connected to an emperor. In a politically subversive move, it was adopted by the likes of Paul to mean news about Christ and his message of salvation. By the later second Century the word gospel was being used
for written and not just oral declarations.

Early Christians regarded a variety of texts as precious and their opinions differed as to whether more or less should be preserved in the New Testament. We now have extensive or fragmentary writings from, or are aware of the one-time existence of, more than 40 gospel-like texts. Much has been added to the corpus thanks to archaeological finds, mainly from Egypt. These include the Gospel of Peter, which was part of a parchment codex (or book) found in a Christian grave at Akhmim in 1886–7. During the same decade two junior scholars, Bernard Grenfell and Arthur Hunt made, the Oxyrhynchus discovery of 250,000–500,000 (c.1,600–1,700 year-old) papyrus fragments in hidden deposits up to 30ft deep. A third discovery, at Nag Hammadi in 1946, was made by an agricultural worker, who found a jar containing 12 complete codices plus fragmentary pages from around the mid-fourth century. Many are of what is sometimes termed a “Gnostic” nature. The Nag Hammadi texts, suggested Dr Foster, may have been for an elite group of Christians.

More recently, the Gospel of Judas has been recovered, which attests to a subversive strategy by “critics of apostolic Christianity. The text mainly says the only apostle who understood Jesus’ message was Judas and even he got it wrong by betraying the Lord”. The most famous non-canonical gospel is that of Thomas, which consists of a Greek prologue and 114, often esoteric, sayings attributed to Jesus. Again, it may have been used by an elite group practising a mystical and ascetic version of Christianity. The survival of several examples of the gospel show it was quite widely known in the second and third Centuries.

The Gospel of Thomas claims to be “secret sayings” of the “living Jesus” and promises life to those who seek a higher understanding. It purports to have been written by Didymus Judas Thomas. Thomas was, in another text, said to be the twin of Jesus, so gospel readers would have seen it as having great authority – taking them back to the lifetime and family of Jesus. The gospel is reminiscent of mystery cults of the era which promised initiates special insights that allowed them to progress to the spiritual realm. The text puts an emphasis on James the Just, leader of the Church in Jerusalem – brother or half-brother of Jesus – who was put to death in 61 AD. It may indicate that those who made use of the texts had a “more positive attitude to Jewish law and traditions and practices” than the “more radical, pro-Gentile, form of Christianity spread around the eastern Mediterranean and beyond by the apostle Paul”. It is
unclear whether this alignment with a Jewish Christianity is a strategy to assert authenticity for the gospel or a theological position.

Another characteristic of the gospel, in common with some other non-canonical texts, is the concept of the transformation or surpassing of gender. This is reflected in the statement about Mary Magdalene attributed to Jesus that he would “make her male in order that she too may become a living spirit resembling you males”. Thomas continues that every woman who makes herself male can enter into the kingdom of Heaven.

Moving to the Gospel of Philip, Dr Foster discussed the importance of understanding non-canonical texts from the perspective of the societies which produced them. This gospel was recently made famous in Dan Brown’s “ripping yarn” The Da Vinci Code, in which it was used to back the idea that Mary Magdalene was the wife of Jesus. The claim partly rests on references to Jesus frequently kissing Mary, sometimes on the mouth. Dr Foster suggested that this imposed a modern and sexualised view of kissing rather than a contemporary one in which kisses were a sign of kinship, and a context in which followers of Christ may have exchanged their birth family for their religious group.

Infancy gospels, describing the youth of Jesus, are a different form of non-canonical text. Some of the tales proved highly resilient, including one from the Infancy Gospel of Thomas (not the gospel discussed above) in which Jesus is chastised by Joseph for breaking the Sabbath by making a dozen clay sparrows. The five-year-old then brings them to life, which means no sin has been committed. This was not only depicted in later western medieval art but also appears in the Koran. The traditions in infancy gospels plugged the gap left by the canonical gospels which said little of Jesus’ life before the start of his ministry. Some stories, though, run counter to our own ideas of Jesus. In one case another child ruins some puddles of water made by Jesus, who tells him that he will dry up – the other child promptly dies. According to Dr Foster, it can be difficult for post-Enlightenment people to understand the mindsets of antiquity, some of which have Jesus performing miracles which lead to others dying or becoming sick. One factor is that it was a time when “the more miraculous, the more spectacular something is, the more likely it is to commend faith”.

Different again is the ‘Protoevangelium’ of James which promotes the idea that not only was Mary, mother of Jesus, a virgin at the time of his birth, but remained so
afterwards. Joseph is an aged widower incapable of sexual relations and Mary is left intact even by the birth process – which takes place when Mary is alone and a cloud passes over her – after which the baby is suckling at her breast. A midwife who arrives later and doubts the tale has her hand turned leprous until it is healed by touching the infant.

The final text Dr Foster discussed was the Gospel of Peter, his own specialist area of study, which begins and ends mid-sentence. It is a passion and resurrection which appears to pick up from the point in Matthew where Pilate washes his hands of Jesus and starts by saying that none of the Jews, or Herod Antipas, would do likewise. By depicting Pilate as simply weak, the gospel shifts blame for the crucifixion away from the Romans and onto the Jews. Section ten of the gospel contains an embellishment of the resurrection which describes elaborate precautions being taken to prevent Jesus’ disciples removing the body from the tomb. It then has two Heaven-sent figures entering the tomb and re-emerging with a third figure. The cross follows them out and after a voice from above asks “have you preached to those who sleep?” it miraculously answers “yes”.

According to Dr Foster, such a tale is in keeping with theological traditions that establish a piety around the cross, some having it move or utter, others having it planted in Hades as a sign of Christ’s victory. The text heightens miraculous content to show that certain events demand belief – and may also have been intended as a gripping read.

The Gospel of Peter also swaps the canonical last words of Jesus “My God, my God why have you forsaken me?” with the less problematic “My power, the power, you have left me”. This underlines that early Christians were happy to reword traditions and deal with them freely.

In conclusion, Dr Foster suggested that the non-canonical gospels, with the possible exception of Thomas, do not contain traditions that can be traced back to Jesus. They do, however, offer many insights into the piety and diverse forms of belief among second and third Century Christians. They reveal a messy, vibrant and creative set of ideas that was later replaced by a more monolithic orthodoxy.

“Maybe the lesson for today,” said Dr Foster “is that we should be more comfortable with diversity and not stigmatise those who don’t agree with us.”
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Professor Paul Jowitt FRSE

Facing up to Climate Change
The RSE Christmas Lecture
16 December 2009

This year’s Christmas Lecture was given at Lochaber High School, Camaghael, Fort William, as part of the RSE’s programme to organise events and discussions outside the Central Belt.

Humanity faces cataclysm and conflict unless it faces up to climate change. Professor Paul Jowitt FRSE, of Heriot-Watt University, and President of the Institution of Civil Engineers, considered what will happen if we fail to act and the merits of different approaches to tackling the problem. Introductions were provided by Jim Sutherland, the school’s Head Teacher, and RSE President Lord Wilson of Tillyorn KT GCMG.

“Climate change is real” – these were the first words in a declaration by 11 national science academies, including those of the UK, France, Russia and China, in 2005. It went on to cite World Health Organisation evidence that the bulk of greenhouse gas emissions, the root cause of the problem, come from the developed world but that most deaths linked to climate change are in developing countries.

Professor Jowitt stated that UK carbon emissions are 50 times greater than those of Bangladesh. But if global warming results in the predicted 50cm sea level rise it will inundate vast areas of Bangladesh, exposing six million people to disease and hunger, and forcing mass migration. While the immediate impact of climate change will be most severe for those nations, and people, least responsible for its creation, the results could be catastrophic for all. While Hurricane Katrina was probably not directly caused by global warming, similar events are likely to become more frequent and severe as the planet gets hotter.

The hurricane caused £125 billion of financial damage to New Orleans but “the social cost was far greater because a whole city was reduced to chaos,” he said.

Professor Jowitt showed how structural failings had contributed to the rapid collapse of the New Orleans flood defences, causing a chain reaction as power and clean water supplies were cut. With no access to money, fuel, food or other necessities there was a swift breakdown in law and order – even though it took place in the richest and most powerful country in the world. “What happens is
that people’s behaviour reduces to depths it would not normally do,” said the Professor and warned: “it could happen here too. It takes about eight hours”.

Science is advancing all the time, but the expectation is that we are heading for global temperature rises of 2–4 degrees Centigrade, sea level rises of 0.5m and the vanishing of the Arctic summer ice by the end of the century. Because the Earth takes time to adapt, some effects of climate change are already locked in and would take place even if CO₂ emissions were halted today. Nonetheless, the economic evidence shows it is much more cost-effective to act now rather than to try to clear up afterwards.

Turning to the role of engineering solutions in confronting the problems we could face, Professor Jowitt showed slides of the huge extent of flooding in Holland caused by the great storm surge of 1953. The Dutch responded by creating defences which allowed them to protect vulnerable areas of the country. However, such solutions are not always possible. The courses followed by large rivers in the low-lying delta regions of Bangladesh are constantly shifting, making it impractical to build barriers.

Left unchecked, climate change will massively increase the amount of water in some areas and reduce it in others. Parts of Western Europe could be submerged, while areas of southern Europe might become desert. Fragile ecologies in areas of Africa, Asia and elsewhere could cease to be able to produce food.

Professor Jowitt then asked the audience to vote on a series of questions about their perceptions of the impact of climate change.

*What is the biggest threat from global warming?*
- a) Food security
- b) Terrorism
- c) Access to fresh water (most votes)

*Is population growth a bigger threat than climate change?*
- a) Yes
- b) No (most votes)

*Can carbon offset compensate for greenhouse gas emissions?*
- a) Yes
- b) No (most votes)

The Professor likened carbon offset (planting trees to soak up CO₂ while still using polluting energy sources) to “giving money to the hostel for fallen women while still using the brothel”.

*Bio fuels are not a solution but the source of new problems?*
- a) Yes (most votes)
- b) No

Commenting on bio fuels, the Professor Jowitt highlighted that the land used for growing the crops to produce them is vital to world food production.
What is the most effective source of carbon-free energy?

a) Wind
b) Nuclear (most votes)
c) Wave

*The best response to climate change is:

a) Move to high ground?
b) Build defences regardless of cost?
c) Tell society that it needs to take tough decisions and prepare for the consequences? (most votes)

One of the chief difficulties for humanity is that the future is tough to predict. Professor Jowitt gave the example of how, as recently as 1957, most intercontinental transport was by ship and there was little expectation of the mushrooming of cheap air travel. This presents immense challenges, because while we know that the climate is changing, we do not know the direction that society will take – perhaps becoming more selfish or possibly more co-operative. Nor can we predict how power and influence will be shared out between important players like politicians, multinational corporations or ordinary people.

Professor Jowitt argued that the answers to these questions will help determine where we end up. He used scenario-planning techniques to look at possible outcomes. One option was to take a free-market approach which relies on profit and competition to drive the development of future technologies that will solve the world’s problems. Another was to act in a more co-operative fashion, treat markets as servants not masters, and to act now. Asked to vote on which they favoured, around 75% of the audience chose immediate action.

The audience was asked to look at the kinds of world that could result from the success or failure of policies that were optimistic or pessimistic about the capacity of future technologies to solve climate change problems. These were characterised as a Star Trek world of slick and reliable technology, a Mad Max social breakdown, a green Ecotopia, or overbearing Big Government. In common with findings from the USA and Sweden, the audience regarded Ecotopia as the best possible outcome and was concerned that reliance on future technological developments could result in social collapse. Ecologically-minded approaches, said Professor Jowitt, were likely to be the most reliable in addressing seven major pressures facing the world.

These are:
- Land demand;
- Changing demography;
- Fossil fuel depletion;
- Changing diet;
- Climate change;
- Presence or absence of water; and
- Urbanisation.

More than half the human race now lives in cities, often in slums, and people are continuing to abandon the countryside in millions. These changes and pressures require concerted action which takes account of a whole variety of factors if we are going to cater for human need without destroying our environment.

Professor Jowitt argued that the solutions require fundamental changes in the operating systems driving human society. “There are lots of interacting systems going on here … and we need to rethink what we are going to do,” he said.

Addressing the issue of how to combat climate change Professor Jowitt said the need is for far-reaching changes in our behaviour and the technology we use. Change has to happen at all levels from individuals to businesses and to whole nations. We must also ask searching questions. For example, if nuclear energy is to be part of the solution, then it is important to consider what will happen if there is a sudden expansion in demand for enriched uranium, leading to high prices and shortages. There also has to be planning for risks, such as terrorist attacks or accidents. We also need to look at options like carbon capture technology that permit clean energy production from coal.

At the same time measures must be taken to ensure buildings become energy efficient. This is not just about ensuring that new and iconic structures are environmentally friendly, but retrofitting existing buildings as most of them will remain in use for decades to come. We also need to consider the problems that can arise from clean energy projects. In Africa the traditional sources of energy, such as charcoal, are vanishing. A plan to generate 40GW of hydro-power from damming the Congo could bring immense gains. But we have seen how the Three Gorges Dam project in China has resulted in mass displacements of people, damage to biodiversity, land loss and the destruction of archaeology.

Professor Jowitt concluded with a call to engineer the world away from the environmental crisis and to tackle poverty. This demands the creation of entirely new infrastructures which reduce carbon emissions, mitigate the locked-in effects of climate change and prepare us for downstream consequences such as population movements. He added that a new golden age of engineering is needed if we are going to achieve these goals and guide the world safely to the end of the present century and beyond.
Viruses might be small, but they can be deadly. Light on their feet and quick to adapt, they constantly try to evade man’s best attempts to keep them down. From smallpox to HIV, from flu to ebola, Professor Dorothy Crawford reminded us why we should take viruses seriously – and why we should respect them too.

Professor Crawford began by discussing her book, *The Invisible Enemy: A Natural History of Viruses*. Seven years in the writing – largely because the field moves so quickly – it provides a scientific account of viruses.

Viruses are tiny, but they are abundant, diverse and ubiquitous. She is often asked, she said, why she illustrated the book with a tulip. This was because of tulip mania, which gripped Holland in the 17th Century. When tulips were imported to Holland, the Dutch created new varieties which were variegated, with breaks in the colour. These became hugely desirable. But, as it turned out, the ‘breaks’ were caused by a virus (brought by aphids from surrounding fruit trees), which stopped the affected cells developing colour. The tulips cost up to the equivalent of £400,000 in today’s money, being so expensive because they were weak and unreliable due to the virus infection.

The second question she is asked is why she wrote the book. She was “irritated with the press”, she said, because they persistently use the term ‘virus’ for all sorts of “nasties”, routinely mixing it up with bacteria; *E. coli*, for example, which is a bacterium, but is regularly called a virus.

There are huge differences between the two, she says, and not only the size (bacteria are much larger). Viruses are unique, because they are particles, not cells – “a piece of bad news wrapped up in protein”, to quote Sir Peter Medawar. They have no molecular machinery for generating energy or making proteins so, in order to survive and reproduce, they rely on host cells, which they invade. Although she often uses the terms ‘smart’ and ‘clever’ to describe viruses, Professor Crawford stresses that they have no brain, and there is debate over whether they can be considered ‘alive’.
Nevertheless, they are the most abundant form of life on the planet – or 'virosphere' – have been around since ancient times, are ubiquitous, and there are more than 100 million different types. Just one litre of sea-water contains 10 billion viruses and, laid side by side, the viruses in the ocean would span 10 million light years or six galaxies. “The stupidest virus is cleverer than the cleverest virologist,” said George Klein. That’s because viruses are so quick to evolve. Over the years, host species have evolved immune mechanisms to combat virus attack, but viruses have evolved ways of evading host immunity. In this ‘arms race’ the viruses have the advantage of being able to evolve faster.

Viruses have evolved to spread in any number of ways – through skin-to-skin contact, in water, from animals, in food and in the air, to name a few.

To illustrate, she quoted an example from her book, which involved a dinner at the elite Apothecaries’ Hall. Two weeks later, the chef, a waiter, and 50 distinguished guests went down with jaundice caused by hepatitis A virus. The finger was eventually pointed at the raspberry parfait, specifically at the raspberries, which had been picked near Dundee two years previously, and frozen. The case uncovered some unsavoury practices by berry-pickers, including the habit of urinating in the buckets of fruit to save the walk to the loos – and to increase the weight of the fruit (they were paid by weight).

Factors which aid viruses to infect and spread among humans include exposure to animal viruses, crowding and poverty, and travel. This is illustrated by HIV, the ‘killer’ virus, which has been responsible for more than 25 million deaths so far, mostly in the developing world. The source of HIV has been traced to a chimpanzee subspecies, Pan troglodytes. A technique called ‘molecular clock’ has shown that it is a hybrid virus, probably a combination of viruses from two monkeys.

Although HIV probably first transferred to humans in 1900, it took around 60 years before it began to take off. By 1959 it had spread from rural Cameroon to the over-crowded city of Kinshasa. From there, it travelled to Haiti, possibly with a single infected traveller, then, in 1969, to the US, where it began to spread through the population and the world.

Crowding and poverty are dream conditions for viruses, whether that be in a poverty-stricken shanty town or a luxury cruise ship, some of which have been hit by epidemics of gastroenteritis caused by norovirus.

Smallpox too, the world’s most deadly virus to date, probably passed to man from gerbils or...
camels and probably took hold when man moved from the ‘hunter-gatherer’ phase and started to live closely with domesticated animals. And, as travel times have collapsed, it has become much easier for viruses to go global. It now takes under a day to reach Australia from the UK, whereas it would have taken a year in the 18th Century.

Persistent viruses, such as those which cause warts, were inherited from our primate ancestors. They rarely cause serious illness, and have a survival strategy designed to cause long-term infection in an otherwise healthy host. The herpes virus family, for example, dates back some 400 million years. It has co-evolved with its hosts, showing remarkable adaption, and it doesn’t go away. The chicken pox virus stays in the body once the actual disease has passed, hiding in the nerve cells in the spinal column and sometimes being reactivated in the form of shingles – which can, in turn, pass on chicken pox to a new generation.

Professor Crawford spoke a little about her latest book, *Deadly Companions: How Microbes Shaped our History*, which was published in 2007. This covers a wider range of microbes, and looks at why epidemics and plagues happened at certain points in our history, and whether our lifestyle was to blame. She concluded that the great epidemics of the past were caused by much the same factors which help viruses spread, that is, animal microbes, crowded living, travellers and poverty.

And it is still happening. In 2003, there was an outbreak of monkey pox in the US, which affected 71 people before it was controlled. The finger was eventually pointed at the exotic animal trade, which had imported it in a giant Gambian rat. This spread to prairie dogs in a pet shop, which in turn passed it to humans. “How mad is that?” concluded Professor Crawford.

**Questions**

The talk was followed by an extremely lively question and answer session, chaired by RSE President, Lord Wilson of Tillyorn. It covered issues ranging from whether viruses were alive to which viruses Professor Crawford respected most.

Asked if journalists who misused the word ‘bug’ should be fined or otherwise punished, Professor Crawford said she did not feel as strongly about that as the questioner clearly did. She had even, she admitted, used it herself.

One member of the audience described how he had been taken to hospital more than 20 years ago, having fainted in the night, and been diagnosed with a virus. Doctors told him they didn’t know what the virus was, but said that didn’t make a difference to the
treatment, and he made a full recovery. Would treatment be so haphazard now, he asked.

Professor Crawford said he was lucky to survive, because we knew far less about viruses then, and there were few antiviral drugs. Today we can diagnose more quickly and have more drugs at our disposal.

Asked how the virus in the frozen raspberries had survived, Professor Crawford said that freezing does not kill viruses – indeed, the viruses used in her research are stored at -20°C “and they thaw all right”.

Given that America had been essentially divided from the world until 1492, she was asked, were the persistent viruses found now the same as in other parts of the world?

They hadn’t really diverged, said Professor Crawford, which shows that they were very ancient and stable viruses.

Asked the question she had herself invited, that is, “are viruses alive?”, Professor Crawford responded by asking for a definition of what it means to be alive. She believes that viruses are pieces of DNA which hijack cells, so “does that mean living?” Lord Wilson asked the audience to vote, and, fairly overwhelmingly, the audience decided that viruses were not alive.

Before the evolution of bacteria, how did viruses reproduce themselves?

Professor Crawford said there was a theory that viruses might have degenerated, and might have once been free living bacteria. In any case, as soon as an organism developed, viruses would be quick to take advantage.

Given that the story of viruses keeps changing, does Professor Crawford plan to write another book?

‘Yes’, she said. She is planning one about the origins of HIV, in the style of a detective story – the work done to trace the spread is fascinating, she said.

Asked if we should still live with domestic animals, including birds, Professor Crawford said they were a threat (because they pass on viruses). Swine flu was a reminder of that, she said. We’re never going to conquer viruses, so we have to think about how we live.

Would it be possible for man to bring back viruses from outer space? There’s a possibility, but there’s no scientific evidence so far, she said.

Asked about resistance to drugs, Professor Crawford said that viruses were already becoming resistant to antivirals – because viruses have the ability to evolve so quickly.

The Epstein-Barr virus, and other herpes viruses, are the viruses she
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works on and are most respected by Professor Crawford. Most human bodies are infected with Epstein-Barr and, in most cases, it doesn’t make them ill. These viruses don’t want to make the host ill; they want it to survive so they can survive, she said, and Epstein-Barr “has it taped”.

Viruses can already be used as technical tools, as vectors to take DNA into cancer cells, for example, she said, when asked about their possible use in medicine.

Asked if we can synthesise viruses, Professor Crawford said we could do so if we knew the DNA sequence. Making a new virus would be risky, however, as you wouldn’t know how it would act. There was a story some years ago, she said, that the USSR was manufacturing a combination between smallpox and ebola, but fortunately there was no evidence that this had happened.

She was asked several questions about what we could do about viruses. We already are fighting back, she said. For example, viruses used to be transmitted via blood transfusions, but these are now much safer. Working towards eradicating poverty would also be good, she said.

Asked if we need viruses to keep our immune system in good shape, Professor Crawford replied that that is a theory, but she is not convinced, since vaccines also stimulate the immune system.

Part of her work is looking at why viruses hit people differently at different ages, but she doesn’t have a definite answer yet, she said in response to another question. It might be that people who, for example, develop glandular fever become ill because their immune system over-responds to the virus and causes the symptoms. Perhaps the response is less strong in a child because the immune system is less developed.

Finally, Lord Wilson, feeling sorry for the animals being blamed for passing humans viruses, asked if it was a two-way street. Yes, we pass viruses back and forth with animals, said Professor Crawford. But naturally we pay more attention when animals pass them to humans.
In the UK we tend to regard bilingualism as something special, but in most parts of the world it is normal to grow up speaking two, or more, languages. This is despite the fact that, in Britain, we live in a society with tremendous international mobility and in which there are many multilingual groups.

Recent research suggests that at least 161 languages are spoken in Scottish schools. “This linguistic diversity creates a real need for information about how bilingualism works … this diversity is something precious, it’s something we want to maintain,” said Professor Sorace. The survival of languages spoken by minority groups, such as Gaelic, depends heavily on persuading each generation to pass them on to the next. In order to encourage and enable parents, and others, to pass languages on, it is important to understand how children learn languages.

“One of the problems that we have to face is that there are a lot of misconceptions about bilingualism, so because of these negative attitudes, sometimes children don’t have the opportunity to develop more than one language, even when they could,” said Professor Sorace. These misconceptions make it harder to
maintain minority languages, not least because they can raise doubts in parents about what is best for their child. The Professor outlined a series of common myths about bilingualism:

- it delays a child’s mental development;
- it causes confusion so the child learns neither language properly;
- it’s only useful if the languages are widely spoken;
- it happens spontaneously if both parents are native speakers of another language.

The Professor said the first of these ideas seems to rely on the curious idea that a child’s mind is like a box with limited space, so you overfill it by trying to force in two languages. The reality is that the brain is very flexible, and certainly not geared to be monolingual. Indeed, the delight about learning languages at an early age is that it is almost effortless. If there is sufficient exposure, encouragement, and if it is fun, then children will learn two, or even three, languages.

According to Professor Sorace, research demonstrates that there are significant advantages in bilingualism – whether this involves learning from birth or a little later in childhood. These include greater tolerance of differences, interest in other countries, and having access to two cultures. “They may also have future advantages in the job market,” she added.

There are other less well-known benefits, such as gaining an automatic understanding of how language works. By having two names for objects, such as an apple, they understand that words and labels are a matter of convention and not natural – that they are cultural tools. This may be why bilingual children often find it easier to learn third and even fourth languages later on.

Bilingual children also find it easier to recognise sounds in spoken language. This can give them a head start when they are learning to read in languages like English or Gaelic because they are quicker at grasping that letters on a page correspond to spoken sounds. In fact, bilingual children are often more precocious readers.

Far from leading to confusion, research shows that babies of three months old are already able to distinguish between languages, even when they are very similar, such as Spanish and Catalan. Nor do children inappropriately mix up languages in conversation. Where people do mix it is not random, but according to complex rules. In some cultures the capacity to jump between languages is a valued skill. Bilingual children learn quickly whom to address in what language, which means they have taken the major psychological step of being able to put
themselves in someone else’s shoes. According to Professor Sorace, the ability to distinguish between what they know and what someone else knows emerges around a year earlier in bilingual youngsters. Similarly, tests have shown that their attention levels, ability to switch tasks requiring different instructions, and capacity to filter out distractions are also better.

Overall, the Professor said, bilingual children are more flexible at reasoning, which can be useful in many situations. This appears to be because they get very good at blocking out one language when they are using the other, but being able to switch to the other straight away. These kinds of benefits exist regardless of what the languages are. “Whether they are spoken by 50 people or five billion people is completely irrelevant, and this is another reason for keeping minority languages active,” said Professor Sorace.

In looking at potential disadvantages, she said that some bilingual children start talking a little later, but still within normal boundaries. They may start off with a smaller vocabulary in each of the languages, but the number of words they know across the two can be greater.

If parents are to succeed in bringing their children up to be bilingual, they cannot leave it to chance. Transmission between generations means they must make a substantial effort to ensure the children get lots of exposure to each language and feel that it is valued. Where this is done, she concluded, it is an investment which will prove valuable for the rest of their child’s life.

Professor Sorace encouraged anyone with an interested in the issues she raised to visit the Bilingualism Matters website at www.bilingualism-matters.org.uk/

Dr Thomas H Bak

_Bilingualism in Later Life: a Protection against Dementia?_

Dr Bak, who grew up in the Polish city of Krakow but had a German mother, opened by saying his own family had worried that raising children bilingually could cause confusion. Nonetheless, he was exposed to German at home and succeeded in picking it up. Subsequently he went to universities in Hamburg and Freiburg, and later took up posts in Switzerland, then in Cambridge and now in Edinburgh.

In Edinburgh Dr Bak has maintained his interest in language disorders, but is now also study-
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ing dementia. That day’s news headlines pointed to the rapidly growing demands being placed on the NHS by the increasing number of patients with dementia. Dr Bak added that medical science has had little success in finding drugs to prevent or treat dementia – the best available can stall its progress for around a year but are very expensive.

There is, however, evidence to suggest that bilingual people may have highly significant advantages in coping with dementia. Work with students in their 20s shows that those who are bilingual from an early age perform much better in certain complex cognitive tests. This was true whether the students had been raised from their earliest years as bilingual or had learned a second language between the age of around four and puberty.

According to Dr Bak the generally higher performance of bilinguals over monolinguals in non-verbal reasoning does not appear to be confined to childhood, or early adulthood, but extends into old age. One study which points in this direction was by Kave and collaborators, which looked at around 800 people in Israel who had come from many different countries and backgrounds. “The results were quite stunning, namely that the mental function was better the more languages people spoke,” said Dr Bak. He added that further research is vital before the findings can be treated with confidence, as there might be other explanations for the findings and in order fully to understand the implications.

If it is true that bilingualism leads to relatively higher mental function in later life, Dr Bak proposed that it should also impact on dementia, by delaying its onset, making its effects less pronounced, or by slowing its progress. A study by Bialystok conducted in Toronto, where 50% bilingualism means that languages spoken are recorded on patient notes when they are admitted to hospital, suggests this may be the case. A small sample of 184 patients presenting with dementia suggested that those who were bilingual were developing the condition four years later.

Again, further research is needed as there are many unanswered questions. One important issue is whether the key factor is the learning of languages at an early age, regardless of what is spoken later in life, or whether the benefits rely on continued use. It is also unclear whether bilingualism helps with all forms of dementia, or just some.

The degeneration caused by dementia tends to be gradual and it is difficult to pinpoint its start – there normally seems to be a pre-clinical phase where the brain cells are dying but the symptoms are
not noticed. In all but the final stages dementia also tends to be selective, so a patient may lose certain abilities, or kinds of memory, but retain others. This is important, as the less affected parts of the brain may help compensate for the more damaged areas.

In considering why bilingualism might be an advantage, Dr Bak suggested that one option is that it stimulates the process that strengthens the links between different parts of the brain. Brains with more and better connections might take longer to start showing the effects of degeneration. Alternatively, the reason might be functional. Bilingual brains are better at control, resource allocation and switching from one area to another. So if one area is damaged they may be better at getting another to take over.

It is very much in the interests of the health service and policy makers to carry out more work to identify whether bilingualism does indeed have a major impact on dementia and to discover why. According to Dr Bak there are parts of Scotland, such as the Western Isles, which are ideal for research. This is because they have bilingual populations of similar social and genetic backgrounds. This would allow researchers to be sure that effects they were observing were related to bilingualism and not other factors.

Such research programmes would benefit the communities themselves by attracting greater clinical resources and large amounts of funding, putting them specifically, and Scotland more generally, at the forefront of a hugely valuable area of study. This in turn, added Dr Bak, would promote the Gaelic language and strengthen the view that it is an advantage rather than a burden.
Scotland has an opportunity to realise its great renewable energy potential while developing other low carbon technologies and the required infrastructure. Jim McDonald argued that the nation could lead the world in creating an energy industry for the 21st Century.

The Scottish Government has set ambitious targets for the nation's energy provision. By 2011, 31 per cent of electricity will be from renewables; 50 per cent by 2020. Furthermore, there will be a 42 per cent carbon reduction by 2020; 80 per cent by 2050. Professor McDonald regards these targets as opportunities that Scotland has to capitalise on if it is to become one of the green powerhouses of Europe. This requires addressing Scotland's energy base – renewables, hydrocarbons and nuclear power – as well as the means to distribute electricity.

Professor McDonald said that Scotland could be particularly effective in developing renewable technologies such as onshore and offshore wind, marine, hydrogen and fuel cells, and biofuels. We have around 25 per cent of Europe's wind energy resource, 10 per cent of its wave resource and 25 per cent of its tidal resource.

While Scotland's peak electricity demand is about 6GW, there is an estimated 11.5GW of available onshore wind power, 25GW offshore wind, 10GW tidal and 14GW wave. Professor McDonald believes that much of this renewable resource would be exploitable over the next 20 years.

Scotland is “blessed” with its wind resource and has begun to exploit it. Professor McDonald lives a few miles from Europe's largest onshore wind farm, Whitelees Windfarm near Glasgow, which produces 322MW peak output from 140 turbines, while there are plans for a larger development, the Clyde Wind Farm, which will approach 600MW. The largest commercially available turbines are 120 metres across and generate 5MW each, while a new generation capable of 10MW is on the horizon. At the other end of the scale are micro projects such as the eight 1.5KW turbines installed in the facia of The Lighthouse building in Glasgow.

Increasingly, the opportunity to deploy such innovative technology will be offshore. Scotland has
some experience here. The Beatrice Wind Farm Demonstrator, off the northeast coast, was the world's first deep water offshore wind installation, with two 5MW turbines.

There is significant potential in Scotland's wave and tidal resources. The country already possesses an impressive research and development laboratory in the European Marine Energy Centre (EMEC) in Orkney. EMEC, which Professor McDonald regards as a “genuine jewel in our crown”, takes research and development to demonstration and deployment in the world's only grid-connected wave and tidal test centre. There are more than a dozen devices currently being trialled, based on university know-how, but also involving innovative SMEs and some larger companies.

Professor McDonald estimated that the marine energy industry is roughly where the wind energy industry was 15 years ago, with remarkable projects such as the Pelamis wave energy converter leading the way. But he argued that to maintain a grip on this opportunity, scientific literacy has to be retained and translated into economic development.

Another significant area for energy is in electricity transmission and distribution. The UK Grid was conceived in 1926 and its 60-year-old infrastructure is reaching its capacity, with some of the challenges linked to renewables set to take it to the limits of its technical capability. A range of ideas to replace this is emerging, but it essentially boils down to major investment in infrastructure.

Power electronics would allow a multi-variable frequency power supply to take the place of the existing 50Hz, three-phase 240V supply that was the product of pre-war technology limitations. “It can completely change the way in which we deliver and transmit electrical energy,” Professor McDonald said.

The big push is towards the Smart grid. This would see large-scale grids dissolve into hundreds of smaller networks that could reconfigure into autonomous power islands. Power electronics and advanced control systems would optimise network security and capitalise on the available generation. Professor McDonald said the opportunity to redefine the grid for the 21st Century has to be grasped within the next five years.

The mismatch between the existing grid and the location of the onshore wind farm sites also suggests new infrastructure is needed. It will not be cheap. The 170-mile Beauly–Denny power line will cost £400 million. “If we’re going to rewire Scotland and add a potential subsea grid, we will need probably more than £10 billion of network investment over the next decade,” Professor
McDonald said. But without such investment, he warned that Scotland will not have the transmission capacity to capitalise on its renewable resource.

Such networks might then be more fully linked to Ireland, the south of England and Scandinavia. France and Germany want a European supergrid that might be further connected into the Mediterranean, North Africa and then on to the Gulf states. The concept of a world grid has been proposed. Progress would be rapid, Professor McDonald said.

Another significant area is the built environment, focusing on demand-side management. This includes developing more effective use of energy, novel materials, sustainable architecture and even new ways of living. One concept is to distribute power around buildings through the Ethernet. This could supply low voltage DC at levels sufficient to power devices such as PCs.

The poor performance of buildings leads to significant waste of energy. Digital design could assess the feasibility of more advanced energy management systems. Building regulations might help drive this. “If we were a bit more demanding and ambitious about the types of specifications we are building to, we might move forward,” Professor McDonald said.

Other important energy issues include advances in technology around gas and oil, which Professor McDonald believed would be around for at least another generation. He also argued that nuclear power should remain part of Scotland’s energy mix, although without future investment, there will only be two working nuclear power stations in the country by 2020 and none by 2030.

Professor McDonald said there is an opportunity for Scotland to lead on carbon storage and sequestration demonstration projects, taking high-quality university research through to deployment, through initiatives such as the prospective Peterhead carbon capture and storage project. Such an industry could provide Scotland with 10–15 thousand jobs over the next decade.

Proposals to create a Scottish National Energy Laboratory could bring together and learn from ventures such as EMEC, the Aberdeen Harbour Demonstration Offshore Wind Farm, the Hydrogen Office Demonstration Centre at Methil and the Power Network Demonstration Centre at Cumbernauld. This would further bridge the gap between the research community and industry.

If this approach was replicated across Scotland, Professor McDonald argued it would present
Scotland as an innovation hub for the world “where we cannot only conceive of energy ideas but get to products that are ready to roll and support the growth of industry and the creation of jobs.”

Professor McDonald emphasised the need for a multidisciplinary approach, which is being championed by the Energy Technology Partnership (ETP), an alliance of Scottish universities that he chairs and co-directs. This includes not only science and engineering but also the social sciences to address the impact of these technologies on people.

The ETP covers many Scottish academic research groups that are pioneering different fields that could have a significant impact on Scotland’s energy future. Scotland’s research pools are already bringing together expertise from a great range of disciplines to tackle issues such as energy and climate change.

The concept of wind crofting, coined by the green energy pioneer Gordon Proven, is beginning to generate interest. This would involve rural communities harvesting the wind through distributed networks of 5–10KW turbines over several thousand acres. A low-cost DC network would connect farms and homes and, through a single grid interface, could have commercial value by selling surplus energy.

In an urban setting, Professor McDonald is currently involved in the Sustainable Glasgow initiative, which aims to make the city one of the most sustainable and low carbon cities in Europe. The creation of an integrated low-energy system would create jobs, reduce emissions and attract investment.

While he acknowledges that the recent lack of an agreement at the UN Framework Convention on Climate Change in Copenhagen was disappointing, Professor McDonald argued that there is a genuine opportunity for Scotland not only to become a low carbon country but also an international leader. This requires continued support for universities, developing new skills for the renewables industry, attracting investment and better integration of planning regulation and investment.

“We need to act now, Professor McDonald said. “Scotland has great energy resources but we’re not in a one-horse race – most of the rest of the world is looking to do this as well. We have a significant opportunity to realise the commercial value and policy targets by getting genuine partnership between Government, the private sector and universities and colleges. We’re big enough to be significant in Scotland and small enough to be practical about realising this.”
Professor Jonathan Rees FMedSci
Grant Professor of Dermatology, University of Edinburgh

The Importance of Being Red
David Anderson Berry Medal Lecture
1 March 2010

Delivering the David Anderson Berry Medal Lecture, Professor Jonathan Rees described his work in discovering the gene which determines whether we have red hair or not – and discussed the pros and cons of being red.

Around half the patients who visit a dermatology clinic do so because of an evolutionary decision made around one and three quarter million years ago. That was when our ancestors moved from the forests into the plains and deserts, due to climate change: from the forest, where a dense coat of hair was an asset, to the open, where we evolved by shedding our hair and becoming much more effective as hunters and endurance runners as a result.

This nakedness may have helped us sweat more efficiently (which is why a human will beat a horse in a race over marathon distance), but it left our bodies vulnerable to the rays of the Sun, specifically to ultra-violet (uv) rays. The rays of the Sun can be dangerous to exposed skin. Skin cancers are most commonly found in areas exposed to the Sun, such as the top of bald men’s heads, while melanomas (when adjusted for differences in body area) are most commonly found on the tops of men’s ears – not women’s ears, which tend to be protected by hair. In the absence of hair, the pigment melanin protects against the UV rays. Where melanin is absent, the skin is not protected and, exposed to sunlight, will burn, or go red. This is because the rays damage the DNA in our skin cells; when they repair, the redness goes. Melanin could be described as an inbuilt sun-block.

Indeed, Professor Rees showed a slide showing skin cells with dark melanin on top, much like “little sun-hats”, as he put it. These melanin pigments absorb UV rays, thus protecting against damage.

Genetics show us what happens when melanin isn’t there. Various conditions are associated with poor melanin production, even in those countries where protection against the Sun would seem an evolutionary necessity, such as in equatorial Africa. Nevertheless, there are forms of albinism in Africa, which drastically shortens sufferers’ lives, and also vitiligo, a disorder found world-wide, where patches of skin which have lost pigment are vulnerable to Sun
damage, while the pigmented areas of skin are protected. So why do people in different parts of the world have different skin colours? This was something which fascinated the Victorians, who were great explorers and who produced maps of skin colour across the Empire. They noted that skin colour seemed to be different depending on the environments in which people lived. These explorers did not come up with an explanation however; this being left to a man who by contrast literally only left his garden once, Gregor Mendel.

We all recognise an association between place, appearance and ancestry, said Professor Rees, speculating on the assumptions that would be made by two people with red hair and freckles meeting anywhere. Oscar Wilde said that it is only shallow people who do not judge by appearance, that the true mystery of the world is the visible, not the invisible. Professor Rees thinks that Wilde was on to something. Quoting Jacob Bronowski, he said “Man has only one means of discovery, and that is to find likenesses between things”. That’s what genetics is – the “study of that which makes related individuals alike and different at the same time”, he added. Humans have been studying genetics for years – with an interest in how to modify inherited characteristics; for example, in improving plants. Mendel, the ‘founder’ of genetic studies, was interested in inheritance, and followed this through by studying garden peas. He came up with what Professor Rees calls an extraordinary hypothesis for the time, on inherited characteristics. Peas inherit two ‘particles’ (genes), one from the mother and one from the father. Furthermore, if they are different, one will be dominant and one recessive. His hypothesis on inheritance was at odds with the ‘experts’ of the time – and perhaps he was able to come up with this because he was in part an outsider, not a career scientist, said Professor Rees. One example would be sex – men and women produce children who are boys or girls, not an ‘average’ of the two. It’s a binary effect. Mendel’s work lay dormant until the turn of the 20th Century, and soon after this his ideas were applied to the inheritance of red hair. If two people who carry the ‘red hair gene’, but do not exhibit red hair, have children, on average close to one in four of their children will have red hair. This pattern of inheritance, that following an autosomal pattern, was described almost half a century earlier by Mendel in the garden pea.

“Most of what we’ve learned from human pigmentation, we’ve learned from mouse geneticists” said Professor Rees. In the early 1990s, scientists were able to explain the basis for many of the
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differences in coat colour (and other characteristics) in mice. This showed that the production of brown melanin or red or yellow pigment in the pigment cells (i.e. melanocytes) of mouse skin, depended on the functioning of a particular receptor, the melanocortin 1 receptor (MC1R). Professor Rees and colleagues (Professor Tony Thody in Newcastle and Professor Ian Jackson in Edinburgh) set to work to sequence the MC1R in humans, and discovered that there were lots of changes in this gene in people with red hair. If the receptor didn’t work properly, you got red or yellow pigment, and got the ‘phenotype’ of a redhead. If it did work properly, then you would switch on darker pigment.

While this pathway seemed to provide an explanation for red hair in humans, there were a few problems with the idea. One was that while they were looking for one change, or maybe two changes, there seemed to be many, many changes. It’s unlikely that people sitting next to each other, for example, would share the same sequence of the gene. In the experiments, some people had one change in the gene, some had two and some had three – so there must have been more than one change at this locus on each chromosome.

When you look at the pattern of inheritance of red hair, you find that there isn’t a simple, black and white answer – it’s ‘shades of grey, or shades of red’. The changes in the gene differ to varying degrees and it’s not all or nothing.

Using human genes, it is possible to create mice in a range of colours. Professor Ian Jackson has shown that creating mice using differing variants leads to mice where the colour is not the same. Although it’s a small gene, there are over 100 variations in it. Some variations have profound effects, but others have more moderate effects.

There are degrees of red hair. People who have one variant in the gene are more likely to have auburn hair, whereas people with two variants are more likely to have strawberry blonde or bright red hair. People who have red beards, but don’t have red scalp hair, are more likely to carry one variant than people who don’t have red beards. Similarly, people with two variants have more freckling sites than those with no variant, and people with one variant are somewhere in the middle. Within each group – one variant, two variants, or no variants – there will also be variation because, for example, other genes may be at play, so hair colour won’t be identical for all people. We can see this effect of gene dosage not just on hair colour but also on skin colour. People with two variants are very
sun sensitive and don’t tan, while those with no variants are at the other end of the spectrum and tend to tan well and burn less frequently.

Professor Rees described some work done with colleagues in the West Indies on people who are ethnically black, but who have red hair (‘Red Ibos’). Even against a very different genetic background, the red hair shines through, he said.

Although this genetic information is useful in a research context, it is less so in a clinical environment. Although we are very good at predicting who will have red hair, we’re less good at predicting who will develop skin cancer. Indeed, we can probably predict it just as well by looking at the person, without needing to sequence the DNA.

Our knowledge of MC1R has other uses, however. Red hair was probably the first example of where you could take scene-of-crime DNA and make informed guesses about what the individual looked like and be right a lot of the time.

Another forensic application could be using the genetics to reconstruct our biological past – as done by a group in Spain some years ago, who published a study showing that Neanderthals had a variation in MC1R which would have caused them to have red hair.

There is lots of variation in MC1R. Why should this be? If one looks at many genes, there is more variety in Africa than in populations out of Africa. This largely reflects that Man has been in Africa longer than anywhere else, and the rest of the world is in one sense a subset of African diversity. MC1R is, however, very different. Most diversity is in non-African populations. How can we make sense of this?

In Africa, having pale skin and red hair would not be an advantage for those living near the equator. Out of Africa, however, there could be an advantage. Pale skin is better than dark skin at making vitamin D (for which sunlight is essential); for example, giving people with pale skin more protection against rickets, which could be fatal. Moving away from the equator, there is less UV radiation, so people with pale skin, who are better at making vitamin D, have an advantage.

For the last 25,000 years or so, humans’ diet has been cereal-based, and vitamin D status would have been sub-optimal. Going out in the sun is a way of getting vitamin D, but it is hazardous because prolonged exposure to UV rays can cause skin cancer. We can define the extremes – i.e., the risk of bone disease or of skin cancer – but are less confident about what’s happening in the middle. It’s difficult to say how
much sunshine people need and what the benefits are between these extremes – there remains much disagreement between different scientists and clinicians. Finally, Professor Rees has argued that the changes seen in MC1R are as a result of adaptation of the skin to the environment over the last 50–100,000 years. However, one should be aware that other less explored factors may be at work. There are lots of anecdotes about differences in behaviour and physiology of those with and those without red hair. Professor Rees said that he normally avoided expressing any opinions on such phenomena. However, recent work in mouse and man has suggested that certain red-hair-associated alleles are associated with differences in pain perception. The biological significance of these differences is currently unknown. If further works confirms these observations, it might appear that sunburn might indeed be more than skin deep.
The energy in the wind is generated by the Sun heating the Earth’s atmosphere which then cools as the Earth rotates on its axis, forcing movements of large volumes of air across the globe; a simple behaviour that will persist for as long as conditions on earth allow.

Humans have been utilising this energy for thousands of years and used increasingly technical developments to efficiently extract its power. However, despite the general development of engineering capability, there is still some way to go towards fully optimising the potential of wind energy conversion devices.

Ian Irvine, co-founder and Technical Director of SgurrEnergy, explained why he believes the origin of this issue is the character of wind and a general lack of understanding of the complexity of this renewable energy resource. Ian also explained his belief that remote sensing will enable wind energy technology to increase its contribution to carbon emission reduction.


As climate change and declining supplies of fossil fuels become increasingly pressing issues, it is becoming widely acknowledged that we need to derive more of our energy from clean and renewable sources such as wind energy. However, wind energy is not without its difficulties, and key amongst them is the difficulty of predicting accurately the wind resource and character at a potential wind farm site. It is often said that the wind is free, which is true, but the upside to this coin is that it is also variable and difficult to predict. Furthermore, the capital costs of constructing wind projects is relatively high, so it is essential to have accurate revenue (i.e. wind resource) predictions in order to gain access to financing.

As a result, estimation of wind resource and character is the single largest risk factor when considering the viability of a wind farm project. The energy output of a wind farm installation is typically proportional to the square of the wind speed. So the difference in energy output between a 6m/s project and a 7m/s project is about 35%, even
though the difference in wind speed is only about 17%. Given this level of sensitivity, it is therefore crucial that a developer does as much as possible to minimise uncertainty in assessment of the wind resource. The wind character will have a significant impact on operational costs and turbine life.

When considering wind resource, it is important to realise that it varies both in time and space, and any wind assessment campaign must address both of these issues. Looking first at time, wind speed varies from one second to the next, and from one year to the next. Standard deviation in mean annual wind speed is about 6% in the UK, which would result in a variation in energy output of around 12%. To minimise the uncertainty associated with variation in wind speed over time, the ideal solution would be to measure the wind speed at a proposed wind farm location for a very long time, for example 25 years, before building the wind farm. However, this is not generally practical, and so wind speed is typically measured for a period of a year, and the data collected is then corrected to a long term value through a procedure called Measure–Correlate–Predict (MCP). This involves correlating the wind data measured on site with concurrent data from a long-term met station and effectively allows one year of data to be extrapolated to a long-term value, reducing the uncertainty associated with temporal variation.

Turning now to variation in wind speed with space, wind flow is affected by the local topography of the land, roughness effects such as areas of forestry or houses, and obstacles such as single buildings. In addition, it is also affected by the wind turbines that make up a wind farm. A number of software packages have been developed to model wind flow, allowing single-point wind measurements from a measurement mast to be extrapolated across a potential wind farm site. However, these models are generally limited, and so it is strongly recommended that wind measurements are made at several locations across a wind farm site to ensure that the model is correctly calibrated and to reduce uncertainty. The conventional method for capturing wind speed and directional data has been the use of anemometer cups installed on met masts at various heights; the data is logged and analysed using computer modelling techniques to build up a picture of the entire site. This allows consultants to then design the wind farm and position the wind turbines.

However, Lidars are quickly becoming the tool of choice for this type of work. Lidars use a laser to measure wind data, and, compared to a mast, they are
highly portable, can measure at various heights and are easy to deploy.

SgurrEnergy’s Galion Lidar is the second generation of this mature technology, transforming wind measurement campaigns and allowing a far greater understanding of this complex energy source.

A strong wind measurement campaign accompanied by good analysis and modelling will typically result in an uncertainty in the energy yield prediction of around 10%. This could make it easier to secure finance and the best possible terms.
Review of Sessions 2008/09 and 2009/10

Discussion Forum
A Question of Chemistry: The Role of the Composer and Librettist in the Creation of Opera
19 April 2010

In his opening remarks, Lord Wilson of Tillyorn, President of the Royal Society of Edinburgh, said it was unusual for the Society to have an event focusing exclusively on the arts. Nevertheless, the word “chemistry” in the title would reassure any of the Society’s members who feared it might be straying too far from the sciences. He said the choice of subject illustrated the Society’s desire – in contrast to its London counterpart – to cover “the whole waterfront of intellectual life” in Scotland.

Lord Wilson introduced Alex Reedijk, General Director of Scottish Opera, who was to chair the discussion panel. He pointed out that Mr Reedijk’s previous experience – as head of NBR New Zealand Opera, Executive Director of the New Zealand International Festival of the Arts and the first promoter of the Edinburgh Tattoo outside Scotland – had amply equipped him for the task of finding new ways to put across opera.

**Alex Reedijk**

After welcoming onto the stage his three fellow panellists – the composer Stuart MacRae, the author Louise Welsh and the *Financial Times* music critic Andrew Clark – Mr Reedijk said that when he took up his post with Scottish Opera in 2007, he faced the challenge of defining its attitude to operatic creation in the 21st Century. The company had developed a strong tradition of representing the 17th, 18th and 19th Centuries in opera. It was emerging from a difficult period in its history, but had yet to formulate a policy on new opera. Full-length operas could take up to five years from germination to performance; Scottish Opera could not wait that long. In his talks with composers and writers, Mr Reedijk had sensed a ground-swell of enthusiasm for opera and a desire to be involved in creating new operatic works. His task was to find a way of tapping this enthusiasm. The template he devised was *Five:15* – an evening of five operas, each written by a new composer–writer partnership and lasting 15 minutes. The purpose of the 15-minute format was to get works on stage as quickly as possible. It minimised the risk of failure, for the audience as much as for the creative teams. The first *Five:15* duly took place in 2008. It was such a success that the process was repeated in 2009 and is about to go into its third year.
There is another good reason for working in the “short opera” format: contemporary opera in the UK has focused extensively on the composer. There has not been enough focus on the librettist, on the narrative, on the idea behind the opera. To help to shift the focus, each creative partnership in Five:15 starts by providing a one-page summary of their proposal. It is Mr Reedijk’s experience that when it comes to fleshing out the proposals, the partnerships that work best are those where the two partners are honest with each other, recognising when material had to be cut, either because it is not good enough or does not fit the scenario as it develops.

Mr Reedijk defined opera as “a judicious blend of music and theatre – a form of story-telling with music”. He said the 15-minute format is not an end in itself. It is a muscle-building process which should enable Scottish Opera to produce a full-length work every two-to-three years.

There is another, equally important dimension to Five:15. It has enjoyed an international “viral spread”. Cape Town Opera has adopted Scottish Opera’s idea and is hoping to perform a Five:15 work from Scotland later this year, alongside others made in South Africa. Scottish Opera has also developed a partnership with a privately-funded project in Canada, the Tapestry New Work Studio Company. Tapestry has paired three alumni of Five:15 with three North American counterparts to produce another batch of new works, one of which has since been performed in the Russian city of Rostov – and a Rostov-based composer is contributing to the latest Five:15 in Scotland. The Royal Opera House in London is also introducing various manifestations of short new operas.

“I am quietly pleased that what started off as a small idea in Scotland has spread around the world,” said Mr Reedijk. Five:15 has been financed entirely from private sources: that shows a willingness of people in Scotland to get behind new and good ideas. Looking to the future, Mr Reedijk announced that Stuart MacRae and Louise Welsh, whose opera Remembrance Day had enjoyed a success at the 2009 Five:15, have been commissioned to write a 45–60 minute piece for performance by Scottish Opera in 2012.

Andrew Clark

To understand operatic creation today, and especially the changing relationship between composer and librettist, some sort of context is needed: how has opera evolved over the centuries, and what is going on elsewhere in the opera world today? Picking up this theme, Mr Clark reminded the
audience that opera’s roots lie in 17th-Century Italy. It grew out of popular entertainments involving all the arts – music, song, storytelling, drama, poetry, movement, design. By the 18th Century it had established itself in the form we recognise today, but it was an art form for the privileged. The composer worked on a by-your-leave from his patron – either an aristocratic public as in Handel’s London, or a ruling monarch, as at Versailles and Saint Petersburg. The libretto was little more than a peg on which the composer could hang his music. It often followed a plot that, by implication, underlined the wisdom of the ruler who had commissioned it.

As the 18th Century progressed, so did opera. It started to reflect the society around it. Mozart’s *The Marriage of Figaro* spoke of social change under the shadow of the French Revolution. Beethoven’s *Fidelio*, written shortly afterwards, treated the themes of tyranny and injustice. As the Romantic era dawned, Weber’s *Der Freischütz* hinted at all sorts of psychological complexities and social taboos.

During the 19th Century, opera’s popularity grew in harness with the rise of the bourgeoisie. The composer was lionised: he had to entertain, but he also had to respond to the romantic ideal of art as something edifying and uplifting. Like his predecessors, he was invariably a practising musician and often an opera conductor, as Wagner was, and later Strauss and Zemlinsky. He was still subject to the censorship rules of the day, but his genius was the driving force. Librettists were there to do the composer’s bidding. Verdi, for example, frequently bullied his librettists and substituted his words for theirs.

The problem with opera in the 20th Century, Mr Clark argued, was that it lost touch with its popular roots. Post-1945 Modernism rejected opera in its traditional guise. While Pierre Boulez famously called for opera houses to be blown up, Karlheinz Stockhausen concocted wild and wacky visions, as lengthy as they were impractical. Luciano Berio, at heart a lyrical composer, renounced traditional story-telling in favour of what he called “musical action” – a collage of ideas with no coherent narrative. Thanks to the enormous influence of these and other leaders of the avant-garde, composers lost touch with the opera house. They retreated into academia, wrote instrumental and electronic music and favoured spaces and forces that lay beyond conventional resources. Opera was dismissed as an outdated art form.

The same period witnessed the rise of popular culture. Film and television supplanted opera as the medium for communicating...
stories about life, love and the human experience, absorbing much of the available creative talent. By the late 20th Century, opera had become an interpretative art, not a creative one. The creativity was to be found in directing – finding new meaning for old-established tales. The opera house became a museum. The art of libretto-writing fell by the wayside.

Since the 1990s, opera has fought back. While composers and authors often lack practical experience in the medium of opera, *Five:15* demonstrates they still have enthusiasm for it. That is a marked change from the 1960s, 70s and 80s. Some attempts to revive the art form elsewhere suggest many would-be composers and writers are intent on ‘reinventing the wheel’: in their enthusiasm for experiment, they have made elementary mistakes. Some have not even visited an opera house to learn from tradition.

In continental Europe, established composers are still writing large-scale stage works – mostly to a formula that tries to fuse opera’s vocal and dramatic essence with the musical and intellectual legacy of post-war Modernism. Hardly any of these works have joined the repertory. North America is producing full-length works, usually to an old-fashioned formula. Most are triumphs of marketing over substance. Their selling point is the fame or notoriety of the plays or novels on which they are based. One type of American opera that has aroused interest elsewhere is the documentary opera, based on the lives of public individuals of the recent past. Mr. Clark cited John Adams’s *Nixon in China* as the best-known. Whether these works have enough intrinsic value to appeal beyond their immediate historical context is an open question.

Mr. Clark reminded the audience that for every successful opera in today’s repertory, there are hundreds that had fallen by the wayside. He said that if the art form is to survive, composers and librettists today need opportunities, such as *Five:15*, to give their ideas practical shape. They also have to be allowed to make mistakes. The legacy for future generations should be a corpus of operas reflecting the problems and preoccupations and artistic priorities of our time – just as composers and librettists of the past have done.

**Stuart MacRae and Louise Welsh**

The two creative members of the panel made their presentation as a ‘double act’, taking turns to pursue their argument and react to the other’s comments. In his initial remarks, Mr. MacRae recalled that he had spent much of his early career writing for
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orchestra and ensemble, and that opera represented a step into the unknown: it made different demands. Outlining the history of his working partnership with Ms Welsh, Mr MacRae said they had become friends and admirers of each other’s work before they ever thought of collaborating on an opera. During preliminary discussions with Mr Reedijk about Five:15, Mr MacRae had recognised that narrative was not his best suit, while telling stories was one of Ms Welsh’s great gifts. On that basis, it seemed a logical step to invite her to collaborate.

Ms Welsh said she needed no persuading: she had felt envious of the writers selected for the first Five:15 in 2008. Writers spend a lot of time on their own, and so the opportunity to collaborate, especially with someone she knew and trusted, was too good to miss. Friendship did not mean they never disagree, but they do so with courtesy. Their advantage is that they do not have to go through the formalities of getting to know each other, as many collaborators do, before being able to say “That’s rubbish!”. Ms Welsh has been an opera goer but does not consider herself a knowledgeable one. The chance to learn is something new. She is not being called upon to adapt someone else’s play or short story, but to engage with a particular art form and write specially for that.

“For a writer that is very satisfying,” she said.

Mr MacRae said one of the most positive aspects of the Five:15 commission is that it takes the form of a developing process, in which the creative team discusses ideas with Mr Reedijk and the stage director Michael McCarthy, and benefit from their practical advice and guidance. What is missing from the education of modern composers is the opportunity to write dramatic music, a genre that goes far beyond the process of working out how to put words and music together. Composers today are accustomed to developing relationships with orchestras, ensembles and singers, but not opera houses. They will readily dissect any opera they hear, but their analysis rarely goes beyond the music. It is necessary to relate the music intrinsically to everything else, “and when you start getting involved with the medium as we have, you see it in a totally different way,” Mr MacRae said.

He added that most operas in the repertory have good music, but what really makes an opera work is the way all the elements speak to each other and form a unit. Having the right words is an essential starting point. In that context, it is important to let the librettist take an idea forward and not let the “composerly side” get in the way.
Describing their modus operandi, Ms Welsh said the germ of Remembrance Day – “the initial spark and vision” – had come not from her but from Mr MacRae. They began by meeting in a café for a lengthy chat. Each would then mull things over on their own and reconvene a week or so later. She said Mr Reedijk and Mr McCarthy had “put us through our paces”. When finally the time came to write the libretto, more changes took place, because “a structure and a plan are not the piece, and as soon as you begin to write it, things become apparent that weren’t apparent when you started.”

Mr MacRae said the only problem about their initial conversations was that they generated so many ideas: a lot of the creative process involved honing down the material to what was absolutely necessary. In the end each had to go off and do their part of the work. Ms Welsh would make a first draft of the libretto, and after “a bit of shuffling around” with what she proposed, he would then get to work on the music.

Ms Welsh said she regards Mr MacRae as the “senior partner”. She will ask him about structure, timing and words; they will also discuss voices and instruments. She said it is useful to have a tight remit, even down to the number of words she can use.

Mr MacRae explained the relevance of a word-count: singing words takes longer than speaking them. It is necessary to maintain subtleties and subplots and keep the piece working on various levels, while using the minimum number of words; in that context, the composer needs to keep the librettist informed of places where the music could cover ground that might occupy several paragraphs in a novel. Mr MacRae said that once he had grasped these lessons and adapted his techniques to the 15-minute format, Remembrance Day became easier to write. The challenge now, writing a 45-minute piece for 2012, is to hold the audience’s attention over a longer span, while letting the piece breathe, “because you can’t be at the threshold of intensity for 45 minutes.”

Ms Welsh concurred, adding that one of the challenges of a longer piece is not to be frightened of it. It is important for the librettist to trust the skill of collaborators, including singers and orchestra, and not to overwrite. What they had learned was that there is no “right” way to create an opera: each of the Five:15 partnerships has found its own individual way.

Mr MacRae pointed out that, while he would not dare to compare himself with Puccini or Verdi, “their work is what we are competing with for stage time.”
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Unlike in Handel’s day, composers and librettists of the 21st Century were not writing three or four operas a year. An opera company might produce one full-length piece every three or four years, and that increases the burden of expectation. Being part of a team helps to ease the pressure.

Invited to comment on what Mr MacRae and Ms Welsh had said, Mr Clark observed that it is easy to forget that until the late 19th Century, almost everything an opera company produced was new, not a revival of existing works. What *Five:15* proves is that opera is alive and well, and is still changing and developing. It cannot not repeat the past; it has to come up with new solutions to old problems.

**Questions and Answers**

The question of design was raised: how did it figure in the creation of a new opera? Mr Reedijk replied that it had not been the intention of *Five:15* to “get bogged down in the artifice of opera, scenery, props etc”, but to focus instead on the truthfulness of the story-telling. A clear, open set, perhaps with a small bench, encourages everyone to use their imagination. A design issue specific to *Five:15* is the positioning of the orchestra: for practical purposes it had been decided to place it behind rather than in front of the playing area, in order to maximise audibility of the words. For the longer piece now being developed, a more traditional configuration will be used – and there will be a greater role for stage design.

Another questioner asked how writing for the voice compares to writing for the page. Ms Welsh said she is accustomed to thinking about the voice: even while writing novels she reads each sentence aloud, “a good way of pointing up what’s wrong”. While writing a libretto, she thinks in terms of rhythms and tunes, even if she refrains from sharing her tunes with Mr MacRae – who said he is glad Ms Welsh feels able to tell him when she imagines a repeating rhythm in the background of a certain section, “as it may save me from having to work it out for myself.”

Did libretto-writing involve a degree of poetic writing? Ms Welsh said she sees the libretto as offering more scope for poetic turns of phrase than a novel, but it cannot function properly without music. Mr MacRae added that the libretto Ms Welsh has provided for *Remembrance Day* has many poetic turns of phrase without manifesting itself as poetry. Ms Welsh said that what they are aiming at is an idea of speech, involving half-rhymes and rhythms, rather than “actual speech”. Before starting to write, one of her techniques is to draw up a vocabulary list relevant to the subject.
Did the composer need to be aware of the sound of vowels at the top of the voice – and when writing each role, did he have specific voices in mind? Mr MacRae said he has learned not to use certain vowels on high notes. He has also learned to be sensitive to this during the rehearsal process, making small changes where necessary. Similarly, if a line of the libretto proves unsympathetic to musical development in terms of rhythm or length, he has had no qualms about asking Ms Welsh to make changes, perhaps by lengthening the line to suit a musical climax. One of the great pleasures of working with singers is discovering the character of their voices and how tailoring the music to suit can improve the result. Ms Welsh added that in any creative work, be it science, literature or opera, it is the solving of problems that usually gives most satisfaction.

Did Ms Welsh have a view about singers’ diction? And should the audience be given a copy of the libretto in advance? Her reply suggested the responsibility for verbal clarity lies as much with the librettist as singer: part of her task is to write words and phrases that allow clear diction. “I have the ego of any other creative artist: I don’t want my genius to be lost.”

[laughter] As to the audience being told the story beforehand, Ms Welsh said she likes to have a copy of the libretto of the opera she is seeing, but usually leaves the reading of it till afterwards. As far as her own narratives are concerned, she prefers not to give away her surprises to the audience in advance.

How does a composer control the musical/lyrical narrative within the overall shape of the work? Mr MacRae said that once the composition process is underway, it is like juggling: you have several balls in motion at any given time, and with every bar and syllable, the composer has to judge how it relates to the character who is singing, the other characters on stage, its place in the overall timescale and its relationship to the words before and after. The pacing is partly dictated by shifts in the libretto and the changing moods of each character. During the composition of Remembrance Day, it had been useful to keep a notebook following the mood of each character, and trying to find the patterns and threads within that – a technique designed to make the opera multi-layered and multi-textured. At the same time it is easy to overcomplicate the whole process. Getting the pacing right – the sense of a drama moving forward – is the hardest task of all.
Reputations come and go, as Gordon Graham, the Henry Luce III Professor of Philosophy and the Arts at Princeton Theological Seminary, pointed out in his introduction to this lecture on the life and influence of Thomas Reid. Two hundred years ago, a century after his birth in Scotland, the star of Reid, an 18th-Century Scottish philosopher, was in the ascendant. A century later, it had sunk without trace. Yet, 300 years on, in the tercentenary year of his birth, his star is rising again. “Reid is back,” Graham said, adding that no-one was better qualified to tell us why than John Haldane, Professor of Philosophy at St Andrews University, who has rekindled interest among scholars on both sides of the Atlantic in Reid’s work.

So much esteem is Reid now held in that celebrations of his tercentenary are being held both in Scotland, his birth place, and in America (at Princeton), where the Scottish philosopher’s influence is still widespread, Haldane said. Some of the scholars who were due to be at both events were here today and although his lecture was intended for those with no prior knowledge of Reid, he hoped he would not leave Reid scholars without something to take issue with.

In saying that, he was thinking not only about the issues that Reid was most associated with but about the nature of philosophy itself, particularly in relation to the natural sciences as invoked as opposition to traditional philosophical understandings. This led neatly on to the “art” of philosophy – the title of the lecture - a discipline which may now be under threat.

So how was Reid’s reputation recovered? The revival dates back to 1941 with the publication of an abridged version of Reid’s Essays on Intellectual Powers of Man produced by the late Anthony Wolseley, who was at the time in military service with the Dragoon Guards in the Middle East but later became Professor of Moral Philosophy at St Andrews University. Wolseley saw in Reid an affinity with the style of philosophy then developing in England, with particular attention to ordinary language and the diagnosis of sceptical philosophical theories arising from mis-use of the language.
It was possible to say that Wolseley rediscovered Reid. He was certainly neglected, even in Scotland, partly because his writings were not easily available, but more so because of the prevailing verdict on his Scottish School of Common Sense system of philosophy. That verdict dates back to Emmanuel Kant in the 18th Century, but which was revived by 19th-Century Scottish neo-Kantians philosophers, namely James Frederick Ferrier, Professor of Moral Philosophy at St Andrews. Prior to Wolseley’s 1941 edition, scholars would have to have gone back to Sir William Hamilton’s works from 1849. These ill-served Reid in two respects, with their double columns and small print and the long notes that Hamilton made to improve them, when no improvement was called for. Wolseley’s work had the disadvantage of being an abridgement, so the serious work of producing a critical edition only got underway 20 years ago by Princeton University and Edinburgh University Press. These volumes are transforming the study of Reid, Haldane said, so once again, as in his own time, he is becoming read and appreciated.

So who was Reid and what was his background? Reid was born in the manse in Strachan in Deeside, in 1710, a year to the day before David Hume and 15 years before Kant. Reid, like Kant, was brought to life as a critical philosopher by reflecting on Hume’s sceptical empiricism, which Reid sought to counter by placing human knowledge on a better foundation than that of impressions and ideas. For this reason, Reid was described as the Scottish Kant. As it happens, Kant believed his own grandfather to be an emigrant from northern Scotland, so he could himself have taken that moniker. However, Reid’s antecedents were in no doubt. On his father’s side he had clergy and officers of the court. On his mother’s side there were a number of distinguished mathematicians.

With this family background, it is no surprise that he showed an appetite for study and intellectual life. Educated at home until the age of 10, he went to school in Kincardine, then briefly to Aberdeen Grammar before Marischal College. At that time, Marischal operated a regenting system in which each student was taught natural, moral and metaphysical philosophy by the same teacher throughout. For three years, Reid was instructed by George Turnbull, an important figure in the development of Scottish moral philosophy.

Turnbull could not have failed to influence Reid. His principles of moral philosophy, published in 1740, included particular claims that contain echoes in Reid’s own philosophy. Turnbull maintains
that judgements and reasoned conclusions in the moral sphere should be tested against common sense, which is fully adequate to determine their truth or falsity.

The idea that common sense provides a standard appears in Reid’s own thoughts, although broadened and deepened. It became a term in Reid’s philosophy and has been ascribed to his name ever since the publication in 1764 of his *Inquiry into the Human Mind on the Principles of Common Sense*. One school of thought was that common sense was literally another sense, with a sense faculty or organ, but this is not what Reid meant, Haldane argued. It was not a distinctive power of the intellect, nor the common consensus conceived of as a general opinion. It is reason itself, according to a set of principles, the negation of which is self contradictory of self-refuting.

Reid describes this as the first degree of reason, which judges a thing self-evident and puts it to use to refute Hume. Hume saw knowledge as rooted in experience, as did Reid, but in a much pared-down way of flickering impressions. On that basis, Hume concluded that our ordinary understanding of the world around us was a mental construction. That produced a scepticism, because we have no direct experience ourselves that there is a world of objects beyond our own faculties.

Reid saw very clearly the meaning of Hume’s ideas, perhaps more clearly than anyone else. He was in fact the first philosopher to do so, as he was a reader of the *Treatise on Human Nature*, published in 1739 when Hume was just 27. A little over a decade later, Reid published his *Inquiry*. It was only this that awakened Kant from his ‘dogmatic slumber.’ It was a quarter of a century later that Reid published his rejoinder to Hume’s philosophy, but he had been working on it for many years. But it began with readings of Hume once he was established as the minister in Newmachar, west of Aberdeen, in 1737. The years that followed brought marriage to his cousin Elizabeth and the start of a family. Two of his daughters were born either side of the 1745 rebellion. The same year, Elizabeth fell ill and Reid wrote a petitionary prayer on her behalf, asking for her life to be spared. She was 22 and her life was spared and she lived on until 1792. Reid was then 82 and wrote of the “bosom friend” to whom he had been married for 50 years. Between times, he had been publishing, had been elected to Regent Mastership at King’s College, in Aberdeen, co-founded the Aberdeen Philosophical Society, gained a doctorate of divinity at Marischal College in 1752 and later become Professor of Moral
Philosophy at Glasgow University in succession to Adam Smith. At the same time, Reid sold to a publisher the text of a reflection on the scepticism of Hume’s philosophy. Letters between them suggest a mutual respect, but Kant was not as kind. But while there is no evidence of Kant ever reading Hume’s work, Ferrier had no such excuse to miss the point of Hume’s philosophy.

In 1774, Reid published *A Brief Account of Aristotle’s Logic*, his only publication while teaching at Glasgow. A month later, he wrote he was growing old and said he was going to retire. What he did, Haldane said, was set about amending his lectures for publication. He died in 1796, followed by Kant eight years later, so within a decade the two great anti-sceptical contemporaries of Hume had passed away. People have speculated on how they might be compared. Kant’s influence has been the greater, Haldane said, and his imaginative powers were superior, yet his writing is more difficult and most obscure where it needs to be clear. Reid, by contrast, is wholly devoid of pretension and lays great store on clarity and brevity of expression. In that, his prose is the most modern of any 18th-Century writer.

So Reid on the art of philosophy? More needs to be said about Hume, Haldane said. The power of his (Hume’s) thought resides in its ambiguity in that it suggests two philosophies. One is avowedly sceptical, which is what Kant and Ferrier were troubled by. In the sceptical system, certainties are dissolved into impressions and ideas. In the second, we return to a more mature common sense. Here nature is the beginning and end of things. So was Hume an unsettling radical or a reassuring conservative? One way of regarding Hume is as a certain kind of naturalist; but how would he have responded to questioners? How would he have responded to a real thinking Aristotelian, which is what Reid was?

Reid was in the middle, with Kant and Ferrier at one end and Hume at the other. Ferrier is withering (about Reid) in the 19th Century and he was influential, which partly explains the neglect of Reid. But, Haldane argued, if we merely look at the mind scientifically, then we lose sight of what the mind is about, which is consciousness. Ferrier was over-ambitious in his attack on the commonsense tradition deriving from Reid; but, like Kant, alludes to the successors of Reid, who were second rate, rather than Reid himself. He also brings philosophy into ridicule, doing great damage. If we have to choose between a study of nature that is merely an observation of objects or this crazed attempt to define everything logically and scientifically, then philosophy will lose out.
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The greatness of Reid is that he negotiates a course between these two extremes. He believes philosophy can yield substantive knowledge about the world and the cause of the world and the conduct that should regulate us. But it is achieved not by pure logic but by inquiry into the world and ourselves.

Scepticism is overcome by showing its impossibility. But if there is nothing to be discovered beyond what science engages with, there would be no scope for philosophy. But with no scope for philosophy, there would be no questioning of the directions in which science was being taken. What Reid offers us is a view of the nature of philosophy that raises it, with dignity, into an inquiry into nature, but without the absurd pretensions of thinking an inquiry into nature is some sort of special domain of facts. We are investigating what is familiar to us, and what is revealed to us in the wise and prudent judgement that philosophy aims to arrive at is supported by the principles of common sense.
China has one of the richest floras in the world. Yet it is being threatened by the environmental impact of the country's remarkable economic growth and by global climate change. Peter Raven argued that acting morally to secure sustainability is the only viable response to both challenges.

In 2013, botanists from around the world will gather in Beijing to celebrate the completion of the English translation of the *Flora of China*. Professor Raven has been involved in the ambitious project since it was proposed by Chinese scientists in 1979. He drove the work forward in 1987 by devising an effective formula to turn the second edition of the 120-volume Chinese Flora into a more concise English version. The endeavour not only recorded the great diversity of plant life in China for the first time, it also took Professor Raven back to the country of his birth and fired his interest in the impact of China's enormous economic growth on the country's environment.

Such environmental pressures stem from the development of crop agriculture, which started in the eastern Mediterranean 10,500 years ago and laid the foundations of civilisation. At the time, the world's human population was smaller than that of Scotland today. By the time Thomas Malthus wrote about population growth outstripping the food supply 200 years ago, that global population was approaching 800 million. Today a third of the planet's land surface is devoted to food production, with 7.1 billion people to feed and another 2 to 2.5 billion more projected before the population curve levels out.

Professor Raven noted that individual levels of consumption differ so significantly between developed and developing countries that the overall impact is a compound of population, affluence and technology.

When Professor Raven was born in Shanghai in 1936, China had 500 million people, a quarter of the world's population. Today it has 1.3 billion people, 19 per cent of the world's population. Its economy has grown by around 10 per cent each year for the past two decades.
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Professor Raven said China and its 1.3 billion people will have a huge impact on the prospect of achieving global sustainability. As its level of consumption has risen, China’s ecological footprint has quadrupled in the last 40 years. It has become the world leader in the production of waste and greenhouse gases. Sixteen of the 20 world cities with the worst air pollution are in China. Air pollution is now the country’s chief cause of human health problems, resulting in 400,000 premature deaths each year. China’s manufacturing economy is also highly polluting. It has been estimated that environmental damage costs China 8–13 per cent of its gross domestic product.

Professor Raven observed that while basic environmental programmes are strong, the uniform application of laws across the country is difficult.

China has a great deal to lose. Professor Raven described the country as incredibly rich in biodiversity. This is in part due to the way China’s mountain ranges link the temperate north with the tropical south, providing organisms with a relatively easy migration route in the face of climate change. Furthermore, the many separate ranges have provided places for the evolution of distinct species. In Europe, where the Alps and the Mediterranean present barriers to migration, there are about 12,000 species of plants. In China there are 31,500 in an equivalent area.

We rely on biodiversity for our food, most medicines worldwide, and to add interest and beauty to our lives. Professor Raven estimated there are more than 12 million species of organisms, not counting bacteria. Only 1.9 million of them have been given names, of which perhaps 150,000 are known about to any degree. China possesses about 1 million species, half of which are found nowhere else. Some are familiar to us, such as primulas, roses, pandas and rhododendrons. About 5,000 plant species in China are used as medicines. Professor Raven described them as a unique resource for China and for the world that should be preserved. However, species are disappearing rapidly as habitat destruction, climate change, invasive alien species, pests, pathogens and over-gathering take their toll. Professor Raven said one think tank (www://globalfootprint.org) has concluded that humankind is using about 160 per cent of what the world can produce on an ongoing basis.

Even as China has outlawed the extraction of timber from native forests, it has accelerated the destruction of forests elsewhere to meet its requirements.

Global warming and climate change make the situation more urgent. The speed with which the
Earth’s temperature is rising threatens the survival of many species. Rising sea levels could take 30,000 sq km from China’s three major industrial areas by the end of the century. Glaciers and the snow pack on the Tibetan Plateau that feed the major rivers will be mostly gone by the end of the century. Professor Raven said the Intergovernmental Panel on Climate Change has estimated 20–30 per cent of the world’s species may be lost to the effects of global warming this century. He concluded that this challenge requires new ways to conserve plants and animals if we want to keep them around. The increasing rate of extinction could wipe out as many as two thirds of species by 2100, the majority before they have even been recognised by science.

Rich biodiversity could only be preserved in a sustainable world. Professor Raven said this requires finding sustainable levels of consumption per individual and the promotion of equal opportunity for every person, especially women and children. He said that new technologies are important, but they cannot save the world without addressing the need for a sustainable level of population and a moral standard of consumption. With 50 per cent of the world’s population living on under US$2 a day, he said the ingredients for sustainability are simply absent at present. A better balance between poor and affluent people has to be found.

Professor Raven argued: “We have to give things up individually – the change has to come from us.” He explained that moral, religious and philosophical systems will have much to contribute to finding solutions. To conserve biodiversity, information has to be gathered and disseminated rapidly, while reserves in which species can move in elevation need to be built up with the involvement of local people. Plants and animals could be brought into cultivation or domestication if they are likely to become extinct otherwise. Plants have to be replanted and reintroduced even as the climate changes.

In China, it is essential to continue studying existing eco-systems to establish baselines against which progress can be measured. The principles of restoration biology have to be adopted to set up biological communities where they’ve been destroyed. Ways to preserve species and make eco-tourism sustainable are needed. Professor Raven remarked that the midge is an effective way to control eco-tourism in Scotland. He added that education is also vital to make sure children are interested in the nature around them from an early age.

Professor Raven concluded that the quality of the future of China
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and the world depend on attaining sustainability. Otherwise, the world will be less diverse, beautiful and interesting than it is now. He said: “It is up to us how and when we can come to our senses. This will in turn depend on a level of national determination and international co-ordination far beyond what we have now.”
Diabetes & Obesity: Getting to the Heart of the Matter
A Joint conference with The Academy of Medical Sciences
Supported by The Caledonian Research Fund
of the RSE Scotland Foundation
26 May 2010

The symposium featured experts from within Scotland and across the UK and was chaired by Professor Jonathan Seckl FRSE FMedSci. Speakers’ presentations and subsequent discussions began by considering the current trends in obesity and the role of genetics, epigenetics and other factors in predisposing individuals to these. The focus then moved to management strategies, including the role of exercise and emerging therapies. Finally, speakers considered how policy interventions might help tackle the obesity epidemic and the role of informatics in enhancing the translation of research into healthcare benefits. The meeting was attended by around 170 delegates, including researchers, research funders, and representatives from industry, the NHS, Government and professional bodies.

Rates of obesity and diabetes are increasing globally. The UK has experienced a particularly large rise in obesity prevalence and an associated increase in Type 2 diabetes incidence. A similar trend is now emerging in developing countries. On 26 May 2010, The Academy of Medical Sciences and the Royal Society of Edinburgh hosted a joint symposium, to discuss the changing trends, consider contemporary findings in diabetes and obesity research, identify the wider implications for future research directions in the field and explore future opportunities to develop better preventative strategies. This report summarises the themes and issues raised during the event.

Key points include:

• Obesity and diabetes will be responsible for a growing burden of disease in the next 20 years, with the highest increases in developing countries. The rise in obesity and diabetes already seen in the UK and other developed countries represents a heavy burden for healthcare systems. However, the prevalence of these diseases is now rising in developing countries and the circumstances are complex; for example, increasingly cases of both over- and under- nutrition exist within the same household.

• Research on genetics and other biological mechanisms is providing new insights, which are expected to lead to better
treatments. Research into genetics, epigenetics and metabolic pathways is beginning to reveal the biological differences between individuals who become obese and those who stay lean in the face of an ‘obesogenic’ environment. This research offers the opportunity to identify individual risk factors and stratify treatments, increasing efficacy and reducing toxicity.

- Foetal development is important in establishing a predisposition to disease in later life, and there may be critical periods for positive intervention during development. Identifying the factors that predispose people to obesity and diabetes will be helpful in determining how we might identify individuals who are at risk and develop effective interventions.

- Determining the most effective management strategies will be central to reducing the incidence of obesity and diabetes. Academia and industry are seeking new, creative approaches to treatment. For Type 2 diabetes patients, current drugs do not consistently offer tight enough control of blood glucose. Developing new drugs with a more durable and accurate effect on blood glucose control will improve the quality of care for these patients.

- Novel technologies, including imaging, offer promise for understanding the mechanisms of the complications of diabetes and obesity in humans and to speed drug discovery. Progress is currently being made in molecular imaging techniques, which may in future allow real-time patient monitoring at the bedside and potentially improve diagnostics and drug delivery, guide intervention choices, help to identify new therapeutic targets and enhance drug trials.

- There is growing evidence to support particular policy interventions that may be helpful in preventing obesity, but better quality evidence is needed. National strategies should seek to prevent individuals from developing diabetes and obesity, as well as treating patients already diagnosed. Government policy interventions can be made within the physical, economic, political and socio-cultural environments, and can be directed at entire populations or individuals. Scientific evidence and robust evaluation can help to assess which interventions are most likely to be effective and reach the largest proportion of people, and thus which are worthy of further consideration by policy makers.

- Comprehensive patient information systems can help improve care and increase participation
in clinical trials. As management strategies improve, translating them into patient benefits should be a central focus for health policy. Using informatics to improve patient monitoring and to increase the availability of data and volunteers for research studies will help to improve the management of risk factors. It will also provide a useful mechanism for assessing the quality and safety of newly introduced management strategies.

The discussions clearly highlighted some important areas for future research, which should seek to:

- Refine understanding of the contributions of genetic and epigenetic, early life and adult factors to the development of the obesity–diabetes–metabolic disease continuum and to individual risk in humans.
- Examine mechanisms of pathogenesis, in particular exploiting known and novel pathways revealed by genetic and epigenetic data.
- Consider how findings can be applied to develop effective validated biomarkers of such risk, particularly to define those most likely to develop complications.
- Develop evidence-based pragmatic policy interventions to reduce population risk.

Obesity is a medical condition characterised by an individual having excess body fat caused by a higher energy intake than expenditure. The excess energy must be stored and this is done in the form of adipose tissue, leading to an increase in body mass. The health implications of obesity are significant, as it is associated with a number of other conditions, including Type 2 diabetes, cardiovascular diseases, cerebrovascular diseases, and certain types of cancer. Obesity is conventionally measured through calculating an individual’s body mass index (BMI). Diabetes mellitus is a disease that affects the individual’s ability to control their blood sugar levels.

- Type 1 diabetes is usually present in children and is characterised by the body’s failure to produce insulin, the hormone that causes a fall in blood glucose levels. Insulin is produced and released by the beta cells in the pancreas, but auto-immune destruction of these cells means that they do not function properly in Type 1 diabetes patients, thus patients must inject the hormone to control their blood sugar.
- Type 2 diabetes is more common, approximately 90% of diabetes is Type 2 and it more
often affects adults. Patients gradually become resistant to the effects of insulin, despite maintaining the ability to produce it. They must control their blood sugar through lifestyle changes and possibly drugs. However, as the disease progresses, pancreatic beta cell function diminishes and patients may need to supplement existing treatments with insulin. Obesity is associated with insulin resistance and the subsequent risk of Type 2 diabetes, thus the main risk factor for Type 2 diabetes is obesity, with 90% of people with Type 2 diabetes having a BMI of more than 23 kg/m². Type 2 diabetes is a more heterogeneous entity, in terms of its pathogenesis, than Type 1. Further types of diabetes also exist, relating to specific genetic mutations affecting beta cells or insulin action.

Both types of diabetes are associated with a substantial risk of serious complications, notably accelerated atherosclerotic heart disease, eye disease, kidney disease, peripheral vascular disease and nerve damage. The incidence of these complications is significantly reduced with successful treatment of the underlying diabetes and obesity.

The western world has seen a significant rise in the incidence of obesity and diabetes over the last few decades. This trend is now spreading across the globe and the burden of these conditions and the associated chronic health implications has received attention internationally from governments. The World Health Organisation (WHO) has deemed the rise in obesity to be a global epidemic, estimating that over one billion adults worldwide are overweight and that at least 300 million of these people are obese. Obesity prevalence in the UK is amongst the highest in the world and in 2007, the UK Government Office for Science commissioned Foresight to produce a report on the topic, ‘Tackling Obesities: Future Choices’. It estimated that by 2050, 60% of men and 50% of women in the UK could be obese. Such high figures have been challenged, for example, data from the US Centers for Disease Control and Prevention (CDC) suggest that obesity may asymptote at around 30-35% in the West. However, even figures of 30% represent obesity levels that will be accompanied by significant economic impacts. The Foresight report predicted that the cost to the NHS of dealing with overweight and obese people could reach almost £10 billion per year by 2050 and the wider costs to society and business of obesity and associated conditions could reach £49.9 billion per year.

Scotland has a particularly high rate of obesity and is home to an active diabetes and obesity
research community. The Scottish Government has paid particular attention to the topic as a national health problem, supporting research and looking for opportunities to utilise promising initiatives in this area. For example, the Government is funding a national database of diabetes patients with the aim of improving the quality of patient care and the availability of data and volunteers for research into the condition. Scotland therefore provided an appropriate location for a one-day symposium to discuss the latest findings of research in this area and its implications, and also provided an opportunity for the Academy of Medical Sciences and the Royal Society of Edinburgh to collaborate on their first joint symposium on a topic of mutual concern.
Delivering the BP Prize Lecture, which celebrates excellence in the arts, Dr Deirdre Heddon took the RSE audience on a journey – a journey of many walks. Sharing some of her emerging research, she described how women are using walking in art and performance, an area which traditionally has been considered the realm of men.

A specialist in theatre studies and contemporary performance, Deirdre Heddon’s latest research is nevertheless taking her into the worlds of art history, literature and geography. She is exploring women walking, when it is art or performance.

In a fascinating talk, she described how women are making art through walking, whether it be in the heart of the city or the beauty of the countryside. She described how women use what they find while walking to make art – whether it be taking photographs of found objects, seeking out nature in unexpected places or even using knitting as a means towards artistic discourse.

“Think of walking and art and male names come to mind”, she says. For example, Richard Long, who has based several works round walks he has taken, perhaps most memorably his 1967 A Line Made Walking. In her previous work, Autobiography and Performance (2008), Dr Heddon wrote about performance and walking, but was struck by women’s relative invisibility. Together with Dr Cathy Turner (a woman artist who walks), she has set out to redress that balance by seeking out instances of women using walking in their art. The idea was not so much to explore women walking, or, indeed, female artists who happen to walk. Instead, it was specifically to look at women who use walking in their art, or walking as artistic practice – as defined by the women themselves.

If the history of walking and art is almost exclusively male, it has been popular through several ‘movements’, albeit for different reasons. The naturalists and romantics – for example, Rousseau and Thoreau – enjoy the wildness of the landscape; for them, walking is about getting back to nature and leaving the civilised world behind. The avant-gardists, on the other hand, seek
adventure in the day-to-day surroundings of the city. She quoted Rousseau saying that he only meditates while walking. “When I stop, I cease to think; my mind only works with my legs.” Henry Thoreau took that further, saying: “If you are ready to leave father and mother, and brother and sister, and wife and child and friends, and never see them again; if you have paid your debts, and made your will, and settled all your affairs, and are a free man; then you are ready for a walk.” Walking, then, was seen by these men as a throwing off of society and its obligations – and a moving away from the world, the world inhabited by women. Woman is, in one sense, left behind in the home by these ‘free men’ who go walking, but in another sense, she also represents nature (for it is her ‘nature’ that ties her to the realm of the domestic). Where there is a reversal of the traditional roles – such as in Ibsen’s A Doll’s House – it seems ‘shocking’, Heddon claims.

The ‘bad boys’ of the avant-garde, on the other hand, favour the urban environment; yet they follow a similar path, turning ‘culture’ into ‘nature’. They look for the new in the path well-trodden. As Walter Benjamin has it, to lose oneself in a city – as one loses oneself in a forest – “takes some schooling”: “Then signboards and street names, passers-by, roofs, kiosks, or bars must speak to the wanderer like a cracking twig under his feet, like the startling call of a bittern in the distance, like the sudden stillness of a clearing with a lily standing erect at its centre.” Situationist International member Guy Debord agrees, talking of “slipping by night into houses undergoing demolition, hitching non-stop and without destination through Paris during a transportation workers strike in the name of adding to the confusion, wandering in subterranean catacombs forbidden to the public.”

Women who might want to walk in the night-time city, like the Surrealists, however, risked being read as streetwalkers – something which has inspired some to take matters into their own hands. There are well-known women walkers, such as Dorothy Wordsworth, but they tend to be in the margins as ‘exceptions’ and to be excluded from histories of these movements, said Dr Heddon. Recognising a gap in knowledge about women artists using walking, Heddon and Turner advertised on mailing lists, and were impressed with the replies. Some 150 women responded and Heddon and Turner have met up with some of them, walking and talking to them about their art. Heddon described some of these encounters. Rachel Gomme, for
example, has focused on ‘found’ flowers, which she picks up as she walks the streets. ‘Drifting is how she walks, so we drift through Peckham in a response to the urban landscape.’ Gomme also made a performance, Undergrowth, which drew attention to weeds growing in unexpected places, usually unnoticed; and performed Ravel – walking while knitting, incorporating items found en route into her knitting and hearing stories shared by others intrigued to see a woman walking and knitting. Another walking artist, Linda Cracknell, challenges herself with long walks – as a woman walking alone, she tends to attract notice, unlike a man in the same circumstances.

Misha Myers’ 2007 work, Yodel Rodeo, involved bringing together a group of line dancers to walk around the old city walls of Exeter. Other projects described pairing walkers in different places, both across Britain and over the Atlantic; while yet another involves looking for the unexpected – a perfect ‘allotment’ style garden in front of a block of flats, for example.

Many of these women challenge Debord’s notion that somehow there is something limiting about a life lived in a particular locale. Debord tells of a female student who basically walks in a triangle that encompasses the school of political science, her home and that of her piano teacher. Debord displayed ‘outrage’ at such a ‘pathetically limited life’, using it as an example to prove the necessity of developing derives (or drifts). The group Walk Walk Walk, Heddon says, respond to Debord by creating an ‘anti-derive’, walking only familiar paths, recognising a splendour and value in everyday walks.

The women artists that Heddon and Turner catch up with walk everywhere, town and country, home and abroad. Sometimes the walk itself makes the art. Tamara Ashley and Simone Kenyon, in The Pennine Way: The Legs that Make Us (2007), walk as dancers, paying close attention to how their bodies feel at every stage of the 270 mile journey. The whole process takes on a certain simplicity, however, because whatever happens, their focus is getting up the next day and getting on the trail.

One cannot easily essentialise the women Heddon and Turner have walked with – each has her own agenda and motivation; there is no single practice of walking for women or for men. But there is much to explore – such as scale of walking, cultural values, motivations and sociological issues, as well as those directly related to gender. We need to rethink what we see as ‘adventure’ says Dr Heddon – we might even have to scale it down – but that doesn’t mean it is not adventure.
Professor Valerie Beral, Head of the Cancer Epidemiology Unit, at Oxford University, argued that there is compelling evidence for a close link between breast cancer rates, number of children and breast-feeding. She believes that in the past there has been an over-emphasis on the importance of a woman’s age when she has a first child. In fact, she claimed, something happens to women in the later stages of pregnancy which has a protective effect. She called for this to be studied with the aim of producing a breast cancer vaccine. Professor Beral was welcomed by RSE President Lord Wilson of Tillyorn and the event was supported by the Cruden Foundation and Scottish Cancer Foundation.

Women in the West have a 6.3% chance of developing breast cancer by the age of 70, compared to 1% in areas of rural Asia and Africa. Understanding why, could provide the key for a successful approach to prevention.

Breast cancer has been known for a long time; surviving evidence shows that it was present in Ancient Egypt. In 1743, Ramazzini described it as an occupational disease of nuns. Professor Beral said this observation was given strength by Rigoni-Stern in 1842, who reported that it caused 2.7% of deaths among nuns in Verona compared to 0.4% for other women – seven times higher, and a similar magnitude to the differences between developed and developing societies today.

A League of Nations study in 1925 showed that single women in England and Wales had higher rates of breast cancer than those who were married. In 1926 Lane-Claypon’s epidemiological study demonstrated that married women with an average 5.3 children were less likely to have breast cancer than those with fewer (3.5). She also found that rates were higher among those who did not breast-feed. “For centuries it was thought that women got breast cancer because they didn’t use their breasts for their natural purpose, breast-feeding – and actually that’s right and that is the reason why there was the difference in rates between nuns and other women, and between developing countries and the West,” said Professor Beral.
The Professor argued that our understanding of the causes of breast cancer took a wrong turn in 1970, following a large scale study by MacMahon et al. This claimed that births after the first, even at an early age, give little or no protection against breast cancer. The idea that age at first birth is the key to breast cancer rates became the dominant theory. However, Professor Beral pointed out that Western and rural Asian and African women all tend to have their first child at around 25, yet there is a six- to seven-fold difference in rates. She added that if the average age of first childbirth was 19, there would only be a slight reduction in the occurrence of breast cancer. “If it’s just age at first birth then why do we have this big gap between developing and developed countries?”

More recently, questions have been raised about whether the difference in rates may be due to environmental, lifestyle, chemical or genetic factors. In 1991, The Collaborative Group on Hormonal Factors in Breast Cancer was set up and has looked at the effects of the pill and hormone replacement therapy (HRT). The Professor said the group found that “when people are on the Pill they have an increased risk of breast cancer and when they stop taking the Pill the risk goes away”. The findings were similar for HRT, with the breast cancer risk rising while they were on it then reducing between two and five years afterwards. This, said the Professor, seems strange to many people, as they do not tend to think of cancer-causing factors being reversible. But the fall in breast cancer rates after women stop using HRT has now been observed in around a dozen countries, including Scotland.

Turning to childbearing, Professor Beral asserted that age at first birth does matter but is not the only factor. “You can also look at how many children someone has had and you can see that the more they have had, the more the risk goes down, and down, and down.” It takes around a decade for the protective effect of childbirth to show; indeed breast cancer risks increase immediately after a birth.

One reason the Professor became interested in the Pill and breast cancer was that she hoped that the oral contraceptive provided protection – but it doesn’t. Also, the natural protection is not simply related to pregnancy, as it does not occur in women who have been induced or had spontaneous abortions. But the final factor in childbearing, which does have an effect, is breast-feeding; the more time spent breast-feeding the higher the protection.

Pulling all the evidence together, it is possible to estimate what the
impact on breast cancer rates
would be if Western women had
more children and breast-fed for
longer. A shift to five or six
children, rather than two or three,
and to breast-feeding for two
years would more than halve the
levels in developed countries. “I’m
not saying that’s what women
should do; I’m saying it does
account for a very large part of the
high rates of breast cancer in the
West.”

When nutritional factors, includ-
ing alcohol consumption and
post-menopausal obesity, are
taken into account, Western rates
would drop to around 1.8%,
closer to those of rural Asia and
Africa. The Professor added that
genetic predisposition does make
a difference, but only for individu-
als (and not as much as many
imagine) and is not significant
between populations. A woman
in the West with the lowest
genetic predisposition to breast
cancer is still at greater risk than a
typical woman in the developing
world.

Ethnicity is not an important
factor, as black and white Ameri-
cans have similar breast cancer
rates, while rural Africans do not.
Similarly, the incidence used to be
low in Japan, but has accelerated
as social changes take place.
Rapid increases in breast cancer
numbers are currently being
reported in China.

Current trends suggest that the
number of new cases a year
worldwide will double from two
million in 2000 to four million by
2040. “The question is what we
are going to do about it. It’s not
going to go away; it’s going to get
worse,” said Professor Beral.
Returning to having very high
numbers of children is not an
option, nor is concentrating
simply on cures; thus a preventa-
tive approach is essential. Of the
50,000 annual cases in the UK,
around a fifth could be avoided if
all women stopped drinking,
using HRT and avoided obesity –
still leaving the bulk of the
problem untouched.

Emphasising that that she was
now straying into an area of
speculation, the Professor said:
“Shouldn’t we be thinking of
some kind of intervention that
mimics the positive effects of
childbearing? We know that
something happens in the later
stages of pregnancy that gives
life-long protection against breast
cancer, and it appears to be linked
to hormonal changes. What is
needed”, she argued, “is a
concerted drive to identify the
source of this protection so it can
be used to create a hormonal
vaccine. “We know where we
should be looking but we are just
not doing it,” she concluded.
What are gravitation and relativity? What are black holes; how do they form; and what do they do to space and time? What do all these have to do with our existence and the possibilities of interstellar travel?
Professor Brown discussed these near magical cosmic questions using demonstrations from his repertoire as a semi-professional magician.
As part of the 11th International Meeting on Statistical Climatology (11 IMSC), in partnership with the Royal Society of Edinburgh, Professor Heinz Wanner and Professor John Haslett explained to a packed audience details about climate change during the last 10,000 years. The speakers addressed both the factors affecting the climate and the problem of uncertainties in our knowledge, as well as the difficulties facing scientists in communicating the nature of this uncertainty to others.

The first speaker was Professor Heinz Wanner, an expert in palaeoclimate reconstructions, who discussed the key factors affecting past climate. He showed how the climate has changed over the past 20,000 years, warming from an initially cold ice age period until the present interglacial period, called the Holocene, by showing a graph of temperature reconstructed from observations made from Greenland ice cores. The warming trend shown was not smooth however, and after an initial strong warming, the temperature fell rapidly again back to ice age conditions for a short period of 600-700 years, known as the Younger Dryas, caused by melt-water fluxes from the Laurentide ice sheet influencing the Gulf Stream. After another period of warming during the Holocene, the climate became comparatively stable, albeit with observable temperature fluctuations in the mid-latitudes and polar areas, and precipitation fluctuations in the equatorial areas. Professor Wanner mentioned that it has been proposed that this relative stability could have played a crucial role in the development of humankind.

A strong factor in the Holocene climate has been the slow melting of the ice sheets, in particular the gradual melting of the Laurentide ice sheet over northern North America. This melting resulted in a strongly rising sea level until
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about 7000 years ago. Also important is the melting of sea ice. Sea ice reflects light, as can be clearly seen from satellites in space, as opposed to the sea which absorbs and therefore appears black; consequently the quantity of sea ice is hugely influential for our climate. Since we have no precise information about its quantity, this represents one of the greatest uncertainties in our understanding of the Holocene climate.

One of the key drivers of climate during the Holocene is the change in solar radiation due to variations in the Earth’s orbit round the Sun. Over the last 10,000 years, the summer solar insolation in the Northern Hemisphere has declined by approximately 40Wm⁻², a significantly large amount. Conversely, the summer insolation in the Southern Hemisphere has been gradually increasing. These changes have had a large influence on the climate of the Holocene, which can be roughly divided into four periods. The first, ‘temperate’ period is characterised by the Northern Hemisphere ice sheet melt, and a successive warming due to the stronger solar insolation. The middle, ‘warm’, period, also referred to as the ‘optimal’ period, has the warmest temperature, also attributable to warming from the ocean, which integrated the high Northern Hemisphere summer insolation. The third ‘cool’ period shows a gradual cooling due to a drop in Northern Hemisphere solar insolation. Finally, over the last 100–150 years, this temperature trend has been reversed, with the temperature showing a warming. This change in the energy input has other effects, most notably a change in the position of the Intertropical Convergence Zone (ITCZ), which is an area of high convection near the Equator. The solar insolation change has caused the ITCZ to move southward which, in turn, has caused a weakening of the monsoons over the last 6,000 years. Also important is the effect of the change in energy input on glacier dynamics. Observations of tree-rings, moraines and sediments show that over the last 6,000 years glaciers have been advancing in the Northern Hemisphere while they possibly retreated in the Southern Hemisphere.

As well as these long-term trends, the observational record also shows periods of rapid climate change where the temperature rapidly cools, referred to as ‘Bond cycles’, identified by looking at sediments in the Atlantic Ocean. It is thought that some of the early events may be due to changes in the thermohaline circulation; however the cause of the later events is still highly uncertain.

Looking at the last 1,000 years, temperature reconstructions show that, on average, temperature was
higher during the Medieval Warm Period (MWP) and lower during the Little Ice Age (LIA). However, if we look at maps showing temperature anomalies for these periods, the situation is more complex. It can be clearly seen that while many areas were warmer during the MWP, there were also areas which were actually colder; equally during the LIA, although many areas were colder, there were also areas showing increased temperature.

Studies show that over the last 1,000 years, volcanoes have been strongly influential on the climate, having a cooling effect; in addition, changes in solar activity have also had some influence. Over the last couple of centuries, the human (anthropogenic) influence has been rapidly growing due to the burning of fossil fuels. Models including these forcings have been developed and the effect of these forcings, both in the model results and in observations, can be seen. These models show us that the anthropogenic forcings outweigh the natural forcings over the most recent period, with a high degree of certainty. It is a still an open question as to what the climate would have been like now if the anthropogenic influence had been removed, although it is thought that it would have been similar to either the LIA or to conditions experienced around 1900.

Professor Wanner concluded his talk by discussing the impact of recent climate change on mankind. People in the richer developed countries in the north such as Scotland and Switzerland (his own country), might be able to afford to adapt to the changes, but people in the developing world, particularly in the areas predicted to get drier around Asia, Africa and Latin America, will face real problems.

The second speaker was Professor John Haslett, a statistician from Trinity College, Dublin. He primarily addressed the issue of uncertainty and how this can be communicated. “How much do we know these things? How much of them do we know?”

Professor Haslett showed how it is possible for scientists to communicate uncertainty to other scientists by the use of error bars. But how does the media ‘do’ uncertainty? He demonstrated this by use of an example. Data from Glendalough, a glacial valley in Ireland, indicated a period of rapid climate change in the past. About 10,000 years ago, there was a period of rapid warming, when the climate went from an extremely severe cold climate to one not unlike today’s climate. No one knows for sure over how short a period this warming took place; however the scientists are reasonably certain that it probably happened over a period of less
than 30 years, and maybe even as short as seven. A national newspaper took up this story and illustrated it with a large picture showing, on one side, a current photo of Glendalough and, on the other, a photo of the same location with glaciers and ice superimposed, with a title “How Wicklow went from Arctic to mild in seven years ...”.

Scientists have investigated this episode by collecting many different types of data, called ‘proxies’, from around Glendalough; for example pollen found in mud cores. It is then possible for scientists to calculate many different scenarios that are consistent with the data. This then allows for plots which show statistical uncertainty, and make possible statements such as “ninety five percent of models which fit the data lie within a certain range”. Rapid climate change such as this has been found to occur frequently in the past, and is an important, significant and interesting phenomenon. When the audience were asked whether the photos from the newspaper were more memorable than the scientific plots, the majority picked the photos, thus illustrating the problems in communicating scientific ideas and uncertainty to the public.

Professor Haslett explained that although mathematicians can do proofs, statisticians, scientists and even the law struggle with them, (although in many cases it is possible to disprove an idea by proposing a single counter example). This then means uncertainty is involved. It is possible to study our uncertainty – statisticians make a living out of it, – but it is much harder to communicate it. The website Understanding Uncertainty, set up by David Spiegelhalter, the Winton Professor of the Public Understanding of Risk, does a good job of this.

The talk concluded by discussing the large discrepancy between the scientific view on climate change and the public. The scientific community, almost to a man, is united in believing one thing, but public opinion instead is divided. Communicating the science to the public is an important and difficult task and one in which what the press say is probably more important than what the scientists say.
Despite the gloomy outcome of the Copenhagen Summit, Nicholas Stern is optimistic that an international agreement to tackle climate change could emerge within the next two years. The man whose team produced the Stern Review on the Economics of Climate Change in 2006 argues that the existence and effectiveness of such an agreement will be determined by political will.

Lord Stern argued that there are two defining challenges of the 21st Century – managing climate change and overcoming poverty; failure to tackle one spells failure tackling the other. If climate change is not addressed, the environment will become too hostile for development. But if addressing climate change requires strong constraints on living standards in developing countries in the next two or three decades, it will be impossible to create the necessary international coalition. This interrelation underpinned Lord Stern’s argument.

Lord Stern outlined the basic climate change argument, as he recognised that not everyone has understood the magnitude of the problem. Global warming is being caused by the increasing concentration of greenhouse gases in the atmosphere, currently 435ppm (parts per million) of carbon dioxide equivalent. These gases are being emitted faster than the planet can absorb them and so more energy is being trapped, driving up temperatures. These higher temperatures lead, in a fairly complicated way, to climate change.

Each year about 2.5ppm carbon dioxide equivalent is being added to the atmosphere, and that rate is increasing. Given that the current level of concentrations is around 435ppm, over a century, concentrations will rise to around 750ppm or more if no action is taken to curb greenhouse gas emissions. This will result in perhaps a 50 per cent chance of a temperature rise of 5°C above pre-industrial levels, a mean temperature not known on the planet for some 30 million years. The climate change that will follow might lead to southern Europe becoming like the Sahara Desert, to many low-lying parts of the world being inundated by the sea, and to the collapse of the
Amazon rainforest. We cannot predict the temperature increase or its consequence with certainty; this is about risk management. But we should recognise that the risks are potentially immense.

Lord Stern warned that perhaps billions of people will need to move. “We’re talking about prolonged, severe global conflict,” he said. “These are the kinds of stakes we’re playing for.”

The Stern Review of 2006 under-estimated many of those risks, he argued. Greenhouse gas concentrations are building faster than the economists had expected, the ability of the planet to absorb them is deteriorating more rapidly than had previously been understood, and some of the impacts of climate change are manifesting themselves earlier than anticipated. Lord Stern said the magnitude of the response to this challenge has to correspond to the magnitude of the risk.

Currently, around 47 billion tonnes of carbon dioxide equivalent are emitted per year. Lord Stern argued that to give humanity a 50:50 chance of limiting the temperature rise to 2°C above that of the mid 19th Century, this total would have to be reduced to well below 35 billion tonnes per annum by 2030, and well below 20 billion tonnes by 2050. Per capita, this means cutting today’s level of seven tonnes to four by 2030, and to around two by 2050, taking projected global population increases into consideration.

The good news is that ways to achieve these goals are being developed rapidly. Lord Stern said the reductions could be produced by energy efficiency, low carbon technology and by stopping deforestation. This amounts to what he described as a new energy-industrial revolution.

Lord Stern said that previous industrial revolutions had involved an initial surge of investment lasting two or three decades. He predicted that the transition to a low-carbon economy that an energy industrial revolution will entail could be a very dynamic period. Whilst this is motivated by a necessity to cut climate risk, the result could be a dynamic growth surge for 30 years or more. That could be particularly attractive to developing countries, where the challenge of overcoming poverty is so important. “If we don’t get growth, we won’t get a coalition,” Lord Stern said. And when we achieve low-carbon growth, it will be more energy-secure, cleaner, quieter, safer and more biodiverse; in other words much more attractive than current forms. And any attempt at high-carbon growth will kill itself from the very destructive environment it would create.

The signs are encouraging. Lord Stern observed that the flow of
low-carbon ideas in the last few years in fields such as transport, architecture, power generation and agriculture has been extraordinary.

The focus of the economic policy side of climate change management is on market failure. Lord Stern said that markets failed when they did not reflect the costs of actions and that there is a big cost to the emissions of greenhouse gases. He argued that emissions are being systematically subsidised because they are not being priced. To get the markets to work well, Lord Stern said there has to be some kind of price for carbon.

The matter is not just about carrots and sticks, but also about responsibility. Reducing risk by changing behaviour is a responsible response to the challenge of climate change. We, as John Stuart Mill argued, form our views of what is right and responsible by careful discussion of the issues.

In summary, we know the magnitude of what we have to do, we know the areas in which we have to act, we can see the technologies to deliver this, we can see the economic policies that can support this and we know enough to get started. What is missing, Lord Stern said, is the political will. “This subject tests our rationality as human beings to think through the consequences,” Lord Stern said. If we wait, as in the narrow evolutionary model, to see the full consequences of our ways, it will be too late.

On a national level, helping people understand the magnitude of the risks they face is of fundamental importance. Lord Stern said it is also vital that they understand that actions to reduce the risks can have attractive aspects. He said that the price of some things will go up and that electricity, for example, might cost 15 to 20 per cent more. But there will also be the many economic and social benefits described, as well as the redirection of climate risk.

Lord Stern said that many countries are increasingly recognising the new industrial revolution carries big advantages for whoever gets there first. For instance, there has been a remarkable shift in the debate over tackling climate change in China.

On an international level, climate change has become a major political issue over the last five years in a way that was not true five years ago. Lord Stern argued that there have been some positive aspects to the United Nations Climate Change Conference in Copenhagen last year, not least the fact that more than 100 presidents and prime ministers attended. But that should not obscure the fact that the meeting was “cold, chaotic, quarrelsome and disappointing”.

Events 09/10
Lord Stern said the Copenhagen Accord was much less than many had hoped for and much less than could have been achieved. He said there had been serious misunderstandings, bad listening and, what he described as “crazy”, an attempt by rich countries to tell the poor countries what to do. But he said that Brazil, South Africa, China and India are no longer just looking for the rich countries to act but are instead asking what they might or should do themselves, considering that they are among those who will probably be hit first and hardest by the impact of climate change. Whilst Lord Stern said the Copenhagen Accord was fragile, it seems to be less fragile than many had feared at the time. “If you look at the detail of the commitments, of the ideas and the groups that have been convened, we are moving forwards,” he said. When we left Copenhagen in December we did not know that the “emissions intentions for 2020” envisaged in the Accord and to be submitted by the end of January 2010 would in fact be submitted. In fact, all major countries have presented their intentions and 85 per cent of emissions are covered.

The next United Nations Climate Change Conference, to be held in Cancun, Mexico, later this year, should aim for a political agreement, Lord Stern argued. The following conference, in Durban, South Africa, in 2011, might aim for a treaty. The animosity and acrimony that was evident at Copenhagen is still there, fuelled by a sense of injustice amongst developing countries. But Lord Stern said there has been, at least the beginnings of, a political shift in those countries to take the future of the planet into their own hands.

Lord Stern said that individual responsibility has an important role to play, not least in building and influencing the political will to tackle the issue. This is a challenge for academics, journalists and politicians, amongst others.

“If we all decide it’s too difficult, that people cheat, that the US won’t give up its cars or China give up its coal, then we will be absolutely right,” Lord Stern said. “The only way forward is to describe analytically and carefully what we can do and why it’s attractive.” He recognised that we cannot know with confidence whether sufficient political will can be generated, but argued it is vital to try.
“More listening, less judgement. More sensitivity, less aggression.”

Billed in advance as “a lightning rod for controversy,” the Swiss-born academic Tariq Ramadan said everybody living in the West – Muslims as well as non-Muslims – should engage in open dialogue and listen to each other, exploring what we have in common rather than focusing on the problems that drive us apart...

Introduced by Chairman Stuart Kelly (Literary Editor of Scotland on Sunday) as the “Muslim Martin Luther,” Ramadan stressed throughout the one-hour event that all of us have multiple identities but share the same future. Ramadan himself is a self-styled reformist, comfortable in many roles, including European, universalist and Muslim. “Can the Muslim community be fully Western and fully Muslim at the same time?” he asked at the start.

“Indigenous citizens are simply earlier immigrants,” he said near the end, “but some have to prove they are citizens more than others.”

Ramadan has also been accused by his critics as “a Trojan horse for radical Islam,” but ultimately he seeks “intellectual empathy” and reconciliation. He started his talk by explaining why he wrote his recent book, What I believe – an attempt to talk about the “controversial topic” of Islam in such a way that it would be accessible to Muslims as well as non-Muslims. Without seeking to avoid complexity, he wanted to go beyond the “problems” of Islam to talk about citizenship and identity, as well as the essence of Islam. He also wanted to discuss the socio-economic problems faced by us all rather than reduce all problems to religion, and go beyond blame to talk about our shared responsibilities and the need for more constructive debate.

Many Westerners are ignorant or “frightened” of Islam, and even talk about the “silent colonisation” of the West by Islam. These issues can’t be ignored, but Ramadan also suggested that many politicians and journalists stir up controversy for personal gain. “We can’t be spiritual and colonised by fear,” he said, since religion is all about coming to terms with our fears.

Even though Ramadan seeks dialogue and understanding,
Review of Sessions 2008/09 and 2009/10

several “controversial” problems would not go away, including the infamous Danish cartoons, Islamic extremists, terrorism and attempts to ban the burqa in several countries – topics raised by members of the audience. In Switzerland, said Ramadan, there have even been attempts to outlaw minarets, despite constitutional backing for freedom of conscience and freedom of worship.

Ramadan also talked about the recent proposal to build an Islamic community centre near the site of ‘Ground Zero’, saying that although most Westerners are ignorant of Islam and see it as a threat, the Muslim community should also be more sensitive to people’s feelings – and be aware of other factors, not just their rights. The proposal is a “bad good idea,” he added, and it could be perceived as “an insult to memory” in certain quarters. We need wisdom as well as the law, he suggested, but even though a lot of people talk about the need for open dialogue, what they actually engage in is an “interactive monologue.” Later on, he also said that freedom must have limits. Just because we have the right to do something does not mean we should do it. “More sensitivity, less aggression,” he added.

Ignorance and misrepresentation of Islam can also lead to division, and Kelly suggested that language was part of the problem, including now common words such as jihad. Ramadan explained that jihad has nothing to do with ‘holy war’ but actually means ‘road to peace’ and improvement. He then turned his attention to the European concept of “tolerance,” saying that tolerance is not enough. “I want to be respected not accepted or tolerated,” Ramadan said. “I can tolerate you and ignore you but I cannot ignore you if I respect you.” Sometimes we use the same words but not the same meaning, he added.

Ramadan also said that to “avoid any kind of doubletalk,” he wanted to get to the essence of the religious message and stop talking about Islam as a problem but as a religion. Intellectual empathy is critical to Ramadan’s approach to religion and philosophy: “I may not agree with you but I am trying to understand. Now is the time to love more and open the door.”

In the quest for meaning, Ramadan continued, “let us talk about our West” and what we have in common. As part of this new narrative, we need to recognise our “common history of diverse memories.” Ramadan is also “full of hope” that a new generation of scholars and citizens is trying to understand and “build bridges,” recognising “we are from the same society.”
Ramadan also highlighted some of the contradictions which get in the way of more open debate. Muslims used to be criticised for not knowing enough about European civilisation, but today they are mistrusted for knowing too much. He also suggested that the much higher profile of Muslims today in the West is ironically because they are more integrated – not less. Instead of hiding in the background, they are more confident about displaying their identity and thus more visible. They want to be welcomed.

Asked about the UK Government’s attitudes to Islam and support for Turkey’s entry into the EU, Ramadan pointed out that according to surveys, 73 per cent of all Europeans supported Israel in 1967 but that today the situation is reversed, with 67 per cent supporting Palestine. The critical question is consistency, said Ramadan. There is hypocrisy regarding Turkey’s entry, he added, as if it is regarded as a Muslim state, not really European. Europe also has no single policy on Palestine. Ramadan condemned violent extremism, but said that even though some politicians, such as ex-PM Tony Blair, say there is no relationship between the UK’s foreign policy and acts of terrorism, the simple fact is that the extremists do make the connection. The Iraq war was “based on lies,” he continued, but we should talk about it as Europeans, not according to religious or political beliefs.

Asked what he thought about the “new atheism” in Europe, Ramadan said that these “militant” atheists are responding to the fact that religion is on the agenda again. “God is back,” he added, but if atheists want to engage in debate, they should be “more serious and less reductive” and not treat people with religious beliefs as “dreamers and simplistic minds.” Similarly, religious people should face up to the complex challenges of modern life. “Ethics must be applied in everyday life,” he continued. “Don’t just pray for change in the world but pray while changing the world.”

When it comes to understanding Islam, Ramadan said it was important to listen to Muslims as well as read the primary sources, including the Quran. There are many different kinds of Muslims, he continued, the same as with Christians. “Don’t be a judge,” he said, “but an active participant in the dialogue. Read the books and listen to what people say about them – more listening, less judgement.”

In response to an audience question about the reaction of “the whole Muslim world” to the “blasphemous” Danish cartoons,
Ramadan explained that it was three months after publication before there were any significant protests, and also many voices of dissent among Muslims. There was also a difference between the reaction of media and politicians, while many of the protests should be seen in the context of the frustration felt by many Muslims in countries where they have no political freedoms and “a negative perception of the West.” It is easier, he added, for some governments to allow demonstrations against the West rather than against their own regimes, because it diverts people from reality. We must condemn excessive reactions, he said, but we should also understand why feelings do run so high, in face of Western dominance and arrogance.

Ramadan also said he was opposed to any new laws for the protection of religious minorities (e.g. blasphemy laws), saying that we have enough already, including anti-racist legislation. In France, there are proposals to take away citizenship from anyone who advocates “unconstitutional” practices such as female circumcision or polygamy, but Ramadan believes this is a dangerous idea that would only be counter-productive, “not only changing the law but the spirit of the law” by creating different levels of citizenship.

On a more scriptural note, Ramadan explained that there are primary and secondary sources in Islamic law, and a lot of ignorance about the main sources. As a reformist, he believes that we must understand the context of the primary sources and how they apply to ethics today. Muslims should engage in dialogue with Christians, Jews, Buddhists and atheists, but “let’s look at our principles and values, not just the texts,” he said. The models in the scriptures are historical, he added, but the principles are universal. Similarly, we should not avoid discussing extremists but see them in context. George W. Bush may have said that the terrorists hated Western civilisation, but it is not a battle of good versus bad. Muslims range across the spectrum of humanity, like everyone else. “Political Islam is as complex as Islam itself,” he added.
Dr Martin Hendry  
Department of Physics and Astronomy, University of Glasgow  

**Probing the Dark Side of Einstein’s Universe**  
Orkney International Science Festival Lecture  
**7 September 2010**

Gravitational waves, the ripples in spacetime predicted by Einstein’s Theory of General Relativity, are produced by some of the most violent and energetic phenomena in the universe, including black holes, neutron stars and supernovae. Dr Martin Hendry of Glasgow University introduced the new field of gravitational astronomy and explained what discovery of gravitational waves could mean for attempts to understand the mysteries of dark matter and dark energy.

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**Spitalfields Day : Geometry and Algebra**  
**17 September 2010**

This Spitalfields Day was organised in connection with the election in May 2010 of Professor Hirzebruch to Honorary Fellowship of the Royal Society of Edinburgh.

These lectures were aimed at a general mathematical audience, accessible to graduate students.

Talks were given by Sir Michael Atiyah, Friedrich Hirzebruch and Andrew Ranicki.
At a political turning point, with a new Coalition government in power at Westminster with its own policy objectives to pursue, Professor Krebs opened by saying he was not going to talk about the science of climate change. Rather, his main focus would be on asking if what we are doing as a nation at present to reduce the impact of carbon emissions is working and, if not, can we begin to behave differently? Are individuals willing to change; is there political will for change, and, indeed, can we end what is known as the culture of “virtuous consumption?”

First, though, a brief recap of the evidence for global warming and climate change. Data from official sources, including the Met Office and the University of East Anglia, show clearly that the 2000s were the hottest decade on record. Sea levels are rising, the oceans are becoming more acidic and there is more rainfall – all signs of climate change as has been modelled. Climate change is happening and the evidence points to it being man made. “We know the general direction of travel”, Professor Krebs declared, “only the pace and extent of change is uncertain. If we accept that, then what are we going to do about it?” he asked. There are two broad responses: either cut emissions and try to alter the pattern of global warming, or sit it out and adapt once changes are evident.

In his view, it makes economic sense to try to mitigate the impact of rising emissions now. Nicholas Stern, in his 2006 report (The Economics of Climate Change), said modest investments now would save huge costs later on. There are other reasons too to take action. Climate change will affect food and water supplies, fish stocks and forestry around the world. Although the worst effects might not appear in the lifetime of those in the room – “I will be dead and buried” – what risks are our generation prepared to take with the future of its grandchildren?

There are compelling arguments for mitigating now, Krebs insisted, not least a consensus that temperature will rise by up to two degrees centigrade, whatever actions we take now. There is activity at international level, despite the failure to reach
agreement at the Copenhagen environment summit last year. But making global change is like “turning a supertanker”, in that altering course is very slow. Globally, we need to reduce carbon emissions by 50% by 2050 to have a 50% chance of keeping rises below two degrees. Individually, we are all emitting ten tonnes annually and we need to get that down to two tonnes. Some countries are making big improvements, but there are others, where emissions are rising rapidly, who say that we have to cut faster to make up for the greater share of emissions we produced in the past. In the UK, we emit 680 million tonnes a year and we need to get that figure down to 159 by 2050. “It is a huge mountain to climb down,” Krebs said. Even then, another problem remains to be addressed. As we have exported a great deal of our carbon emissions to countries which manufacture goods that we consume, the emissions from consumption should also be added on top, even though that would increase our footprint.

“That’s the challenge”, Krebs said. “How to meet it?” The job of the climate change committee is to lay out a ‘road map,’ taking into account what is technically feasible, the cost per tonne of carbon saved by any measures that might be taken, the policies that should be pursued, the targets we are trying to achieve and how our actions fit in with global actions.

So what actions should be taken? Decarbonising power generation is a priority, with at least 20 gigawatts of generation to be provided by wind by 2020. There should be a role for nuclear power and development of carbon capture and storage at coal and gas powered plants. Government has a role in guaranteeing price stability to producers, as an unregulated energy market would not be effective. Improving energy efficiency is also a key area, as is making major change in the use of transport, particularly on the roads.

It’s an ambitious programme, Krebs said. But although emissions are reducing by 0.5% a year, there needs to be step change up to 2–3%. Although the UK’s carbon footprint went down in 2008/9, it was a ‘blip’ most likely caused by the recession. The pace of change at present, returning to the ‘mountain’ metaphor, is that we are not even heading towards base camp at the moment.

The new Environment Secretary, Chris Huhne, has asked whether we can go further than our target of increasing electricity generated by renewables from the present 3% to 15% by 2020. But we will be stretched to get to 15%. We need a step change in investment and the removal of barriers to
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investment. But we have to avoid mistakes along the way, such as the production of ethanol in the US, which caused problems of its own.

Aviation emissions are another area we need to tackle. Government wants to keep expansion down but the bottom line is that we have to curb air travel if we are serious, and cap it at 60%. Unconstrained growth will bring 150% expansion by 2050.

There are ambitious targets to cut emissions by more than 40% by 2020. To reach those targets, however, we need new policies and a step change in attitudes. Otherwise, it will be very tough indeed. The things that need to be done are radical and we need to change lifestyles. Will we do this voluntarily, or do we need to be coerced into doing it by government? People don’t like that, so are there pointers in the new science of behavioural change as to how we move forward?

US author Robert Cialdini has written about the ‘six weapons of influence’ that persuade individuals to follow a course of action. They are:

1. Reciprocity – getting something back.
2. Commitment – I want it.
3. Social validation – everyone else has it.
4. Authority – leading experts say “this is good.”
5. Liking – my friends have got it and like it.
6. Scarcity – I have something others don’t have and can’t necessarily afford.

Some of these techniques will have to be employed if we are going to change our behaviour, become green warriors, not fly, wear jumpers, and do what the government would like us to do. There are behavioural change success stories that we can refer to, including drink driving, seatbelts and smoking. All involved a combination of education, legislation and (in the case of tobacco) taxation. With drink driving, in the late 1970s, 1500 people were killed as a result. That figure in 2008 was 430. Legislation made a difference, even though there was a 71% increase in traffic over that period.

Individuals won’t make changes in big enough numbers on their own. Take green consumerism. Although 30% of consumers say they are concerned about the environment, only 5% buy green products. That is less than 1% of household expenditure. Education has a role too. We know which devices will make most impact on carbon emissions, but most consumers do not. Changing the temperature setting on a washing
machine will make a huge difference, but changing a light bulb won’t. The problem for politicians is that changing behaviour is not a vote winner. In opposition, Chris Huhne argued for more regulation and subsidies. What will he say in power?

It’s said we don’t need to worry about climate change because technology will solve the problem. But Professor Krebs argued that technology is not keeping pace with the growth of consumption and cannot reduce emissions fast enough. So we have to question the whole culture of virtuous consumption. Do we want this to end or do we just want to get richer through more economic growth? But above a relatively modest level of wealth, the evidence is that getting richer doesn’t make you healthier or happier. It tails off, as does life expectancy. So why go on creating wealth? We don’t consume because of need, it’s to “keep up with the Joneses.”

But what’s the alternative? Tim Jackson’s book, *Prosperity Without Growth*, suggests moving away from consumerism. Stop measuring progress through GDP and invest in green technologies. The current methods of measuring growth are flawed. If you spill oil in the Gulf of Mexico and spend a lot of money cleaning it up, it adds positively to GDP at the moment. It’s the same with cutting down forests, as that generates wealth. But what’s good for GDP is not necessarily good for you as an individual. So we should not measure progress by GDP but by something else.

As a conclusion, Professor Krebs posed two questions. Would we elect a government that would be coercive on climate change? Are we prepared to stop getting richer? If the answer is no to coercion, then we will not beat climate change.
PUBLICATIONS

2008 – 2009

Proceedings A: Mathematics
Six issues were published: Parts 138.5 & 138.6 (2008) and 139.1, 139.2, 139.3, 139.4 (2009)

Earth and Environmental Science Transactions
Two issues were published: Parts 99.1, 99.2

ReSource – the RSE’s Newsletter:
Issues 22, 23, 24, 25

RSE Directory


Science Scotland:
One issue was published: No. 7

Electronics

2009 – 2010

Proceedings A: Mathematics
Six issues were published: Parts 139.5 & 139.6 (2009) and 140.1, 140.2, 140.3, 140.4 (2010)

Earth and Environmental Science Transactions
Five issues were published: Parts 99.3/4, 100.1-2 and 100.3 including a special issue 100.1/2

The Sixth Hutton Symposium on The Origin of Granites and Related Rocks.

ReSource – the RSE’s Newsletter:
Issues 26, 27, 28

RSE Directory


Science Scotland:
One issue was published: No. 8

Life Sciences: SULSA under the Microscope,

Policy Advice

POLICY ADVICE

2008 – 2009

INQUIRIES
During the Session the Inquiry team carried out a series of dissemination events, across Scotland, related to the Inquiry The Future of Scotland’s Hill and Islands (2008)

SUBMISSIONS
During the Session, the Society submitted comments on the following reports:

Advice Papers (AP) and Briefing Papers (BP)

January 2009
AP 09-01. Putting Science and Engineering at the Heart of Government Policy

February 2009
AP 09-02. Commission on Scottish Devolution
AP 09-03. The Climate Change (Scotland) Bill: A response to the Scottish Parliament’s Transport, Infrastructure, and Climate Change Committee

March 2009
AP 09-04. A Coordinated Agenda for Marine, Environment and Rural Affairs Science

April 2009
Request for Strategic Advice on Business Schools in Scottish Universities: a response to the Scottish Funding Council

AP 09-05. Supplementary evidence for Science and Engineering at the Heart of Government Policy


May 2009
Letter The Marine (Scotland) Bill. Letter to Rural Affairs and Environment Committee
BP 09-02. Debate in the Scottish Parliament on Influenza A (H1N1)

June 2009
AP 09-08. Preparing for a Changing Climate, Second Consultation to Inform Scotland’s Climate Change Adaptation Framework: a response to the Scottish Government
AP 09-09. Supplementary Advice Relating to the 3rd Stage Debate in the Scottish Parliament on the Climate Change (Scotland) Bill
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BP 09-03. The H1N1 Outbreak and the Threat of Pandemic Influenza: Further Comments

August 2009

AP 09-10. The public Services Reform (Scotland) Bill. The Establishment of Creative Scotland

September 2009

AP 09-11a. A Framework for the Development of Clean Coal

AP 09-11b. The Development and Deployment of Carbon Capture and Storage in Scotland

AP 09-12a. Reform of the European Union Budget

AP 09-12b. Reform of the European Union Budget - building on a response to the Scottish Parliament

AP 09-13. Setting Science and Technology Research Funding Priorities

BP 09-04. Debate in the Scottish Parliament on Scotland's Energy Future
INQUIRIES
During the 2009/10 Session, the Society published the Report of its inquiry Digital Scotland. The report sets out why Scotland’s digital future is a crucial issue and what needs to be done. It suggests how the enterprise could develop as a distinctively Scottish community effort, bringing benefit to the whole of Scotland, without the need for major Government funding at a time when public expenditure is under great pressure.

The Imperative
Communication is the life-blood of commerce and society. Digital technologies enable new forms of communication. Broadband infrastructure has become a key fitness factor for talent, investment and prosperity in today’s global economy, essential to public service delivery, cultural vitality and economic efficiency. Scotland must aim for universal digital inclusion and avoid the threat of a widening digital divide.

Scotland has to take the lead in creating this infrastructure because:

- it has both the authority and resources to do so
- there is currently no adequate UK or European plan
- Scotland has unique demographic and social challenges
- any effective plan will require local action from local communities.

This report sets out an effective strategy for making Next Generation Broadband (NGB) accessible to the whole of Scotland by 2015. The strategy is largely self-financing. It involves investment in long-term infrastructure that will enable access for all individuals, businesses and public institutions (schools, libraries, hospitals) in the country.

Key recommendations:

- Establish a Digital Scotland Trust, to raise finance, procure, operate and maintain the required core infrastructure in the national interest.
- Create an optic fibre backbone, analogous to the trunk roads of our transport network that brings next-generation speeds to a nationwide network of digital hubs where community networks and service providers can connect to a trunk connection to the global internet. Any circle drawn on the map of Scotland to include a settled population of at least 2,000 people, should also include a hub.
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- Provide social hubs, where internet access and support is available to all, in libraries and other community centres.

*Digital Scotland* - RSE Committee of Inquiry Report (Oct 2010).
ISBN: 9780902198364

**SUBMISSIONS**
During the session, the Society submitted comments on the following reports:

**Advice Papers**

**November 2009**
AP 09-14. Scotland and the UK: cooperation and communication between governments

**December 2009**
AP 09-15. Inquiry into Bioengineering
AP 09-16. The Research Excellence Framework
AP 09-17. Sustainable fisheries: reform of the Common Fisheries Policy
BP 09-05. Climate Change and the U.N Copenhagen Summit

**January 2010**
AP 10-01. Impact of the Lisbon Treaty on Scotland
AP 10-02. Alcohol etc, (Scotland) Bill - including proposals for minimum pricing

**March 2010**
AP 10-03. Future Support for Agriculture in Scotland
AP 10-04. The efficient delivery of public services within a period of tightening public expenditure

**April 2010**
AP 10-05. Scotland’s Higher Activity Radioactive Waste Policy

**May 2010**
AP 10-06. End of Life Assistance (Scotland) Bill

**June 2010**
AP 10-07. Graham Donaldson’s Review of Teacher Education in Scotland
AP 10-08. Reform of Double Jeopardy
AP 10-09. Towards a Low Carbon Economy for Scotland
AP 10-10. Scotland’s International Engagement

**August 2010**
AP 10-11. Preventative Spending

**September 2010**
AP 10-12. Scotland’s Enterprise
The Scottish Bioinformatics Forum (SBF) was set up in 2001 under the stewardship of Scottish Enterprise to establish Scotland as a globally recognised and leading location for conducting cutting-edge bioinformatics research and sustainable commercial activity.

SBF began operating under the auspices of The RSE Scotland Foundation from 1 January 2008.

SBF aims to enhance knowledge and understanding of bioinformatics technology in both the academic research base and commercial organisations in the informatics and life sciences communities. SBF actively promotes training and knowledge transfer of bioinformatics skills, including facilitating multi-centre collaborations, industry and academic joint ventures, partnering, knowledge transfer, and bioinformatics training.
EVENTS FOR YOUNG PEOPLE

2008 – 2009

RSE@Arbroath

The Arbroath 2008 programme was launched on 25 February at Angus College.

The Arbroath project developed activities with and for young people, and the wider public, and included the art and humanities as well as science and technology based subjects.

Classes and workshops or both primary and secondary school students were held in various venues and a series of both school and public lectures on interdisciplinary topics were also delivered.

The themes for the year were:
- Identity and the people of Arbroath (January to March 2008)
- Wealth creation in Arbroath (March to June 2008)
- The Arts in Arbroath (June to August 2008)
- Places in Arbroath (August to December 2008)

RSE Roadshows

The Autumn Roadshow took place as part of RSE@Arbroath.

Three workshops and activities for primary year students took place: The Cliffs: Wildlife/Geology; The Coastline and The Harbour and Local Geology and The Cliffs: Legends and Myths.

RSE@Schools

RSE@Schools talks are available for P6/P7 and all secondary school years. They aim to enthuse and excite students about a wide programme, keen to share their enthusiasm for their subjects with students.

Talk (S3/4) - The Bellrock Lighthouse and the Stevenson Family ‘The Engineer and the Author’

Christmas Lecture

The 2008 Christmas Lecture entitled Science and Arbroath in the 21st Century was presented by Prof. Anne Glover FRSE, Chief Scientific Advisor for Scotland. This lecture touched on how science informs us of climate change, and how climate change will impact on communities such as Arbroath, what we can do about it and how scientists can make a difference.

Public Lecture

10 Nov 2008. Seven Wonders of the Industrial World – The Bell Rock Lighthouse. Bob McIntosh BSc.CEng MICE, Northern Lighthouse Board
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2009 – 2010

RSE Roadshows
The Spring Roadshow took place in Largs and took a nautical theme. Dr Sabrina Malpede shared her knowledge about how sailboats sail by delivering a series of workshops to P6 pupils from several local primary schools and the Roadshow concluded with a lecture *How does a sail boat sail?* Dr. Sabrina Malpede is the co-founder and Managing Director of SMAR Azure Ltd. She was awarded an Enterprise Fellowship in 2003 by the Royal Society of Edinburgh and Scottish Enterprise.

RSE @ Schools
RSE@Schools talks are available for P6/P7 and all secondary school years. They aim to enthuse and excite students about a wide range of topics. A wide variety of speakers contribute to the programme, keen to share their enthusiasm for their subjects with students.

- *The Man Who Planted Trees.* Various Schools
- *Solar System.* Burray Primary
- *Exploring the Dark Side of Einstein’s Universe.* Public Audience

Rocket Science. Stromness Academy

Apollo Moon Landings. Stromness Academy

Gravity. Kirkwall Grammar School


The Runaway Universe. Public Audience

Black holes, black magic and interstellar travel. Prof Alan Heavens FRSE. Public Audience, Mid Yell Junior School

Big Bangs, Black holes and White Rabbits. Prof. John Brown FRSE. Baltasound Junior School

A Career in Science. Various

The Suffering Gene, and Science meets Art, Art meets Science. Dr James Close. St John’s School, Dundee.

Bacteria live in communities. Dr Nicola Stanley-Wall. Coatbridge High

Christmas Lecture
The 2009 RSE Christmas Lecture entitled *Facing up to Climate Change* was presented by Professor Paul Jowitt FRSE
RESEARCH AND ENTERPRISE AWARDS

The following awards were made in Sessions 2008/2009 and 2009/10

RESEARCH FELLOWSHIPS

BP Trust Personal Research Fellowship 2009
Dr J Klett, Department of Pure and Applied Chemistry, University of Strathclyde - Application of Synergic Synthesis to Metal-Organic Supramolecules and Nanomolecules

BP Trust Personal Research Fellowship 2010
Dr J Thijssen, School of Physics and Astronomy, The University of Edinburgh - Novel soft materials for enhanced energy storage and conversion

CRF European 2009
Dr I A Biliarsky, Institute of History, Bulgarian Academy of Sciences - The Old Testament in the Political Ideas of Iro-Scottish and Slavic-Orthodox Tradition.

Dr M Cappuccio, Centro di Ricerca Sulla Complessità, Università Degli Studi Di Bergamo - Anti-representationalism and mirror-neurons-based action recognition models: ideomotor schemata, motor intentionality and smooth coping.

Professor K Dixon, British & North American Research & Studies Centre, Université Lumière de Lyon – Influences in contemporary British politics

Professor A Torre, Faculty of Law, University of Bari, Italy - Scottish Government and Constitution from the 1707 Union to Devolution

Ms E A Kirk, School of Law, University of Dundee - Arctic Governance

Dr P La Porte, Department of Language & Intercultural Studies, Heriot-Watt University - Perception and Misperception in International Politics: Britain, France, Spain and the Rif War (1921 – 1926)

Dr P Travlou, Open Space, Edinburgh College of Art – Examining New Approaches in Youth Specific Research Methodologies

Dr Z Varga, Centre for Russian, East & Central European Studies, University of Glasgow - National identity and language in 19th century travel writing.

CRF European 2010
Dr M Gurova, National Institute of Archaeology and Museum, Bulgarian Academy of Sciences - Comparative functional analysis of flint tools from Mesolithic and Early Neolithic sites in Scotland and SE Europe
Review of Sessions 2008/09 and 2009/10

Dr A Kovacs, Deprecen Reformed University, Hungary - The Impact of British Evangelicalism on the formation of New Orthodox Calvinism of Debrecen 1864 – 1914.

Dr K Milek, Department of Archaeology, School of Geosciences, University of Aberdeen - Social Spaces and Social Structures in Viking Age Iceland.

CRF Personal 2009

Dr K Zeng, Institute of Evolutionary Biology, University of Edinburgh - Modelling Genome Evolution in Bacteria.

CRF Personal 2010

Dr S Wang, Centre for Cognitive & Neural Systems, University of Edinburgh - The neuropsychology of memory persistence.

Lloyds TSB Personal 2009

Dr M Dewar, Human Cognitive Neuroscience, University of Edinburgh - Improving memory in amnestic MCI via minimal interference.

Scottish Government Personal Research Fellowships 2009

Dr S Coulthurst, MMB Division, University of Dundee - Investigation into the role of a new protein secretion system in the virulence of the opportunistic pathogen, Serratia marcescens.

Dr P Griffin, Department of Physics SUPA, University of Strathclyde - Microphotonic Quantum Regist-ters: Single Trapped Atoms for Quantum Simulation

Dr E Huitema, College of Life Sciences Plant Science, University of Dundee - Mechanisms of virulence acquisition during Phytophthora-host associations.

Dr A J McGowan, Department of Geographical and Earth Science, University of Glasgow - Disentangling signals of regional biodiversity change from geological and sampling biases.

Dr M Naylor, School of Geosciences, University of Edinburgh - Managing Uncertainty in Earth Systems.

Dr I M Overton, Medical Research Council. Institute of Genetics and Molecular Medicine - Integrative Computational Studies of Epithelial-Mesenchymal - Transition in Development, Stem Cells and Cancer.

Scottish Government Personal Research Fellowships 2010

Dr J I B Bos, Scottish Crop Research Institute - Manipulation of plant host cell processes by aphid saliva proteins.

Dr E Kay, School of Chemistry, University of St Andrews - Metamaterials Through Self-Assembly Across Multiple Size Scales.

Dr R Macleod, Division of Ecology & Evolutionary Biology, University of Glasgow - Can we predict impacts of environmental change.
on biodiversity from knowledge of behavioural decisions?

Dr C Moiras, Department of Chemistry, University of Glasgow - Non Equilibrium Engineering, Methods of Functional Metal Oxides

Dr J Stevenson, School of Geosciences, University of Edinburgh - Explosive silicic eruptions in Iceland: from vents to peat bogs

Scottish Government Support Research Fellowships 2009

Professor I G Main FRSE, School of Geosciences, University of Edinburgh - Identifying reservoir compartments

Professor J M Reese FRSE, Department of Mechanical Engineering, University of Strathclyde - Engineering Micro and Nano Flow Systems

Scottish Government Support Research Fellowships 2010

Professor D Heald, Business School, University of Aberdeen - Improving the Quality of Public Expenditure

Professor R Ocone FRSE, School of Engineering & Physical Sciences, Heriot-Watt University - Modelling Chemical Looping Technology for Clean Energy Production

Dr I Trendafilova, Department of Mechanical Engineering, University of Strathclyde - Modelling the vibration of structures made of composite materials

RESEARCH GRANTS, WORKSHOPS AND NETWORKS

Arts and Humanities Networks 2010

Dr R Jones Philosophy, School of Humanities, University of Dundee. Engendering Dialogue: feminist thought and contemporary debates in art, science and education

Ms E Ogilvie Art, Space, Nature, School of Landscape Architecture Edinburgh College of Art and Ms A Bevan, School of Sculpture, Edinburgh College of Art - Creative Research into the Environment

Arts & Humanities Small Grants 2009

Dr K Anipa, Department of Spanish, University of St Andrews - A Probe into the Early History of Juan de Valdes’s Dialogo de la lengua

Professor A Boyle, Scottish Centre for International Law, University of Edinburgh - The United Nations and International Law-making
Dr M Chrisman, Department of Philosophy, University of Glasgow - Why Knowledge is better

Professor R Evans, Department of English Studies, University of Stirling - What can a fourteenth-century manuscript held in a Scottish library tell us about Lollardy, the textual transmission of English vernacular devotional books and the medieval understanding of a “text”?

Dr C Gair, Department of English Literature/Andrew Hook Centre for American Studies, University of Glasgow - Writing Americans: The White City and the Invention of National Culture 1893 – 1917

Professor T Ingold FBA FRSE, Department of Anthropology, University of Aberdeen - Reconnecting the cultural and the natural: engaging art and anthropology in northwest Greenland.

Dr R McAllister, Department of Research, Royal Scottish Academy of Music and Drama - Celtic – Cossack Connections

Professor A Murphy, School of English, University of St Andrews - Ireland’s English: Edward Dowden and the Politics of Victorian Literary Studies

Professor J Porter, Department of Music, University of Aberdeen - Critical performing edition of Premier [Second] Livre du mes-lange des pseaumes et cantiques a trois parties, recueillis de la musique d’Orlande de Lassus, & autres excellens musiciens de nostre temps.

Ms A Thomas, Department of Archaeology, Orkney College - Monumental Visions: Art and Archaeology in the Heart of Neolithic Orkney World Heritage Site.

Arts & Humanities Small Grants 2010

Dr S Alves, OPENspace Research Centre, Edinburgh College of Art - Outdoor Environments and their impact on the quality of life of urban residents: Psychological and environmental aspects.

Dr S Dickson, Department of Modern Languages, University of Glasgow - Digital Edition of the Magazin zur Erfahrungsseelenkunde (Journal of Empirical Psychology).

Dr A Dimitrakaki, Department of History of Art, The University of Edinburgh - Gender, Art/Work and the Global Imperative...

Dr R McMaster, Department of Management, University of Glasgow - Conceptualising Care, Dignity and Generosity in an Institutional Economics Approach to Health Care

Dr K Pena, School of Modern Languages & Cultures, University of Glasgow - The Scottish Translator at Work: Alastair Reid on Borges.
Dr C Rossignoli, Italian Department, University of St Andrews - Castelvetro’s Dante: Reformation and Exegesis

Dr W Tuladhar-Douglas, School of Divinity, History and Philosophy, University of Aberdeen - Scotland’s devolved administration and the nationalist government: immigrant Buddhist perspectives...

Dr J Vergunst, Department of Anthropology, University of Aberdeen - Exploring Environmental Change Through New Connections in Arts and Anthropology...

**Arts & Humanities Workshops 2009**

Dr C Deliss, Future Academy, Edinburgh College of Art - Future Collections: Imagining Study Collections in the 21st Century

Professor S Frith, Department of Music, University of Edinburgh - Music Research and Music Policy

Mr R A Jamieson, Department of English Literature, University of Edinburgh - Between Leith and Lerwick.

Professor S Newman, Department of History, University of Glasgow - The Transatlantic Slave Trade and Plantation Slavery in the Americas: Exploring Scottish Connections

Dr K Whitby-Last, School of Law, University of Aberdeen - Obstacles and Solutions to the Repatriation of Sacred-ceremonial Objects from Scottish Collections to their Indigenous Owners

**Arts & Humanities Workshops 2010**

Professor L Abrams, Department of History, University of Glasgow, and

Dr A Shepard, Department of History, University of Glasgow - Scottish masculinity in historical perspective

Dr T Ahnert, School of History and Classics, University of Edinburgh, and

Professor C Kidd FRSE, Department of Scottish History, University of Glasgow – Ancients and Moderns in the Scottish Enlightenment

Dr S Bayne, Moray House School of Education, University of Edinburgh, and

Ms R Bailey, The Royal Commission on the Ancient and Historical Monuments of Scotland - The digital futures of cultural heritage education: a social media research agenda for the Scottish national collections

Dr K Brophy, Department of Archaeology, University of Glasgow; and

Dr C Dalglish, Department of Archaeology, University of Glasgow; and

Dr A Leslie, GUARD, University of Glasgow; and
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Dr G MacGregor, GUARD, University of Glasgow - Transforming practice: inter-disciplinary research into the philosophies, methods and impacts of the ways in which we value landscape

Professor J J Smith FRSE, Department of English Language, University of Glasgow - Textual Afterlives Workshop Programme

Cormack Small Astronomy Research Grants 2009

Mr R Hussey, Shetland Astronomical Society - International Year of Astronomy 2009

Dr A MacKinnon, Department of Adult & Continuing Education, University of Glasgow - Astronomy Project for able schoolchildren during the 2010 National Astronomy Meeting

Mr A Morrison, Sir E Scott Secondary School, Isle of Harris - Promote Astronomy in the Western Isles

Dr G Russell, Cosmic Sky - Moon-Watching For All: the Science and Beauty of the Moon.

RESEARCH SCHOLARSHIPS AND PRIZES

Carnegie Caledonian Scholarship 2010

Mr G Mackenzie, School of English, University of St Andrews - Landscape as Identity in Twentieth-Century Poetry

Cormack Postgraduate Prize 2009

Ms H Bain, Department of Astronomy and Physics, University of Glasgow - Hard X-ray emission from a flare-related jet

Cormack Postgraduate Prize 2010

Mr M Campbell, Institute for Astronomy, University of Edinburgh - VLT-MAD Observations of the core of 30 Doradus

Cormack Undergraduate Prize 2009

Miss J McCormick, School of Mathematics and Statistics, University of St Andrews - The 3D Structure of Emerging Magnetic Flux on the Sun

Cormack Undergraduate Prize 2010

Mr J Simpson, Department of Physics and Astronomy, University of St Andrews - Alternative techniques for reverberation mapping

Cormack Vacation Scholarships 2009

Mr J Henderson, Department of Physics, University of Strathclyde - Understanding the nature and formation of water ice in the interstellar medium
Miss J McCormick, School of Mathematics and Statistics, University of St Andrews - *The 3D Structure of Emerging Magnetic Flux on the Sun*

Mr M Uhrin, Department of Physics, University of Strathclyde - *Initial stages of planetary formation: Simulation of dust cluster growth and collision*

**Cormack Vacation Scholarships 2010**

Ms S Brown, Institute for Astronomy, University of Edinburgh - *Measuring weak gravitational lensing*

Mr N Gordon, Department of Physics and Astronomy, University of Glasgow - *A study of solar flare ribbons with the Hinode Solar Optical Telescope.*

Mr R D Hall, School of Mathematics & Statistics, University of St Andrews - *MHD Simulations of Magnetic Flux Emergence*

Ms S Platten, Department of Mathematics & Statistics, University of St Andrews – *Aspects of Three-dimensional Reconnection*

Mr C Thomson, Department of Physics & Astronomy, University of Glasgow - *Imaging spectroscopy with RHESSI*

Mr A Wilson, Department of Physics & Astronomy, University of Glasgow - *Plasma flow around deformable structures: space tether dynamics in the solar wind*

**Henry Dryerre Scholarship 2010**

Mr R Morrison, Division of Developmental Medicine, University of Glasgow - *Novel Intervention Techniques to Improve Child Physical Activity, Energy Expenditure and Body Composition*

**Lessells Scholarships 2009**

Dr S Ivekovic, School of Computing, University of Dundee - *Swarm Intelligence and Projective Geometry for Computer Vision.*

Mr Y Liu, School of Engineering and Physical Sciences, Heriot-Watt University - *Micromechanical Cantilever Biosensors for Rapid Disease Diagnosis.*

Ms M Mari, Centre for Biomedical Engineering, University of Edinburgh - *Unravelling Alzheimer’s disease.*

Ms R Raheem, Centre for Biomedical Engineering, University of Edinburgh - *Techniques to Identify Live Cell DNA Damage.*

Mr A J Sadowski, School of Engineering and Electronics, University of Edinburgh - *Exploration of the elastic and plastic buckling of shells under unsymmetrical loads.*

Mr D Tyndall, School of Engineering, University of Edinburgh - *Parallel Fluorescence Correlation Spectroscopy (FCS).*
Lessells Scholarships 2010
Mr Douglas S Brodie, Department of Mechanical Engineering, Heriot-Watt University - ZnO Based Surface Acoustic Wave Devices for Bio-sensing and Fluid Transportation.
Mr J Franklin, Department of Civil Engineering, University of Dundee - Breaking of internal solitary waves in shallow, stratified waters.
Ms A Furber, Institute for Infrastructure & Environment, University of Edinburgh - Effective Engagement with Stakeholders for Water and Sanitation Projects in Rural Africa - an Engineering Perspective.
Mr S Grindrod, School of Engineering, University of Edinburgh - Project METRO - Medium-scale experiments in a section of a tunnel.

Mr N P Macdonald, Bioelectronics Research Centre, University of Glasgow - Development of microfluidic biochips for Absorption, Distribution, Metabolism and Excretion Toxicology studies (ADME-Tox) for Foods and HPC products.
Mr A Pujari, School of Engineering, University of Aberdeen - Use of appropriate advanced signal processing techniques on surface Electromyographic Signals (sEMG) to analyse muscle response to different vibration levels.

Piazzi Smyth Bequest 2009
Mr D Lawson, Department of Physics & Astronomy, University of Glasgow – The analysis of a Ca II (854.2 nm) line of a solar flare

Piazzi Smyth Bequest 2010
Mr J Simpson, Department of Physics & Astronomy, University of St Andrews – Reverberation Mapping of Active Galactic Nuclei

ENTERPRISE FELLOWSHIPS
Scottish Enterprise Enterprise Fellowships 2009
Paul Adderley, School of Informatics, University of Edinburgh – Sustainable Opportunity Solutions’ FUSITRAM®: Sustainable Decision Support Tool for Business Travel
Dr Norman Alm, School of Computing, University of Dundee – A Communication Support System for Older People with Dementia

Dr Dan Arnold, Institute of Petroleum Engineering, Heriot-Watt University – A method for adding geological knowledge to quantify the true uncertainty in petroleum reservoirs
Dr Antoine Assal, Department of Civil Engineering, University of Strathclyde – Environmental Forensics as a Tool to Cut the Cost of Brown-field Development
Gordon Dobie, Department of Electronic and Electrical Engineering, University of Strathclyde – Miniature Robotic Vehicles for Structural Inspection

Dr Michael Gilroy, Department of Electronic and Electrical Engineering, University of Strathclyde – Condition Based Monitoring

Brian O’Reilly, Institute for Energy and Environment, University of Strathclyde – The Energy Egg

Professor M Babs Oyeneyin, School of Engineering, The Robert Gordon University, Aberdeen – Integrated Flow Assurance Solutions for the Energy Industry

Dr Andy Spence, School of Mathematical and Computer Sciences, Heriot-Watt University – t3D: the Software Suite for Web-based Product Presentation

Scottish Enterprise Enterprise Fellowships 2010

Ann Attridge, The Business School, University of Strathclyde – Interactive Online Learning

Tom Larkworthy, School of Informatics, University of Edinburgh – Commercialising Self-Reconfiguring Robotic Systems

Dr Michael Lincoln, Centre for Speech Technology Research, University of Edinburgh – MICAR – Multiparty Interaction Capture, Analysis and Replay

Dr Nicholas Psaila, School of Engineering and Physical Sciences, Heriot-Watt University – Custom 3D Laser micro-fabrication of integrated optical devices

BBSRC Enterprise Fellowships 2009

Dr Burcak Alp, Institute of Orthopaedics and Musculoskeletal Sciences, University College London – Use of Novel Collagen for Clinical and Industrial Translation

Dr Simon Baker, Jack Birch Unit for Molecular Carcinogenesis, Department of Biology, University of York – The Bioimetic Urothelium

Dr Jorge Garcia-Lara, Department of Molecular Biology and Biotechnology, University of Sheffield – Novel vaccine and antibody therapy against Staphylococcus aureus (MRSA) infections

Nir Grossman, Institute of Biomedical Engineering & Division of Neurosciences, Imperial College London – Patterned Excitation of Light-Sensitive Biological Compounds

Angela J Murray, School of Biosciences, University of Birmingham – Biorecovery of Precious Metals from Secondary Sources and Biorefining into New Catalysts

Professor Stefan Przyborski, School of Biological Science, Durham University – Platform Technology for Routine Three-Dimensional Cell Culture
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Dr Liisa Van Vliet, Department of Biochemistry, University of Cambridge – Cell-type tuning for transfection reagents
Matthew Wilcox, Institute of Cell and Molecular Bioscience, Newcastle University – Alginates are a Natural Product to Aid in Weight Management

BBSRC Enterprise Fellowships 2010

Dr Leigh Cassidy, School of Biological Sciences, University of Aberdeen – DRAM – A Device for Remediation and Attenuation of Multiple-pollutants
Dr Timothy Dafforn, School of Biosciences, University of Birmingham – Phage-based detection of pathogens
Dr Neil Dixon, School of Chemistry, based in the Manchester Interdisciplinary Biocentre, University of Manchester – RNA Switch Technology – Gene Expression Control

Dr Timothy Knowles, School of Cancer Sciences, University of Birmingham – The SMALP system, a generic tool for the preparation of high-value membrane protein drug targets enabling high throughput drug screening

STFC Enterprise Fellowship 2009

Dr Anke Lohmann, Micro and Nano Technology, Science and Technology Facilities Council, Rutherford Appleton Laboratory – Industrial scale-up of electrospinning of nanofibres

STFC Enterprise Fellowships 2010

Joanna Davies, Science & Technology Facilities Council Space Science Department, Rutherford Appleton Laboratory – The Micro-FTS – a miniature Fourier transform spectrometer
Dr Alexandre Pechev, Surrey Space Centre, University of Surrey – From Spacecraft control to Computer Animation

SCOTTISH CRUCIBLE

Scottish Crucible 2009

Dr T Ball, School of Social and Environmental Sciences, University of Dundee
Dr G Baxter, School of Computer Science, University of St Andrews
Dr R A Blythe, Department of Physics and Astronomy, University of Edinburgh

Dr S Bordas, Department of Civil Engineering, University of Glasgow
Dr I Burns, Department of Chemical Engineering, University of Strathclyde
Mr R By, School of Business, Queen Margaret University
Research and Enterprise Awards

Dr W Chrzanowski, Mechanical Engineering, University of Glasgow
Dr A S F Dawson, Department of Applied Social Science, University of Stirling
Dr M Delibegovic, School of Biological Sciences, University of Aberdeen
Dr A Elliott, Foresterhill Health Centre, University of Aberdeen
Dr A Fletcher, Department of Chemical Engineering, Strathclyde University
Dr M Fletcher, CIER Department of Management, University of Glasgow
Dr T George, SCRI
Dr W Gidman, Institute of Pharmacy and Biological Sciences, University of Strathclyde
Dr J Illian, School of Mathematics and Statistics, University of St Andrews
Dr L Lee, Institute for the Study of Science, Technology and Innovation, University of Edinburgh
Dr S Louchart, School of Mathematical and Computer Sciences, Heriot-Watt University
Dr D Lusseau, Institute of Biological and Environmental Sciences, University of Aberdeen
Dr S Lynagh, Biopta Ltd.
Dr M Naylor, School of Geosciences, University of Edinburgh

Dr S Rhodes, Department of Psychology, University of Strathclyde
Dr M Shearer, School of Biology, University of St Andrews
Dr S Smith, Scottish Microelectronics Centre, University of Edinburgh
Dr C Switzer, Department of Civil Engineering, University of Strathclyde
Dr C Torres-Sanchez, DMEM, University of Strathclyde
Dr Jano van Hemert, School of Informatics, University of Edinburgh
Dr F Van Wijk, School of Health Sciences, Queen Margaret University
Dr J Vergunst, School of Social Science, University of Aberdeen
Dr R Wade, Urban Water Technology Centre, University of Abertay
Dr N Wheate, Institute of Pharmacy and Biomedical Sciences, Strathclyde University

Scottish Crucible 2010

Dr J Bos, School of EPS – Chemistry, Heriot-Watt University
Dr C Bradbury-Jones, School of Nursing and Midwifery, University of Dundee
Dr K Chiang, Department of Higher and Community Education, University of Edinburgh
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Dr T Drysdale, Department of Electronics & Electrical Engineering, University of Glasgow
Dr E Duncan, NWAHP Research Unit, University of Stirling
Dr L Han, School of Informatics, University of Edinburgh
Dr H Hastie, School of Maths & Computer Sciences, Heriot-Watt University.
Dr A Ioris, Department of Geography and Environment, University of Aberdeen
Mr M Kumar, School of Management and Law, Edinburgh Napier University
Dr J G A Leach, Department of Physics and Astronomy, University of Glasgow
Dr X Luo, School of Engineering & Physical Sciences, Heriot-Watt University
Dr I Mackenzie, Medicines Monitoring Unit (MEMO), University of Dundee.
Dr E C Macknight, School of Divinity, History & Philosophy, University of Aberdeen
Dr D MacLaren, Department of Physics & Astronomy, University of Glasgow
Mr N Mody, Institute of Biological & Environmental Sciences, University of Aberdeen
Dr D Moran, Department of Electronics & Electrical Engineering, University of Glasgow

Dr S Neale, Department of Electronics & Electrical Engineering, University of Glasgow
Dr M Noguchi, Mackintosh School of Architecture, Glasgow School of Art
Dr P Ohberg, Department of Physics, Heriot-Watt University
Dr I M Overton, MRC Human Genetics Unit.
Dr N Robertson, School of Engineering and Physical Sciences, Heriot-Watt University
Dr B Seitz, Department of Physics and Astronomy, University of Glasgow
Dr C Selman, Institute of Biological and Environmental Sciences, University of Aberdeen
Dr K Spencer, Division of Ecology and Evolutionary Biology, University of Glasgow
Dr C Taylor, School of Life Sciences, Edinburgh Napier University
Dr S Taylor, Biomedical Research Centre, University of Glasgow
Miss G Teal, Design Office, Glasgow School of Art
Dr M Watson, Centre of Academic Primary Care, University of Aberdeen
Dr T Wood, Institute of Condensed Matter and Complex Systems, University of Edinburgh
Dr S Wright, Centre for Transport Research, University of Aberdeen
MEDALS, PRIZES AND PRIZE LECTURESHIPS

Royal Medals

Royal Medals were presented by HRH The Duke of Edinburgh on 11 August 2009 and 9 August 2010.

2009
Professor Sir James Mirrlees FBA HonFRSE
Professor W Sibbett CBE FRS FRSE
Professor K H Vousden CBE FRS FRSE

2010
Dr J L MacMillan CBE FRSE
Sir Fraser Stoddart FRS HonFRSE

IEEE/RSE/Wolfson, James Clerk Maxwell Award

2009
Professor A Sangiovanni-Vincentelli, Edgar L and Harold H Buttner Professor of Electrical Engineering, University of California at Berkeley, Berkeley, CA, USA.
For pioneering innovation and leadership in Electronic Design Automation that has enabled the design of modern, complex, electronics and communications systems and their industrial implementation.

2010
Mr A G Bose, Chairman, Bose Corporation, Framingham, MA, USA
For outstanding contributions to consumer electronics in sound reproduction, industrial leadership, and engineering education.
In **Session 2008/2009**, the Grants Committee considered 50 applications and a sum of £22,767 was awarded. Approximately 60% of this sum was awarded as travel assistance.

**Travel Assistance**

- Professor P Bishop. For travel to Australia. £950
- Professor G Brown (Corr FRSE). For travel to Australia. £950
- Professor E Clarkson. For travel to Canada. £500
- Professor J Connelly. For travel to Democratic Republic of Congo. £950
- Professor S Crampin. For travel to South Africa. £950
- Professor B Crawford. For travel to Iceland. £500
- Professor J Dickson. For travel to Italy. £500
- Professor D Dritschel. For travel to Australia. £500
- Professor S Harley. For travel to Czech Republic. £500
- Professor A Hawkins. For travel to Ireland. £500
- Professor D Jasper. For travel to the USA. £300
- Professor J McGeough. For travel to China. £500
- Professor S McKee. For travel to Brazil. £400
- Professor R Logie. For travel to Japan. £900
- Professor R Morris. For travel to the USA. £867
- Professor J Pickering. For travel to China. £700
- Professor M Rennie. For travel to Japan. £750
- Professor A Robertson. For travel to Austria. £300
- Professor T C Smout. For travel to Denmark. £500
- Professor J Sprent. For travel to the USA. £800
- Professor D Titterington. For travel to South Africa. £500
- Professor B Webber. For travel to India. £400

**Support for Meetings**

- Professor D Campbell. *International Symposium on Wind Instrument Acoustics*. £500
- Professor A Carbery. *Operators and Operator Algebras*. £500
- Professor Ian Deary. *Advancing Years: current research in cognitive ageing and dementia – a multi-disciplinary approach*. £250
- Professor G Gadd. *The Fungal Cell*. £500
- Professor S Harley. *MAPT: MicroAnalysis, Process and Time*. £750
- Professor D Heggie. *NBODY6 and GPU*. £300
- Professor T Ingold. *Redrawing Anthropology: Materials, Movements, Lines*. £750
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Professor J Jones. SUSSP66
International Summer School. £500

Professor P Maitland. 6th International Charr Symposium. £750

Professor S Ralston. New Developments in Clinical Trials in Neuroscience and Psychiatry. £300

Professor N Rapport. A Cosmopolitan Anthropology? £500

Professor C Warlow. Cell Death Signalling. £500

Professor A Welch. 43rd Annual Universities of Scotland Inorganic Conference (USIC). £500

Professor C Withers. Correspondence: Travel, Writing and Literatures of Exploration, c1750-c1850. £500

Professor C Wright. Contemporary Perspectives on Scepticism. £750

Research Visitors to Scotland.

Professor J C Brown. To enable Professor D B Melrose, of the University of Sydney, to travel to Scotland in April 2010 to visit the Department of Physics and Astronomy at the University of Glasgow, make short visits to the Universities of St Andrews and Strathclyde and to participate in the UK National Astronomy, Solar and MIST Meetings being held at the University of Glasgow to mark 250 years of the Glasgow Astronomy Chair. £600

Professor X Mao. To enable Professor Mufa Chen of the Department of Mathematics, Beijing Normal University in China, to visit the University of Strathclyde in October. £300

Professor M Pickering. To enable Dr Tanya Kraljic, University of Pennsylvania, USA, to visit the Department of Psychology at the University of Edinburgh in September 2009. £300
In **Session 2009/2010** the Grants Committee considered 33 applications and a sum of £16,319 was awarded. Approximately 63.5% of this sum was awarded as travel assistance.

**Travel Assistance**

Professor J Speakman. For travel to India. £500
Professor J C Brown. For travel to the USA. £500
Professor D Davidson. For travel to Austria. £300
Professor B Harte. For travel to Austria. £500
Professor K Opara. For travel to the USA. £819.52
Professor T Palmer. For travel to the USA. £950
Professor I Parsons. For travel to the USA. £950
Professor M Scott. For travel to Chile. £950
Professor R W Byrne. For travel to Japan. £700
Professor R Knops. For travel to Germany. £400
Professor X Mao. For travel to China. £500
Professor J McGeough. For travel to Australia. £500
Professor H Scott. For travel to the USA. £400
Professor R Mackie. For travel to Australia. £950
Professor S Salter. For travel to South Africa. £950
Professor D Szechi. For travel to the USA. £500

**Support for Meetings**

Professor R Jarrett. *Glasgow Virology Workshop*. £250
Professor C Trevarthen. *The Young Child’s Curriculum: the Value of Pre-school Education and Care*. £300
Professor D Porteous. *DISC1 2010*. £750
Professor I Gordon. *New Developments in Noncommutative Algebra and its Applications*. £750

**Research Visitors to Scotland.**

Professor A Magurran. To enable Dr Kimberley Hughes, Associate Professor of Biological Science at Florida State University, to visit the Scottish Oceans Institute, School of Biology at the University of St Andrews in June. £650
Professor J McGeough. To enable Professor Hassan A El-Hofy, Chairman and Professor of the Production Engineering Department of the University of Alexandria, to visit the University of Edinburgh in summer 2010. £600
Professor M Siddiqui. To enable Professor Miroslav Volf, Henry B Wright Professor of Theology at
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Yale University, to visit the University of Glasgow for the first colloquium of its kind “Love and Law in Islam and Christianity” in October. £500

Professor M Sinclair. To enable Professor Roger R Smith of Texas A&M University, USA, to visit the School of Mathematics at the University of Edinburgh in summer 2010. £450

Professor T Bedford. To enable Professor Berenguer of the Universite de Technologie de Troyes to travel to Scotland to visit the Strathclyde University Risk and Reliability Group. £400

Professor C Davies. To enable Dr Justin Foley of the University of Utah to visit the Department of Physics and Astronomy at the University of Glasgow. £500

Research Liaison within Scotland.

Professor A Sorace. For her forthcoming project with Dr Gareth Davies of the Health & Wellbeing Research Unit, Lews Castle College, UHI Millennium Institute. £400

Professor A Sorace. For her forthcoming project with Dr Thomas Bak of the School of Philosophy, Psychology and Language Sciences at the University of Edinburgh. £400
INTERNATIONAL PROGRAMME

Activities 2008–2009

A Memorandum of Understanding was signed with the Royal Society of New Zealand in Spring 2009.

Exchange visits totalling 100 person-weeks took place through the Bilateral Programme, run with sister academies in India, Pakistan, Slovenia, the Czech Republic, Hungary, Poland, Taiwan and Malaysia.

The International Committee agreed this year to prioritise the RSE’s existing bilateral links and, specifically, the RSE’s Joint Projects with the National Natural Science Foundation of China (NSFC). As a result, it was not possible to run the Open Exchange Programme this year.

Six RSE–NSFC Joint Project awards were made and the RSE continues to support five projects awarded in 2007 (which commenced in Spring 2008 and continue for two years).

A joint workshop with the NSFC took place in Beijing in October 2008, and brought together experts in the areas of management science, engineering and public policy. Researchers from both countries came together to progress potential collaboration and develop proposals for Joint Projects. The workshop participants also had an opportunity to visit Tsinghua University, Beijing, one of the top universities in China.

The RSE supported a joint symposium on Internal Waves held with the Norwegian Academy of Science and Letters in Oslo in October 2008. This promoted increased collaboration between our academies, reviewed research activity in both countries and explored the initiation of new collaborative research. The symposium was the first of two. The second will take place in Scotland during 2010.

The Society hosted a joint workshop in Edinburgh with the National Science Council of Taiwan (NSC) on Tidal Current Energy in February during a week-long visit to Scotland. The Workshop was an opportunity for the participants from the UK and Taiwan, representing academia and industry, to present their current research, policy and practice, and to discuss possible areas for future collaborations. The delegation also participated in the SuperGen Marine Research Seminar, hosted by the University of Edinburgh, and undertook a site visit to SeaGen, Portaferry, Northern Ireland, to see an example of tidal energy technology in use. The workshop has already resulted in further visits of academics between Scotland and Taiwan to take forward the collaborations.

A high-level delegation from the Chinese Academy of Sciences (CAS), led by its President, Professor Lu Yongxiang, visited the RSE
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in December 2008. The RSE and CAS discussed the scope for even closer research cooperation between Scotland and China, mediated through the MoU between RSE and CAS, signed in 2002. Topics such as clean energy technology and sustainable environment were identified as being of mutual interest.

The first annual MacCormick European Lecture was held at the Society in May. This lecture series (formerly the Annual European Lecture) was re-named in honour of the late Professor Sir Neil MacCormick FBA FRSE, in recognition of his contribution to Scottish and European politics and his international work for the Society. Lord Kerr of Kinlochard GCMG HonFRSE gave the lecture, which explored today’s European Union and whether or not all the passion is spent. In his vote of thanks, the Society’s International Convener, Sir David Edward, said “we could not have had a better first MacCormick European Lecture”, singling out Lord Kerr’s hard practicality, deep and wide experience, rich sense of humour, rare wisdom and much needed passion, as qualities Sir Neil would have wished for in the lecture named in his honour.

The RSE was pleased to participate in the Japan–UK 150 celebrations by organising a Discussion Forum “Engineering Scotland and Japan: Past, Present and Future” in September 2009. Japan–UK 150 is a series of events in the UK organised to celebrate 150 years of a Treaty of Amity friendship between Japan and the UK. Activities during this year are designed to encourage exchange in such fields as culture, the arts, sport, education and science.

Activities 2009–2010

82 exchange visits totalling more than 220 person-weeks took place through the Bilateral Programme, run with sister academies in India, Slovenia, Slovakia, the Czech Republic, Hungary, New Zealand, Poland, Taiwan and Malaysia; and through our Open Exchange Programme.

The Society’s joint projects with the National Natural Science Foundation of China (NSFC) continued to be a priority focus. Six new Joint Project awards were made and we continued to support 11 projects awarded in previous years.

The Society also supported a Scotland–China Higher Education Research Partnership for PhD Studies collaboration between the University of Stirling and the Chinese Academy of Science’s Institute of Automation, on the subject of Telecommunications and Information Technologies.

In October 2009, in partnership with the United States Consulate, we hosted a lecture given to an invited audience by the US Ambassador to the UK.
International

Exchanges and Awards

The following exchange awards were made during the Sessions.

**Czech Republic—Incoming**
Dr V Arrighi. Heriot-Watt University.
Dr A Christev. Heriot-Watt University.
Dr J Culik. University of Glasgow.
Dr P Favaro. Heriot-Watt University.
Dr J J Hughes. University of the West of Scotland.
Dr K Kalna. Swansea University.
Professor P Kocovsky. University of Glasgow.
Dr K Milek. University of Aberdeen.
Professor R Ó Maolalaigh. University of Glasgow.
Professor M G H Pittock. University of Glasgow.
Dr T Proschold. Scottish Association for Marine Science.

**Czech Republic—Outgoing**
Dr E Grist. University of the Highlands and Islands.
Dr R Hector. Glasgow Caledonian University.
Dr J J Hughes. University of the West of Scotland.
Dr K Milek. University of Aberdeen.

**Hungary—Incoming**
Dr P Frisco. Heriot-Watt University.
Dr A Konovalov. University of St Andrews.
Professor N B Metcalfe. University of Glasgow.

**Hungary—Outgoing**
Dr S Molloy. University of Edinburgh.

**India—Incoming**
Professor M E Cates. University of Edinburgh.
Professor J C Eilbeck. Heriot-Watt University.
Professor S L Harley. University of Edinburgh.
Dr D Harris. Royal Botanic Garden Edinburgh.
Dr A Kar. Heriot-Watt University.
Professor M McCoustra. Heriot-Watt University.

**India—Outgoing**
Mr S Cross. University of Dundee.
Professor P Das. University of Strathclyde.
Professor P Taylor. University of Strathclyde.

**Malaysia—Outgoing**
Dr J O Mason. University of Edinburgh.
Dr P Wilkie. Royal Botanic Garden Edinburgh.

**New Zealand—Incoming**
Dr A Lees. University of Dundee.
Review of Sessions 2008/09 and 2009/10

New Zealand–Outgoing.
Dr G Bewick. University of Aberdeen.
Dr D Burslem. University of Aberdeen.
Dr G Grelet. University of Aberdeen.
Dr S Hoppler. University of Aberdeen.
Professor G Jordan. University of Aberdeen.
Dr J Porter. Heriot-Watt University.

Open–Incoming
Professor A Almaini. Edinburgh Napier University. PALESTINE
Dr L Bussiere. University of Stirling. CANADA
Dr S A F Coupaud. University of Glasgow. JAPAN
Professor I Guz. University of Aberdeen. UKRAINE
Professor R Logie. University of Edinburgh. JAPAN
Dr G Maluf Medero. Heriot-Watt University. BULGARIA
Dr K Read. University of Dundee. USA
Dr J Smith. University of Glasgow. JAPAN
Dr L Torrance. The James Hutton Institute. SWEDEN
Dr I Trendafilova. University of Strathclyde. BULGARIA
Professor A P Waters. University of Glasgow. GERMANY
Dr M Watson. Royal Botanic Garden Edinburgh. JAPAN
Professor S Welburn. University of Edinburgh. NIGERIA

Open–Outgoing
Dr M J Bain. University of Aberdeen. RUSSIA
Dr J Farkas. University of Stirling. USA
Professor C Fyfe. University of the West of Scotland. SPAIN
Dr S Gratz. University of Aberdeen. AUSTRALIA
Dr Y Guo. University of Aberdeen. CHINA
Dr H Hall. Edinburgh Napier University. USA
Dr J Leach. University of Aberdeen. AUSTRALIA
Dr M Lewitt. University of the West of Scotland. SWEDEN
Dr C Liu. Newcastle University. Australia
Dr I Mackie. University of Aberdeen. THAILAND
Dr P McCaffery. University of Aberdeen. HONG KONG
Professor L McKee. University of Aberdeen. SWEDEN
Dr R McMaster. University of Glasgow. NETHERLANDS
Dr J Monios. Edinburgh Napier University. USA
Dr C Morelli. University of Dundee. GERMANY
Dr G Morozov. University of the West of Scotland. CANADA
Dr C Morrison. University of the West of Scotland. USA
Dr M S Plumb. Oxford Brookes University. AUSTRALIA
Dr T Rathcke. University of Glasgow. GERMANY
Dr V Relf. Moredun Research Institute. AUSTRALIA
Dr V Rinterknecht. University of St Andrews. SPAIN
Dr M Singer. University of St Andrews. FRANCE
Dr K D Smith. Edinburgh Napier University. CANADA
Mr A Tesfai. University of St Andrews. THAILAND
Dr S Theriault. University of Aberdeen. JAPAN
Dr I Tsalavoutas. University of Stirling. FRANCE
Dr Y Veld-Merkoulova. University of Stirling. AUSTRALIA

**Pakistan–Incoming**
Professor P Clift. University of Aberdeen
Dr J McGrady. University of Glasgow.

**Poland–Incoming**
Dr B Cohen. University of Glasgow.
Professor H Jones. University of Dundee.
Dr D McKee. University of Strathclyde
Dr D McKee. University of Strathclyde

**Poland–Outgoing**
Professor R Ó Maolalaigh. University of Glasgow.
Dr I Stancheva. University of Edinburgh.
Dr K Williamson. University of Edinburgh.

**Poland–Outgoing**
Mrs A Atkinson. Scottish National Blood Transfusion Service.
Dr A Heinrich. University of Glasgow.
Dr D Kilpatrick. Scottish National Blood Transfusion Service.
Dr S MacDonald. Scottish National Blood Transfusion Service.
Dr M Nijnik. The James Hutton Institute
Dr N Robertson. University of Edinburgh.
Dr S Wallis. Heriot-Watt University.

**Slovakia–Incoming**
Professor A Clark. University of Edinburgh.
Dr S Woodin. University of Aberdeen.

**Slovakia–Incoming**
Dr K Campbell. University of Edinburgh

**Slovenia–Outgoing**
Dr D McArdle. University of Stirling

**Taiwan–Incoming**
Dr K Boyd. University of the Highlands and Islands.
Professor J Corbett. University of Macau.
Review of Sessions 2008/09 and 2009/10

Dr L Del Debbio. University of Edinburgh.
Dr R Fu. University of the West of Scotland.
Professor N D Hastie. MRC Human Genetics Unit, Western General Hospital.
Professor J Haywood. University of Edinburgh.
Professor P W Macfarlane. University of Glasgow.
Professor J Ooi. University of Edinburgh.
Dr H Pinto. University of Strathclyde.
Dr R Fu. University of the West of Scotland.
Professor C Liu. Newcastle University
Professor G Markx. Heriot-Watt University.
Professor A R Wallace. University of Edinburgh
Professor E Wilkinson. University of Glasgow.

NSFC Joint Projects
Dr M Baptista. University of Aberdeen. Fundamentals for a chaos-based wireless underwater communication system.
Professor U Bititci. University of Strathclyde. Support models for collaborative innovation in global environments.

Taiwan - Outgoing
Professor J Bradshaw. University of Edinburgh.
Dr Y Y Chang. University of Abertay Dundee.
Dr Y Chau. University of Edinburgh.
Dr J Chen-Burger. University of Edinburgh.
Professor M G Dunlop. University of Edinburgh.
Dr B Dutia. University of Edinburgh.
Dr J Ellis. Northumbria University.
Dr D Fitzpatrick. University of Edinburgh.

Dr R Fu. University of the West of Scotland.
Dr C Liu. Newcastle University
Professor G Markx. Heriot-Watt University.
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Professor M G Dunlop. University of Edinburgh.
Dr B Dutia. University of Edinburgh.
Dr J Ellis. Northumbria University.
Dr D Fitzpatrick. University of Edinburgh.
Dr H Liu. University of St Andrews. Identification and structural analysis of tobacco vein banding mosaic virus HC-Pro, VPg pathogenicity complex.

Professor X Mao. University of Strathclyde. Analysis and synthesis of stochastic hybrid systems and their applications to freeway traffic control.

Professor D Song. Robert Gordon University. Towards a context-sensitive high-order language model for information retrieval via information geometry.

Professor J R Speakman. University of Aberdeen. Reproductive performance of the Mongolian gerbil (Meriones unguulatus) under variable environmental conditions

Dr M Vallejo-Marin. University of Stirling. Reproductive biology of an alien weed (Solanum rostratum, Solanaceae) and its potential for evolutionary modification

Dr X Wang. Heriot-Watt University. Research on modulation and coding for EWB over fibre signals.


Dr L Xiong. Robert Gordon University. Financing female entrepreneurship: Do social networks matter?

FELLOWS’ SOCIAL EVENTS

2008/09

New Fellows’ Induction Day

The Induction Day for new Fellows was held on Monday 11 May 2009. The Induction Day is an opportunity for new Fellows to meet RSE staff and Officers and familiarise themselves with the work of the Society. Thirty-two new Fellows, comprising three Corresponding and 29 Ordinary Fellows, attended.

Summer Reception

This annual reception for Fellows and their spouses/guests was held at the RSE on 12 August 2009 at 7 pm.

Fellows Coffee Meetings

In conjunction with the weekly Coffee Meetings, talks were presented once a month during the Winter and Spring as follows:

14 October 2008. Telford at the Frontiers of Technology. Professor Roland Paxton
2 December 2008. Democracy Ancient and Modern. Professor John Richardson
6 January 2009. Forgotten pioneers, the case of Robert Chambers. Professor Bruce Proudfoot

3 February 2009. Tackling Scotland’s Health Inequalities - a major challenge for the next decade. Professor John Coggins
3 March 2009. Reconstructing Historical Sites; Fact or Fiction? Dr Barbara E Crawford

The Royal Society Dining Club

The Club was established on 3 January 1820, with the view of promoting the objectives of the Royal Society of Edinburgh. In Session 2008/2009 meetings were held as follows:

846th Dinner - 13 October 2008
Praeses: Professor Ian Sword
Croupier: Professor David Ingram

847th Dinner - 8 December 2008
Praeses: Professor Jan McDonald
Croupier: Ms Eileen Mackay

848th Dinner - 6 April 2009
Praeses: Sir John Shaw
Croupier: Professor Gavin McCrone

849th Dinner - 8 June 2009
Praeses: Professor John S Richardson
Croupier: Lord Ross

Fellows’ Golf

Stewart Cup 2009 at Kilmacolm.
Winner : Professor Sean McKee

The winners - from the Life Sciences Group - were Professors Nick Wade and Bill Stimson.
2009/10

New Fellows Induction Day

The 2010 Induction Day took place on Monday 3 May 2010. Thirty-seven new Fellows, comprising four Corresponding and 33 Ordinary Fellows, attended and were given an overview of the Society, and more details about the role of the Fellowship.

Summer Reception - 12 June 2010. City Chambers Glasgow.

The Rt Hon Lord Provost of Glasgow, Councillor Bob Winter, co-hosted the reception with Lord Wilson in the magnificent setting of Glasgow City Chambers. During the evening, there was an opportunity to view displays from organisations connected with the recently-launched Glasgow City of Science initiative.

Fellows Coffee Meetings

Weekly Coffee Meetings were held through the Winter and Spring months, as follows:

13 October 2009. Recognising a Masterpiece. Michael Clarke
8 December 2009. The President, Lord Wilson of Tillyorn
12 January 2010. Runs on homozygosity, population history and disease. Dr James Wilson

2 February 2010. Events, adaptability and survival, the case of the European Union. Sir David Edward

9 March 2010. Are we destroying Edinburgh? Professor Charles McKean

The Royal Society Dining Club

In Session 2009/2010, meetings were held as follows:

850th Dinner - 12 October 2009
Praeses: Professor Geoffrey Boulton
Croupier: Professor Gordon Craig

851st Dinner - 7 December 2009
Praeses: Sir David Edward
Croupier: Professor Carol Duffus

852nd Dinner - 12 April 2010
Praeses: Professor Robin Knops
Croupier: Professor Gordon Craig

853rd Dinner - 14 June 2010
Praeses: Lady Balfour of Burleigh
Croupier: Professor Bruce Proudfoot

Fellows’ Golf

Stewart Cup 2010 - at Rosemount, Blairgowrie. Winner : Professor Wilson Sibbett

Sectors 2010 - The Golf House Club, Elie. 20 May 2010. The overall team winner was Sector B - the individual winner was David Bell.
GRANTS, SPONSORSHIP AND DONATIONS

The Society is grateful to the following organisations for their continuing support during the Financial years 2008–09 and 2009–10.

BBSRC          Gannochy Trust
BP Research Fellowship Trust  Scottish Enterprise
Caledonian Research Foundation  Scottish Government
Lessells Trust
Lloyds TSB Foundation for Scotland

and also to the following for their support for specific events and activities:

Airborne Initiative          RBS Group PLC
Anonymous                        Royal Academy of Engineering
Alcohol Education and Research Council  Royal Society of Chemistry
Angus Council Education Department  RSPB Scotland
Binks Trust
BP Exploration
British Council Scotland  Scottish Aquaculture Research Forum
Council for Industry and Higher Education  Scottish Arts Council
Darwin Trust
Ewan & Christine Brown Charitable Trust  Scottish Enterprise Borders
Glaxo SmithKline plc  Scottish Environmental Protection Agency
Highland Council  Scottish Estates Business Group
Highlands and Islands Enterprise  Scottish Forestry Trust
Institute of Physics  Scottish Health Action on Alcohol Problems
Lifespan Scotland Limited  Scottish Power plc
Marks & Spencer plc  Scottish Universities Physics Alliance
Microsoft Research Limited  Shell UK
National Museums of Scotland  Standard Life plc
Royal Bank of Scotland plc  UHI Millennium Institute
University of Edinburgh
### Royal Society of Edinburgh Schedule of Investments - movements at valuation. Year Ended 31 March 2009

<table>
<thead>
<tr>
<th>Investment Holdings</th>
<th>Closing No.</th>
<th>Opening Market Value</th>
<th>Purchase Cost</th>
<th>Sales Proceeds</th>
<th>Gain/(Loss) on Sale</th>
<th>Revaluation for Year</th>
<th>Closing Market Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gilts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasury 5.75% 2009</td>
<td></td>
<td>- 110,173</td>
<td>- (109,713)</td>
<td>- 460</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasury 4.25% 2011</td>
<td>600,000</td>
<td>- 906,292</td>
<td>(311,583)</td>
<td>- (9,485)</td>
<td>32,568</td>
<td>277,456</td>
<td>636,763</td>
</tr>
<tr>
<td>Treasury 5% 2012</td>
<td>255,000</td>
<td>135,650</td>
<td>- 128,527</td>
<td>- -</td>
<td>889</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treasury 5% 2014</td>
<td>260,000</td>
<td>137,730</td>
<td>135,218</td>
<td>- -</td>
<td>22,818</td>
<td></td>
<td>295,766</td>
</tr>
<tr>
<td>Treasury 4.75% 2015</td>
<td>260,000</td>
<td>135,616</td>
<td>133,243</td>
<td>- -</td>
<td>24,030</td>
<td></td>
<td>292,899</td>
</tr>
<tr>
<td>Treasury 2.5% Index-Linked 2016</td>
<td>36,000</td>
<td>- 100,174</td>
<td>- -</td>
<td>- 1,213</td>
<td></td>
<td></td>
<td>101,387</td>
</tr>
<tr>
<td><strong>Other Fixed Interest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R B of Scotland 7.387% 2010/49</td>
<td>70,000</td>
<td>68,886</td>
<td>- -</td>
<td>- (40,886)</td>
<td>28,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>European Inv’t Bank 4.75% 2018</td>
<td>200,000</td>
<td>134,689</td>
<td>68,102</td>
<td>- -</td>
<td>13,756</td>
<td>216,547</td>
<td></td>
</tr>
<tr>
<td>Tesco 5.5% Nts 13/12/19</td>
<td>100,000</td>
<td>100,412</td>
<td>- -</td>
<td>- 4,728</td>
<td>105,140</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Investment &amp; Unit Trusts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aberdeen Asian Income Fund</td>
<td>200,000</td>
<td>158,900</td>
<td>58,626</td>
<td>- -</td>
<td>(21,526)</td>
<td>196,000</td>
<td></td>
</tr>
<tr>
<td>Aberforth Geared Cap &amp; Inc Trust</td>
<td>45,000</td>
<td>50,963</td>
<td>- -</td>
<td>- (8,213)</td>
<td>42,750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aberforth Smaller Co Trust</td>
<td>12,500</td>
<td>70,625</td>
<td>- (22,402)</td>
<td>(327)</td>
<td>(23,531)</td>
<td>25,019</td>
<td></td>
</tr>
<tr>
<td>Dunedin Income Growth Inv Trust</td>
<td>47,000</td>
<td>125,828</td>
<td>- -</td>
<td>-</td>
<td>(43,358)</td>
<td>82,470</td>
<td></td>
</tr>
<tr>
<td>Henderson Far East Income Trust</td>
<td>80,000</td>
<td>168,350</td>
<td>33,299</td>
<td>- -</td>
<td>(28,849)</td>
<td>172,800</td>
<td></td>
</tr>
<tr>
<td>Scottish Mortgage &amp; Trust</td>
<td>24,000</td>
<td>144,000</td>
<td>- -</td>
<td>- (59,280)</td>
<td>84,720</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Royal Society of Edinburgh Schedule of Investments - movements at valuation

**Year Ended 31 March 2009**

<table>
<thead>
<tr>
<th>Investment</th>
<th>Closing No.</th>
<th>Opening Market Value</th>
<th>Purchase Cost</th>
<th>Sales Proceeds</th>
<th>Gain/(Loss) on Sale</th>
<th>Revaluation for Year</th>
<th>Closing Market Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barclays</td>
<td>7,883</td>
<td>35,710</td>
<td>-</td>
<td>-</td>
<td>(24,043)</td>
<td>11,667</td>
<td></td>
</tr>
<tr>
<td>HSBC Holdings Ord US $0.50</td>
<td>21,279</td>
<td>91,300</td>
<td>77,218</td>
<td>(6,225)</td>
<td>(6,225)</td>
<td>(84,466)</td>
<td>84,052</td>
</tr>
<tr>
<td>Land Securities Group</td>
<td>5,900</td>
<td>89,031</td>
<td>-</td>
<td>(1,591)</td>
<td>(1,591)</td>
<td>(63,233)</td>
<td>25,798</td>
</tr>
<tr>
<td>Legal &amp; General Group Ord 2.5p</td>
<td>68,000</td>
<td>85,952</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(56,712)</td>
<td>29,240</td>
</tr>
<tr>
<td>Lloyds Banking group</td>
<td>14,000</td>
<td>63,140</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(53,242)</td>
<td>9,898</td>
</tr>
<tr>
<td>Prudential</td>
<td>4,984</td>
<td>33,169</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>(16,373)</td>
<td>16,796</td>
</tr>
<tr>
<td>Royal Bank of Scotland</td>
<td>34,348</td>
<td>50,588</td>
<td>47,383</td>
<td>-</td>
<td>-</td>
<td>(89,556)</td>
<td>8,415</td>
</tr>
<tr>
<td><strong>Consumer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aviva</td>
<td>10,000</td>
<td>-</td>
<td>53,098</td>
<td>-</td>
<td>-</td>
<td>(31,473)</td>
<td>21,625</td>
</tr>
<tr>
<td>Diageo</td>
<td>11,250</td>
<td>54,864</td>
<td>53,917</td>
<td>-</td>
<td>-</td>
<td>(20,300)</td>
<td>88,481</td>
</tr>
<tr>
<td>Marks &amp; Spences Ord 25p</td>
<td>15,500</td>
<td>-</td>
<td>34,748</td>
<td>-</td>
<td>-</td>
<td>11,132</td>
<td>45,880</td>
</tr>
<tr>
<td>Unilever Ord 1.4p</td>
<td>8,513</td>
<td>54,589</td>
<td>92,379</td>
<td>-</td>
<td>-</td>
<td>(34,767)</td>
<td>112,201</td>
</tr>
<tr>
<td><strong>Pharmaceuticals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Astrazeneca</td>
<td>886</td>
<td>16,692</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5,024</td>
<td>21,716</td>
</tr>
<tr>
<td>Glaxo Smith Kline Ord 25p</td>
<td>9,765</td>
<td>104,095</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2,099</td>
<td>106,194</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firstgroup Ord £0.50</td>
<td>10,000</td>
<td>30,993</td>
<td>59,084</td>
<td>(38,444)</td>
<td>(3,113)</td>
<td>27,996</td>
<td>26,750</td>
</tr>
<tr>
<td>Greggs Ord £0.20</td>
<td>1,445</td>
<td>44,863</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4,990</td>
<td>49,853</td>
</tr>
<tr>
<td>Northgate Ord Sp</td>
<td>13,041</td>
<td>-</td>
<td>8,204</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Telecommunications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT Group Ord £0.50</td>
<td>68,000</td>
<td>60,830</td>
<td>66,384</td>
<td>-</td>
<td>-</td>
<td>(74,038)</td>
<td>53,176</td>
</tr>
<tr>
<td>Vodafone Group Ord $</td>
<td>91,000</td>
<td>58,851</td>
<td>66,531</td>
<td>-</td>
<td>-</td>
<td>(13,679)</td>
<td>111,703</td>
</tr>
</tbody>
</table>
### Schedule of Investments

#### Year Ended 31 March 2009

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Utilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Grid Transco</td>
<td>7,446</td>
<td>51,489</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51,489</td>
</tr>
<tr>
<td>National Grid Ord 11p</td>
<td>9,300</td>
<td></td>
<td>66,962</td>
<td>-</td>
<td></td>
<td>(28,776)</td>
<td>38,186</td>
</tr>
<tr>
<td>Scottish &amp; Southern Energy £ 0.5</td>
<td>6,500</td>
<td>-</td>
<td>72,449</td>
<td>-</td>
<td></td>
<td>(364)</td>
<td>72,085</td>
</tr>
<tr>
<td><strong>Industrials</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redrow Ord £0.10</td>
<td>-</td>
<td>29,808</td>
<td></td>
<td>(15,519)</td>
<td>14,289</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rotork Ord £0.05</td>
<td>10,000</td>
<td>-</td>
<td>74,840</td>
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<td>115,211</td>
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<td>108,544</td>
<td>18,530</td>
<td>-</td>
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<td>(15,891)</td>
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### Review of Sessions 2008/09 and 2009/10


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<th>Investment</th>
<th>Current Holdings</th>
<th>Closing No.</th>
<th>Opening Market Value</th>
<th>Purchase Cost</th>
<th>Sales Proceeds</th>
<th>Gain/(Loss) on Sale</th>
<th>Revaluation for Year</th>
<th>Closing Market Value</th>
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## Royal Society of Edinburgh Schedule of Investments- movements at valuation. Year Ended 31 March 2010

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<tr>
<th>Investment Current Holdings</th>
<th>Closing No.</th>
<th>Opening Market Value</th>
<th>Purchase Cost</th>
<th>Sales Proceeds</th>
<th>Gain/(Loss) on Sale</th>
<th>Revaluation for Year</th>
<th>Closing Market Value</th>
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<td><strong>Gilts</strong></td>
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<td>Treasury 4.25% 2011</td>
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<td>636,763</td>
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<td>5,974</td>
<td>(295,437)</td>
<td>(6,303)</td>
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<td>(3,958)</td>
<td>(108)</td>
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<td>(3,528)</td>
<td>(105)</td>
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<td>Revaluation for Year</td>
<td>Closing Market Value</td>
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<th>Opening Market Value</th>
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<th>Sales Proceeds</th>
<th>Gain/(Loss) on Sale</th>
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<th>Closing Market Value</th>
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<td>Revaluation for Year</td>
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<td>49,495</td>
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<td>Rotork Ord £0.05</td>
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<td>85,200</td>
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<td>-</td>
<td>-</td>
<td>6,667</td>
<td>56,800</td>
</tr>
<tr>
<td>Resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP Ord US $0.25</td>
<td>36,900</td>
<td>173,984</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>56,051</td>
<td>230,035</td>
</tr>
<tr>
<td>Johnson Matthey Ord £1</td>
<td>3,800</td>
<td>40,014</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26,334</td>
<td>66,348</td>
</tr>
<tr>
<td>Rio Tinto Ord £0.10</td>
<td>-</td>
<td>96,115</td>
<td>(122,359)</td>
<td>26,244</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Royal Dutch Shell Ord 25p</td>
<td>11,400</td>
<td>153,100</td>
<td>25,024</td>
<td>-</td>
<td>-</td>
<td>28,843</td>
<td>206,967</td>
</tr>
<tr>
<td>Total SA</td>
<td>3,850</td>
<td>90,131</td>
<td>49,227</td>
<td>-</td>
<td>-</td>
<td>7,991</td>
<td>147,349</td>
</tr>
<tr>
<td>Cash</td>
<td>-</td>
<td>33,329</td>
<td>(1,645,673)</td>
<td>1,650,015</td>
<td>-</td>
<td>-</td>
<td>37,671</td>
</tr>
<tr>
<td>TOTALS</td>
<td>2,212,406</td>
<td>4,214,785</td>
<td>40,801</td>
<td>0</td>
<td>124,265</td>
<td>862,785</td>
<td>5,242,639</td>
</tr>
</tbody>
</table>
FRIENDS OF THE SOCIETY

In 2009, the RSE launched Friends of the Society, a corporate engagement scheme established with the purpose of developing the RSE’s relationship with Scotland’s business sector.

The initiative provides an opportunity for the “Friends” to find out more about the RSE and the important work it carries out. It also presents the RSE and its corporate partners with a platform to explore areas of mutual interest and develop joint projects. Members of the scheme also receive a number of tangible benefits in return for a modest annual fee.

CHANGES IN FELLOWSHIP DURING THE SESSION

DEATHS REPORTED TO THE SOCIETY 2008/09

Fellows

June Beatrice Mary Gordon, Marchioness of Aberdeen and Temair
James Baddiley
George Robert Bishop
Jack Dainty
Charles Kemp Davidson
Robert Arthur Eden
Peter Berners Fellgett
Norman Gash
Thomas Lothian Johnston
Charles Goethe Kuper

Walter Ledermann
Gething Morgan Lewis
Donald Neil MacCormick
Colin Frederick Mills
Walter Douglas Munn
Karl Howard Overton
Lewis Robertson
John Alexander Simpson
George Morgan Thomson
Ewart Kendall Walton
Geoffrey Barratt Warburton
Hamish Christopher Swan Wood

Honorary Fellows

Norman Ernest Borlaug
DEATHS REPORTED TO THE SOCIETY 2009/10

Fellows

George Warburton Ashcroft  Hector Laing of Dunphail
Margaret Barnes  Peter Theodore Landsberg
Geoffrey Herbert Beale  Harold Lister
Keith Boddy  Douglas Maurice MacDowell
Brian Capon  Douglas Mack
Peter Brian Denyer  Iain Duncan Mcphail
Robert Balson Dingle  Donald Bertram McIntyre
Kenneth James Dover  Alasdair Duncan McIntyre
Geoffrey John Fraser Dutton  James Francis McMillan
Bernard Francis Fell  Arthur John Robin Gorell Milner
George Alan Garton  Geoffrey Edwin Rickman
John Spence Gillespie  David John Robins
Francis John Gillingham  David Mitchell Shepherd
Norman William Graham  Ronald Henry Smith
Richard Langton Gregory  Douglas Walter Noble Stibbs
Philip George Harper  Charles James Taylor
Alan Jeffrey  Thomas Summers West
Arthur Colville Kennedy

Honorary Fellows

James Whyte Black  Edwin George Morgan
John Wenman Crofton
Changes in Fellowship

ELECTIONS 2008/09

Fellows

Douglas Crombie Anderson  Leonhardt Ulf
Paul Reid Beaumont  Ronald McCaffer
Henry James Gerard Burns  Ian Graham Main
James Cassidy  Jean Manson
James Stephen Clark  David Ernest Newby
Leroy Cronin  Oliver Michael Timothy
Ian David Diamond  O’Donovan
Lynn Drummond  Thomas Alexander Owen-Hughes
Owen Dudley Edwards  Massimo Palmarini
Douglas Eaglesham Dunn  Tracy Palmer
John William Elvidge  Nicholas Hugh Roe
Tom Farmer  Mark Edwin Schaffer
Maria Fernanda Ferreira  Padma Kant Shukla
Robert William Furness  Peter Smith
Christopher Andrew Glasbey  Agata Smoktunowicz
Susan Jane Hart  Tomoyuki Tanaka
Anthony Bryan Hayward  Michael David Tyers
Alan Francis Heavens  Richard John Warburton
David Arthur Hume  Marian Wiercigroch
Jack Jackson  Alison Willow Yarrington
Irene May Leigh

Corresponding Fellows

Oral Buyukozturk  Richard B Sher
Marc Steven Mangel  Sergios Theodoridis
Review of Sessions 2008/09 and 2009/10

ELECTIONS 2009/10

Fellows

James Iain Walker Anderson
Andrew Howard Baker
Timothy John Bedford
Archibald A Bethel
Gerald Stuart Buller
Geoffrey Allan Codd
Patrick William Michael Corbett
Victoria Elizabeth Crowe
Richard Michael Dixon
Julian Alexander Thomas Dow
Robert Mark Ellam
Philip Francis Esler
Michael Paul Fourman
Iain Grant Gordon
Neva Elizabeth Haites
Christopher Hall
Jill Diana Harries
Pavel Kocovsky
David Michael Lane
David Reginald Francis Leach
Janet Lowe

William Maclean
Jonathan Edward Harland Mills
Stuart Monro
Jeremy Charles Mottram
Ian Paterson
Jill Patricia Pell
Edgar Peltenburg
George William Penrose
Louise Mary Richardson
Jack Satsangi
Paul Martin Sharp
Richard Michael Sharpe
David Malcolm St Clair
Kenneth Alexander Strain
Allan David Struthers
David Tregear Ulph
Daniel Marinus Ferdinand Van Aalten
Andrew Paul Waters
Steven Yearley

Corresponding Fellows

David Richard Armitage
Angus Stewart Deaton
Peter John Hudson

David Maxwell Scott
William George Stirling

Honorary Fellows

Friedrich Ernst Peter Hirzebruch
Neil Robert MacGregor

Jonathan Adair Turner of Echinswell
STAFF CHANGES DURING THE SESSION

2008/09
Arrivals
Ms Sheryl Anderson, Finance Officer
Ms Susan Bishop, Policy Officer
Ms Rebecca Mann, Admin/Receptionist
Mrs Karen O’Neill, Admin/Receptionist
Ms Asa Seljestad, Events Officer

Departures
Mr Stuart Brown, PR and Communications Manager
Ms Koren Calder, Education Outreach Officer
Mrs Sheila Stuart, Admin/Receptionist
Mr Duncan Welsh, Events Officer

Other Staff in post throughout the Sessions
Mr Gordon Adam, Director of Business Development
Ms Christel Baudère, HR Officer
Mrs Róisín Calvert-Elliott, Events Manager
Mrs Catriona Blair, Events/Education Assistant
Ms Sandra Borthwick, Administrator, Scottish Bioinformatics Forum
Ms Jennifer Cameron, Office Services and IT Support Manager
Dr Lesley Campbell, Fellowship, Policy and Journals Manager
Ms Morven Chisholm, International Relations Officer
Mr Andy Curran, Property Services Officer
Dr William Duncan, Chief Executive
Miss Kate Ellis, Director of Finance
Mrs Anne Fraser, Research Awards and International Manager
Mrs Jean Geoghegan, Accounts Officer
Mrs Vicki Hammond, Journals and Archive Officer
Mr William Hardie, Consultations Officer
Mrs Isabel Hastie, Admin/Receptionist
Mr Graeme Herbert, Director of Corporate Services and Deputy Chief Executive

2009/10
Arrivals
Ms Martina Hlinkova, Front of House Manager
Mr Conor Hull, Education Outreach Officer
Mrs Kate Kennedy, Dumfries and Galloway Project Officer

Departures
Ms Asa Seljestad, Events Officer
Ms Claire Swatton, Conference centre Co-ordinator

Mr Andy Curran, Property Services Officer
Dr William Duncan, Chief Executive
Miss Kate Ellis, Director of Finance
Mrs Anne Fraser, Research Awards and International Manager
Mrs Jean Geoghegan, Accounts Officer
Mrs Vicki Hammond, Journals and Archive Officer
Mr William Hardie, Consultations Officer
Mrs Isabel Hastie, Admin/Receptionist
Mr Graeme Herbert, Director of Corporate Services and Deputy Chief Executive
Review of Sessions 2008/09 and 2009/10

Mr Robert Hunter, Evening Caretaker
Dr Chris Janssen, Director, Scottish Bioinformatics Forum
Mr Robert Lachlan, Accounts Officer
Mrs Jenny Liddell, Communications Officer
Mr Bristow Muldoon, Parliamentary Liaison Officer
Miss Angela Nicholson, Records Management Officer

Mr George Pendleton, Conference Centre Assistant
Dr Marc Rands, Evidence and Advice Manager
Ms Tracy Rickard, Research Awards Co-ordinator
Mr Brian Scott, Technical Support Assistant
Ms Susan Walker, Events Officer
Mrs Doreen Waterland, PA to Chief Executive and Officers
Structure, governance and management

The RSE Council, chaired by the President, comprises thirteen Trustees, including four Vice-Presidents, the General Secretary, the Treasurer, the Fellowship Secretary and five ordinary members. At the Annual Statutory Meeting in October 2008, the Laws of the Society were changed to increase the number of Vice-Presidents from three to four. This means that each of the four Sector Groups now has a Vice-President. The Sector Groups are: Life Sciences; Physical, Engineering and Informatic Sciences; Arts, Humanities and Social Sciences; and Economics, Business and Industry. Subject to annual re-election, Council members serve for three years, except for the General Secretary and Treasurer, who may serve for up to four years. All are unpaid.

The Council is responsible for the strategic direction and policies of the RSE, and normally meets quarterly.

An Executive Board has delegated responsibility from the Council for delivery of the RSE’s activities. It is chaired by the General Secretary, and also has as its elected members, the Treasurer, the Convenors of the main operational committees and the Curator, as well as the Chair of the RSE Scotland Foundation and senior executive staff. The Executive Board normally meets quarterly and reports to the Council.

The Council members and the office-bearers serving on the Executive Board are all elected annually by the Fellowship in a postal ballot. New members of the Council and the Executive Board are given an extensive induction through discussions with the Chief Executive and senior staff.

Reporting to the Council through the Executive Board are operational committees, including the Education Committee, International Committee, various Research Awards Committees, the Meetings Committee and the Young People’s Committee. These Committees largely, but not exclusively, comprise Fellows of the RSE and are concerned with the operational delivery of the RSE’s varied activities. All Fellows are actively encouraged to participate in the RSE’s activities.

Two other charitable trusts founded by and closely connected to the RSE, the BP Research Fellowships Trust (the BP Trust) and the RSE Scotland Foundation (the Foundation), are included in the consolidated accounts. The Foundation plays a leading role in the RSE’s public outreach activities and manages the premises in George Street. Its Trustees are appointed for three years by the RSE Council.
In March 2009, The Caledonian Research Foundation (CRF) merged with the Foundation to deliver a joint programme of activities in support of research in Scotland. CRF transferred its activity portfolio and assets of around £6.3m to the Foundation, which is now responsible for managing these within its wider programme of activities. CRF is expected to be wound up as an independent organisation from the summer of 2009, but its charitable objectives will continue to be met through the Foundation. To ensure a smooth transition, three CRF Governors became Foundation Trustees.

The BP Trust was created following a donation of £2m in 1988 from BP to support a scheme of three-year, post-doctoral research fellowships in specified subjects and which are awarded at the sole discretion of the RSE. The RSE President, General Secretary and Treasurer are the BP Trustees, ex officis.

Statement of Council’s responsibilities

Under charities legislation applicable in Scotland, the Council is required to prepare accounts for each financial year that give a true and fair view of the RSE’s financial activities during the year and of its financial position at the end of the year. The Council is responsible for preparing the annual report and the financial statements in accordance with applicable Law and United Kingdom Generally Accepted Accounting Practice (UK GAAP).

In preparing accounts giving a true and fair view, the Council should follow best practice and:

- select suitable accounting policies and apply them consistently;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards and statements of recommended practice have been followed, subject to any departures disclosed and explained in the accounts;
- prepare the accounts on a going concern basis unless it is inappropriate to presume that the RSE will continue in operation.

The Council is responsible for keeping accounting records which disclose with reasonable accuracy the financial position of the RSE and which enable it to ensure that the accounts comply with the Charities and Trustee Investment (Scotland) Act 2005, the Charities Accounts (Scotland) Regulations 2006 and the RSE’s own Laws. It is also responsible for safeguarding the assets of the RSE and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.
Risk management
The Audit and Risk Committee, operating on a joint basis with the Foundation and the BP Trust, reports directly to the Council, the Foundation and the BP Trust. Its Chair, who cannot be a Trustee or other office-bearer of the RSE, is invited to attend Council meetings as an observer. Its remit includes keeping under review the effectiveness of internal control and risk management systems of the RSE and its connected charities. The Council believes that the existing systems and the structure of decision taking and reporting through senior staff, the Executive Board and the Council continues to provide assurance that risks are properly assessed and carefully managed.

OVERVIEW
This section describes the main achievements of the RSE, the Foundation and the BP Trust, reflecting the fact that the Financial Statements are presented on a consolidated basis for this Group of connected charities. The highlights, in what was a successful year include:

- Independent Inquiry into the Future of Scotland’s Hill and Island Areas was published in September 2008 and was widely welcomed;

- Completion of the James Clerk Maxwell Statue in George Street, Edinburgh in November 2008;

- Joining with the Caledonian Research Foundation in March 2009, with the transfer of its portfolio and assets of around £6.3m to the RSE Scotland Foundation;

- Awarding an increased number of Scottish Government Research Fellowships, a total of six new Personal Research Fellowships, each of up to five years in length, implementing the recommendations of the Enderby Report;

- Significant growth in the RSE’s international activities, including new agreements signed with the Academy of Sciences Malaysia and the Royal Society of New Zealand, and an increase in the number of international exchanges;

- The first rounds of the Phase III scheme of Enterprise Fellowships. Twenty-six applications were received and eleven were awarded;

- RSE@Arbroath. A year-long programme of wide-ranging public outreach activities concluding with the Christmas Lectures given by Professor Anne Glover CBE FRSE, Chief Scientific Adviser for Scotland.
The Royal Society of Edinburgh

Results for the year
The statement of financial activities includes two major non-recurring receipts. These were the legacy from Dr Harold Thomas amounting to £2.1m and the transfer of assets from CRF of £6.3m. The underlying financial outcome for the year was a surplus of £39,000, an improvement on the budget expectation of a modest deficit. The majority of the improvement arose from higher-than-expected property and investment income.

Performance Monitoring
The performance of the RSE and its connected charities, compared to the output targets set in the Operational Plan, is reported quarterly to the Executive Board, and thereafter to the RSE Council and to the Trustees of the other connected bodies. As in previous years, the overwhelming majority (>95%) of the targets were reached or exceeded; those that were not arose either through external factors or not being able to secure or apply the necessary resources.

<table>
<thead>
<tr>
<th>Description</th>
<th>£’000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net incoming resources</td>
<td>2,107</td>
</tr>
<tr>
<td>Less: Major legacy</td>
<td>(2,158)</td>
</tr>
<tr>
<td>Appeal income</td>
<td>(9)</td>
</tr>
<tr>
<td>Add: Expenditure for James Clerk Maxwell statue for which income was received in 2007-08</td>
<td>99</td>
</tr>
<tr>
<td>Surplus on recurring activities</td>
<td>39</td>
</tr>
</tbody>
</table>

The balance sheet net assets increased from £11.8m to £18.6m, despite an unrealised loss on investments for the year of £1.3m.
FINANCIAL REVIEW AND POLICIES

Reserves policy and funds
The RSE holds a number of restricted funds resulting from bequests for particular purposes, details of which are set out in note 2 to the financial statements. The Council has created designated funds, from its unrestricted funds, the purposes of which are also set out in note 2 to the financial statements.

The General Fund represents the balance of unrestricted funds arising from past operations. The Council has examined the requirement to hold unrestricted funds, and concluded that, whilst the present level of reserves gives adequate working capital for core costs, it would be desirable to have a General Fund reserve in the range of six months’ expenditure on central costs or approximately £700,000. The current fund balance is £784,000.

The Council has also reviewed the purposes and amounts of each of the designated funds and concluded that in future the designated funds should comprise allocations for specific purposes of those sums that had been donated, rather than generated from past surpluses, together with the Capital Asset Reserve. Result for the year.

As a result of a major legacy, the consolidated total net incoming resources were £2.1m. The underlying surplus, after adjusting for the net effect of expenditure of income received last year for the statue of James Clerk Maxwell and appeal income, was £39,000. This pleasing result was offset by realised losses of £101,000 on investments, mainly arising from the sale of some of the holdings transferred as part of the Dr Thomas Legacy and by the unrealised losses on investments of £1.34m.

The transfer of assets from CRF, amounting to £6.29m, resulted in a net movement on funds for the year, after FRS 17 pension movements, of £6.74m.

Income and Expenditure

Total incoming resources
Total incoming resources were £6.76m, including the exceptional amount referred to above. On a like-for-like basis, excluding the major legacy (£2.16m), total income increased by 31% to £4.60m. The increase arose mainly from increases in income received from charitable activities, of which the increase in funding for the Enterprise Fellowships and Scottish Government Research Fellowships of £615,000 was the largest contribution.

Voluntary income (note 4) of £2.61m includes the legacy income of £2.16m and receipts for the James Clerk Maxwell statue. Following the change in
Scottish Government funding from grant–in-aid to grant, the funding previously recognised as voluntary income is now shown with other programme activities in note 5.

Incoming resources from charitable activities of £3.38m increased by 74% from the 2007–08 level of £1.93m. As well as the increases for research and innovation, it also includes income recognised on conclusion of the Inquiry into Scotland’s Hills and Islands and an increased contribution for the letting of the George Street premises for charitable purposes.

**Resources expended**

Total resources expended have increased by 39% (£1.33m) from last year. This includes the expenditure on completion of the James Clerk Maxwell statue, as well as increased expenditure on charitable activities.

Cost of generating funds (note 6) includes the cost of the Fellowship office, the costs of building management in respect of income from letting of surplus space, as well as fundraising costs, both direct and management time in securing funding. It also includes the costs of the new Director of Business Development. Overall, expenditure on charitable activities has increased by £1.29m.

Grants payable in support of research and innovation made up the major part of this increase, rising from £1.76m to £2.67m. This reflected the increase in Enterprise Fellowships, both those funded by Scottish Enterprise and by the Research Councils, and the increased number of Scottish Government Research Fellows appointed.

Expenditure on informing and influencing public policy increased by £37,000, reflecting the work done to bring the Inquiry on Scotland’s Hills & Islands to its conclusion and launch the Report.

Costs in the Foundation include a full year of the support of the Scottish Bioinformatics Forum and the conclusion of the statue project. Costs of journal publications have risen in line with the numbers of issues published. Governance costs, which have remained at a similar level to previous years, represent around 3% of total recurring income.

Transfers between funds shown in the Statement of Financial Activities comprise the recurring transfer from the Capital Asset Reserve of a total of £101,000 to match the depreciation of buildings and the capital repayment of the loan to the Foundation; and a transfer on consolidation from the Foundation restricted fund balance to the General Fund, equivalent to the net inter-entity income received in the RSE.
The remaining balance of restricted income for the statue has been transferred to restricted funds to form an endowment for the maintenance of the statue.

**Balance sheet**

Consolidated net assets have increased from £11.8m to £18.61m; the main reasons being the transfer from CRF and the major legacy. These have been offset by the decrease in the investment portfolio reflecting unrealised losses of £1.34m and a £212,000 decrease (2008 – £217,000 increase) in the FRS17 pensions adjustment, decreasing the previously reported asset to £139,000. Net current assets increased from £1.2m to £1.76m, comprising mainly cash received in advance of expenditure, reflected in an increase in the provision for liabilities, and an increase in debtors arising from changes to the payment profile of a major grant.

**Future plans**

Against the background of the external financial climate, the strategy of diversification of income sources is challenging. However, the flexibility derived from donations and legacies, such as the very substantial legacy from Dr Harold Thomas received in 2008, provides welcome support.

The Council’s aim is to continue to build relationships and work in partnership with stakeholders and funders in support of the RSE’s varied programmes with public benefit outcomes. Initial steps taken in 2008–09 in developing relationships and links will in due course make their contribution.

Plans for 2009–10 have been developed in the context of the RSE Strategic Framework covering 2007–2012.

The RSE continues to aim to make a difference and all of its activities are planned with a view to contributing to public benefit outcomes.

The Operational Programmes for 2009–10 will continue to be: Core Public Benefits, the Fellowship and Support Services.

**Signed on behalf of the Council**

Ewan Brown CBE
Treasurer
7 September 2009
Independent auditors’ report to the Council of the Royal Society of Edinburgh

We have audited the financial statements of The Royal Society of Edinburgh (RSE) for the year ended 31 March 2009 which comprise the group statement of financial activities, the charity statement of financial activities, the group balance sheet, the charity balance sheet, the cash-flow statement and the related notes. These financial statements have been prepared in accordance with the accounting policies set out therein.

This report is made solely to the charity’s trustees, as a body, in accordance with section 44 (1)(c) of the Charities and Trustee Investment (Scotland) Act 2005 and regulation 10 of the Charities Accounts (Scotland) Regulations 2006 and the Laws of the RSE. Our audit work has been undertaken so that we might state to the charity's trustees those matters we are required to state to them in an auditor’s report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the charity and its trustees as a body, for our audit work, for this report, or for the opinions we have formed.

Respective responsibilities of Trustees and Auditors

The Trustees’ responsibilities for preparing the Trustees’ Annual Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice) are set out in the Statement of Trustees’ Responsibilities.

We have been appointed as auditors under section 44(1)(c) of the Charities and Trustee Investment (Scotland) Act 2005 and report in accordance with regulations made under that Act. Our responsibility is to audit the financial statements in accordance with relevant legal and regulatory requirements and International Standards on Auditing (UK and Ireland).

We report to you our opinion as to whether the financial statements give a true and fair view and are properly prepared in accordance with the Charities and Trustee Investment (Scotland) Act 2005 and regulation 8 of the Charities Accounts (Scotland) Regulations 2006.

We also report to you if, in our opinion, the information given in the Trustees’ Annual Report is not consistent with the financial statements, if the charity has not kept proper accounting records, if the charity’s financial statements
Trustees’ Report and Accounts to 31 March 2009

are not in agreement with these accounting records, or if we have not received all the information and explanations we require for our audit.

We read the Trustees’ Annual Report and consider the implications for our report if we become aware of any apparent misstatements within it.

Basis of audit opinion

We conducted our audit in accordance with International Standards on Auditing (UK and Ireland) issued by the Auditing Practices Board. An audit includes examination, on a test basis, of evidence relevant to the amounts and disclosures in the financial statements. It also includes an assessment of the significant estimates and judgments made by the Trustees in the preparation of the financial statements and of whether the accounting policies are appropriate to the charity’s circumstances, consistently applied and adequately disclosed.

We planned and performed our audit so as to obtain all the information and explanations which we considered necessary in order to provide us with sufficient evidence to give reasonable assurance that the financial statements are free from material mis-statement, whether caused by fraud or other irregularity or error. In forming our opinion we also evaluated the overall adequacy of the presentation of information in the financial statements.

Opinion

In our opinion:

• the financial statements give a true and fair view, in accordance with United Kingdom Generally Accepted Accounting Practice, of the state of the group’s and the charity’s affairs as at 31 March 2009 and of the group’s and charity’s incoming resources and application of resources for the year then ended; and

• the financial statements have been properly prepared in accordance with the Charities and Trustee Investment (Scotland) Act 2005, regulation 8 of the Charities Accounts (Scotland) Regulations 2006 and the Laws of the RSE.

Henderson Loggie
Registered auditors
(Eligible to act as an auditor in terms of section 25 of the Companies Act 1989).

7 September, 2009
**Group statement of financial activities**

*(incorporating the income & expenditure account)*

*for year ended 31 March 2009*

<table>
<thead>
<tr>
<th>Note</th>
<th>General Fund</th>
<th>Designated Funds</th>
<th>Restricted income</th>
<th>Restricted funds</th>
<th>2009 Total</th>
<th>2008 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voluntary income</td>
<td>4</td>
<td>293,766</td>
<td>2,072,255</td>
<td>109,580</td>
<td>140,064</td>
<td>2,615,665</td>
</tr>
<tr>
<td>Activities for generating income</td>
<td>4</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>256,030</td>
<td>256,030</td>
</tr>
<tr>
<td>Investment income</td>
<td>4</td>
<td>69,890</td>
<td>152,398</td>
<td>–</td>
<td>281,538</td>
<td>503,826</td>
</tr>
<tr>
<td><strong>Incoming resources from generated funds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>363,656</td>
<td>2,224,653</td>
<td>109,580</td>
<td>677,632</td>
<td>3,375,521</td>
<td>1,566,371</td>
</tr>
<tr>
<td><strong>Incoming resources from charitable activities</strong></td>
<td>5</td>
<td>100,591</td>
<td>–</td>
<td>3,005,592</td>
<td>281,936</td>
<td>3,388,119</td>
</tr>
<tr>
<td><strong>Total incoming resources</strong></td>
<td></td>
<td>464,247</td>
<td>2,224,653</td>
<td>3,115,172</td>
<td>959,568</td>
<td>6,763,640</td>
</tr>
<tr>
<td><strong>Expenditure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of generating funds</td>
<td>6</td>
<td>(184,904)</td>
<td>(5,538)</td>
<td>–</td>
<td>(61,930)</td>
<td>(252,372)</td>
</tr>
<tr>
<td>Charitable activities</td>
<td>6</td>
<td>(270,943)</td>
<td>(45,717)</td>
<td>(3,214,179)</td>
<td>(714,673)</td>
<td>(4,245,512)</td>
</tr>
<tr>
<td>Governance</td>
<td>6</td>
<td>(125,410)</td>
<td>–</td>
<td>–</td>
<td>(32,536)</td>
<td>(157,946)</td>
</tr>
<tr>
<td><strong>Total resources expended</strong></td>
<td></td>
<td>(581,257)</td>
<td>(51,255)</td>
<td>(3,214,179)</td>
<td>(809,139)</td>
<td>(4,655,830)</td>
</tr>
<tr>
<td><strong>Net incoming resources before transfers</strong></td>
<td></td>
<td>(117,010)</td>
<td>2,173,398</td>
<td>(99,007)</td>
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<td>2,107,810</td>
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<td>Transfers between funds</td>
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<td>(101,818)</td>
<td>(20,275)</td>
<td>(58,693)</td>
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</tr>
<tr>
<td><strong>Other recognised gains/(losses)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gains/(losses) on investment assets</td>
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</tr>
<tr>
<td>Realised gains/(losses)</td>
<td></td>
<td>(53)</td>
<td>(100,927)</td>
<td>–</td>
<td>(196)</td>
<td>(101,176)</td>
</tr>
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<td>Unrealised gains/(losses)</td>
<td></td>
<td>(14,326)</td>
<td>(563,319)</td>
<td>–</td>
<td>(767,419)</td>
<td>(1,345,064)</td>
</tr>
<tr>
<td>Actuarial gains on Lothian Pension Fund</td>
<td></td>
<td>(212,000)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>(212,000)</td>
</tr>
<tr>
<td><strong>Net movement in funds</strong></td>
<td></td>
<td>(162,603)</td>
<td>1,407,334</td>
<td>(119,282)</td>
<td>(675,879)</td>
<td>(449,570)</td>
</tr>
<tr>
<td>Transfer of assets from the CRF</td>
<td>4</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>6,290,710</td>
<td>6,290,710</td>
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<tr>
<td><strong>Net movement in funds after transfer of assets</strong></td>
<td></td>
<td>(162,603)</td>
<td>1,407,334</td>
<td>(119,282)</td>
<td>5,614,831</td>
<td>6,740,280</td>
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<tr>
<td>Balance brought forward at 1 April 2008</td>
<td></td>
<td>1,086,155</td>
<td>5,504,310</td>
<td>119,282</td>
<td>5,160,055</td>
<td>11,869,802</td>
</tr>
<tr>
<td><strong>Balance carried forward at 31 March 2009</strong></td>
<td></td>
<td>923,552</td>
<td>6,911,644</td>
<td>–</td>
<td>10,774,886</td>
<td>18,610,082</td>
</tr>
</tbody>
</table>
## The Royal Society of Edinburgh

**Group balance sheet at 31 March 2009**

<table>
<thead>
<tr>
<th>Note</th>
<th>2009</th>
<th>2008</th>
<th>2009</th>
<th>2008</th>
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<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td><strong>Fixed assets</strong></td>
<td></td>
<td></td>
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<tr>
<td>Tangible fixed assets</td>
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<td>4,067,558</td>
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<td>Investments at market value</td>
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<td>6,103,053</td>
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<tr>
<td>Debtors</td>
<td>16</td>
<td>462,559</td>
<td>217,956</td>
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</tr>
<tr>
<td>Cash at bank and in hand</td>
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<td>372,913</td>
<td>353,670</td>
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<td>Money Market deposits – Designated funds</td>
<td></td>
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<td>700,163</td>
<td></td>
</tr>
<tr>
<td>Money Market deposits – Restricted funds</td>
<td></td>
<td>1,167,068</td>
<td>941,516</td>
<td></td>
</tr>
<tr>
<td>Money Market deposits – General funds</td>
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<td>687,790</td>
<td>941,516</td>
<td></td>
</tr>
<tr>
<td><strong>Current liabilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creditors: amounts falling due within one year</td>
<td>17</td>
<td>(553,513)</td>
<td>(453,837)</td>
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<tr>
<td><strong>Net current assets</strong></td>
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<tr>
<td><strong>Total assets less current liabilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Provision for liabilities and charges</strong></td>
<td>18</td>
<td>(630,228)</td>
<td>(352,277)</td>
<td></td>
</tr>
<tr>
<td><strong>Net assets excluding pension fund</strong></td>
<td>18</td>
<td>18,471,082</td>
<td>11,577,802</td>
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<tr>
<td>Lothian Pension Fund defined benefit Scheme asset</td>
<td>23</td>
<td>139,000</td>
<td>292,000</td>
<td></td>
</tr>
<tr>
<td><strong>Net assets after pension fund asset</strong></td>
<td>18</td>
<td>18,610,082</td>
<td>11,869,802</td>
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</tr>
<tr>
<td><strong>Funds</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>General Fund</td>
<td>19</td>
<td>784,552</td>
<td>794,155</td>
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<tr>
<td>Add. Pension reserve</td>
<td>20</td>
<td>139,000</td>
<td>292,000</td>
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<tr>
<td>Designated Funds</td>
<td>21</td>
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<td>1,086,155</td>
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<tr>
<td>Restricted Funds</td>
<td>22</td>
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<td>5,504,310</td>
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<tr>
<td><strong>Total funds</strong></td>
<td></td>
<td>18,610,082</td>
<td>11,869,802</td>
<td></td>
</tr>
</tbody>
</table>

The accounts were approved by the Council on 7 September 2009 and signed on its behalf by:

Ewan Brown, CBE
Treasurer
## Trustees’ Report and Accounts to 31 March 2009

### RSE balance sheet at 31 March 2009

<table>
<thead>
<tr>
<th>Note</th>
<th>2009 £</th>
<th>2008 £</th>
<th>2009 £</th>
<th>2008 £</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed assets</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>14</td>
<td>2,228,585</td>
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<td>2,264,526</td>
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<td><strong>Fixed asset investments</strong></td>
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<td></td>
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<tr>
<td>Investments at market value</td>
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<td>4,214,788</td>
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<td>15(b)</td>
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<td><strong>Total</strong></td>
<td></td>
<td>8,240,893</td>
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<td>7,199,630</td>
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<tr>
<td>Debtors</td>
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<td>202,623</td>
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<tr>
<td>Money Market deposits – Designated funds</td>
<td></td>
<td>95,388</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Money Market deposits – Restricted funds</td>
<td></td>
<td>1,167,068</td>
<td></td>
<td>700,163</td>
</tr>
<tr>
<td>Money Market deposits – General funds</td>
<td></td>
<td>687,790</td>
<td></td>
<td>941,516</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
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<td></td>
<td>1,945,331</td>
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<td>Creditors: amounts falling due within one year</td>
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<td>18</td>
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<td>(352,277)</td>
</tr>
<tr>
<td><strong>Net assets excluding pension fund</strong></td>
<td></td>
<td>9,208,790</td>
<td></td>
<td>8,065,641</td>
</tr>
<tr>
<td>Lothian Pension Fund defined benefit scheme asset</td>
<td>23</td>
<td>139,000</td>
<td></td>
<td>292,000</td>
</tr>
<tr>
<td><strong>Net assets after pension fund asset</strong></td>
<td></td>
<td>9,347,790</td>
<td></td>
<td>8,357,641</td>
</tr>
<tr>
<td><strong>Funds</strong></td>
<td></td>
<td>784,552</td>
<td></td>
<td>794,155</td>
</tr>
<tr>
<td>General Fund</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add: Pension reserve</td>
<td>19</td>
<td>923,552</td>
<td></td>
<td>1,086,155</td>
</tr>
<tr>
<td>Designated Funds</td>
<td>20</td>
<td>6,911,644</td>
<td></td>
<td>5,504,310</td>
</tr>
<tr>
<td>Restricted Funds</td>
<td>21</td>
<td>1,512,594</td>
<td></td>
<td>1,767,176</td>
</tr>
<tr>
<td><strong>Total funds</strong></td>
<td></td>
<td>9,347,790</td>
<td></td>
<td>8,357,641</td>
</tr>
</tbody>
</table>

The accounts were approved by the Council on 7 September 2009 and signed on its behalf by:

Ewan Brown, CBE
Treasurer
# RSE statement of financial activities

(incorporating the income & expenditure account)

for year ended 31 March 2009

<table>
<thead>
<tr>
<th></th>
<th>General Fund</th>
<th>Designated Funds</th>
<th>Restricted income</th>
<th>Restricted funds</th>
<th>2009 Total</th>
<th>2008 Total</th>
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<tbody>
<tr>
<td><strong>Income</strong></td>
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<td></td>
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<tr>
<td>Voluntary income</td>
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<td>2,072,255</td>
<td>109,580</td>
<td>12,160</td>
<td>2,487,761</td>
<td>904,537</td>
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<td>Investment income</td>
<td>158,101</td>
<td>152,398</td>
<td>–</td>
<td>75,136</td>
<td>385,635</td>
<td>322,928</td>
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<tr>
<td><strong>Incoming resources from generated funds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>451,867</td>
<td>2,224,653</td>
<td>109,580</td>
<td>87,296</td>
<td>2,873,396</td>
<td>1,227,465</td>
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<tr>
<td><strong>Incoming resources from charitable activities</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>100,591</td>
<td>–</td>
<td>3,298,613</td>
<td>–</td>
<td>3,399,204</td>
<td>1,841,363</td>
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<td><strong>Total incoming resources</strong></td>
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<td></td>
<td></td>
<td></td>
<td>6,272,600</td>
<td>3,068,828</td>
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<td><strong>Expenditure</strong></td>
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<tr>
<td>Cost of generating funds</td>
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<td>–</td>
<td>–</td>
<td>(190,442)</td>
<td>(159,524)</td>
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<td>Charitable activities</td>
<td>(280,186)</td>
<td>(45,717)</td>
<td>(3,408,193)</td>
<td>(81,338)</td>
<td>(3,815,434)</td>
<td>(2,879,802)</td>
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<tr>
<td>Governance</td>
<td>(125,410)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>(125,410)</td>
<td>(130,540)</td>
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<tr>
<td><strong>Total resources expended</strong></td>
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<td></td>
<td></td>
<td></td>
<td>(4,131,286)</td>
<td>(3,169,866)</td>
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<td><strong>Net incoming resources before transfers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(38,042)</td>
<td>2,173,398</td>
<td>–</td>
<td>5,958</td>
<td>2,141,314</td>
<td>(101,038)</td>
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<td>Transfers between funds</td>
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<td>(101,818)</td>
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<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Other recognised gains/(losses)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gains/(losses) on investment assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Realised gains/(losses)</td>
<td>(53)</td>
<td>(100,927)</td>
<td>–</td>
<td>(962)</td>
<td>(101,942)</td>
<td>(3,680)</td>
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<td>Unrealised gains/(losses)</td>
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<td>(563,319)</td>
<td>–</td>
<td>(259,578)</td>
<td>(837,223)</td>
<td>(138,782)</td>
</tr>
<tr>
<td>Actuarial gains on Lothian Pension Fund</td>
<td>(212,000)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>(212,000)</td>
<td>217,000</td>
</tr>
<tr>
<td><strong>Net movement in funds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(162,603)</td>
<td>1,407,334</td>
<td>–</td>
<td>(254,582)</td>
<td>990,149</td>
<td>(26,500)</td>
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<td><strong>Balance brought forward at 1 April 2008</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1,086,155</td>
<td>5,504,310</td>
<td>–</td>
<td>1,767,176</td>
<td>8,357,641</td>
<td>8,384,141</td>
</tr>
<tr>
<td><strong>Balance carried forward at 31 March 2009</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>923,552</td>
<td>6,911,644</td>
<td>–</td>
<td>1,512,594</td>
<td>9,347,790</td>
<td>8,357,641</td>
</tr>
</tbody>
</table>
## Trustees' Report and Accounts to 31 March 2009

### Group cash flow statement

for the year ended 31 March 2009

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cash flow statement</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Net cash inflow/(outflow) from operating activities</td>
<td>(364,340)</td>
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<td>(42,177)</td>
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</tr>
<tr>
<td><strong>Returns on investments and servicing of finance:</strong></td>
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<td></td>
</tr>
<tr>
<td>Interest received</td>
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<td>90,727</td>
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</tr>
<tr>
<td>Dividends received</td>
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<td>302,934</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>503,826</td>
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<td>393,661</td>
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</tr>
<tr>
<td><strong>Capital expenditure and financial investment:</strong></td>
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<td></td>
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<tr>
<td>Purchase of tangible fixed assets</td>
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<td></td>
<td>(32,880)</td>
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<tr>
<td>Proceeds from sale of investments</td>
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<td>Purchases of investments</td>
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<td>Capital receipt</td>
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<td><strong>Total</strong></td>
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<td><strong>Net cash flow before financing:</strong></td>
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<td>Appeal receipts</td>
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<td>9,368</td>
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<td><strong>Total</strong></td>
<td>327,810</td>
<td>349,940</td>
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<tr>
<td><strong>Reconciliation of net cash flow to movement in net funds</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>(Decrease) / Increase in cash in the year</td>
<td>327,810</td>
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<td>349,940</td>
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<tr>
<td>Net funds at beginning of year</td>
<td>1,995,349</td>
<td>1,645,409</td>
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<tr>
<td><strong>Net funds at end of year (note 28)</strong></td>
<td>2,323,159</td>
<td>1,995,349</td>
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<td></td>
</tr>
</tbody>
</table>

### Reconciliation of net movement in funds

to net cash outflow from operating activities

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net incoming resources before transfers</td>
<td>8,398,520</td>
<td>174,348</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retirement benefit scheme current service cost</td>
<td>61,000</td>
<td>101,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retirement benefit scheme contributions</td>
<td>(94,000)</td>
<td>(99,000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retirement benefit scheme finance cost</td>
<td>(26,000)</td>
<td>(28,000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appeal receipts</td>
<td>(8,910)</td>
<td>(9,368)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividends receivable</td>
<td>(430,598)</td>
<td>(302,934)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest receivable</td>
<td>(73,228)</td>
<td>(90,727)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>120,299</td>
<td>124,493</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital receipt in cash</td>
<td>(190,560)</td>
<td>(21,796)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital receipt in shares</td>
<td>(8,253,887)</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss on sale of fixed assets</td>
<td>-</td>
<td>2,442</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in debtors</td>
<td>(244,603)</td>
<td>(40,491)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase / (decrease) in creditors</td>
<td>99,676</td>
<td>99,492</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement on provision for liabilities</td>
<td>277,951</td>
<td>48,364</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net cash outflow from operating activities</strong></td>
<td>(364,340)</td>
<td>(42,177)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Royal Society of Edinburgh

1 Accounting basis
The accounts have been drawn up to comply with the provisions of the Charities & Trustee Investment (Scotland) Act 2005 and the Charities Accounts (Scotland) Regulations 2006, and follow the recommendations of the Statement of Recommended Practice for charities (SORP) approved by the Accounting Standards Board in February 2005 and applicable accounting standards. The accounts have been prepared under the historical cost accounting rules as modified to include the revaluation of investments.

The accounts comprise five primary financial statements: the Group and RSE statement of financial activities incorporating the income and expenditure account, the Group and RSE balance sheet and the Group cash flow statement.

The consolidated financial statements include the financial statements of the RSE and of entities which are under its control: RSE Scotland Foundation and BP Research Fellowship Trust. As the objectives of each of these entities are narrower than those of the RSE, they have been treated as restricted funds.

2 Funds
The RSE’s funds are classified in accordance with the definitions in SORP into Restricted Funds, where there are restrictions placed by a donor as to the use of income or capital, Designated Funds where the Society has set aside sums from its unrestricted funds for a particular purpose and the General (unrestricted) Fund. The classifications made are as follows:

General Fund
A discretionary Fund available to the Council to meet the ordinary activities of the Society.

Designated Funds
- Capital Asset Reserve Fund – representing the book cost of the buildings at 22-24 George Street and 26 George Street together with the building project loan to the RSE Scotland Foundation.
- Development Appeal Fund – to provide development finance to implement the RSE Strategic Framework.
- Programme Fund – a fund created to act as a source of funding for meetings activities.
- C. H. Kemberl Fund – income from this fund is used to provide hospitality for distinguished visitors from other learned societies and Academies.
- Dr James Heggie Fund – income from this fund supports the RSE’s activities with young people.
- Grants Fund – a fund created by contributions and legacies from Fellows and used to provide grants to support research activities to Fellows.
- Restricted Income Fund – income funds received for expenditure on current projects.

Restricted Funds
- Robert Cormack Bequest – to promote astronomical knowledge and research in Scotland
- Lessells Trust – to fund scholarships abroad for engineers
- Auber Bequest – to fund research in Scotland and England by naturalised British citizens over 60 years of age
- Prizes Fund – to fund various prizes
- Dryerre Fund – to fund postgraduate scholarships in medical or veterinary physiology
- Fleck Bequest Fund – to promote interest, knowledge and appreciation of science and its applications throughout Scotland.
- Piazzi Smyth Legacy Fund – to fund high altitude astronomical research.
- Sillitto Fund – to promote interest in physics among young people.
- CASS Fund – to fund academic / industrial liaison
- Retailing Seminar Fund – to fund a programme of seminars on retailing
- Edinburgh Drug Absorption Foundation Fund – to fund a series of conferences on the broad theme of ‘Drugs Futures’.
- RSE Scotland Foundation – a trust to advance the education of the public in Scotland in science, engineering and technology, incorporating assets transferred from the CRF.
- BP Research Fellowships Trust – a trust to fund postdoctoral research fellowships in Scotland.

notes to the financial statements
Trustees’ Report and Accounts to 31 March 2009

notes to the financial statements

3 Accounting policies

Incoming resources

Voluntary income
Subscriptions are accounted for on the basis of the subscription year to October 2009 and include income tax recoverable on the subscriptions paid under Gift Aid.

Revenue grants are credited to income in the period in which the RSE becomes entitled to the resources.

Donations of a recurring nature from other charitable foundations and one-off gifts and legacies included in other income are taken to revenue in the period to which they relate.

Investment income
Interest and dividends are accounted for in the year in which they are receivable.

Incoming resources for charitable activities
Incoming resources for activities are accounted for on an accruals basis.

Publication income receivable in foreign currencies is converted into sterling at rates of exchange ruling at the date of receipt.

Incoming resources for research fellowships are accounted for in the period in which the RSE becomes entitled to the resources.

Income received for specific projects, and received in advance of the commencement of the project, is deferred. If the project were not to proceed as planned, the RSE would not be entitled to retain the funds. For performance related grants, where entitlement to the incoming resource only arises with the performance of the specific outputs agreed under the contracts, income is deferred.

Resources expended

Expenditure and support costs
All resources expended are included on an accruals basis, having regard to any constructive obligations created by multi-year grant commitments.

Where directly attributable, resources expended are allocated to the relevant functional category. Overhead and support costs are allocated to functional category on the basis of direct staff costs in each area of activity.

Cost of generating funds
The cost of generating funds includes expenditure incurred in supporting the Fellowship and incurred on fundraising initiatives.

Charitable activities
Grants payable are recognised as a liability when the RSE is under an actual or constructive obligation to make a transfer to a third party. Where grants are time related to future periods and are to be financed by specific grants receivable in those future periods, they are treated as liabilities of those periods and not as liabilities at balance sheet date. Such grants are disclosed as future commitments.

Governance costs
Governance costs are those incurred in connection with the management of RSE assets, organisational administration and compliance with constitutional and statutory requirements.

Tangible fixed assets, depreciation and repairs

The RSE’s principal assets are its buildings in George Street, Edinburgh. Under FRS15 the Society depreciates the buildings assuming a 50-year life. It is the policy of the Council to maintain the buildings to a high standard. Any permanent diminutions in value are reflected in the statement of financial activities. Costs of repairs and maintenance are charged against revenue.

Expenditure incurred by the RSE Scotland Foundation in the improvements to 26 George Street is being depreciated from the date of completion of the refurbishment over the period of the lease to the RSE Scotland Foundation to 30 June 2047.

Minor equipment is charged against revenue in the year of purchase. Computer and audio-visual is depreciated on a straight line basis over 3–20 years.

Investments
Investments are stated at their market value at the balance sheet date. Gains and losses on disposal and revaluation of investments are charged or credited in the statement of financial activities and allocated to funds in accordance with their proportionate share of the investment portfolio.

Pensions
The RSE participates in defined benefit pension schemes which are externally funded. The cost of providing pensions is allocated over employees working lives with the RSE and is included in staff costs.
notes to the financial statements

4 Incoming resources

Current year 2009

<table>
<thead>
<tr>
<th></th>
<th>Voluntary income</th>
<th>Activities for generating income</th>
<th>Investment</th>
<th>Promotion of research</th>
<th>Other charitable activities</th>
<th>Total 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fellows</td>
<td>196,615</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>196,615</td>
</tr>
<tr>
<td>Individuals</td>
<td>45,495</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>47,746</td>
<td>93,241</td>
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<tr>
<td>Legacies</td>
<td>2,158,734</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2,158,734</td>
<td></td>
</tr>
<tr>
<td>Companies</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>30,894</td>
<td>30,894</td>
</tr>
<tr>
<td>Charitable trusts</td>
<td>86,918</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>518,937</td>
<td>788,173</td>
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<td>Scottish Government</td>
<td>–</td>
<td>–</td>
<td>1,126,993</td>
<td>–</td>
<td>645,580</td>
<td>1,772,573</td>
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<td>Public sector bodies</td>
<td>–</td>
<td>–</td>
<td>471,822</td>
<td>–</td>
<td>81,893</td>
<td>553,715</td>
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<td>Bank interest</td>
<td>–</td>
<td>73,228</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>73,228</td>
</tr>
<tr>
<td>Dividends</td>
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<td>224,197</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>224,197</td>
</tr>
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<td>RSE</td>
<td>2,487,762</td>
<td>–</td>
<td>297,425</td>
<td>2,117,752</td>
<td>988,431</td>
<td>5,891,370</td>
</tr>
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<td>BP Research Fellowship Trust</td>
<td>–</td>
<td>152,304</td>
<td>–</td>
<td>–</td>
<td>152,304</td>
<td></td>
</tr>
<tr>
<td>RSE Scotland Foundation</td>
<td></td>
<td>256,030</td>
<td>–</td>
<td>–</td>
<td>256,030</td>
<td></td>
</tr>
<tr>
<td>– grant re SBF</td>
<td>127,903</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>127,903</td>
</tr>
<tr>
<td>– rental income</td>
<td>–</td>
<td>256,030</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>256,030</td>
</tr>
<tr>
<td>– charitable activities</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>281,936</td>
<td>281,936</td>
</tr>
<tr>
<td>– dividends and interest</td>
<td>–</td>
<td>54,097</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>54,097</td>
</tr>
<tr>
<td>Transfer of assets from the CRF</td>
<td>2,615,665</td>
<td>256,030</td>
<td>503,826</td>
<td>2,117,752</td>
<td>1,270,367</td>
<td>6,763,640</td>
</tr>
<tr>
<td></td>
<td>6,290,710</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>6,290,710</td>
</tr>
<tr>
<td></td>
<td>8,906,375</td>
<td>256,030</td>
<td>503,826</td>
<td>2,117,752</td>
<td>1,270,367</td>
<td>13,054,350</td>
</tr>
</tbody>
</table>

Prior year 2008

<table>
<thead>
<tr>
<th></th>
<th>Voluntary income</th>
<th>Activities for generating income</th>
<th>Investment</th>
<th>Promotion of research</th>
<th>Other charitable activities</th>
<th>Total 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fellows</td>
<td>192,070</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>192,070</td>
</tr>
<tr>
<td>Individuals and legacies</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>28,961</td>
<td>114,574</td>
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<td>Companies</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>40,867</td>
<td>86,117</td>
</tr>
<tr>
<td>Charitable trusts</td>
<td>121,731</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>318,405</td>
<td>500,496</td>
</tr>
<tr>
<td>Scottish Government</td>
<td>458,000</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>671,653</td>
<td>1,299,653</td>
</tr>
<tr>
<td>Public sector bodies</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>247,139</td>
<td>294,405</td>
</tr>
<tr>
<td>Bank interest</td>
<td>–</td>
<td>81,628</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>81,628</td>
</tr>
<tr>
<td>Dividends</td>
<td>–</td>
<td>151,217</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>151,217</td>
</tr>
<tr>
<td>Other</td>
<td>1,873</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1,873</td>
</tr>
<tr>
<td>RSE</td>
<td>904,537</td>
<td>–</td>
<td>232,845</td>
<td>1,237,197</td>
<td>437,454</td>
<td>2,812,033</td>
</tr>
<tr>
<td>RSE Scotland Foundation</td>
<td></td>
<td>241,652</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>241,652</td>
</tr>
<tr>
<td>– grant re SBF</td>
<td>26,521</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>26,521</td>
</tr>
<tr>
<td>– rental income</td>
<td>–</td>
<td>241,652</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>241,652</td>
</tr>
<tr>
<td>– charitable activities</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>261,101</td>
<td>261,101</td>
</tr>
<tr>
<td>– interest</td>
<td>–</td>
<td>1,098</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1,098</td>
</tr>
<tr>
<td>BP Research Fellowships Trust – interest</td>
<td>–</td>
<td>8,001</td>
<td>–</td>
<td>–</td>
<td>8,001</td>
<td></td>
</tr>
<tr>
<td>BP Research Fellowships Trust – dividends</td>
<td>–</td>
<td>151,717</td>
<td>–</td>
<td>–</td>
<td>151,717</td>
<td></td>
</tr>
<tr>
<td></td>
<td>931,058</td>
<td>241,652</td>
<td>393,661</td>
<td>1,237,197</td>
<td>698,555</td>
<td>3,502,123</td>
</tr>
</tbody>
</table>
notes to the financial statements

4 Incoming resources (continued)

4a Voluntary income

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions from RSE Fellows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admission fees</td>
<td>12,320</td>
<td>14,280</td>
</tr>
<tr>
<td>Annual subscriptions</td>
<td>160,576</td>
<td>152,913</td>
</tr>
<tr>
<td>Income tax recoverable under Gift Aid</td>
<td>23,719</td>
<td>24,877</td>
</tr>
<tr>
<td></td>
<td>196,615</td>
<td>192,070</td>
</tr>
<tr>
<td>Lessells Trust additional receipt</td>
<td>12,160</td>
<td>9,730</td>
</tr>
<tr>
<td>Appeal receipts</td>
<td>8,910</td>
<td>9,368</td>
</tr>
<tr>
<td>Legacies</td>
<td>2,158,735</td>
<td></td>
</tr>
<tr>
<td>Scottish Government Grant -in-aid – General activities</td>
<td>–</td>
<td>458,000</td>
</tr>
<tr>
<td>Receipts for James Clerk Maxwell Statue</td>
<td>109,580</td>
<td>211,700</td>
</tr>
<tr>
<td>Sillitto Fund</td>
<td>–</td>
<td>21,796</td>
</tr>
<tr>
<td>Other income</td>
<td>1,762</td>
<td>1,873</td>
</tr>
<tr>
<td></td>
<td>2,487,762</td>
<td>904,537</td>
</tr>
</tbody>
</table>

In addition to the donations set out above, the RSE receives donations made specifically in support of activities which are included in activities income (see note 26(b)).

5 Incoming resources from charitable activities

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scottish Government Grant – research fellowships</td>
<td>1,050,130</td>
<td>671,653</td>
</tr>
<tr>
<td>Scottish Government Grant – arts &amp; humanities awards</td>
<td>76,863</td>
<td>–</td>
</tr>
<tr>
<td>Franco-Scottish PhD scholarships</td>
<td>12,000</td>
<td>24,000</td>
</tr>
<tr>
<td>Caledonian Research Foundation</td>
<td>21,237</td>
<td>18,405</td>
</tr>
<tr>
<td>Scottish Enterprise</td>
<td>228,148</td>
<td>84,763</td>
</tr>
<tr>
<td>BBSRC Enterprise Fellowships</td>
<td>201,812</td>
<td>138,376</td>
</tr>
<tr>
<td>STFC Enterprise Fellowships</td>
<td>29,862</td>
<td>–</td>
</tr>
<tr>
<td>Lloyds TSB Foundation for Scotland</td>
<td>497,700</td>
<td>300,000</td>
</tr>
<tr>
<td></td>
<td>2,117,752</td>
<td>1,237,197</td>
</tr>
</tbody>
</table>

Scottish Government Grant – generating & communicating knowledge | 372,161| –     |
Scottish Government Grant – International activities | 273,419| 170,000|
Gannochy Trust | 105,000| 105,000|
Scottish Funding Council | 37,316| 32,536|
Meetings | 102,652| 87,723|
Inquiry income | 73,577| 19,073|
IEEE / RSE / Wolfson James Clerk Maxwell Award | 19,494| 17,132|
Educational activities | 4,597| 3,013|
Sale of sundry publications | 215| 2,977|
|                                                  | 988,431| 437,454|
RSE Scotland Foundation – Journal publications | 134,390| 122,105|
RSE Scotland Foundation – Conference facilities letting | 147,546| 138,996|
|                                                  | 281,936| 261,101|
|                                                  | 3,388,119| 1,935,752|

Further information relating to grants, donations and receipts and their application is set out in note 26.
The Royal Society of Edinburgh

notes to the financial statements

6 Resources expended

<table>
<thead>
<tr>
<th>Costs of generating funds</th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct costs</td>
<td>Support costs (Note 12)</td>
</tr>
<tr>
<td>Fundraising</td>
<td>49,863</td>
<td>34,199</td>
</tr>
<tr>
<td>Fellows' subscriptions</td>
<td>–</td>
<td>100,842</td>
</tr>
<tr>
<td>Appeal donations</td>
<td>–</td>
<td>5,538</td>
</tr>
<tr>
<td></td>
<td>49,863</td>
<td>140,579</td>
</tr>
<tr>
<td>RSE Scotland Foundation</td>
<td>–</td>
<td>61,592</td>
</tr>
<tr>
<td>Building management</td>
<td>–</td>
<td>100,842</td>
</tr>
<tr>
<td>BP Research Fellowship Trust</td>
<td>338</td>
<td>–</td>
</tr>
<tr>
<td>Total costs of generating funds</td>
<td>50,201</td>
<td>202,171</td>
</tr>
</tbody>
</table>

Charitable activities

| Increasing World-Class Researchers | 1,914,665 | 276,830 | 2,191,495 | 1,181,481 | 295,636 | 1,477,117 |
| Increasing International Research Connections | 178,995 | 97,437 | 276,432 | 178,211 | 76,860 | 255,071 |
| Increasing Connections Between Business and Academia | 482,772 | 95,896 | 578,668 | 281,417 | 60,824 | 342,241 |
| Increasing Numbers Taking Science as a Career | 12,757 | 60,533 | 73,310 | 23,474 | 58,385 | 81,859 |
| Enhancing Public Appreciation of Science and Culture | 165,680 | 227,887 | 393,567 | 126,537 | 221,037 | 347,574 |
| Influencing Public Policy | 53,644 | 125,327 | 178,971 | 30,619 | 110,992 | 141,611 |
|                          | 2,808,513 | 883,930 | 3,692,443 | 1,821,739 | 823,734 | 2,645,473 |

RSE Scotland Foundation

| Journal Publications       | 95,594 | 32,390 | 127,984 | 74,615 | 31,313 | 105,928 |
| James Clerk Maxwell Statue | 208,586 | –      | 208,586 | 92,418 | –      | 92,418 |
| SBF                        | 112,903 | 15,000 | 127,903 | 22,771 | 3,750  | 26,521 |
| Conference facilities letting | –     | 88,596 | 88,596  | –     | 78,066 | 78,066 |
|                          | 417,083 | 135,986 | 553,069 | 189,804 | 113,129 | 302,933 |

Total cost of charitable activities | 3,225,596 | 1,019,916 | 4,245,512 | 2,011,543 | 936,863 | 2,948,406 |

Governance (note 10)

| RSE                       | 6,612 | 118,798 | 125,410 | 6,562 | 123,978 | 130,540 |
| RSE Scotland Foundation   | 3,250 | 28,041 | 31,291 | 1,856 | 24,719 | 26,575 |
| BP Research Fellowships Trust | 1,245 | –      | 1,245  | 1,253 | –      | 1,253 |
| Total governance costs    | 11,107 | 146,839 | 157,946 | 9,671 | 148,697 | 158,368 |

Resources expended

| 3,286,904 | 1,368,926 | 4,655,830 | 2,037,800 | 1,289,975 | 3,327,775 |

Central support costs as set out in note 12 have been allocated to activities in proportion to the employment cost in each area of activity.
notes to the financial statements

7 Grants payable

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion of research (note 8)</td>
<td>2,124,730</td>
<td>1,439,875</td>
</tr>
<tr>
<td>Prizes and grants</td>
<td>66,765</td>
<td>37,242</td>
</tr>
<tr>
<td>Promotion of Innovation (note 9)</td>
<td>482,772</td>
<td>281,417</td>
</tr>
<tr>
<td></td>
<td><strong>2,674,267</strong></td>
<td><strong>1,758,534</strong></td>
</tr>
</tbody>
</table>

8 Increasing Numbers of World-Class Researchers

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scottish Government Fellowships</td>
<td>975,263</td>
<td>612,497</td>
</tr>
<tr>
<td>Marie Curie COFUND actions</td>
<td>1,240</td>
<td>–</td>
</tr>
<tr>
<td>Arts &amp; Humanities Workshop Grants</td>
<td>71,582</td>
<td>35,290</td>
</tr>
<tr>
<td>Franco-Scottish PhD scholarships</td>
<td>12,000</td>
<td>24,000</td>
</tr>
<tr>
<td>CRF European Fellowships</td>
<td>17,364</td>
<td>14,412</td>
</tr>
<tr>
<td>Lloyds TSB Foundation for Scotland Fellowships</td>
<td>476,925</td>
<td>280,150</td>
</tr>
<tr>
<td>Robert Cormack Bequest</td>
<td>6,610</td>
<td>6,161</td>
</tr>
<tr>
<td>John Moyes Lessells Scholarship</td>
<td>18,412</td>
<td>27,635</td>
</tr>
<tr>
<td>Auber Bequest Awards</td>
<td>–</td>
<td>4,000</td>
</tr>
<tr>
<td>Henry Dryerre Scholarship</td>
<td>19,340</td>
<td>19,035</td>
</tr>
<tr>
<td></td>
<td><strong>1,596,736</strong></td>
<td><strong>1,023,180</strong></td>
</tr>
<tr>
<td>Library</td>
<td>200</td>
<td>848</td>
</tr>
<tr>
<td>RSE</td>
<td>1,596,936</td>
<td>1,024,028</td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td>171,082</td>
<td>126,917</td>
</tr>
<tr>
<td>RSE Scotland Foundation – CRF</td>
<td>91,520</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td><strong>1,859,538</strong></td>
<td><strong>1,150,945</strong></td>
</tr>
<tr>
<td>Support costs (note 6)</td>
<td>265,192</td>
<td>288,930</td>
</tr>
<tr>
<td>Promotion of Research</td>
<td>2,124,730</td>
<td>1,439,875</td>
</tr>
<tr>
<td>Prizes and Grants</td>
<td>66,765</td>
<td>37,242</td>
</tr>
<tr>
<td></td>
<td><strong>2,191,495</strong></td>
<td><strong>1,477,117</strong></td>
</tr>
</tbody>
</table>

An analysis of institutions and individual awards made under this expenditure heading is included in the Society’s Review 2008,
The Royal Society of Edinburgh

notes to the financial statements

9 Increasing connections between business and academia

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Scottish Enterprise Fellowships</td>
<td>187,695</td>
<td>78,134</td>
</tr>
<tr>
<td>STFC Enterprise Fellowships</td>
<td>23,625</td>
<td>–</td>
</tr>
<tr>
<td>BRSRC Enterprise Fellowships</td>
<td>186,452</td>
<td>122,841</td>
</tr>
<tr>
<td>Gannochy Trust</td>
<td>85,000</td>
<td>80,442</td>
</tr>
<tr>
<td></td>
<td>482,772</td>
<td>281,417</td>
</tr>
<tr>
<td>Support costs (Note 6)</td>
<td>95,896</td>
<td>60,824</td>
</tr>
<tr>
<td></td>
<td>578,668</td>
<td>342,241</td>
</tr>
</tbody>
</table>

10 Enhancing public appreciation of science and culture

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Meetings</td>
<td>115,308</td>
<td>89,831</td>
</tr>
<tr>
<td>Publications</td>
<td>50,372</td>
<td>36,706</td>
</tr>
<tr>
<td></td>
<td>165,680</td>
<td>126,537</td>
</tr>
<tr>
<td>Support costs (Note 6)</td>
<td>227,887</td>
<td>221,037</td>
</tr>
<tr>
<td></td>
<td>393,567</td>
<td>347,574</td>
</tr>
</tbody>
</table>

The RSE Scotland Foundation became publisher of the RSE’s journals and year book with effect from the 1997 volumes. The RSE retains copyright and incurs editorial costs in respect of these publications. The RSE has made a donation to the RSE Scotland Foundation equivalent to its net deficit on publications.

11 Governance

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Management and secretariat</td>
<td>116,416</td>
<td>123,678</td>
</tr>
<tr>
<td>Audit fee</td>
<td>11,107</td>
<td>8,480</td>
</tr>
<tr>
<td>Other professional advice from auditors</td>
<td>2,382</td>
<td>1,491</td>
</tr>
<tr>
<td></td>
<td>129,905</td>
<td>133,649</td>
</tr>
<tr>
<td>RSE Scotland Foundation – Management and secretariat</td>
<td>28,041</td>
<td>24,719</td>
</tr>
<tr>
<td></td>
<td>157,946</td>
<td>158,368</td>
</tr>
</tbody>
</table>
notes to the financial statements

12 Support costs

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Salaries (note 13)</strong></td>
<td>914,868</td>
<td>857,634</td>
</tr>
<tr>
<td><strong>Staff training, agency and recruitment costs</strong></td>
<td>38,918</td>
<td>34,166</td>
</tr>
<tr>
<td><strong>Non-cash pension cost adjustments (FRS 17)</strong></td>
<td>(59,000)</td>
<td>(26,000)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>894,786</td>
<td>865,800</td>
</tr>
</tbody>
</table>

**Other costs**

<table>
<thead>
<tr>
<th>Description</th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment expenses</td>
<td>193,476</td>
<td>172,317</td>
</tr>
<tr>
<td>Computer and equipment costs</td>
<td>29,119</td>
<td>18,024</td>
</tr>
<tr>
<td>Communication, stationery and printing costs</td>
<td>59,957</td>
<td>56,288</td>
</tr>
<tr>
<td>Travel and subsistence, hospitality</td>
<td>21,831</td>
<td>19,627</td>
</tr>
<tr>
<td>Publicity</td>
<td>17,923</td>
<td>6,702</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>8,992</td>
<td>9,694</td>
</tr>
<tr>
<td>Professional fees</td>
<td>22,543</td>
<td>17,030</td>
</tr>
<tr>
<td>Depreciation</td>
<td>120,299</td>
<td>124,493</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>474,140</td>
<td>424,175</td>
</tr>
</tbody>
</table>

**Total central costs**

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>1,368,926</td>
<td>1,289,975</td>
</tr>
</tbody>
</table>

Support costs have been allocated to activities in proportion to the employment cost in each area of activity as set out in note 6.

13 Employees

<table>
<thead>
<tr>
<th>Description</th>
<th>Total 2009</th>
<th>Funded by Foundation 2009</th>
<th>Funded by RSE 2009</th>
<th>Total 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wages and salaries</strong></td>
<td>741,632</td>
<td>96,211</td>
<td>645,421</td>
<td>694,307</td>
</tr>
<tr>
<td><strong>Social security costs</strong></td>
<td>55,701</td>
<td>6,199</td>
<td>49,502</td>
<td>52,397</td>
</tr>
<tr>
<td><strong>Other pension costs</strong></td>
<td>117,535</td>
<td>19,036</td>
<td>98,499</td>
<td>110,930</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>914,868</td>
<td>121,446</td>
<td>793,422</td>
<td>857,634</td>
</tr>
</tbody>
</table>

The average number of employees of the RSE including those employed under joint contracts with the RSE Scotland Foundation was 28 (2008:27). One member of staff earned over £60,000 per year and is a member of a defined benefit pension scheme.
The Royal Society of Edinburgh

notes to the financial statements

14 Tangible fixed assets

<table>
<thead>
<tr>
<th>Group</th>
<th>22 – 24 George Street Purchase cost</th>
<th>26 George Street Purchase cost</th>
<th>Improvements Purchase cost</th>
<th>Computer &amp; equipment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 April 2008</td>
<td>1,103,038</td>
<td>1,647,468</td>
<td>2,136,070</td>
<td>340,326</td>
<td>5,226,902</td>
</tr>
<tr>
<td>Additions</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>37,328</td>
</tr>
<tr>
<td>At 31 March 2009</td>
<td>1,103,038</td>
<td>1,647,468</td>
<td>2,136,070</td>
<td>377,654</td>
<td>5,264,230</td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 April 2008</td>
<td>198,545</td>
<td>296,545</td>
<td>393,771</td>
<td>270,483</td>
<td>1,159,344</td>
</tr>
<tr>
<td>Charge for the year</td>
<td>22,063</td>
<td>32,949</td>
<td>44,467</td>
<td>20,820</td>
<td>120,299</td>
</tr>
<tr>
<td>At 31 March 2009</td>
<td>220,608</td>
<td>329,494</td>
<td>438,238</td>
<td>291,303</td>
<td>1,279,643</td>
</tr>
<tr>
<td>Net book value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 31 March 2008</td>
<td>882,430</td>
<td>1,317,974</td>
<td>1,697,832</td>
<td>69,443</td>
<td>4,067,558</td>
</tr>
<tr>
<td>RSE Net book value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 31 March 2009</td>
<td>882,430</td>
<td>1,317,974</td>
<td>–</td>
<td>28,181</td>
<td>2,228,585</td>
</tr>
<tr>
<td>At 31 March 2008</td>
<td>904,493</td>
<td>1,350,923</td>
<td>–</td>
<td>9,110</td>
<td>2,264,526</td>
</tr>
</tbody>
</table>

15 Fixed asset investments

<table>
<thead>
<tr>
<th>Value at Investments made at cost</th>
<th>Proceeds on sale of investments</th>
<th>Gain / loss</th>
<th>Revaluation</th>
<th>Market value at 31 March 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managed Funds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td>3,090,776</td>
<td>2,063,176</td>
<td>–</td>
<td>(101,941)</td>
</tr>
<tr>
<td>Managed Funds</td>
<td>517,603</td>
<td>50,892</td>
<td>(22,402)</td>
<td>327</td>
</tr>
<tr>
<td>Fixed interest</td>
<td>853,633</td>
<td>1,471,556</td>
<td>(551,296)</td>
<td>8,137</td>
</tr>
<tr>
<td>UK equities</td>
<td>1,333,303</td>
<td>3,093,746</td>
<td>(1,868,511)</td>
<td>(110,405)</td>
</tr>
<tr>
<td>Cash deposits</td>
<td>185,170</td>
<td>2,594,050</td>
<td>2,442,209</td>
<td>–</td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managed Funds</td>
<td>3,012,277</td>
<td>2,663,176</td>
<td>–</td>
<td>(1,897)</td>
</tr>
<tr>
<td>Managed Funds</td>
<td>517,603</td>
<td>50,892</td>
<td>(25,323)</td>
<td>459</td>
</tr>
<tr>
<td>Fixed interest</td>
<td>880,597</td>
<td>200,754</td>
<td>(85,909)</td>
<td>(6,325)</td>
</tr>
<tr>
<td>UK equities</td>
<td>1,439,560</td>
<td>170,254</td>
<td>(85,909)</td>
<td>(6,325)</td>
</tr>
<tr>
<td>Cash deposits</td>
<td>174,517</td>
<td>448,882</td>
<td>366,306</td>
<td>–</td>
</tr>
</tbody>
</table>

The loss on sale of investments measured against their historical cost was £105,750 (2008: Surplus (£323,097). The historical cost of investments was £13,792,748 (2008: £5,602,741). (RSE 2009: £4,794,342, 2008: £2,697,440) Investments comprising more than 5% of the market value of the portfolio were: Treasury 5% (2012), Treasury 5% (2014) and European Investment Bank 4.75% (2011).
15 Fixed asset investments (continued)

<table>
<thead>
<tr>
<th>Loan by RSE to RSE Scotland Foundation</th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due within one year</td>
<td>£46,808</td>
<td>£46,808</td>
</tr>
<tr>
<td>Due after one year</td>
<td>£1,795,712</td>
<td>£1,797,520</td>
</tr>
<tr>
<td></td>
<td>£1,797,520</td>
<td>£1,844,328</td>
</tr>
</tbody>
</table>

The loan bears interest at 4% per annum, capped at the amount of rent received by the Foundation and is repayable over the period to 30 June 2047, the expiration of the lease of 26 George Street.

16 Debtors

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>General debtors</td>
<td>309,874</td>
<td>59,435</td>
</tr>
<tr>
<td>Prepayments and accrued income</td>
<td>14,795</td>
<td>11,048</td>
</tr>
<tr>
<td>Income tax recoverable</td>
<td>24,277</td>
<td>30,546</td>
</tr>
<tr>
<td>RSE</td>
<td>348,946</td>
<td>101,029</td>
</tr>
<tr>
<td>RSE Scotland Foundation - Debtors</td>
<td>82,909</td>
<td>102,112</td>
</tr>
<tr>
<td>RSE Scotland Foundation - Prepayments</td>
<td>21,879</td>
<td>7,518</td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td>8,825</td>
<td>7,297</td>
</tr>
<tr>
<td>Group</td>
<td>462,559</td>
<td>217,956</td>
</tr>
</tbody>
</table>

17 Creditors: Amounts falling due within one year

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>General creditors</td>
<td>378,026</td>
<td>166,434</td>
</tr>
<tr>
<td>Accruals</td>
<td>69,535</td>
<td>64,522</td>
</tr>
<tr>
<td>VAT payable</td>
<td>18,098</td>
<td>30,929</td>
</tr>
<tr>
<td>University of Glasgow (note 22)</td>
<td>6,723</td>
<td>5,371</td>
</tr>
<tr>
<td>Deferred income</td>
<td>29,165</td>
<td>80,577</td>
</tr>
<tr>
<td>Symposia income deferred</td>
<td>30,000</td>
<td>22,400</td>
</tr>
<tr>
<td>Advance receipts – Publications</td>
<td>21,966</td>
<td>83,604</td>
</tr>
<tr>
<td>Group</td>
<td>553,513</td>
<td>453,837</td>
</tr>
</tbody>
</table>

Deferred income and advance receipts analysis

<table>
<thead>
<tr>
<th></th>
<th>At 1 April 2008</th>
<th>Received in year</th>
<th>Recognised in year</th>
<th>At 31 March 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>French PhD scholarships</td>
<td>12,000</td>
<td>–</td>
<td>(12,000)</td>
<td>–</td>
</tr>
<tr>
<td>Hills &amp; Island Inquiry</td>
<td>68,577</td>
<td>5,000</td>
<td>(73,577)</td>
<td>–</td>
</tr>
<tr>
<td>Climate Change Inquiry</td>
<td>–</td>
<td>11,209</td>
<td>–</td>
<td>11,209</td>
</tr>
<tr>
<td>Chemistry Project</td>
<td>–</td>
<td>18,000</td>
<td>(44)</td>
<td>17,956</td>
</tr>
<tr>
<td></td>
<td>80,577</td>
<td>34,209</td>
<td>(85,621)</td>
<td>29,165</td>
</tr>
<tr>
<td>Journal receipts</td>
<td>83,604</td>
<td>72,752</td>
<td>(134,390)</td>
<td>21,966</td>
</tr>
<tr>
<td>Symposia income</td>
<td>22,400</td>
<td>26,245</td>
<td>(18,645)</td>
<td>30,000</td>
</tr>
</tbody>
</table>
The Royal Society of Edinburgh

notes to the financial statements

17 Creditors: Amounts falling due within one year (continued)

<table>
<thead>
<tr>
<th>RSE</th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>General creditors</td>
<td>367,036</td>
<td>161,236</td>
</tr>
<tr>
<td>RSE Scotland Foundation current account</td>
<td>492,543</td>
<td>457,459</td>
</tr>
<tr>
<td>Deferred income</td>
<td>29,165</td>
<td>80,577</td>
</tr>
<tr>
<td>University of Glasgow (note 22)</td>
<td>6,723</td>
<td>5,371</td>
</tr>
<tr>
<td>Symposia income deferred</td>
<td>30,000</td>
<td>22,400</td>
</tr>
<tr>
<td></td>
<td>925,467</td>
<td>727,043</td>
</tr>
</tbody>
</table>

18 Provision for liabilities and charges

<table>
<thead>
<tr>
<th></th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitments for research fellowships</td>
<td></td>
</tr>
<tr>
<td>At 1 April 2008 – Group &amp; RSE</td>
<td>352,277</td>
</tr>
<tr>
<td><strong>New commitments:</strong></td>
<td></td>
</tr>
<tr>
<td>Lloyds TSB Foundation for Scotland Research Fellowships</td>
<td>497,700</td>
</tr>
<tr>
<td><strong>Grants paid in the year</strong></td>
<td>(219,749)</td>
</tr>
<tr>
<td>At 31 March 2009</td>
<td>630,228</td>
</tr>
</tbody>
</table>

The provision represents amounts payable under a constructive obligation in respect of research fellowships due as follows:
2009-10 £239,849; 2010-11 £111,580; 2011-12 £37,301

19 General Fund

<table>
<thead>
<tr>
<th></th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 April 2008</td>
<td>1,086,155</td>
</tr>
<tr>
<td>Net movement in funds for the year from statement of financial activities</td>
<td>(162,603)</td>
</tr>
<tr>
<td>At 31 March 2009</td>
<td>923,552</td>
</tr>
</tbody>
</table>
Trustees’ Report and Accounts to 31 March 2009

notes to the financial statements

### 20 Designated Funds

<table>
<thead>
<tr>
<th>Fund</th>
<th>At 1 April 2008</th>
<th>Investment income</th>
<th>Other income</th>
<th>Expenditure</th>
<th>Gains / (losses)</th>
<th>Transfers</th>
<th>At 31 March 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Asset Reserve</td>
<td>4,099,744</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>(101,818)</td>
<td>3,997,926</td>
</tr>
<tr>
<td>Development Appeal Fund</td>
<td>478,013</td>
<td>111,680</td>
<td>2,072,255</td>
<td>(5,538)</td>
<td>(513,182)</td>
<td>–</td>
<td>2,143,228</td>
</tr>
<tr>
<td>Programme Fund</td>
<td>102,386</td>
<td>4,499</td>
<td>–</td>
<td>–</td>
<td>(16,693)</td>
<td>–</td>
<td>90,192</td>
</tr>
<tr>
<td>CH Kemball Fund</td>
<td>24,787</td>
<td>1,089</td>
<td>–</td>
<td>(1,535)</td>
<td>(4,041)</td>
<td>–</td>
<td>20,300</td>
</tr>
<tr>
<td>Grants Fund</td>
<td>581,721</td>
<td>25,564</td>
<td>–</td>
<td>(34,066)</td>
<td>(94,843)</td>
<td>–</td>
<td>478,376</td>
</tr>
<tr>
<td>Dr James Heggie Fund</td>
<td>217,659</td>
<td>9,566</td>
<td>(10,116)</td>
<td>(35,487)</td>
<td>–</td>
<td>181,622</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,504,310</td>
<td>152,398</td>
<td>2,072,255</td>
<td>(51,255)</td>
<td>(664,246)</td>
<td>(101,818)</td>
<td>6,911,644</td>
</tr>
</tbody>
</table>

The transfers represent the release from the Capital Asset Reserve of a total of £101,818 to match the depreciation of buildings and the amount of capital repayment of the loan to the Foundation.

### 21 Restricted Funds

<table>
<thead>
<tr>
<th>Fund</th>
<th>At 1 April 2008</th>
<th>Investment income</th>
<th>Other income</th>
<th>Expenditure</th>
<th>Gains / (losses)</th>
<th>Transfers</th>
<th>At 31 March 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Cormack Bequest</td>
<td>109,724</td>
<td>4,822</td>
<td>–</td>
<td>(6,920)</td>
<td>(17,889)</td>
<td>–</td>
<td>89,737</td>
</tr>
<tr>
<td>Lessells Trust</td>
<td>429,460</td>
<td>18,873</td>
<td>12,160</td>
<td>(25,575)</td>
<td>(70,019)</td>
<td>–</td>
<td>364,899</td>
</tr>
<tr>
<td>Auber Bequest</td>
<td>399,615</td>
<td>17,561</td>
<td>–</td>
<td>(6,666)</td>
<td>(65,153)</td>
<td>–</td>
<td>345,357</td>
</tr>
<tr>
<td>Prizes Fund</td>
<td>74,763</td>
<td>3,285</td>
<td>–</td>
<td>(6,919)</td>
<td>(12,189)</td>
<td>–</td>
<td>58,940</td>
</tr>
<tr>
<td>Dryerre Fund</td>
<td>492,575</td>
<td>21,646</td>
<td>–</td>
<td>(28,057)</td>
<td>(80,309)</td>
<td>–</td>
<td>405,855</td>
</tr>
<tr>
<td>Fleck</td>
<td>53,450</td>
<td>2,349</td>
<td>–</td>
<td>(891)</td>
<td>(8,715)</td>
<td>–</td>
<td>46,193</td>
</tr>
<tr>
<td>Piazzi Smyth</td>
<td>14,396</td>
<td>633</td>
<td>–</td>
<td>(960)</td>
<td>(2,347)</td>
<td>–</td>
<td>11,722</td>
</tr>
<tr>
<td>Sillitto</td>
<td>33,233</td>
<td>975</td>
<td>–</td>
<td>(184)</td>
<td>–</td>
<td>–</td>
<td>34,024</td>
</tr>
<tr>
<td>Others</td>
<td>24,036</td>
<td>1,056</td>
<td>–</td>
<td>(401)</td>
<td>(3,919)</td>
<td>–</td>
<td>20,772</td>
</tr>
<tr>
<td>Restricted Income Fund</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>3,408,193</td>
<td>(3,408,193)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>RSE</td>
<td>1,767,176</td>
<td>75,136</td>
<td>3,420,353</td>
<td>(3,489,531)</td>
<td>(260,540)</td>
<td>–</td>
<td>1,512,594</td>
</tr>
<tr>
<td>RSE Scotland Foundation</td>
<td>430,678</td>
<td>54,097</td>
<td>6,663,559</td>
<td>(342,223)</td>
<td>220,798</td>
<td>(78,968)</td>
<td>6,947,941</td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td>3,081,483</td>
<td>152,305</td>
<td>–</td>
<td>(191,564)</td>
<td>(727,873)</td>
<td>–</td>
<td>2,314,351</td>
</tr>
<tr>
<td>Total</td>
<td>5,279,337</td>
<td>281,538</td>
<td>10,083,912</td>
<td>(4,023,318)</td>
<td>(767,615)</td>
<td>(78,968)</td>
<td>10,774,886</td>
</tr>
</tbody>
</table>
The Royal Society of Edinburgh

notes to the financial statements

21 Restricted funds (continued)


"Others" comprise the Retailing Seminars Fund and The CASS Fund. The Restricted Income Fund represents restricted income received and expended in the year.

Under the terms of the Lessells Trust the University of Glasgow is entitled to 10% of additional amounts received by the RSE from the Trust. The balance included in creditors at 31 March 2009 represents the total sum apportioned but not yet paid over to the University (note 17).

The funds of the RSE Scotland Foundation are treated as restricted in respect of the consolidated accounts and comprise funds received from the CRF £6,466,390, the endowment for the upkeep of the James Clerk Maxwell statue £27,277 and the balance of the Foundation general fund of £454,274.

22 Analysis of assets between funds

<table>
<thead>
<tr>
<th>Group</th>
<th>General</th>
<th>Designated Funds</th>
<th>Restricted Funds</th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fund balances at 31 March 2009 are represented by:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>28,181</td>
<td>2,200,404</td>
<td>1,756,002</td>
<td>3,984,587</td>
<td>4,067,558</td>
</tr>
<tr>
<td>Investments</td>
<td>52,992</td>
<td>2,818,332</td>
<td>10,013,194</td>
<td>12,884,518</td>
<td>6,103,053</td>
</tr>
<tr>
<td>Loan to RSE Scotland Foundation</td>
<td></td>
<td></td>
<td>1,797,520</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current assets</td>
<td>348,946</td>
<td></td>
<td>113,613</td>
<td>462,559</td>
<td>217,956</td>
</tr>
<tr>
<td>RSE Scotland Foundation current account</td>
<td>(492,543)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deposits</td>
<td>687,790</td>
<td>95,388</td>
<td>1,167,068</td>
<td>1,950,246</td>
<td>1,641,679</td>
</tr>
<tr>
<td>Cash</td>
<td>224,400</td>
<td></td>
<td>148,513</td>
<td>372,913</td>
<td>353,679</td>
</tr>
<tr>
<td>Current liabilities</td>
<td>(65,214)</td>
<td></td>
<td>(488,299)</td>
<td>(553,513)</td>
<td>(453,837)</td>
</tr>
<tr>
<td>Provisions for liabilities and charges</td>
<td></td>
<td></td>
<td>(630,228)</td>
<td>(630,228)</td>
<td>(352,277)</td>
</tr>
<tr>
<td>Pension fund liability</td>
<td>139,000</td>
<td></td>
<td></td>
<td>139,000</td>
<td>292,000</td>
</tr>
<tr>
<td></td>
<td>923,552</td>
<td>6,911,644</td>
<td>10,774,886</td>
<td>18,160,082</td>
<td>11,869,802</td>
</tr>
<tr>
<td><strong>RSE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fund balances at 31 March 2009 are represented by:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>28,181</td>
<td>2,200,404</td>
<td></td>
<td>2,228,585</td>
<td>2,264,526</td>
</tr>
<tr>
<td>Investments</td>
<td>52,992</td>
<td>2,818,332</td>
<td>1,343,464</td>
<td>4,214,788</td>
<td>3,090,776</td>
</tr>
<tr>
<td>Loan to RSE Scotland Foundation</td>
<td></td>
<td></td>
<td>1,797,520</td>
<td>1,797,520</td>
<td>1,844,328</td>
</tr>
<tr>
<td>Current assets</td>
<td>348,946</td>
<td></td>
<td></td>
<td>348,946</td>
<td>101,029</td>
</tr>
<tr>
<td>RSE Scotland Foundation current account</td>
<td>(492,543)</td>
<td></td>
<td></td>
<td>(492,543)</td>
<td>(457,459)</td>
</tr>
<tr>
<td>Deposits</td>
<td>687,790</td>
<td>95,388</td>
<td>1,167,068</td>
<td>1,950,246</td>
<td>1,641,679</td>
</tr>
<tr>
<td>Cash</td>
<td>224,400</td>
<td></td>
<td>148,513</td>
<td>372,913</td>
<td>353,679</td>
</tr>
<tr>
<td>Current liabilities</td>
<td>(65,214)</td>
<td></td>
<td>(367,710)</td>
<td>(432,924)</td>
<td>(269,584)</td>
</tr>
<tr>
<td>Provisions for liabilities and charges</td>
<td></td>
<td></td>
<td>(630,228)</td>
<td>(630,228)</td>
<td>(352,277)</td>
</tr>
<tr>
<td>Pension fund liability</td>
<td>139,000</td>
<td></td>
<td></td>
<td>139,000</td>
<td>292,000</td>
</tr>
<tr>
<td></td>
<td>923,552</td>
<td>6,911,644</td>
<td>1,512,594</td>
<td>9,347,790</td>
<td>8,357,641</td>
</tr>
</tbody>
</table>

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Trustees’ Report and Accounts to 31 March 2009

notes to the financial statements

23 Pension costs

(a) Universities Superannuation Scheme

The RSE participates in the Universities Superannuation Scheme, a defined benefit pension scheme which is externally funded and contracted out of the State Earnings-Related Pension Scheme. The assets of the scheme are held in a separate trustee-administered fund. The fund is valued every three years by a professionally qualified independent actuary using the projected unit method, the rates of contribution payable being determined by the trustee on the advice of the actuaries. In the intervening years the actuaries review the progress of the scheme.

It is not possible to identify each Institution’s share of the underlying assets and liabilities of the scheme and hence contributions to the scheme are accounted for as if it were a defined contributions scheme. The cost recognised within the result for the year is equal to the contributions payable to the scheme for the year.

The latest actuarial valuation of the scheme was at 31 March 2008. The most significant assumptions, those relating to the rate of return on investments and the increase in salary and pensions are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Past service liabilities</th>
<th>Future service liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment return</td>
<td>4.4%</td>
<td>6.1%</td>
</tr>
<tr>
<td>Salary increase</td>
<td>4.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Pension increase</td>
<td>3.3%</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

At the valuation date the market value of the scheme’s assets was £28,842.6 million and the value of past service liabilities was £40,619.2 million on the scheme’s historical funding basis. The value of the assets represented 71% of the benefits that had accrued to members, after allowing for expected future increases in earnings. The contribution rate payable by the RSE in the year was 14.0% of pensionable salaries. The actuary has confirmed that it is appropriate to take the pension charge to be equal to the actual contribution paid during the year. The contribution rate payable will increase to 16% of pensionable salaries with effect from 1 October 2009.

(b) Lothian Pension Fund

The RSE also participates in the Lothian Pension Fund, a defined benefit pension scheme established under Local Government Pension Fund Regulations. This scheme has determined that it is possible to ascertain the shares of assets and liabilities relating to individual admitted bodies. The assets of the scheme are held in a separate trustee-administered fund.

The fund is valued every three years by a professionally qualified independent actuary using the projected unit method, the rates of contribution payable being determined by the trustee on the advice of the actuaries. In the intervening years the actuaries review the progress of the scheme.

At the latest valuation date the market value of the scheme’s assets was £2,903 million and the value of past service liabilities was £3,427 million. The value of the assets represented 85% of the benefits that had accrued to members, after allowing for expected future increases in earnings. The contribution rate payable by the RSE was 315% of employees’ contributions of 6% of pensionable salaries, amounting to 18.9%. The actuary has confirmed that it is appropriate to take the pension charge to be equal to the actual contribution paid during the year.
### 23 Pension costs (continued)

**Pension fund asset / (liability)**

The RSE pension fund asset at 31 March and the movements of its component parts comprise:

<table>
<thead>
<tr>
<th></th>
<th>2009 £,000</th>
<th>2008 £,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of funded liabilities (defined benefit obligation)</td>
<td>(1,128)</td>
<td>(1,145)</td>
</tr>
<tr>
<td>Fair value of employer assets</td>
<td>1,267</td>
<td>1,437</td>
</tr>
<tr>
<td><strong>Net asset at 31 March</strong></td>
<td>139</td>
<td>292</td>
</tr>
</tbody>
</table>

**Movement in present value of defined benefit obligation**

<table>
<thead>
<tr>
<th></th>
<th>2009 £,000</th>
<th>2008 £,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 April</td>
<td>1,145</td>
<td>1,298</td>
</tr>
<tr>
<td>Current service cost</td>
<td>61</td>
<td>101</td>
</tr>
<tr>
<td>Interest cost</td>
<td>82</td>
<td>74</td>
</tr>
<tr>
<td>Contribution by members</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>Actuarial gains</td>
<td>(184)</td>
<td>(358)</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(6)</td>
<td>(2)</td>
</tr>
<tr>
<td><strong>At 31 March</strong></td>
<td>1,128</td>
<td>1,145</td>
</tr>
</tbody>
</table>

**Movement in fair value of employer assets**

<table>
<thead>
<tr>
<th></th>
<th>2009 £,000</th>
<th>2008 £,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 April</td>
<td>1,437</td>
<td>1,347</td>
</tr>
<tr>
<td>Expected return on assets</td>
<td>108</td>
<td>102</td>
</tr>
<tr>
<td>Contributions by members</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>Contributions by the employer</td>
<td>94</td>
<td>99</td>
</tr>
<tr>
<td>Actuarial losses</td>
<td>(396)</td>
<td>(141)</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(6)</td>
<td>(2)</td>
</tr>
<tr>
<td><strong>At 31 March</strong></td>
<td>1,267</td>
<td>1,437</td>
</tr>
</tbody>
</table>

**The net expense recognised in the statement of financial activities after FRS17 adjustments was**

<table>
<thead>
<tr>
<th></th>
<th>2009 £,000</th>
<th>2008 £,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current service cost</td>
<td>61</td>
<td>101</td>
</tr>
<tr>
<td>Interest cost</td>
<td>82</td>
<td>74</td>
</tr>
<tr>
<td>Expected return on employer assets</td>
<td>(108)</td>
<td>(102)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35</td>
<td>73</td>
</tr>
</tbody>
</table>

The total amount recognised in the statement of financial activities in respect of actuarial gains and losses is a loss of £212,000 (2008: gain of £217,000).
Trustees’ Report and Accounts to 31 March 2009

notes to the financial statements

23 Pension costs (continued)

The fair value of the employer assets at 31 March and the return on them in the year was:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Equities</td>
<td>1,001</td>
<td>1,091</td>
<td>7.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Bonds</td>
<td>139</td>
<td>128</td>
<td>5.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Property</td>
<td>127</td>
<td>171</td>
<td>4.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Cash</td>
<td>–</td>
<td>47</td>
<td>4.0</td>
<td>4.8</td>
</tr>
</tbody>
</table>

1,267 1,437

Actual return on plan assets (257) (38)

The expected rates of return on plan assets are determined by reference to relevant indices. The overall expected rate of return is calculated by weighting the individual rates in accordance with the anticipated balance in the Plan’s investment portfolio.

Principal actuarial assumptions (expressed as weighted averages) at the year end were as follows:

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation/pension increase rate</td>
<td>3.1</td>
<td>3.6</td>
</tr>
<tr>
<td>Salary increase rate</td>
<td>4.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Expected return on assets</td>
<td>6.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Discount rate</td>
<td>6.9</td>
<td>6.9</td>
</tr>
</tbody>
</table>

The assumptions relating to longevity underlying the pension liabilities at the balance sheet date as based on standard actuarial marketing tables and include an allowance for future improvements in longevity. The assumptions are equivalent to expecting a 65 year old to live for a number of years as follows:

<table>
<thead>
<tr>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.8 years</td>
<td>22.8 years</td>
</tr>
<tr>
<td>21.0 years</td>
<td>24.0 years</td>
</tr>
</tbody>
</table>

The history of the plan for the current and prior periods is as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of defined benefit obligation</td>
<td>(1,128)</td>
<td>(1,145)</td>
<td>(1,298)</td>
<td>(1,250)</td>
<td>(561)</td>
</tr>
<tr>
<td>Fair value of employer assets</td>
<td>1,267</td>
<td>1,437</td>
<td>1,347</td>
<td>1,130</td>
<td>485</td>
</tr>
<tr>
<td>Surplus/(deficit)</td>
<td>139</td>
<td>292</td>
<td>49</td>
<td>(120)</td>
<td>(76)</td>
</tr>
</tbody>
</table>

Experience gains and losses on assets and liabilities have been as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience gains/(losses) on liabilities</td>
<td>28</td>
<td>–</td>
<td>–</td>
<td>(30)</td>
<td>–</td>
</tr>
<tr>
<td>Experience gains/(losses) on assets</td>
<td>(396)</td>
<td>(140)</td>
<td>8</td>
<td>171</td>
<td>13</td>
</tr>
</tbody>
</table>

The RSE expects to contribute approximately £110,000 to the Lothian Pension Fund defined benefit scheme in the next financial year.

(c) Pension charge

The total pension charge for the year, including FRS17 adjustments, was £58,534 (2008: £84,929).
notes to the financial statements

24 Transactions with Council members
No member of Council received any payments other than reimbursements of expenditure on travel and subsistence costs actually and necessarily incurred in carrying out their duties as Councillors and Officers. The aggregate of such reimbursements to those Council members who charged expenses amounted to £2,750 (2008: £1,552).

25 Connected charitable trusts
(a) RSE Scotland Foundation
The RSE Scotland Foundation is a charitable trust, recognised in Scotland as Scottish charity number SCO24636. It was created in March 1996 with the object of advancing the education of the public in Scotland in science and engineering and in so doing to conserve the scientific and cultural heritage of Scotland. The President, General Secretary, Treasurer, Curator and a Vice-President of the RSE are ex officis Trustees of the Foundation, which draws on the resources of the RSE in carrying out its objects. The Foundation also has five nominated Trustees. The Foundation became publisher of the RSE’s journals under a Publications Rights License effective from 1 January 1997.

On 1 July 1997 the RSE granted to the Foundation a 50-year lease over 26 George Street carrying an obligation to refurbish the building within a three-year period. The Council of the RSE agreed to make a loan of up to £2.3 million available to the Foundation in support of the refurbishment. The agreed terms of the loan are as described in note 16.

(b) BP Research Fellowships Trust
The BP Research Fellowships Trust funds a scheme of three-year post doctoral fellowships administered by the RSE.

26 Supplementary information: grants, donations and receipts

(a) Scottish Government Grants Income

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion of research</td>
<td>1,050,130</td>
<td>671,653</td>
</tr>
<tr>
<td>Arts and Humanities Award</td>
<td>76,863</td>
<td>–</td>
</tr>
<tr>
<td>Activities grant</td>
<td>–</td>
<td>458,000</td>
</tr>
<tr>
<td>Generating &amp; Communicating knowledge</td>
<td>372,161</td>
<td>–</td>
</tr>
<tr>
<td>International activities</td>
<td>273,419</td>
<td>170,000</td>
</tr>
<tr>
<td>Joint Scottish French PhD studentships</td>
<td>12,000</td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td>1,784,573</td>
<td>1,311,653</td>
</tr>
</tbody>
</table>

In 2008 The Scottish Government provided grant-in-aid under the powers of S.23 National Heritage (Scotland) Act 1985 to meet the costs of Scottish Government-funded Research Fellows, the cost of maintaining the RSE’s premises and a share of the RSE’s staff and other costs.

The funding for 2008–09 was a grant under S23 Natural Heritage (Scotland) Act 1985 in support of the four programmes of activity: Research Fellowships, Arts & Humanities Awards; International grants & relations and Generating & Communicating knowledge.

At 31 March 2009 the financial commitment in respect of Personal and Support Fellowships awarded subject to Scottish Government funding in the years, 2009–10, 2010–11, 2011–12, 2012–13 and amounted to £1,084,615, £657,070, £541,624, £557,239 and £49,528 respectively. These amounts are treated as obligation of future years to be financed by specific funding expected to be made available from the Scottish Government.
notes to the financial statements

26 Supplementary information: grants, donations and receipts (continued)

(b) Recurring donations in support of activities

<table>
<thead>
<tr>
<th></th>
<th>Caledonian Research Foundation £</th>
<th>Scottish Enterprise £</th>
<th>Lloyds TSB Foundation for Scotland £</th>
<th>Gannochy Trust £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion of research &amp; innovation</td>
<td>21,237</td>
<td>228,147</td>
<td>497,700</td>
<td>105,000</td>
</tr>
<tr>
<td>Meetings</td>
<td>6,874</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28,111</td>
<td>228,147</td>
<td>497,700</td>
<td>105,000</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion of research &amp; innovation</td>
<td>17,364</td>
<td>188,828</td>
<td>198,972</td>
<td>84,138</td>
</tr>
<tr>
<td>Provision for future costs</td>
<td>–</td>
<td>–</td>
<td>277,953</td>
<td>–</td>
</tr>
<tr>
<td>Lectures</td>
<td>6,013</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Conferences</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>RSE administration and staff costs recovery</td>
<td>4,734</td>
<td>39,319</td>
<td>20,775</td>
<td>20,862</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28,111</td>
<td>228,147</td>
<td>497,700</td>
<td>105,000</td>
</tr>
</tbody>
</table>

The income and expenditure in relation to the CRF relates to the period prior to the transfer of assets to RSE Scotland Foundation on 11 March 2009.
The Royal Society of Edinburgh

notes to the financial statements

26 Supplementary information: grants, donations and receipts (continued)

(b) Recurring donations in support of activities (continued)

The Lloyds TSB Foundation for Scotland supports postdoctoral fellowships, postgraduate studentships and lectures and conferences to fund and disseminate research aimed at improving the quality of life for an ageing population.

(c) Other donations in support of activities

The RSE gratefully acknowledges all those who make donations in support of activities. The companies, trusts and other bodies which made donations of £1,000 or more in support of activities in the year ended 31 March 2009 were as follows:

Alcohol Education and Research Council
Angus Council Education Department
Council for Industry and Higher Education
Ewan & Christine Brown Charitable Trust
Highlands and Islands Enterprise
Institute of Physics
Lifescan Scotland Limited
Microsoft Research Limited
RBS Group PLC
Royal Academy of Engineering
Royal Society of Chemistry
Scottish Enterprise Borders
Scottish Environmental Protection Agency
Scottish Forestry Trust
Scottish Health Action on Alcohol Problems
Scottish Universities Physics Alliance
The Binks Trust
UHI Millennium Institute
University of Edinburgh

27 Analysis of net funds/(debt)

<table>
<thead>
<tr>
<th></th>
<th>At 31 March 2009</th>
<th>Cash flows</th>
<th>At 1 April 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash at bank</td>
<td>312,913</td>
<td>19,243</td>
<td>353,670</td>
</tr>
<tr>
<td>Deposits – general</td>
<td>687,790</td>
<td>(253,726)</td>
<td>941,516</td>
</tr>
<tr>
<td>Deposits – designated funds</td>
<td>95,388</td>
<td>95,388</td>
<td>–</td>
</tr>
<tr>
<td>Deposits – restricted funds</td>
<td>1,167,068</td>
<td>466,905</td>
<td>700,163</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,323,159</strong></td>
<td><strong>327,810</strong></td>
<td><strong>1,995,349</strong></td>
</tr>
</tbody>
</table>

28 Financial Commitments

At the balance sheet date the Foundation had an outstanding financial commitment in relation to the production and installing of the James Clerk Maxwell statue of £ nil (2008: £164,950).
Structure, governance and management

The RSE Council, chaired by the President, comprises thirteen Trustees, including four Vice-Presidents, the General Secretary, the Treasurer, the Fellowship Secretary and five ordinary members. Subject to annual re-election, Council members serve for three years, except for the General Secretary and Treasurer, who may serve for up to four years. All are unpaid.

The Council is responsible for the strategic direction and policies of the RSE, and normally meets quarterly.

An Executive Board has delegated responsibility from the Council for delivery of the RSE's activities. It is chaired by the General Secretary, and has as its elected members, the Treasurer, the Convenors of the main operational committees and the Curator, as well as the Chair of the RSE Scotland Foundation and senior executive staff.

The Executive Board normally meets quarterly and reports to the Council.

The Council members and the office-bearers serving on the Executive Board are all elected annually by the Fellowship in a postal ballot. New members of Council and the Executive Board are given an extensive induction through discussions with the Chief Executive and senior staff.

Reporting to the Council through the Executive Board are operational committees, including the Education Committee, International Committee, various Research Awards Committees, the Meetings Committee and the Young People’s Committee. These Committees largely, but not exclusively, comprise Fellows of the RSE and are concerned with the operational delivery of the RSE’s varied activities. All Fellows are actively encouraged to participate in the RSE’s activities.

Two other charitable trusts founded by and closely connected to the RSE, the BP Research Fellowship Trust (the BP Trust) and the RSE Scotland Foundation (the Foundation), are included in the consolidated accounts. The Foundation plays a leading role in the RSE’s public outreach activities and manages the premises in George Street. Its Trustees are appointed for three years by the RSE Council.

Following a transfer of assets in 2009, the Foundation is also responsible for managing the programme of activities in support of research in Scotland, funded by the Caledonian Research Fund.

The BP Trust was created following a donation of £2m in 1988 from BP to support a scheme of post-doctoral research fellowships in specified subjects and which are awarded at the sole discretion of the RSE. The RSE President,
General Secretary and Treasurer are the BP Trustees, ex officis.

**Statement of Council’s responsibilities**

Under charities legislation applicable in Scotland, the Council is required to prepare accounts for each financial year that give a true and fair view of the RSE’s financial activities during the year and of its financial position at the end of the year. The Council is responsible for preparing the annual report and the financial statements in accordance with applicable Law and United Kingdom Generally Accepted Accounting Practice (UK GAAP).

In preparing accounts giving a true and fair view, the Council should follow best practice and:

- select suitable accounting policies and apply them consistently;
- make judgements and estimates that are reasonable and prudent;
- state whether applicable accounting standards and statements of recommended practice have been followed, subject to any departures disclosed and explained in the accounts; and
- prepare the accounts on a going concern basis unless it is inappropriate to presume that the RSE will continue in operation.

The Council is responsible for keeping accounting records which disclose with reasonable accuracy the financial position of the RSE and which enable it to ensure that the accounts comply with the Charities and Trustee Investment (Scotland) Act 2005, the Charities Accounts (Scotland) Regulations 2006 and the RSE’s own Laws. It is also responsible for safeguarding the assets of the RSE and hence for taking reasonable steps for the prevention and detection of fraud and other irregularities.

**Risk management**

The Audit and Risk Committee, operating on a joint basis with the Foundation and the BP Trust, reports directly to the Council, the Foundation and the BP Trust. Its Chair, who cannot be a Trustee or other Office Bearer of the RSE, is invited to attend Council meetings as an observer. Its remit includes keeping under review the effectiveness of internal control and risk management systems of the RSE and its connected charities. The Council believes that the existing systems and the structure of decision taking and reporting through senior staff, the Executive Board and the Council continues to provide assurance that risks are properly assessed and carefully managed.
OVERVIEW
This section describes the main achievements of RSE, the Foundation and the BP Trust, reflecting the fact that the Financial Statements are presented on a consolidated basis. The highlights of the successful year and which are detailed in the report include:

- Award of a further six Scottish Government Personal Research Fellowships, each of up to five years length, also eligible for the Marie Curie COFUND travel funding awarded in 2008. There are now a total of 14 Personal Research Fellows in post;
- The second year of the Phase III scheme of Enterprise Fellowships resulting in 10 awards, including four to be held in 2010–11, from twenty-eight applications received;
- Friends of the Society initiative – initially with eight corporate partners of the RSE;
- A series of 12 discussions and talks as part of the Edinburgh International Festival on the theme of The Enlightenment;
- Launch of the independent Inquiry entitled Facing up to Climate Change in October 2009, commencing with the gathering of evidence throughout Scotland;
- Visit of HRH The Duke of Edinburgh in August 2009 to present the 2009 Royal Medals and the IEEE/Wolfson/James Clerk Maxwell Award;
- Significant growth in the RSE’s international activities, including a visit in October 2009 from the new US Ambassador to Britain as part of his first visit to Scotland, and an increase in the number of international exchanges;
- Launch of the Business Innovation Forum in January 2010 in the presence of Cabinet Secretary for Finance and Sustainable Growth, John Swinney;
- Celtic–Cossack Connections project (supported through our arts and humanities programme) resulted in public performances, in both Russia and Scotland, of the original version of Prokofiev’s opera War and Peace, attended by 7,000 people;
- A two-day programme of film, theatre and debate about nuclear weapons, centred on Michael Frayn’s play Copenhagen.

Performance Monitoring
The performance of the RSE and its connected charities, compared to the output targets set in the Operational Plan, is reported quarterly to the Executive Board, and to Council and to the Trustees.
FINANCIAL REVIEW AND POLICIES

Investment powers and policy

The management of the investment funds of the RSE, the Foundation and the BP Research Fellowship Trust is carried out by Speirs & Jeffrey Ltd on a discretionary basis. The objectives set by the Council are first to ensure a sufficient level of income to meet the target set annually by the Council, and thereafter to invest for capital growth. The Council has delegated the detailed monitoring of performance to an Investment Committee, which includes at least one ordinary member of Council and two investment advisers and which makes comparisons against a composite benchmark reflecting the mix of assets held and the WM Charities Income Constrained Index. The performance of the portfolios was as shown below.

The Investment Committee meets twice annually with the investment managers to discuss their compliance with the policies set by the Committee and the risk environment. In the year under review, no compliance issues arose which required to be reported to the Committee.

<table>
<thead>
<tr>
<th></th>
<th>Income Target</th>
<th>Actual Income</th>
<th>Total Return</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£’000</td>
<td>£’000</td>
<td>% 3 years to 31 March 2010</td>
<td>%</td>
</tr>
<tr>
<td>RSE</td>
<td>211</td>
<td>196</td>
<td>4.0</td>
<td>1.7</td>
</tr>
<tr>
<td>BP Trust</td>
<td>125</td>
<td>131</td>
<td>2.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Foundation</td>
<td>315</td>
<td>305</td>
<td>*</td>
<td>1.7</td>
</tr>
</tbody>
</table>

* figure for CRF not available

Operating policies – grant making

The RSE makes grants to individuals in higher education institutions in support of research activities in the categories of postdoctoral Research Fellowships, Support Research Fellowships, Post-graduate Studentships, undergraduate Vacation Scholarships, Enterprise Fellowships and international
Trustees’ Report and Accounts to 31 March 2010

exchange grants. Each of these categories is specifically funded from various sources, including the RSE’s restricted funds. The basis of eligibility and selection varies according to the detailed scheme regulations, which are published on the RSE’s website (www.royalsoced.org.uk).

Grants are also made in support of research activities of Fellows of the RSE, including support for travel connected with research or scholarship, small-scale specialist meetings, to assist research visitors to Scotland to undertake collaborative research work with a Fellow, to assist a visiting lecturer to come to Scotland, to assist research collaboration between two institutions in Scotland or between universities and industry and to assist in the publication of books written by Fellows. These grants are funded by the RSE’s designated Grants Fund. The Grants Committee is responsible for making awards in accordance with the detailed rules set out by the Council of the RSE for the disbursement of the Grants Fund.

Reserves policy and funds

The RSE holds a number of restricted funds resulting from bequests for particular purposes, details of which are set out in note 2 to the financial statements. The Council has created designated funds, from its unrestricted funds, the purposes of which are also set out in note 2 to the financial statements. The General Fund represents the balance of unrestricted funds arising from past operations. The Council has examined the requirement to hold unrestricted funds, and concluded that, whilst the present level of reserves gives adequate working capital for core costs, it would be desirable to increase the General Fund reserve from six months expenditure on central costs towards nine months expenditure, or approximately £1.12 million.

The current fund balance is £762,000, before deduction of the FRS17 pension reserve. The Council has also reviewed the purposes and amounts of each of the designated funds and agreed that in future the designated funds should comprise allocations for specific purposes of those sums that had been donated, rather than generated from past surpluses, together with the Capital Asset Reserve.

Result for the year.

The deficit of consolidated net incoming resources for the year was £62,000, compared to the £39,000 underlying surplus, excluding non-recurring items, achieved last year. The main reason was the use of capital to support ongoing expenditure previously committed in the CRF and planned expenditure on computer systems taken from the Development Fund.
Offsetting this were investment gains, comprising £0.34m realised in the year and £2.87m unrealised at the year end. The net movement on funds for the year after the FRS17 actuarial adjustment was £2.54m. Income and Expenditure: Total incoming resources were £5.29m (2009 – £6.76m). On a like-for-like basis, excluding the major legacy in 2009 (£2.16m), total income increased by 15%.

The increase arose mainly from increases in income received from charitable activities, of which the increase in funding for the Enterprise Fellowships and Scottish Government Research Fellowships was the largest contribution. Voluntary income (note 4) of £0.43m includes a final transfer to the Foundation’s CRF fund from the winding up of the Caledonian Research Foundation and the first contributions from the ‘Friends of the Society’ – corporate partners of the RSE.

Incoming resources from charitable activities of £3.94m increased by 16% from the 2008–09 level of £3.38m. The increases for research funded by the Scottish Government and in all the Enterprise Fellowship schemes were offset by decreases as a result of the conclusion of a series of grants from Lloyds TSB Foundation for Scotland and the Gannochy Trust Innovation Award not being awarded in 2009.

**Resources expended**

Total resources expended increased by 15% (£0.70m). This reflects the increased expenditure on grant-giving charitable activities. Governance and costs of generating funds were similar to previous years. Cost of generating funds (note 6) includes the cost of the Fellowship office, the costs of building management as well as fundraising costs, both direct and management time in securing funding.

Overall, expenditure on charitable activities has increased by £0.68m. Grants payable in support of research and innovation made up the major part of this increase, rising from £2.67m to £3.64m. This reflected the increase in Enterprise Fellowships, both those funded by Scottish Enterprise and by the Research Councils, and the increased number of Scottish Government Research Fellows appointed.

Expenditure on international research connections and influencing public policy also increased, the latter due to an increase in staff resource. In 2009, expenditure included £0.21m on the James Clerk Maxwell statue and this, and a small decrease in expenditure on public engagement, offset the other increases. Governance costs, which have remained at a similar level to previous years, represent around 2.9% of total income.
Transfers between funds shown in the Statement of Financial Activities comprise the recurring transfer from the Capital Asset Reserve of a total of £101,000 to match the depreciation of buildings and the capital repayment of the loan to the Foundation; and a transfer on consolidation from the Foundation restricted fund balance to the General Fund, to reflect the actual RSE General Fund balance.

Balance sheet
Consolidated net assets increased from £18.61m to £21.15m; the main reason being the increase in the investment portfolio from £12.89m to £16.08m, reflecting unrealised surpluses of £2.87m. This is offset by a £607,000 decrease (2009 – £212,000 decrease) in the FRS17 pensions adjustment, converting the previously reported asset of £139,000 to a liability of £415,000. Net current assets decreased from £2.23m to £1.99m, as cash previously received in advance of expenditure was paid out, reflected in an decrease in the provision for liabilities.

Total cash balances and creditors are increased by £0.44m due to the pre-funding received from the Marie Curie COFUND scheme, included in deferred income until conditions of grant are met by eligible Research Fellows.

Future plans
In the context of the prevailing external financial uncertainties, the continuing strategy of diversification of income and tight control of expenditure is essential. The Council’s aim of building relationships with a view to working in partnership is progressing in respect of the corporate sector through the Friends of the Society, and good foundations have been laid in the initial year. To highlight the importance of individual giving, a legacy brochure is being prepared – not all can contribute as much as the legacy from Dr Harold Thomas received in 2009, but even the smallest amount is put to good use.

The future of public sector funding is uncertain, but our scenario planning for the next spending review period is well advanced. The delivery of the RSE’s varied programme of activities with public benefit outcomes will be guided by the priorities set by Council to ensure continuing financial stability. In challenging times, the RSE continues to seek new opportunities and develop existing activities, to enhance its contribution to Scottish Society.

Signed on behalf of the Council
Ewan Brown CBE
Treasurer
Independent Auditor's Report to the Trustees of the Royal Society of Edinburgh

We have audited the financial statements of The Royal Society of Edinburgh (RSE) for the year ended 31 March 2010 which comprise the group statement of financial activities, the charity statement of financial activities, the group balance sheet, the charity balance sheet, the cash-flow statement and the related notes. These financial statements have been prepared in accordance with the accounting policies set out therein.

This report is made solely to the charity's Trustees, as a body, in accordance with section 44 (1)(c) of the Charities and Trustee Investment (Scotland) Act 2005 and regulation 10 of the Charities Accounts (Scotland) Regulations 2006 and the Laws of the RSE. Our audit work has been undertaken so that we might state to the charity's Trustees those matters we are required to state to them in an auditor's report and for no other purpose. To the fullest extent permitted by law, we do not accept or assume responsibility to anyone other than the charity and its Trustees as a body, for our audit work, for this report, or for the opinions we have formed.

Respective responsibilities of trustees and auditors

The Trustees’ responsibilities for preparing the Trustees’ Annual Report and the financial statements in accordance with applicable law and United Kingdom Accounting Standards (United Kingdom Generally Accepted Accounting Practice) are set out in the Statement of Trustees’ Responsibilities.

We have been appointed as auditors under section 44(1)(c) of the Charities and Trustee Investment (Scotland) Act 2005 and report in accordance with regulations made under that Act. Our responsibility is to audit the financial statements in accordance with relevant legal and regulatory requirements and International Standards on Auditing (UK and Ireland).

We report to you our opinion as to whether the financial statements give a true and fair view and are properly prepared in accordance with the Charities and Trustee Investment (Scotland) Act 2005 and regulation 8 of the Charities Accounts (Scotland) Regulations 2006.

We also report to you if, in our opinion, the information given in the Trustees’ Annual Report is not consistent with the financial statements, if the charity has not kept proper accounting records, if the charity's financial statements
are not in agreement with these accounting records, or if we have not received all the information and explanations we require for our audit.

We read the Trustees’ Annual Report and consider the implications for our report if we become aware of any apparent misstatements within it.

**Basis of audit opinion**

We conducted our audit in accordance with International Standards on Auditing (UK and Ireland) issued by the Auditing Practices Board. An audit includes examination, on a test basis, of evidence relevant to the amounts and disclosures in the financial statements. It also includes an assessment of the significant estimates and judgments made by the Trustees in the preparation of the financial statements and of whether the accounting policies are appropriate to the charity’s circumstances, consistently applied and adequately disclosed.

We planned and performed our audit so as to obtain all the information and explanations which we considered necessary in order to provide us with sufficient evidence to give reasonable assurance that the financial statements are free from material misstatement, whether caused by fraud or other irregularity or error.

In forming our opinion we also evaluated the overall adequacy of the presentation of information in the financial statements.

**Opinion**

In our opinion:

- the financial statements give a true and fair view, in accordance with United Kingdom Generally Accepted Accounting Practice, of the state of the group’s and the charity’s affairs as at 31 March 2010 and of the group’s and charity’s incoming resources and application of resources for the year then ended; and
- the financial statements have been properly prepared in accordance with the Charities and Trustee Investment (Scotland) Act 2005, regulation 8 of the Charities Accounts (Scotland) Regulations 2006 and the Laws of the RSE.

**Henderson Loggie**

Chartered Accountants and Statutory Auditors

(Eligible to act as an auditor in terms of section 1212 of the Companies Act 2006).
Group statement of financial activities  
(incorporating the income & expenditure account)  
for year ended 31 March 2010

<table>
<thead>
<tr>
<th>Note</th>
<th>General Fund</th>
<th>Designated Funds</th>
<th>Restricted income</th>
<th>Restricted funds</th>
<th>2010 Total</th>
<th>2009 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voluntary income</td>
<td>4</td>
<td>231,577</td>
<td></td>
<td>202,234</td>
<td>433,811</td>
<td>2,615,665</td>
</tr>
<tr>
<td>Activities for generating income</td>
<td>4</td>
<td>32,568</td>
<td>131,439</td>
<td>499,681</td>
<td>663,688</td>
<td>503,826</td>
</tr>
<tr>
<td>Investment income</td>
<td>4</td>
<td>258,362</td>
<td>314,428</td>
<td>3,937,256</td>
<td>3,388,119</td>
<td></td>
</tr>
<tr>
<td>Investment income</td>
<td>4</td>
<td>258,362</td>
<td>314,428</td>
<td>3,937,256</td>
<td>3,388,119</td>
<td></td>
</tr>
<tr>
<td>Incoming resources from generated funds</td>
<td>5</td>
<td>264,145</td>
<td>960,277</td>
<td>3,375,521</td>
<td></td>
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</tr>
<tr>
<td>Incoming resources from charitable activities</td>
<td>5</td>
<td>60,474</td>
<td>3,562,354</td>
<td>1,355,861</td>
<td>3,375,521</td>
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<tr>
<td>Total incoming resources</td>
<td></td>
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<td>3,562,354</td>
<td>1,355,861</td>
<td>3,375,521</td>
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<tr>
<td>Expenditure</td>
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<td>Cost of generating funds</td>
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<td>(188,083)</td>
<td>(9,468)</td>
<td>(70,387)</td>
<td>(252,372)</td>
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<td>6</td>
<td>(201,057)</td>
<td>(104,807)</td>
<td>(3,562,354)</td>
<td>(4,245,512)</td>
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<td>6</td>
<td>(114,751)</td>
<td>(39,438)</td>
<td>(157,946)</td>
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<td></td>
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<tr>
<td>Total resources expended</td>
<td></td>
<td>(503,891)</td>
<td>(3,562,354)</td>
<td>(1,175,015)</td>
<td>(4,655,830)</td>
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<tr>
<td>Net (outgoing)/incoming resources before transfers</td>
<td></td>
<td>(179,272)</td>
<td>17,164</td>
<td>99,690</td>
<td>(62,418)</td>
<td></td>
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<tr>
<td>Transfers between funds</td>
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<td>197,824</td>
<td>(101,818)</td>
<td>(96,006)</td>
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<tr>
<td>Other recognised gains/(losses)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gains/(losses) on investment assets</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Realised gains/(losses)</td>
<td></td>
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<td>83,093</td>
<td>256,974</td>
<td>341,629</td>
<td>(101,176)</td>
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<tr>
<td>Unrealised gains/(losses)</td>
<td></td>
<td>10,848</td>
<td>576,923</td>
<td>2,285,521</td>
<td>2,873,292</td>
<td>(1,345,064)</td>
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<tr>
<td>Actuarial losses on Lothian Pension Fund</td>
<td></td>
<td>(607,000)</td>
<td></td>
<td>(607,000)</td>
<td>(212,000)</td>
<td></td>
</tr>
<tr>
<td>Net movement in funds</td>
<td></td>
<td>(576,038)</td>
<td>575,362</td>
<td>2,546,179</td>
<td>2,545,503</td>
<td>449,570</td>
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<tr>
<td>Transfer of assets from the CRF</td>
<td>4</td>
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<tr>
<td>Net movement in funds after transfer of assets</td>
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<td>(576,038)</td>
<td>575,362</td>
<td>2,546,179</td>
<td>2,545,503</td>
<td>6,740,280</td>
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<tr>
<td>Balance brought forward at 1 April 2009</td>
<td></td>
<td>923,552</td>
<td>6,911,644</td>
<td>10,774,886</td>
<td>18,610,082</td>
<td>11,869,802</td>
</tr>
<tr>
<td>Balance carried forward at 31 March 2010</td>
<td></td>
<td>347,514</td>
<td>7,487,006</td>
<td>13,321,065</td>
<td>21,155,585</td>
<td>18,610,082</td>
</tr>
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</table>
The Royal Society of Edinburgh

Group balance sheet at 31 March 2010

<table>
<thead>
<tr>
<th>Note</th>
<th>2010</th>
<th>2010</th>
<th>2009</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Fixed assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
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<td>3,984,587</td>
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<tr>
<td>Fixed asset investments</td>
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<tr>
<td>Investments at market value</td>
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<td>16,083,212</td>
<td>12,884,518</td>
<td></td>
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<tr>
<td></td>
<td>19,963,701</td>
<td>16,869,105</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debtors</td>
<td>16</td>
<td>770,792</td>
<td>462,559</td>
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</tr>
<tr>
<td>Cash at bank and in hand</td>
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<td>310,904</td>
<td>372,913</td>
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</tr>
<tr>
<td>Money Market deposits – Designated funds</td>
<td></td>
<td>95,864</td>
<td>95,388</td>
<td></td>
</tr>
<tr>
<td>Money Market deposits – Restricted funds</td>
<td></td>
<td>1,499,620</td>
<td>1,167,068</td>
<td></td>
</tr>
<tr>
<td>Money Market deposits – General funds</td>
<td></td>
<td>636,180</td>
<td>687,790</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,313,360</td>
<td>2,785,718</td>
<td></td>
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<tr>
<td>Current liabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Creditors: amounts falling due within one year</td>
<td>17</td>
<td>(1,316,484)</td>
<td>(553,513)</td>
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<tr>
<td>Net current assets</td>
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<td>Total assets less current liabilities</td>
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<td>19,101,310</td>
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<td>18</td>
<td>(389,992)</td>
<td>(630,228)</td>
<td></td>
</tr>
<tr>
<td>Net assets excluding pension fund</td>
<td></td>
<td>21,570,585</td>
<td>18,471,082</td>
<td></td>
</tr>
<tr>
<td>Lothian Pension Fund defined benefit Scheme (liability)/asset</td>
<td>23</td>
<td>(415,000)</td>
<td>139,000</td>
<td></td>
</tr>
<tr>
<td>Net assets after pension fund (liability)/asset</td>
<td></td>
<td>21,155,585</td>
<td>18,610,082</td>
<td></td>
</tr>
<tr>
<td>Funds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Fund</td>
<td></td>
<td>762,514</td>
<td>784,552</td>
<td></td>
</tr>
<tr>
<td>Add. Pension reserve</td>
<td></td>
<td>(415,000)</td>
<td>139,000</td>
<td></td>
</tr>
<tr>
<td>Designated Funds</td>
<td>19</td>
<td>347,514</td>
<td>923,552</td>
<td></td>
</tr>
<tr>
<td>Restricted Funds</td>
<td>20</td>
<td>7,487,006</td>
<td>6,911,644</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13,321,065</td>
<td>10,774,886</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total funds</td>
<td>21</td>
<td>21,155,585</td>
<td>18,610,082</td>
<td></td>
</tr>
</tbody>
</table>

The accounts were approved by the Council on 6 September 2010 and signed on its behalf by:

Ewan Brown, CBE
Treasurer

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## Trustees’ Report and Accounts to 31 March 2010

### RSE balance sheet at 31 March 2010

<table>
<thead>
<tr>
<th>Note</th>
<th>2010</th>
<th>2010</th>
<th>2009</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Fixed assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>14</td>
<td>2,171,157</td>
<td></td>
<td>2,228,585</td>
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<tr>
<td>Fixed asset investments</td>
<td></td>
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<tr>
<td>Investments at market value</td>
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<td>5,242,639</td>
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<td>4,214,788</td>
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<td>1,750,712</td>
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<td>1,797,520</td>
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<td></td>
<td></td>
<td>9,164,508</td>
<td></td>
<td>8,240,893</td>
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<td>Current assets</td>
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<td></td>
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<td>Debtors</td>
<td>16</td>
<td>604,866</td>
<td>348,946</td>
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<td>Cash at bank and in hand</td>
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<td>195,667</td>
<td>224,400</td>
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<td>Money Market deposits – Designated funds</td>
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<td>95,864</td>
<td>95,388</td>
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</tr>
<tr>
<td>Money Market deposits – Restricted funds</td>
<td></td>
<td>1,499,620</td>
<td>1,167,068</td>
<td></td>
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<tr>
<td>Money Market deposits – General funds</td>
<td></td>
<td>636,180</td>
<td>687,790</td>
<td></td>
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<td></td>
<td></td>
<td>3,032,197</td>
<td></td>
<td>2,523,592</td>
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<td></td>
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<td></td>
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<tr>
<td>Creditors: amounts falling due within one year</td>
<td>17</td>
<td>(1,709,422)</td>
<td>(925,467)</td>
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<td>1,322,775</td>
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<td>(389,992)</td>
<td>(630,228)</td>
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<tr>
<td>Net assets excluding pension fund</td>
<td></td>
<td>10,097,291</td>
<td>9,208,790</td>
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<tr>
<td>Lothian Pension Fund defined benefit scheme (liability)/asset</td>
<td>23</td>
<td>(415,000)</td>
<td>139,000</td>
<td></td>
</tr>
<tr>
<td>Net assets after pension fund (liability)/asset</td>
<td></td>
<td>9,682,291</td>
<td>9,347,790</td>
<td></td>
</tr>
<tr>
<td>Funds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Fund</td>
<td></td>
<td>762,514</td>
<td>784,552</td>
<td></td>
</tr>
<tr>
<td>Add: Pension reserve</td>
<td></td>
<td>(415,000)</td>
<td>139,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>347,514</td>
<td>923,552</td>
<td></td>
</tr>
<tr>
<td>Designated Funds</td>
<td>20</td>
<td>7,487,006</td>
<td>6,911,644</td>
<td></td>
</tr>
<tr>
<td>Restricted Funds</td>
<td>21</td>
<td>1,847,771</td>
<td>1,512,594</td>
<td></td>
</tr>
<tr>
<td>Total funds</td>
<td></td>
<td>9,682,291</td>
<td>9,347,790</td>
<td></td>
</tr>
</tbody>
</table>

The accounts were approved by the Council on 6 September 2010 and signed on its behalf by:

Ewan Brown, CBE
Treasurer
RSE statement of financial activities  
(incorporating the income & expenditure account)  
for year ended 31 March 2010

<table>
<thead>
<tr>
<th>Source of Income</th>
<th>General Fund</th>
<th>Designated Funds</th>
<th>Restricted income</th>
<th>Restricted funds</th>
<th>2010 Total</th>
<th>2009 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntary income</td>
<td>231,576</td>
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<td>48,966</td>
<td>280,542</td>
<td>2,487,761</td>
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<tr>
<td>Investment income</td>
<td>118,907</td>
<td>131,439</td>
<td>63,274</td>
<td>313,620</td>
<td>385,635</td>
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<tr>
<td>Total incoming resources</td>
<td>420,625</td>
<td>131,439</td>
<td>4,052,633</td>
<td>112,240</td>
<td>4,716,937</td>
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</table>

<table>
<thead>
<tr>
<th>Source of Expenditure</th>
<th>General Fund</th>
<th>Designated Funds</th>
<th>Restricted income</th>
<th>Restricted funds</th>
<th>2010 Total</th>
<th>2009 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of generating funds</td>
<td>(188,083)</td>
<td>(9,468)</td>
<td></td>
<td>(197,551)</td>
<td>(190,442)</td>
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<tr>
<td>Charitable activities</td>
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<td>(104,807)</td>
<td>(4,052,633)</td>
<td>(4,450,184)</td>
<td>(3,815,434)</td>
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<tr>
<td>Governance</td>
<td>(114,751)</td>
<td></td>
<td></td>
<td>(114,751)</td>
<td>(125,410)</td>
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</tr>
<tr>
<td>Total resources expended</td>
<td>(503,891)</td>
<td>(114,275)</td>
<td>(4,052,633)</td>
<td>(91,687)</td>
<td>(4,762,486)</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Other recognised gains/(losses)</th>
<th>General Fund</th>
<th>Designated Funds</th>
<th>Restricted income</th>
<th>Restricted funds</th>
<th>2010 Total</th>
<th>2009 Total</th>
</tr>
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<tbody>
<tr>
<td>Realised gains/(losses)</td>
<td>1,562</td>
<td>83,093</td>
<td></td>
<td>39,610</td>
<td>124,265</td>
<td>(101,942)</td>
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<td>Unrealised gains/(losses)</td>
<td>10,848</td>
<td>576,923</td>
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<td>275,014</td>
<td>862,785</td>
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<td>Actuarial gains (losses) on Lothian Pension Fund</td>
<td>(607,000)</td>
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<td></td>
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<td>(607,000)</td>
<td>(212,000)</td>
</tr>
<tr>
<td>Net movement in funds</td>
<td>(576,038)</td>
<td>575,362</td>
<td></td>
<td>335,177</td>
<td>334,501</td>
<td>990,149</td>
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<td>Balance brought forward at 1 April 2009</td>
<td>923,552</td>
<td>6,911,644</td>
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<td>1,512,594</td>
<td>9,347,790</td>
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<tr>
<td>Balance carried forward at 31 March 2010</td>
<td>347,514</td>
<td>7,487,006</td>
<td></td>
<td>1,847,771</td>
<td>9,682,291</td>
<td>9,347,790</td>
</tr>
</tbody>
</table>
## Group cash flow statement for the year ended 31 March 2010

<table>
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<tr>
<th></th>
<th>2010</th>
<th>2010</th>
<th>2009</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
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<tr>
<td><strong>Cash flow statement</strong></td>
<td></td>
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<tr>
<td>Net cash outflow from operating activities</td>
<td>(490,497)</td>
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<td>(364,340)</td>
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<td><strong>Returns on investments and servicing of finance:</strong></td>
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<tr>
<td>Interest received</td>
<td>31,429</td>
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<td>73,228</td>
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<td>Dividends received</td>
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<td>430,598</td>
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<tr>
<td></td>
<td></td>
<td>663,688</td>
<td></td>
<td>503,826</td>
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<td><strong>Capital expenditure and financial investment:</strong></td>
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<td></td>
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<tr>
<td>Purchase of tangible fixed assets</td>
<td>(18,110)</td>
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<td>(37,328)</td>
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<td>Proceeds from sale of investments</td>
<td>4,008,894</td>
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<td>2,816,886</td>
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<td>Purchases of investments</td>
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<td>(2,790,704)</td>
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<td>Capital receipt</td>
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<td>39,075</td>
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<td>179,414</td>
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<td><strong>Net cash flow before financing:</strong></td>
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<td>Appeal receipts</td>
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<td><strong>Increase in cash in the year</strong></td>
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<td>327,810</td>
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</tr>
<tr>
<td><strong>Reconciliation of net cash flow to movement in net funds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in cash in the year</td>
<td>219,409</td>
<td></td>
<td>327,810</td>
<td></td>
</tr>
<tr>
<td>Net funds at beginning of year</td>
<td>2,323,159</td>
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<td>1,995,349</td>
<td></td>
</tr>
<tr>
<td>Net funds at end of year (note 27)</td>
<td>2,542,568</td>
<td></td>
<td>2,323,159</td>
<td></td>
</tr>
<tr>
<td><strong>Reconciliation of net movement in funds to net cash outflow from operating activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net (outgoing)/incoming resources before transfers</td>
<td>(62,418)</td>
<td></td>
<td>8,398,520</td>
<td></td>
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<tr>
<td>Retirement benefit scheme current service cost</td>
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<td>61,000</td>
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<td>Retirement benefit scheme contributions</td>
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<td>(26,000)</td>
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<td>Appeal receipts</td>
<td>(7,143)</td>
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<td>(8,910)</td>
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<tr>
<td>Dividends receivable</td>
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<td>(430,598)</td>
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<td>Interest receivable</td>
<td>(31,429)</td>
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<td>(73,228)</td>
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<tr>
<td>Depreciation</td>
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<td>120,299</td>
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<tr>
<td>Capital receipt in cash</td>
<td>(157)</td>
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<td>(190,560)</td>
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<tr>
<td>Capital receipt in shares</td>
<td>(40,801)</td>
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<td>(8,253,887)</td>
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<td>Increase in debtors</td>
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<td>(244,603)</td>
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<td>Increase in creditors</td>
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<td>99,676</td>
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<td>Movement on provision for liabilities</td>
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<td>277,951</td>
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<tr>
<td><strong>Net cash outflow from operating activities</strong></td>
<td>(490,497)</td>
<td></td>
<td>(364,340)</td>
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</table>
The Royal Society of Edinburgh

notes to the financial statements

1 Accounting basis
The accounts have been drawn up to comply with the provisions of the Charities & Trustee Investment (Scotland) Act 2005 and the Charities Accounts (Scotland) Regulations 2006, and follow the recommendations of the Statement of Recommended Practice for charities (SORP) approved by the Accounting Standards Board in February 2005 and applicable accounting standards. The accounts have been prepared under the historical cost accounting rules as modified to include the revaluation of investments. The accounts comprise five primary financial statements: the Group and RSE statement of financial activities incorporating the income and expenditure account, the Group and RSE balance sheet and the Group cash flow statement.

The consolidated financial statements include the financial statements of the RSE and of entities which are under its control: RSE Scotland Foundation and BP Research Fellowship Trust. As the objectives of each of these entities are narrower than those of the RSE, they have been treated as restricted funds.

2 Funds
The RSE’s funds are classified in accordance with the definitions in SORP into Restricted Funds, where there are restrictions placed by a donor as to the use of income or capital, Designated Funds where the Society has set aside sums from its unrestricted funds for a particular purpose and the General (unrestricted) Fund. The classifications made are as follows:

- **General Fund**
  - A discretionary Fund available to the Council to meet the ordinary activities of the Society.

- **Designated Funds**
  - Capital Asset Reserve Fund – representing the book cost of the buildings at 22-24 George Street and 26 George Street together with the building project loan to the RSE Scotland Foundation.
  - Development Appeal Fund – to provide development finance to implement the RSE Strategic Framework.
  - Programme Fund – a fund created to act as a source of funding for meetings activities.
  - C H Kemball Fund – income from this fund is used to provide hospitality for distinguished visitors from other learned societies and Academies.
  - Dr James Heggie Fund – income from this fund supports the RSE’s activities with young people.
  - Grants Fund – a fund created by contributions and legacies from Fellows and used to provide grants to support research activities to Fellows.
  - Restricted Income Fund – income funds received for expenditure on current projects.

- **Restricted Funds**
  - Robert Cormack Bequest – to promote astronomical knowledge and research in Scotland.
  - Lessells Trust – to fund scholarships abroad for engineers.
  - Aubert Bequest – to fund research in Scotland and England by naturalised British citizens over 60 years of age.
  - Prizes Fund – to fund various prizes.
  - Dryerre Fund – to fund postgraduate scholarships in medical or veterinary physiology.
  - Fleck Bequest Fund – to promote interest, knowledge and appreciation of science and its applications throughout Scotland.
  - Piazzi Smyth Legacy Fund – to fund high altitude astronomical research.
  - Sillitto Fund – to promote interest in physics among young people.

CASS Fund – to fund academic / industrial liaison.
Retailing Seminar Fund – to fund a programme of seminars on retailing.
Edinburgh Drug Absorption Foundation Fund – to fund a series of conferences on the broad theme of ‘Drugs Futures’.
RSE Scotland Foundation – a trust to advance the education of the public in Scotland in science, engineering and technology, incorporating assets transferred from the CRF. The CRF funds remain restricted until pre-existing awards and appointments are concluded.
BP Research Fellowship Trust – a trust to fund postdoctoral research fellowships in Scotland.

3 Accounting policies
Incoming resources
Voluntary income
Subscriptions are accounted for on the basis of the subscription year to October 2010 and include income tax recoverable on the subscriptions paid under Gift Aid.

Revenue grants are credited to income in the period in which the RSE becomes entitled to the resources.

Donations of a recurring nature from other charitable foundations and one-off gifts and legacies included in other income are taken to revenue in the period to which they relate.

Investment income
Interest and dividends are accounted for in the year in which they are receivable.

Incoming resources for charitable activities
Incoming resources for activities are accounted for on an accruals basis.
notes to the financial statements

Publication income receivable in foreign currencies is converted into sterling at rates of exchange ruling at the date of receipt.

Incoming resources for research fellowships are accounted for in the period in which the RSE becomes entitled to the resources.

Income received for specific projects, and received in advance of the commencement of the project, is deferred. If the project were not to proceed as planned, the RSE would not be entitled to retain the funds. For performance-related grants, where entitlement to the incoming resource only arises with the performance of the specific outputs agreed under the contracts, income is deferred.

Resources expended
Expenditure and support costs
All resources expended are included on an accruals basis, having regard to any constructive obligations created by multi-year grant commitments.

Where directly attributable, resources expended are allocated to the relevant functional category. Overhead and support costs are allocated to functional category on the basis of direct staff costs in each area of activity.

Cost of generating funds
The cost of generating funds includes expenditure incurred in supporting the Fellowship and incurred on fundraising and development initiatives.

Charitable activities
Grants payable are recognised as a liability when the RSE is under an actual or constructive obligation to make a transfer to a third party. Where grants are time related to future periods and are to be financed by specific grants receivable in those future periods, they are treated as liabilities of those periods and not as liabilities at balance sheet date. Such grants are disclosed as future commitments.

Governance costs
Governance costs are those incurred in connection with the management of RSE assets, organisational administration and compliance with constitutional and statutory requirements.

Tangible fixed assets, depreciation and repairs
The RSE’s principal assets are its buildings in George Street, Edinburgh. Under FRS15 the Society depreciates the buildings assuming a 50-year life. It is the policy of the Council to maintain the buildings to a high standard. Any permanent diminutions in value are reflected in the statement of financial activities. Costs of repairs and maintenance are charged against revenue.

Expenditure incurred by the RSE Scotland Foundation in the improvements to 26 George Street is being depreciated from the date of completion of the refurbishment over the period of the lease to the RSE Scotland Foundation to 30 June 2047.

Minor equipment is charged against revenue in the year of purchase. Computer and audio-visual is depreciated on a straight line basis over 3–20 years.

Investments
Investments are stated at their market value at the balance sheet date. Gains and losses on disposal and revaluation of investments are charged or credited in the statement of financial activities and allocated to funds in accordance with their proportionate share of the investment portfolio.

Pensions
The RSE participates in defined benefit pension schemes which are externally funded. The cost of providing pensions is allocated over employees working lives with the RSE and is included in staff costs.
### The Royal Society of Edinburgh

**notes to the financial statements**

#### 4 Incoming resources

<table>
<thead>
<tr>
<th></th>
<th>Voluntary income</th>
<th>Activities for generating income</th>
<th>Investment</th>
<th>Promotion of research and innovation</th>
<th>Other charitable activities</th>
<th><strong>Total</strong> 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fellows</strong></td>
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<td></td>
<td>206,940</td>
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<td></td>
<td></td>
<td>127,903</td>
</tr>
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<td></td>
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<tr>
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<tr>
<td><strong>Transfer of assets from the CRF</strong></td>
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#### Prior year 2009

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<th></th>
<th>Voluntary income</th>
<th>Activities for generating income</th>
<th>Investment</th>
<th>Promotion of research and innovation</th>
<th>Other charitable activities</th>
<th><strong>Total</strong> 2009</th>
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<td>73,228</td>
</tr>
<tr>
<td><strong>Dividends</strong></td>
<td>224,197</td>
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<td></td>
<td></td>
<td></td>
<td>224,197</td>
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<tr>
<td><strong>RSE</strong></td>
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<td></td>
<td></td>
<td></td>
<td>2,487,762</td>
</tr>
<tr>
<td><strong>BP Research Fellowship Trust</strong></td>
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<td></td>
<td></td>
<td></td>
<td>152,304</td>
</tr>
<tr>
<td><strong>RSE Scotland Foundation</strong></td>
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<td></td>
<td></td>
<td></td>
<td>127,903</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>127,903</td>
</tr>
<tr>
<td><strong>Bank interest</strong></td>
<td>73,228</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>73,228</td>
</tr>
<tr>
<td><strong>Dividends</strong></td>
<td>224,197</td>
<td></td>
<td></td>
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<td></td>
<td>224,197</td>
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<tr>
<td><strong>Transfer of assets from the CRF</strong></td>
<td>32,649</td>
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<td></td>
<td></td>
<td></td>
<td>32,649</td>
</tr>
</tbody>
</table>

|                      |                  |                                  |            |                                      |                             | 8,906,375      |
| **RSE**              | 2,615,665        |                                  |            |                                      |                             | 2,615,665      |
| **BP Research Fellowship Trust** | 503,826         |                                  |            |                                      |                             | 503,826        |
| **RSE Scotland Foundation** |            |                                  |            |                                      |                             | 256,030        |
|                      |                  |                                  |            |                                      |                             | 256,030        |
| **Bank interest**    | 2,117,752        |                                  |            |                                      |                             | 2,117,752      |
| **Dividends**        | 1,270,367        |                                  |            |                                      |                             | 1,270,367      |
| **Transfer of assets from the CRF** | 6,290,710      |                                  |            |                                      |                             | 6,290,710      |

|                      |                  |                                  |            |                                      |                             | 13,054,350     |

The Royal Society of Edinburgh
## 4a Voluntary income

<table>
<thead>
<tr>
<th>Description</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions from RSE Fellows</td>
<td>£11,200</td>
<td>£12,320</td>
</tr>
<tr>
<td>Admission fees</td>
<td>£167,280</td>
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<tr>
<td>Annual subscriptions</td>
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<tr>
<td>Income tax recoverable under Gift Aid</td>
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<td>Lessells Trust additional receipt</td>
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<td>Appeal receipts</td>
<td>£7,143</td>
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<tr>
<td>Legacies</td>
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<td>Fleck Trust transfer</td>
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<tr>
<td>Receipts for James Clerk Maxwell Statue</td>
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<td>£8,910</td>
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<td>Friends of the Society</td>
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<tr>
<td>Other income</td>
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<td>£1,762</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>£280,542</td>
<td>£2,487,762</td>
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</table>

In addition to the donations set out above, the RSE receives donations made specifically in support of activities which are included in activities income (see note 26(b)).

### 5 Incoming resources from charitable activities

<table>
<thead>
<tr>
<th>Description</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scottish Government Grant – research fellowships</td>
<td>£1,456,169</td>
<td>£1,050,130</td>
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<tr>
<td>Scottish Government Grant arts &amp; humanities awards</td>
<td>£122,193</td>
<td>£76,863</td>
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<tr>
<td>Franco-Scottish PhD scholarships</td>
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<tr>
<td>Caledonian Research Foundation</td>
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<td>£21,237</td>
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<tr>
<td>Scottish Enterprise</td>
<td>£719,598</td>
<td>£228,148</td>
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<tr>
<td>BBSRC Enterprise Fellowships</td>
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<td>£201,812</td>
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<tr>
<td>STFC Enterprise Fellowships</td>
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<td>£29,862</td>
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<td>Lloyds TSB Foundation for Scotland</td>
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<td>Scottish Crucible</td>
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<tr>
<td><strong>Total</strong></td>
<td>£2,836,496</td>
<td>£2,117,752</td>
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</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scottish Government Grant generating &amp; communicating knowledge</td>
<td>£372,358</td>
<td>£372,161</td>
</tr>
<tr>
<td>Scottish Government Grant – International activities</td>
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<td>Gannochy Trust</td>
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<td>Scottish Funding Council</td>
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<td>£37,316</td>
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<td>Meetings</td>
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<td>Policy and advice income</td>
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<td>IEEE / RSE / Wolfson James Clerk Maxwell Award</td>
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<td>Educational activities</td>
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<td>Sale of sundry publications</td>
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<td><strong>Total</strong></td>
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<td>£988,431</td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSE Scotland Foundation – Journal publications</td>
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<td>RSE Scotland Foundation – Conference facilities letting</td>
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<td>RSE Scotland Foundation Science and society</td>
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<tr>
<td><strong>Total</strong></td>
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</table>

**Total**                                             | £3,937,256| £3,388,119|

Further information relating to grants, donations and receipts and their application is set out in note 26.
notes to the financial statements

6 Resources expended

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<td>2,893</td>
<td>194,657</td>
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<td>Building management</td>
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<td>Charitable activities</td>
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<td>Increasing International Research Connections</td>
<td>193,765</td>
<td>114,980</td>
<td>308,745</td>
<td>178,995</td>
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<td>Improving Connections Between Business and Academia</td>
<td>1,126,786</td>
<td>107,858</td>
<td>1,234,644</td>
<td>482,772</td>
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<td>Increasing Numbers Taking Science as a Career</td>
<td>8,865</td>
<td>46,928</td>
<td>55,793</td>
<td>12,757</td>
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<td>Enhancing Public Appreciation of Science and Culture</td>
<td>128,357</td>
<td>239,151</td>
<td>367,508</td>
<td>165,680</td>
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<td>Informing and Influencing Public Policy</td>
<td>40,667</td>
<td>179,065</td>
<td>219,732</td>
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<td>86,602</td>
<td>36,181</td>
<td>122,783</td>
<td>95,594</td>
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<td>James Clerk Maxwell Statue</td>
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<td>SBF</td>
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<td>15,000</td>
<td>120,620</td>
<td>112,903</td>
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<td>92,585</td>
<td>88,596</td>
<td>88,596</td>
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<td></td>
<td>193,469</td>
<td>143,766</td>
<td>337,235</td>
<td>417,083</td>
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<td>Total cost of charitable activities</td>
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<td>1,109,143</td>
<td>4,933,408</td>
<td>3,225,596</td>
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<td>Governance (note 11)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>RSE</td>
<td>6,956</td>
<td>107,795</td>
<td>114,751</td>
<td>6,612</td>
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<td>RSE Scotland Foundation</td>
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<td>34,897</td>
<td>38,242</td>
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<td>1,196</td>
<td>1,245</td>
<td>1,245</td>
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<tr>
<td>Total governance costs</td>
<td>11,497</td>
<td>143,766</td>
<td>154,198</td>
<td>11,107</td>
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<tr>
<td>Resources expended</td>
<td>3,839,011</td>
<td>1,516,524</td>
<td>5,355,535</td>
<td>3,286,904</td>
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</table>

Central support costs as set out in note 12 have been allocated to activities in proportion to the employment cost in each area of activity.
Trustees’ Report and Accounts to 31 March 2010

notes to the financial statements

### 7 Grants payable

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Promotion of research (note 8)</strong></td>
<td>2,351,920</td>
<td>2,124,730</td>
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<tr>
<td><strong>Prizes and grants</strong></td>
<td>57,831</td>
<td>66,765</td>
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<tr>
<td><strong>Promotion of Innovation (Note 9)</strong></td>
<td>1,234,644</td>
<td>482,772</td>
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<tr>
<td><strong>Total</strong></td>
<td>3,644,396</td>
<td>2,674,267</td>
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### 8 Increasing Numbers of World-Class Researchers

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Promotion of Research</strong></td>
<td>2,351,920</td>
<td>2,124,730</td>
</tr>
<tr>
<td><strong>Scottish Government Fellowships</strong></td>
<td>1,347,903</td>
<td>975,263</td>
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<tr>
<td><strong>Marie Curie COFUND actions</strong></td>
<td>106,428</td>
<td>71,582</td>
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<tr>
<td><strong>Arts &amp; Humanities Workshop Grants</strong></td>
<td>21,881</td>
<td>17,364</td>
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<tr>
<td><strong>CRF European Fellowships</strong></td>
<td>272,654</td>
<td>476,925</td>
</tr>
<tr>
<td><strong>CRF Personal Fellowships</strong></td>
<td>19,543</td>
<td>19,340</td>
</tr>
<tr>
<td><strong>Lloyds TSB Foundation for Scotland Fellowships</strong></td>
<td>19,166</td>
<td>18,412</td>
</tr>
<tr>
<td><strong>Robert Cormack Bequest</strong></td>
<td>4,901</td>
<td>4,610</td>
</tr>
<tr>
<td><strong>John Moyes Lessels Scholarship</strong></td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td><strong>Auber Bequest Awards</strong></td>
<td>19,543</td>
<td>19,340</td>
</tr>
<tr>
<td><strong>Library</strong></td>
<td>200</td>
<td></td>
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<tr>
<td><strong>RSE</strong></td>
<td>1,795,476</td>
<td>1,596,736</td>
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<tr>
<td><strong>BP Research Fellowship Trust</strong></td>
<td>198,728</td>
<td>171,082</td>
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<tr>
<td><strong>RSE Scotland Foundation CRF</strong></td>
<td>88,615</td>
<td>91,520</td>
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<tr>
<td><strong>Total</strong></td>
<td>2,082,819</td>
<td>1,859,538</td>
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- Support costs (note 6) 269,101 265,192
- Prizes and Grants 49,537 55,127
- Support costs (note 6) 8,294 11,638

Total 2,409,751 2,191,495

An analysis of institutions and individual awards made under this expenditure heading is included in the Society’s Review 2009, obtainable from the address on the back cover.
The Royal Society of Edinburgh

notes to the financial statements

9 Increasing connections between business and academia

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td>Scottish Enterprise Fellowships</td>
<td>647,032</td>
<td>187,695</td>
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<tr>
<td>STFC Enterprise Fellowships</td>
<td>57,616</td>
<td>23,625</td>
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<tr>
<td>BRSRC Enterprise Fellowships</td>
<td>414,515</td>
<td>186,452</td>
</tr>
<tr>
<td>Gannochy Trust</td>
<td>7,623</td>
<td>85,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,126,786</td>
<td>482,772</td>
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Support costs (Note 6)

<table>
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<tr>
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<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>107,858</td>
<td>95,896</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,234,644</td>
<td>578,668</td>
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</table>

10 Enhancing public appreciation of science and culture

Meetings

<table>
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<tr>
<th></th>
<th>2010</th>
<th>2009</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>79,621</td>
<td>115,308</td>
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<td>50,372</td>
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<td><strong>Total</strong></td>
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<td>165,680</td>
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Support costs (Note 6)

<table>
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<th>2009</th>
</tr>
</thead>
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<tr>
<td></td>
<td>239,151</td>
<td>227,887</td>
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<td><strong>Total</strong></td>
<td>367,508</td>
<td>393,567</td>
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</tbody>
</table>

The RSE Scotland Foundation became publisher of the RSE’s journals and year book with effect from the 1997 volumes. The RSE retains copyright and incurs editorial costs in respect of these publications. The RSE has made a donation to the RSE Scotland Foundation equivalent to its net deficit on publications.

11 Governance

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management and secretariat</td>
<td>105,045</td>
<td>116,416</td>
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<tr>
<td>Audit fee</td>
<td>11,497</td>
<td>11,107</td>
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<tr>
<td>Other professional advice from auditors</td>
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<td>2,382</td>
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<tr>
<td><strong>Total</strong></td>
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<td>129,905</td>
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</table>

RSE Scotland Foundation – Management and secretariat

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34,897</td>
<td>28,041</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>154,189</td>
<td>157,946</td>
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</table>
Trustees’ Report and Accounts to 31 March 2010

notes to the financial statements

12 Support costs

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries (note 13)</td>
<td>1,007,318</td>
<td>914,868</td>
</tr>
<tr>
<td>Staff training, agency and recruitment costs</td>
<td>37,522</td>
<td>38,918</td>
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<tr>
<td>Non-cash pension cost adjustments (FRS 17)</td>
<td>(53,000)</td>
<td>(59,000)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other costs</td>
<td>991,840</td>
<td>894,786</td>
</tr>
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<td>Establishment expenses</td>
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<td>193,476</td>
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<tr>
<td>Computer and equipment costs</td>
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<td>29,119</td>
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<tr>
<td>Communication, stationery and printing costs</td>
<td>40,833</td>
<td>59,957</td>
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<tr>
<td>Travel and subsistence, hospitality</td>
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<td>21,831</td>
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<td>Publicity</td>
<td>18,793</td>
<td>17,923</td>
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<td>Miscellaneous</td>
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<td>8,992</td>
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<td>Professional fees</td>
<td>13,680</td>
<td>22,543</td>
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<tr>
<td>Depreciation</td>
<td>122,208</td>
<td>120,299</td>
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<tr>
<td></td>
<td>524,684</td>
<td>474,140</td>
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<td>Total central costs</td>
<td>1,516,524</td>
<td>1,368,926</td>
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Support costs have been allocated to activities in proportion to the employment cost in each area of activity as set out in note 6.

13 Employees

<table>
<thead>
<tr>
<th></th>
<th>Total 2010</th>
<th>Funded by Foundation</th>
<th>Funded by RSE 2010</th>
<th>Total 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Wages and salaries</td>
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<td>102,954</td>
<td>703,774</td>
<td>741,632</td>
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<td>Social security costs</td>
<td>60,591</td>
<td>6,690</td>
<td>53,901</td>
<td>55,701</td>
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<td>Other pension costs</td>
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<td>120,896</td>
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<td></td>
<td>1,007,318</td>
<td>128,747</td>
<td>878,571</td>
<td>914,868</td>
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</table>

The average number of employees of the RSE including those employed under joint contracts with the RSE Scotland Foundation was 29 (2009:28). One member of staff earned over £60,000 per year and is a member of a defined benefit pension scheme.
notes to the financial statements

14 Tangible fixed assets

<table>
<thead>
<tr>
<th>Group</th>
<th>22 George Street Purchase cost</th>
<th>26 George Street Purchase cost</th>
<th>Improvements Purchase cost</th>
<th>Computer &amp; equipment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 April 2009</td>
<td>1,103,038</td>
<td>1,647,468</td>
<td>2,136,070</td>
<td>377,654</td>
<td>5,264,230</td>
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<tr>
<td>Disposals</td>
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</tr>
<tr>
<td>(30,226)</td>
<td>(30,226)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 31 March 2010</td>
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<td>1,647,468</td>
<td>2,136,070</td>
<td>365,538</td>
<td>5,252,114</td>
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<tr>
<td>Depreciation</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>At 1 April 2009</td>
<td>220,608</td>
<td>329,494</td>
<td>438,238</td>
<td>291,303</td>
<td>1,279,643</td>
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<td>On disposals</td>
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<tr>
<td>(30,226)</td>
<td>(30,226)</td>
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<td></td>
<td></td>
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<tr>
<td>At 31 March 2010</td>
<td>242,669</td>
<td>362,443</td>
<td>482,705</td>
<td>283,808</td>
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<tr>
<td>At 31 March 2010</td>
<td>860,369</td>
<td>1,285,025</td>
<td>1,653,365</td>
<td>81,730</td>
<td>3,880,489</td>
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<td>1,317,974</td>
<td>1,697,832</td>
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<tr>
<td>Net book value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 31 March 2010</td>
<td>860,369</td>
<td>1,285,025</td>
<td>1,653,365</td>
<td>81,730</td>
<td>3,880,489</td>
</tr>
<tr>
<td>At 31 March 2009</td>
<td>882,430</td>
<td>1,317,974</td>
<td>1,697,832</td>
<td>86,351</td>
<td>3,984,587</td>
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</table>

15 Fixed asset investments

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<thead>
<tr>
<th>(a) Fixed asset investments</th>
<th>Value at 1 April 2009</th>
<th>Investments made at cost</th>
<th>Proceeds on sale of investments</th>
<th>Gain / Loss</th>
<th>Revaluation</th>
<th>Market value at 31 March 2010</th>
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<td>Managed Funds</td>
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<td></td>
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<td>RSE</td>
<td>603,763</td>
<td>73,549</td>
<td>(10,128)</td>
<td>1,353</td>
<td>305,190</td>
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<tr>
<td>Fixed interest</td>
<td>1,848,808</td>
<td>976,193</td>
<td>(1,213,166)</td>
<td>(10,492)</td>
<td>61,655</td>
<td>1,662,998</td>
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<tr>
<td>UK equities</td>
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<td>636,732</td>
<td>(426,721)</td>
<td>133,404</td>
<td>495,940</td>
<td>2,568,243</td>
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<td>Cash deposits</td>
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<td>(1,645,673)</td>
<td>1,650,015</td>
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<td>37,671</td>
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<tr>
<td>BP Research Fellowships Trust</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Managed Funds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSE</td>
<td>414,559</td>
<td>149,813</td>
<td>(45,529)</td>
<td>12,751</td>
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<tr>
<td>Fixed interest</td>
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<td>348,624</td>
<td>(445,413)</td>
<td>(9,687)</td>
<td>94,455</td>
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<td>275,644</td>
<td>(247,005)</td>
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<td>274,232</td>
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<tr>
<td>Cash deposits</td>
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<td>(794,984)</td>
<td>737,947</td>
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<tr>
<td>RSEF Caledonian Research Fund</td>
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<tr>
<td>Managed Funds</td>
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<td></td>
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<td></td>
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<tr>
<td>RSE</td>
<td>889,944</td>
<td>45,321</td>
<td>(1,187,868)</td>
<td>(7,344)</td>
<td>48,530</td>
<td>2,130,370</td>
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<td>757,622</td>
<td>(433,064)</td>
<td>141,282</td>
<td>989,502</td>
<td>4,744,134</td>
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<tr>
<td>UK equities</td>
<td>556</td>
<td>(1,613,904)</td>
<td>1,620,932</td>
<td></td>
<td></td>
<td>7,584</td>
</tr>
<tr>
<td>Cash deposits</td>
<td>6,411,508</td>
<td>(36,125)</td>
<td></td>
<td>133,938</td>
<td>1,443,971</td>
<td>7,953,292</td>
</tr>
<tr>
<td>RSESF Caledonian Research Fund</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managed Funds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSE</td>
<td>12,884,518</td>
<td>(16,227)</td>
<td></td>
<td>341,629</td>
<td>2,873,292</td>
<td>16,083,212</td>
</tr>
</tbody>
</table>

The loss on sale of investments measured against their historical cost was £226,346 (2009: Surplus (£105,750) The historical cost of investments was £13,661,849 (2009: £13,899,213). (RSE 2010: £4,689,373, 2009: £4,827,672). Investments comprising more than 5% of the market value of the portfolio were: Treasury 5% (2012), Treasury 5% (2014) and European Investment Bank 4.75% (2011).
notes to the financial statements

15 Fixed asset investments (continued)

(b) Loan by RSE to RSE Scotland Foundation

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Due within one year</td>
<td>46,808</td>
<td>46,808</td>
</tr>
<tr>
<td>Due after one year</td>
<td>1,703,904</td>
<td>1,750,712</td>
</tr>
<tr>
<td></td>
<td>1,750,712</td>
<td>1,797,520</td>
</tr>
</tbody>
</table>

The loan bears interest at 4% per annum, capped at the amount of rent received by the Foundation and is repayable over the period to 30 June 2047, the expiration of the lease of 26 George Street.

16 Debtors

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>General debtors</td>
<td>563,664</td>
<td>309,874</td>
</tr>
<tr>
<td>Prepayments and accrued income</td>
<td>15,144</td>
<td>14,795</td>
</tr>
<tr>
<td>Income tax recoverable</td>
<td>26,058</td>
<td>24,277</td>
</tr>
<tr>
<td>RSE</td>
<td>604,866</td>
<td>348,946</td>
</tr>
<tr>
<td>RSE Scotland Foundation - Debtors</td>
<td>151,363</td>
<td>82,909</td>
</tr>
<tr>
<td>RSE Scotland Foundation - Prepayments</td>
<td>10,228</td>
<td>21,879</td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td>4,335</td>
<td>8,825</td>
</tr>
<tr>
<td>Group</td>
<td>770,792</td>
<td>462,559</td>
</tr>
</tbody>
</table>

17 Creditors: Amounts falling due within one year

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>General creditors</td>
<td>550,887</td>
<td>378,026</td>
</tr>
<tr>
<td>Accruals</td>
<td>61,713</td>
<td>69,535</td>
</tr>
<tr>
<td>VAT payable</td>
<td>34,131</td>
<td>18,098</td>
</tr>
<tr>
<td>University of Glasgow (note 22)</td>
<td>7,612</td>
<td>6,723</td>
</tr>
<tr>
<td>Deferred income</td>
<td>510,486</td>
<td>29,165</td>
</tr>
<tr>
<td>Event income deferred</td>
<td>47,130</td>
<td>30,000</td>
</tr>
<tr>
<td>Advance receipts – Publications</td>
<td>104,525</td>
<td>21,966</td>
</tr>
<tr>
<td></td>
<td>1,316,484</td>
<td>553,513</td>
</tr>
</tbody>
</table>

Deferred income and advance receipts analysis

<table>
<thead>
<tr>
<th></th>
<th>At 1 April 2009</th>
<th>Received in year</th>
<th>Recognised in year</th>
<th>At 31 March 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marie Curie COFUND</td>
<td></td>
<td>444,518</td>
<td></td>
<td>444,518</td>
</tr>
<tr>
<td>Friends of the Society</td>
<td></td>
<td>24,250</td>
<td>(16,250)</td>
<td>8,000</td>
</tr>
<tr>
<td>Climate Change Inquiry</td>
<td>11,209</td>
<td>56,750</td>
<td>(12,485)</td>
<td>55,474</td>
</tr>
<tr>
<td>Chemistry Project</td>
<td>17,956</td>
<td></td>
<td>(15,462)</td>
<td>2,494</td>
</tr>
<tr>
<td></td>
<td>29,165</td>
<td>525,518</td>
<td>(44,197)</td>
<td>510,486</td>
</tr>
<tr>
<td>Journal receipts</td>
<td>21,966</td>
<td>230,724</td>
<td>(148,165)</td>
<td>104,525</td>
</tr>
<tr>
<td>Symposia income</td>
<td>30,000</td>
<td>30,744</td>
<td>(13,614)</td>
<td>47,130</td>
</tr>
</tbody>
</table>
The Royal Society of Edinburgh

notes to the financial statements

17 Creditors: Amounts falling due within one year (continued)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>General creditors</td>
<td>483,950</td>
<td>367,036</td>
</tr>
<tr>
<td>RSE Scotland Foundation current account</td>
<td>660,244</td>
<td>492,543</td>
</tr>
<tr>
<td>Deferred income</td>
<td>510,486</td>
<td>29,165</td>
</tr>
<tr>
<td>University of Glasgow (note 22)</td>
<td>7,612</td>
<td>6,723</td>
</tr>
<tr>
<td>Symposia income deferred</td>
<td>47,130</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td>1,709,422</td>
<td>925,467</td>
</tr>
</tbody>
</table>

18 Provision for liabilities and charges

<table>
<thead>
<tr>
<th></th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitments for research fellowships</td>
<td></td>
</tr>
<tr>
<td>At 1 April 2009 – Group &amp; RSE</td>
<td>630,228</td>
</tr>
<tr>
<td>New commitments:</td>
<td></td>
</tr>
<tr>
<td>Lloyds TSB Foundation for Scotland Research Fellowships</td>
<td></td>
</tr>
<tr>
<td>Grants paid in the year</td>
<td>(240,236)</td>
</tr>
<tr>
<td>At 31 March 2010</td>
<td>389,992</td>
</tr>
</tbody>
</table>

The provision represents amounts payable under a constructive obligation in respect of research fellowships due as follows:
2010-11 £165,868; 2011-12 £111,370; 2012-13 £48,899

19 General Fund

<table>
<thead>
<tr>
<th></th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 April 2009</td>
<td>923,552</td>
</tr>
<tr>
<td>Net movement in funds for the year from statement of financial activities</td>
<td>(576,038)</td>
</tr>
<tr>
<td>At 31 March 2010</td>
<td>347,514</td>
</tr>
</tbody>
</table>
Trustees’ Report and Accounts to 31 March 2010

notes to the financial statements

20 Designated Funds

<table>
<thead>
<tr>
<th>At 1 April 2009</th>
<th>Investment income</th>
<th>Other income</th>
<th>Expenditure</th>
<th>Gains/(Losses)</th>
<th>Transfers</th>
<th>At 31 March 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Capital Asset Reserve</td>
<td>3,997,926</td>
<td></td>
<td>(101,818)</td>
<td>3,896,108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Appeal Fund</td>
<td>2,143,228</td>
<td>95,160</td>
<td>477</td>
<td>(89,099)</td>
<td>479,578</td>
<td>2,629,344</td>
</tr>
<tr>
<td>Programme Fund</td>
<td>90,192</td>
<td>4,191</td>
<td></td>
<td>21,122</td>
<td></td>
<td>115,505</td>
</tr>
<tr>
<td>CH Kemball Fund</td>
<td>20,300</td>
<td>943</td>
<td></td>
<td>4,754</td>
<td></td>
<td>25,997</td>
</tr>
<tr>
<td>Grants Fund</td>
<td>478,376</td>
<td>22,229</td>
<td>(16,530)</td>
<td>112,030</td>
<td></td>
<td>596,105</td>
</tr>
<tr>
<td>Dr James Heggie Fund</td>
<td>181,622</td>
<td>8,439</td>
<td>(8,646)</td>
<td>42,532</td>
<td></td>
<td>223,947</td>
</tr>
</tbody>
</table>

6,911,644 130,962 477 (114,275) 660,016 (101,818) 7,487,006

The transfers represent the release from the Capital Asset Reserve of a total of £101,818 to match the depreciation of buildings and the amount of capital repayment of the loan to the Foundation.

21 Restricted Funds

<table>
<thead>
<tr>
<th>At 1 April 2009</th>
<th>Investment income</th>
<th>Other income</th>
<th>Expenditure</th>
<th>Gains/(Losses)</th>
<th>Transfers</th>
<th>At 31 March 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Robert Cormack Bequest</td>
<td>89,737</td>
<td>4,170</td>
<td>(5,882)</td>
<td>21,014</td>
<td></td>
<td>109,039</td>
</tr>
<tr>
<td>Leslie Trust</td>
<td>364,899</td>
<td>16,956</td>
<td>8,008</td>
<td>(26,087)</td>
<td>85,455</td>
<td>449,231</td>
</tr>
<tr>
<td>Auber Bequest</td>
<td>345,357</td>
<td>16,048</td>
<td>(9,550)</td>
<td>80,878</td>
<td></td>
<td>432,733</td>
</tr>
<tr>
<td>Prizes Fund</td>
<td>58,940</td>
<td>2,739</td>
<td>(5,968)</td>
<td>13,803</td>
<td></td>
<td>69,914</td>
</tr>
<tr>
<td>Dryerre Fund</td>
<td>405,855</td>
<td>18,859</td>
<td>(27,240)</td>
<td>95,046</td>
<td></td>
<td>492,520</td>
</tr>
<tr>
<td>Fleck</td>
<td>46,193</td>
<td>2,146</td>
<td>40,958</td>
<td>(876)</td>
<td>10,818</td>
<td>99,239</td>
</tr>
<tr>
<td>Piazzi Smyth</td>
<td>11,722</td>
<td>545</td>
<td>(941)</td>
<td>2,745</td>
<td></td>
<td>14,071</td>
</tr>
<tr>
<td>Sillitto</td>
<td>34,024</td>
<td>170</td>
<td>(148)</td>
<td>34,046</td>
<td></td>
<td>34,046</td>
</tr>
<tr>
<td>Others</td>
<td>20,772</td>
<td>965</td>
<td>(394)</td>
<td>4,865</td>
<td></td>
<td>26,208</td>
</tr>
<tr>
<td>Edinburgh Drug Absorption Foundation</td>
<td>135,095</td>
<td>675</td>
<td>(15,000)</td>
<td>120,770</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted Income Fund</td>
<td>4,052,633</td>
<td>(4,052,633)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSE</td>
<td>1,512,594</td>
<td>63,273</td>
<td>4,101,599</td>
<td>(4,144,319)</td>
<td>314,624</td>
<td>__</td>
</tr>
<tr>
<td>RSE Scotland Foundation</td>
<td>6,947,941</td>
<td>305,182</td>
<td>395,016</td>
<td>(538,005)</td>
<td>1,571,599</td>
<td>(96,006)</td>
</tr>
<tr>
<td>BP Research Fellowships Trust</td>
<td>2,314,351</td>
<td>131,224</td>
<td>(214,280)</td>
<td>649,962</td>
<td></td>
<td>2,881,257</td>
</tr>
<tr>
<td>Total</td>
<td>10,774,886</td>
<td>499,679</td>
<td>4,496,615</td>
<td>(4,896,604)</td>
<td>2,542,495</td>
<td>(96,006)</td>
</tr>
</tbody>
</table>

13,321,065
notes to the financial statements

21 Restricted funds (continued)


“Others” comprise the Retailing Seminars Fund and The CASS Fund. The Restricted Income Fund represents restricted income received and expended in the year.

Under the terms of the Lessells Trust the University of Glasgow is entitled to 10% of additional amounts received by the RSE from the Trust. The balance included in creditors at 31 March 2010 represents the total sum apportioned but not yet paid over to the University (note 17).

The funds of the RSE Scotland Foundation are treated as restricted in respect of the consolidated accounts and comprise funds received from the CRF £7,958,588, the endowment for the upkeep of the James Clerk Maxwell statue £31,870 and the balance of the Foundation general fund of £691,579.

22 Analysis of assets between funds

<table>
<thead>
<tr>
<th>Group</th>
<th>General</th>
<th>Designated Funds</th>
<th>Restricted Funds</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Fund balances at 31 March 2010 are represented by:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>25,763</td>
<td>2,145,394</td>
<td>1,709,332</td>
<td>3,880,489</td>
<td>3,984,587</td>
</tr>
<tr>
<td>Investments</td>
<td>54,648</td>
<td>3,495,036</td>
<td>12,533,528</td>
<td>16,083,212</td>
<td>12,884,518</td>
</tr>
<tr>
<td>Loan to RSE Scotland Foundation</td>
<td>1,750,712</td>
<td>(1,750,712)</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Current assets</td>
<td>604,866</td>
<td>165,926</td>
<td>770,792</td>
<td>462,559</td>
<td></td>
</tr>
<tr>
<td>RSE Scotland Foundation current account</td>
<td>(660,244)</td>
<td>660,244</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Deposits</td>
<td>636,180</td>
<td>95,864</td>
<td>1,499,620</td>
<td>2,231,664</td>
<td>1,950,246</td>
</tr>
<tr>
<td>Cash</td>
<td>195,667</td>
<td>115,237</td>
<td>310,904</td>
<td>372,913</td>
<td></td>
</tr>
<tr>
<td>Current liabilities</td>
<td>(389,992)</td>
<td>(389,992)</td>
<td>(630,228)</td>
<td>(553,513)</td>
<td></td>
</tr>
<tr>
<td>Rdwisions for liabilities and charges</td>
<td>(389,992)</td>
<td>(389,992)</td>
<td>(630,228)</td>
<td>(553,513)</td>
<td></td>
</tr>
<tr>
<td>Pension fund liability</td>
<td>(415,000)</td>
<td>(415,000)</td>
<td>139,000</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td>347,514</td>
<td>7,487,006</td>
<td>13,321,065</td>
<td>21,155,585</td>
<td>18,610,082</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RSE</th>
<th>General</th>
<th>Designated Funds</th>
<th>Restricted Funds</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Fund balances at 31 March 2010 are represented by:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>25,763</td>
<td>2,145,394</td>
<td>2,171,157</td>
<td>2,228,585</td>
<td></td>
</tr>
<tr>
<td>Investments</td>
<td>54,650</td>
<td>3,495,036</td>
<td>5,242,639</td>
<td>4,214,788</td>
<td></td>
</tr>
<tr>
<td>Loan to RSE Scotland Foundation</td>
<td>1,750,712</td>
<td>1,750,712</td>
<td>1,797,520</td>
<td>1,797,520</td>
<td></td>
</tr>
<tr>
<td>Current assets</td>
<td>604,866</td>
<td>604,866</td>
<td>348,946</td>
<td>348,946</td>
<td></td>
</tr>
<tr>
<td>RSE Scotland Foundation current account</td>
<td>(660,244)</td>
<td>(660,244)</td>
<td>(492,543)</td>
<td>(492,543)</td>
<td></td>
</tr>
<tr>
<td>Deposits</td>
<td>636,180</td>
<td>95,864</td>
<td>2,231,664</td>
<td>1,950,246</td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td>195,667</td>
<td>195,667</td>
<td>224,400</td>
<td>224,400</td>
<td></td>
</tr>
<tr>
<td>Current liabilities</td>
<td>(389,992)</td>
<td>(389,992)</td>
<td>(630,228)</td>
<td>(630,228)</td>
<td></td>
</tr>
<tr>
<td>Rdwisions for liabilities and charges</td>
<td>(389,992)</td>
<td>(389,992)</td>
<td>(630,228)</td>
<td>(630,228)</td>
<td></td>
</tr>
<tr>
<td>Pension fund liability</td>
<td>(415,000)</td>
<td>(415,000)</td>
<td>139,000</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td>347,514</td>
<td>7,487,006</td>
<td>1,847,771</td>
<td>9,682,291</td>
<td>9,347,790</td>
</tr>
</tbody>
</table>
notes to the financial statements

23 Pension costs

(a) Universities Superannuation Scheme

The RSE participates in the Universities Superannuation Scheme, a defined benefit pension scheme which is externally funded and contracted out of the State Earnings-Related Pension Scheme. The assets of the scheme are held in a separate trustee-administered fund. The fund is valued every three years by a professionally qualified independent actuary using the projected unit method, the rates of contribution payable being determined by the trustee on the advice of the actuaries. In the intervening years the actuaries review the progress of the scheme.

It is not possible to identify each Institution's share of the underlying assets and liabilities of the scheme and hence contributions to the scheme are accounted for as if it were a defined contributions scheme. The cost recognised within the result for the year is equal to the contributions payable to the scheme for the year.

The latest actuarial valuation of the scheme was at 31 March 2008. The most significant assumptions, those relating to the rate of return on investments and the increase in salary and pensions are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Past service liabilities</th>
<th>Future service liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment return</td>
<td>4.4%</td>
<td>6.1%</td>
</tr>
<tr>
<td>Salary increase</td>
<td>4.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Pension increase</td>
<td>3.3%</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

At the valuation date the market value of the scheme's assets was £28,842.6 million and the value of past service liabilities was £40,619.2 million on the scheme's historical funding basis. The value of the assets represented 71% of the benefits that had accrued to members, after allowing for expected future increases in earnings. The contribution rate payable by the RSE in the year was 14.0% of pensionable salaries. The actuary has confirmed that it is appropriate to take the pension charge to be equal to the actual contribution paid during the year. The contribution rate payable increased to 16% of pensionable salaries with effect from 1 October 2009. The total pension cost payable to USS in the year was £15,817.

(b) Lothian Pension Fund

The RSE also participates in the Lothian Pension Fund, a defined benefit pension scheme established under Local Government Pension Fund Regulations. This scheme has determined that it is possible to ascertain the shares of assets and liabilities relating to individual admitted bodies. The assets of the scheme are held in a separate trustee-administered fund.

The fund is valued every three years by a professionally qualified independent actuary using the projected unit method, the rates of contribution payable being determined by the trustee on the advice of the actuaries. In the intervening years the actuaries review the progress of the scheme.

At the latest valuation date the market value of the scheme's assets was £2,903 million and the value of past service liabilities was £3,427 million. The value of the assets represented 85% of the benefits that had accrued to members, after allowing for expected future increases in earnings. The contribution rate payable by the RSE was 20.1%. The actuary has confirmed that it is appropriate to take the pension charge to be equal to the actual contribution paid during the year.
notes to the financial statements

23 Pension costs (continued)

Pension fund asset / (liability)
The RSE pension fund asset at 31 March and the movements of its component parts comprise:

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of funded liabilities (defined benefit obligation)</td>
<td>(2,299)</td>
<td>(1,128)</td>
</tr>
<tr>
<td>Fair value of employer assets</td>
<td>1,884</td>
<td>1,267</td>
</tr>
<tr>
<td>Net asset at 31 March</td>
<td>(415)</td>
<td>139</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Movement in present value of defined benefit obligation</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 April</td>
<td>1,128</td>
<td>1,145</td>
</tr>
<tr>
<td>Current service cost</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Past service costs</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Interest cost</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>Contribution by members</td>
<td>41</td>
<td>30</td>
</tr>
<tr>
<td>Actuarial losses/(gains)</td>
<td>981</td>
<td>(184)</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(7)</td>
<td>(6)</td>
</tr>
<tr>
<td>At 31 March</td>
<td>2,299</td>
<td>1,128</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Movement in fair value of employer assets</th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 April</td>
<td>1,267</td>
<td>1,437</td>
</tr>
<tr>
<td>Expected return on assets</td>
<td>89</td>
<td>108</td>
</tr>
<tr>
<td>Contributions by members</td>
<td>41</td>
<td>30</td>
</tr>
<tr>
<td>Contributions by the employer</td>
<td>120</td>
<td>94</td>
</tr>
<tr>
<td>Actuarial gains/(losses)</td>
<td>374</td>
<td>(396)</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(7)</td>
<td>(6)</td>
</tr>
<tr>
<td>At 31 March</td>
<td>1,884</td>
<td>1,267</td>
</tr>
</tbody>
</table>

The net expense recognised in the statement of financial activities after FRS17 adjustments was

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current service cost</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Interest cost</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>Expected return on employer assets</td>
<td>(89)</td>
<td>(108)</td>
</tr>
<tr>
<td></td>
<td>54</td>
<td>35</td>
</tr>
</tbody>
</table>

The total amount recognised in the statement of financial activities in respect of actuarial gains and losses is a loss of £607,000 (2009: loss of £212,000).
Trustees’ Report and Accounts to 31 March 2010

notes to the financial statements

23 Pension costs (continued)

The fair value of the employer assets at 31 March and the return on them in the year was:

<table>
<thead>
<tr>
<th></th>
<th>Value 2010 (£'000)</th>
<th>Return 2010 %</th>
<th>Value 2009 (£'000)</th>
<th>Return 2009 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equities</td>
<td>1,488</td>
<td>7.8</td>
<td>1,001</td>
<td>7.0</td>
</tr>
<tr>
<td>Bonds</td>
<td>151</td>
<td>5.0</td>
<td>139</td>
<td>5.4</td>
</tr>
<tr>
<td>Property</td>
<td>170</td>
<td>5.8</td>
<td>127</td>
<td>4.9</td>
</tr>
<tr>
<td>Cash</td>
<td>75</td>
<td>4.8</td>
<td></td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,884</td>
<td></td>
<td>1,267</td>
<td></td>
</tr>
</tbody>
</table>

Actual return on plan assets

463 (257)

The expected rates of return on plan assets are determined by reference to relevant indices. The overall expected rate of return is calculated by weighting the individual rates in accordance with the anticipated balance in the Plan's investment portfolio.

Principal actuarial assumptions (expressed as weighted averages) at the year end were as follows:

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation/pension increase rate</td>
<td>3.8%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Salary increase rate</td>
<td>5.3%</td>
<td>4.6%</td>
</tr>
<tr>
<td>Expected return on assets</td>
<td>7.3%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Discount rate</td>
<td>5.5%</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

The assumptions relating to longevity underlying the pension liabilities at the balance sheet date as based on standard actuarial mortality tables and include an allowance for future improvements in longevity. The assumptions are equivalent to expecting a 65 year old to live for a number of years as follows:

<table>
<thead>
<tr>
<th></th>
<th>Males 2010</th>
<th>Females 2010</th>
<th>Males 2009</th>
<th>Females 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current pensioners</td>
<td>20.8 years</td>
<td>24.1 years</td>
<td>19.8 years</td>
<td>22.8 years</td>
</tr>
<tr>
<td>Future pensioners</td>
<td>22.3 years</td>
<td>25.7 years</td>
<td>21.0 years</td>
<td>24.0 years</td>
</tr>
</tbody>
</table>

The history of the plan for the current and prior periods is as follows:

<table>
<thead>
<tr>
<th></th>
<th>2010 £’000</th>
<th>2009 £’000</th>
<th>2008 £’000</th>
<th>2007 £’000</th>
<th>2006 £’000</th>
<th>2005 £’000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present value of defined benefit obligation</td>
<td>(2,299)</td>
<td>(1,128)</td>
<td>(1,145)</td>
<td>(1,298)</td>
<td>(1,250)</td>
<td>(561)</td>
</tr>
<tr>
<td>Fair value of employer assets</td>
<td>1,884</td>
<td>1,267</td>
<td>1,437</td>
<td>1,347</td>
<td>1,130</td>
<td>485</td>
</tr>
<tr>
<td>Surplus/(deficit)</td>
<td>(415)</td>
<td>139</td>
<td>292</td>
<td>49</td>
<td>(120)</td>
<td>(76)</td>
</tr>
</tbody>
</table>

Experience gains and losses on assets and liabilities have been as follows:

<table>
<thead>
<tr>
<th></th>
<th>2010 £’000</th>
<th>2009 £’000</th>
<th>2008 £’000</th>
<th>2007 £’000</th>
<th>2006 £’000</th>
<th>2005 £’000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience gain/(loss) on liabilities</td>
<td>28</td>
<td>(1)</td>
<td>(30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience gain/(loss) on assets</td>
<td>374</td>
<td>(396)</td>
<td>(140)</td>
<td>8</td>
<td>171</td>
<td>13</td>
</tr>
</tbody>
</table>

The projected amount to be charged in respect of the Lothian Pension Fund defined benefit scheme in the next financial year is £135,000.

(c) Pension charge

The total pension charge for the year, including FRS17 adjustments, was £86,999 (2009: £58,534).
The Royal Society of Edinburgh

notes to the financial statements

24 Transactions with Council members
No member of Council received any payments other than reimbursements of expenditure on travel and subsistence costs actually and necessarily incurred in carrying out their duties as Councillors and Officers. The aggregate of such reimbursements to those Council members who charged expenses amounted to £2,924 (2009: £2,750).

25 Connected charitable trusts
(a) RSE Scotland Foundation
The RSE Scotland Foundation is a charitable trust, recognised in Scotland as Scottish charity number SC024636. It was created in March 1996 with the object of advancing the education of the public in Scotland in science and engineering and in so doing to conserve the scientific and cultural heritage of Scotland. The President, General Secretary, Treasurer, Curator and a Vice-President of the RSE are ex officiis Trustees of the Foundation, which draws on the resources of the RSE in carrying out its objects. The Foundation also has five nominated Trustees. The Foundation became publisher of the RSE’s journals under a Publications Rights License effective from 1 January 1997.
On 1 July 1997 the RSE granted to the Foundation a 50-year lease over 26 George Street carrying an obligation to refurbish the building within a three-year period. The Council of the RSE agreed to make a loan of up to £2.3 million available to the Foundation in support of the refurbishment. The agreed terms of the loan are as described in note 16.
(b) BP Research Fellowships Trust
The BP Research Fellowships Trust funds a scheme of post doctoral research fellowships administered by the RSE.

26 Supplementary information: grants, donations and receipts
(a) Scottish Government Grants Income

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion of research</td>
<td>1,456,169</td>
<td>1,050,130</td>
</tr>
<tr>
<td>Arts and Humanities Award</td>
<td>122,193</td>
<td>76,863</td>
</tr>
<tr>
<td>Activities grant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generating &amp; Communicating knowledge</td>
<td>372,358</td>
<td>372,161</td>
</tr>
<tr>
<td>International activities</td>
<td>307,398</td>
<td>273,419</td>
</tr>
<tr>
<td>Joint Scottish French PhD studentships</td>
<td></td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td>2,258,118</td>
<td>1,784,573</td>
</tr>
</tbody>
</table>

The funding for 2009 10 was a grant under S23 Natural Heritage (Scotland) Act 1985 in support of the four programmes of activity: Research Fellowships, Arts & Humanities Awards, International grants & relations and Generating & Communicating knowledge.

At 31 March 2010 the financial commitment in respect of Personal and Support Fellowships awarded subject to Scottish Government funding in the years, 2010–11, 2011–12, 2012–13, 2013–14 and 2014–15 amounted to £1,766,736, £1,811,176, £1,777,961, £1,212,971 and £615,343 respectively. These amounts are treated as obligation of future years to be financed by specific funding expected to be made available from the Scottish Government.
26 Supplementary information: grants, donations and receipts (continued)

(b) Recurring donations in support of activities

The Lloyds TSB Foundation for Scotland supports postdoctoral fellowships, postgraduate studentships and lectures and conferences to fund and disseminate research aimed at improving the quality of life for an ageing population.

<table>
<thead>
<tr>
<th></th>
<th>Scottish Enterprise</th>
<th>Lloyds TSB Foundation for Scotland</th>
<th>Gannochy Trust</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion of research &amp; innovation</td>
<td>719,598</td>
<td></td>
<td>2,607</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion of research &amp; innovation</td>
<td>647,032</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision for future costs</td>
<td></td>
<td>22,383</td>
<td></td>
</tr>
<tr>
<td>RSE administration and staff costs recovery</td>
<td>72,566</td>
<td>22,383</td>
<td>2,607</td>
</tr>
<tr>
<td></td>
<td>719,598</td>
<td></td>
<td>2,607</td>
</tr>
</tbody>
</table>
The Royal Society of Edinburgh

notes to the financial statements

26 Supplementary information: grants, donations and receipts (continued)

(c) Other donations in support of activities

The RSE gratefully acknowledges all those who make donations in support of activities. The companies, trusts and other bodies which made donations of £1,000 or more in support of activities in the year ended 31 March 2010 were as follows:

Airborne Initiative
Anonymous
Binks Trust
BP Exploration
British Council Scotland
Darwin Trust
Gannochy Trust
Glaxo SmithKline plc
Highland Council
Marks & Spencer plc
National Museums of Scotland
Royal Bank of Scotland plc
Royal Society of Chemistry
RSPB Scotland
Scottish Aquaculture Research Forum
Scottish Arts Council
Scottish Environmental Protection Agency
Scottish Estates Business Group
Scottish Power plc
Shell UK
Standard Life plc

27 Analysis of net funds

<table>
<thead>
<tr>
<th></th>
<th>At 31 March 2010</th>
<th>Cash flows</th>
<th>At 1 April 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash at bank</td>
<td>310,904</td>
<td>(62,009)</td>
<td>372,913</td>
</tr>
<tr>
<td>Deposits – general</td>
<td>636,180</td>
<td>(51,610)</td>
<td>687,790</td>
</tr>
<tr>
<td>Deposits – designated funds</td>
<td>95,864</td>
<td>476</td>
<td>95,388</td>
</tr>
<tr>
<td>Deposits – restricted funds</td>
<td>1,499,620</td>
<td>332,552</td>
<td>1,167,068</td>
</tr>
<tr>
<td></td>
<td>2,542,568</td>
<td>219,409</td>
<td>2,323,159</td>
</tr>
</tbody>
</table>