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**REITH LECTURES 2010: SCIENTIFIC HORIZONS**

**Presenter: Martin Rees**

**Lecture 4: Runaway World**

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**SUE LAWLEY:** Hello and welcome to the Open University in Milton Keynes for the fourth, and last, of this year's BBC Reith Lectures. This is one of the biggest universities in the world, but you won't see many students on its campus. Thanks to the invention first of television, and then of the silicon chip, it reaches the people it teaches remotely today through the network we call The Worldwide Web.

In this series, our lecturer has been lifting our gaze across the frontiers of science - a journey in which we've been shown both the bright and the dark sides of scientific development. Tonight he urges us not to flag, but to keep pace with the constantly expanding body of knowledge that brings so many benefits to mankind. Ladies and gentlemen, can I ask you please to welcome the BBC's Reith Lecturer 2010: President of the Royal Society and Astronomer Royal, Martin Rees.

(APPLAUSE)

**SUE LAWLEY:** Martin, you've said before that it's easier to understand the cosmos than it is the frog. I find that counterintuitive. I mean, after all, you can

hold a frog in your hand; you can cut it up on the laboratory bench. And there is the cosmos. How do you explain that? Why do you say that?

**MARTIN REES:** Well I say that because a star is actually fairly simple. It's so hot inside. There's no complex chemistry; everything's broken down into simple atoms. Whereas a frog, or even an insect, has layer upon layer of complicated structure, so there's much more structure in the smallest living thing than there is in any of the inanimate things which we study.

**SUE LAWLEY:** But I'm sure when you were a boy, you cut up frogs, and you probably played with Meccano sets and did jigsaws. How much does it worry you? And I know this is slightly straying into the subject of your lecture, but how much does it worry you that these days you know everything is controlled on a screen - every game, every plaything is a screen and a mouse?

**MARTIN REES:** Well I do think that virtual reality shouldn't take over from <u>real</u> reality, especially in education, and it's a pity if kids don't see frogs or birds' nests and things and only see things on the screen. So I think there is a loss if people are too much in virtual reality.

**SUE LAWLEY:** But I mean they can play with a Wii, for example. Health reasons apart, they don't have to go out and play a round of golf. They can just wave their arms about in front of a screen.

**MARTIN REES:** Well I think for those of us who are sort of old and immobile, it's great to have these alternatives. But for young people, I think real reality is what they should be in.

**SUE LAWLEY:** But it's a problem, isn't it - that we become observers rather than

participants? That's the fundamental concern, isn't it?

**MARTIN REES:** Well except the internet does allow more to participate, I think. If you compare the internet with television, of course, it's a more interactive medium and that's a good thing.

**SUE LAWLEY:** Martin, can I invite you to deliver your lecture?

**MARTIN REES:** Thank you.

(APPLAUSE)

**MARTIN REES:** In 2002, three mathematicians at Kanpur in India - Manindra Agrewal, and his two students - made a breakthrough that was important for codes and code-breaking. They posted their results on the web. Within just a day, 20,000 people had downloaded the work, which became the topic of hastily-convened discussions in research centres around the world.

This episode - offering instant global recognition to two Indian students - contrasts starkly with the struggles of another young Indian a hundred years ago. Srinivasa Ramanujan, a clerk in Mumbai, mailed long screeds of mathematical formulae to G H Hardy, a professor at Trinity College, Cambridge. Fortunately, Hardy had the percipience to recognise that Ramanujan was not the typical green-ink scribbler who finds numerical patterns in the bible or the pyramids, but that his writings betrayed preternatural insight. Hardy arranged for him to come to Cambridge, and did all he could to foster his genius. Sadly, however, poor health led Ramanujan to an early death.

I use this anecdote to introduce my theme today - how to optimise science and

innovation in the era of global mobility and networking - and how the benefits of globalisation can be shared by developing as well as developed nations.

The Open University was a visionary creation of the 1960s. But its pioneers - in the era of black and white TV - couldn't have conceived how fundamentally IT would change the way we learn - how it could globalise students' horizons, level the playing field between those in major centres and those in relative isolation, and give outstanding teachers a world-wide reach. And the capability to access huge datatsets has transformed not only science, but finance and all international business.

But enterprising individuals aren't content to be linked merely in cyberspace. They still tend to swarm together - most obviously in high-tech hotbeds like Silicon Valley in the US - and indeed around the world's leading 'research universities'. In Cambridge, for instance, a dynamic high-tech community has grown up that offers, in the words of the Financial Times, a "low risk place to do high risk things". Talent attracts talent (and big companies too). Success breeds success - and, just as important, failure is accepted as a step towards later success.

The United States, in particular, benefits hugely by draining highly-skilled migrants from the rest of the world. And its allure has now been enhanced by the rhetoric and the initiatives of the Obama administration, which has boosted America's already world-leading scientific community - in morale and in substance. The UK's success in attracting and retaining mobile talent will be at risk unless we respond. Even to retain our international competitiveness, we must raise our game.

There's now an international market for the best students as well. They are

academic assets, and a long-term investment in international relations. After they graduate they'll feed into all walks of life - networked world-wide, ready to seize the best ideas from anywhere and run with them.

Migrants can now - unlike a century ago - retain contact with their homeland: communications are always open; travel is far easier and cheaper. In fact there is a growing two way traffic.

Some now use the term ‘brain circulation’, rather than 'brain drain' to describe what’s happening in China, India, Taiwan and Ireland.

But there's no such consolation for the very poorest countries: they face daunting challenges in retaining their all-too-few highly-trained people, and even more in attracting them back.

Africa’s predicament is the worst. Around half of its health workers want to leave. And their loss can be ill afforded - and it’s doubly tragic if, after moving to a developed country, they find they’re not accredited - and doctors become cab drivers. It's just as bad in agricultural science, engineering, and all the other specialities that countries need for African development.

The poorest countries need to engage their diaspora communities - encouraging those with expertise to at least make regular visits. But wealthier nations should take some responsibility too. A cost-effective form of aid would be to establish, in Africa and elsewhere, 'centres of excellence' - with strong international links - where ambitious scientists could work in less dispiriting conditions, maybe via linkages with foreign experts. They could then fulfil their potential without emigrating, and strengthen tertiary education in their home country.

Of course the biggest tectonic shift in the world's science stems from the burgeoning growth in the Far East - in China above all. Since 1999, China's R and D spend has risen by 20 percent each year - up to a level that's now second only to the US.

China's technocratic leadership has astutely targeted its scientific investment on 'growth areas'.

Look, for instance, towards the city of Shenzhen. There, a 500-strong research team is hard at work, on the front line of genetic research. They were only established eleven years ago. Now they have more sequencing capacity than anywhere in the world - enough to sequence 10,000 human genomes in a year. And China strives to lead, too, in the quite different field of solar power.

Education is prioritised in China - and in Taiwan, South Korea and other countries of the Far East - with a focus on the aspirations of their fast-developing economies. And concerns are often voiced that we in the UK are falling behind.

The young, here and everywhere, have a natural interest in science - whether focussed on space, dinosaurs, or tadpoles. The challenge for educators around the world is to sustain this interest beyond the primary-school stage.

What's crucial is hands-on involvement - showing, not just telling. And I want to suggest that the sophistication of modern science is, ironically, an impediment to engaging young people with it.

Newton, when young, made model windmills and clocks - the high tech artefacts

of his time. Darwin collected fossils and beetles. Einstein was fascinated by the electric motors and dynamos in his father's factory.

Fifty years ago, inquisitive children could take apart a radio set, or a motorbike, figure out how it worked, and even put it together again. But it's different today. The artefacts that now pervade young people's lives - mobile phones and suchlike - are baffling "black boxes" - pure magic to most people. Even if you take them apart you'll find few clues to their arcane miniaturised mechanisms. And you certainly can't put them together again.

There's now, for the first time, a huge gulf between the artefacts of our everyday life, and what even a single expert, let alone the average child, can comprehend.

Science education isn't just for those who will use it professionally. Indeed everyone should have a 'feel' for science - partly for cultural reasons; partly because they otherwise can't, as citizens, participate in discussing how science is used.

But to sustain our society, enough young people need to attain professional-level expertise - as millions do now each year in the Far East.

A few will become researchers, come what may - what you might call the nerdish element (I'm one of them myself). (LAUGHTER) But we can't survive just on them. At a time when our nation should reduce its dependence on the financial sector, and rebalance towards high-tech manufacturing and services, the sciences must attract a share of those who are ambitious and have flexible talent - those who have a choice of career paths and who are mindful that the city still offers himalayan salaries, if no longer such high esteem.

At the start of the last decade, BBC TV ran a series of programmes to identify '100 Greatest Britons'. The advocates of Darwin and Newton slugged it out among the final six. But there was a third contender - Brunel. And he did better than either - for two reasons: First, his advocate was Jeremy Clarkson. (LAUGHTER) Second, there were rumours that students from Brunel University campaigned hard. Nonetheless, this was an all-too-rare instance of a great engineer being publicly acclaimed. (The others finalists were, incidentally, Churchill, Shakespeare and Princess Diana.)

But Brunel is long dead - the scientists and engineers now living deserve wider acclaim.

To attract the next generation, prominent role models would be helpful - preferably not all male, grey and stale. And we must proclaim science both as an intellectual challenge and as a prerequisite for meeting humanitarian imperatives - health, education and 'clean energy' for the developing world.

I'm fortunate to know many of today's leading scientists - those who've achieved Nobel-level breakthroughs. They're individualists, but they have some things in common.

They have all staked their careers on a specific line of research - and they chose well. They were given the space and the freedom to take professional risks. The path they took was unpredictable, and often the payoff was long in coming.

Universities and institutes won't stay internationally competitive unless they can attract and nurture such people.

It's essential that those with a good track record feel free to follow their own

judgement rather than being constrained by narrow external targets. Scientists are of course accountable to their funders. But those arguing for such permissiveness aren't being self-indulgent: history shows that it's the way research pays the greatest dividends overall.

We can't confidently predict how, when or whether a specific research project will 'pay off'. The social or economic benefit should not be credited solely to the most immediately relevant project, any more than a win at football is due solely to the team members who actually score the goals. So we need to support science broadly.

And now for a brief digression. My lecture title, 'The Runaway World', was used by the sociologist Anthony Giddens for his 1999 Reith Lectures on globalisation - and also indeed, right back in 1967, by the provocative anthropologist Edmund Leach for his.

In homage to these two predecessors - I'll comment briefly on how scientists look from the perspective of sociology.

It is important, as well as enlightening, to appreciate how pervasive the social and political factors that drive and direct science are. And the scientific tribe is a fascinating topic for anthropological study.

The way scientists work, what problems attract their interest, what styles of explanation are culturally appealing - and (more mundanely) what fields attract funding - plainly depend on a range of political, sociological and economic factors.

However - and this is important - the outcome of scientists' efforts is 'objective': and can be evaluated by criteria that don't depend on how these ideas were

motivated and arrived at. How science is applied, however, is a culture-dependent matter.

The physicist Steven Weinberg has given an apt metaphor for scientific breakthroughs. He says: "A party of mountain climbers may argue over the best path to the peak, and these arguments may be conditioned by the history and social structure of the expedition, but in the end either they find a good path to the summit or they do not, and when they get there they know it."

To some, there's a special mystique about science and discovery. But it really doesn't involve any mode of thinking distinct from problem solving by engineers or detectives. And the greatest scientists don't fall into a single mould. Some are brilliant. Newton's mental powers seem to have been really 'off scale'. And his concentration was as exceptional as his intellect: when asked how he cracked such deep problems, he said 'by thinking on them continually'. In contrast, Darwin was modest in his self-assessment: he wrote 'I have a fair share of invention, and of common sense or judgement, such as every fairly successful lawyer or doctor must have, but not, I believe, in any higher degree'.

And when asked about religion, Darwin diffidently responded "The whole subject is too profound for the human intellect. A dog might as well speculate on the mind of Newton. Let each man hope and believe as he can". A glaringly different stance from some of his present-day disciples! (LAUGHTER)

A lot has been written about creativity in science and in the arts. There are parallels, but differences too. Any artist's work is individual and distinctive - but it generally doesn't work, doesn't last. Contrarywise, even the journeyman scientist adds a few durable bricks to the corpus of 'public knowledge'. But our contributions as scientists lose their identity. If A didn't discover something, in

general B soon would - indeed there are many cases of near-simultaneous discovery.

Not so, of course, in the arts. As another Reith Lecturer, Peter Medawar, remarked, when Wagner diverted his energies for ten years, in the middle of the Ring cycle, to compose Meistersinger and Tristan, he wasn't worried that someone would scoop him on Gotterdammerung. (LAUGHTER)

Even Einstein exemplifies this contrast. He made a greater imprint on 20th century science than any other individual; but had he never existed all his insights would by now have been revealed - though gradually, by several people, rather than by one great mind.

Einstein's fame extends far wider than science - he was one of the few who really did achieve public celebrity. His image - the benign and unkempt sage - became as much an icon of creative genius as Beethoven. His impact on general culture though has been ambivalent. It's a pity, in retrospect, that he called his theory 'relativity'.

Its essence is that the local laws are <u>just the same</u> in different frames of reference. 'Theory of invariance' might have been an apter choice, and would have staunched the misleading analogies with relativism in human contexts. But in terms of cultural fallout he's fared no worse than others. Heisenberg's uncertainty principle - a mathematically precise concept, the keystone of quantum mechanics - has been hijacked by adherents of oriental mysticism. And Darwin has likewise suffered tendentious distortions, especially in applications to human psychology.

Scientific knowledge is collective, public and international - it's in principle

accessible to the entire world. But its benefits can only actually be 'captured' by those who are educated and discerning enough - who are 'plugged in' to the research community. That's why it's in the interest of each country to maintain strong and broad expertise. And that's specially true of the UK. Our science is overall at least as strong as that of any country apart from the US. We are the only country outside the US with several universities in the international 'premier league'. It would be tragic to jeopardise these strengths - once the tap has been turned off, it can't readily be turned on again.

Let me offer a supportive quote. I quote. 'We are supposed to be the clever country. We used to be the commonsense country. Not for much longer if the politicians continue to undervalue the potency of those Francis Bacon called the 'merchants of light', of new knowledge, especially scientific knowledge, which is unarguably the only sure wealth of the future. ' That quote's from Melvyn Bragg, who has himself done more than anyone to bridge the two cultures.
We don't know what will be the 21st century counterparts of the electron, quantum theory, the double helix and the computer - nor where the great innovators of the future will get their formative training and inspiration. But one thing seems clear: The UK's standing depends on sustaining our edge as discoverers and innovators - on ensuring that some of the key creative ideas of the 21st century germinate and - even more - are exploited here in the UK.

But it would be perverse to strike a jingoistic note. Science has always crossed national boundaries. Like in the 1660s, the Royal Society proclaimed its intention 'to promote' - I quote - 'commerce in all parts of the world with the most curious and philosophical process to be found'.

Any leading laboratory - whether it's run by a university, or multinational company, contains a broad mix of nationalities wherever it is located. And, as I

emphasised earlier, we need to share and spread expertise throughout the developing world.

Collaborations in science straddle today's deepest political divides. To quote just one instance, a physics facility (with the acronym SESAME) is being built in Jordan, with support from countries across the Middle East. A project that brings Iran and Israel to the same table on an equal footing could be acclaimed a success in political terms alone.

And individual scientists act as global citizens. For instance, John Sulston, the Nobel Prizewinner who in the 1990s led the UK part of the human genome project, now campaigns to provide affordable drugs for Africa. The great American ecologist EO Wilson, argues eloquently for the preservation of biodiversity.

But my overall theme in these lectures is that it's imperative to multiply such examples. We need a change in priorities and perspectives - and soon - if the world's people are to benefit from our present knowledge - and from the further breakthroughs that this century will bring. It's urgent to apply new technologies optimally, and avoid their nightmarish downsides: to stem the risk of environmental degradation; to develop clean energy, and sustainable agriculture; and to ensure that we don't in 2050 still have a world where billions live in poverty and the benefits of globalisation aren't fairly shared.

I'll close with a personal perspective, which links back to the Open University. The University's East Anglian graduates receive their degrees in Ely Cathedral. I was privileged to attend one such ceremony in that immense and glorious building.

Ely Cathedral overwhelms us today. But think of its impact 900 years ago - think of the vast enterprise its construction entailed.

Most of its builders had never travelled more than 50 miles - the Fens were their world. Even the most educated knew of essentially nothing beyond Europe. They thought the world was a few thousand years old - and that it might not last another thousand.

But despite these constricted horizons, in both time and space - despite the deprivation and harshness of their lives, despite their primitive technology and meagre resources - they built this cathedral - pushing the boundaries of what was possible. Those who conceived it knew they wouldn't live to see it finished.

Their legacy still elevates our spirits, nearly a millennium later.

What a contrast to so much of our discourse today! Unlike our forebears, we know a great deal about our world - and indeed about what lies beyond. Many phenomena still make us fearful, but the advance of science spares us from irrational dread. We know that we are stewards of a precious 'pale blue dot' in a vast cosmos - a planet with a future measured in billions of years - whose fate depends on humanity's collective actions this century.

But all too often the focus is short term and parochial. We downplay what's happening even now in impoverished far-off countries. And we give too little thought to what kind of world we'll leave for our grandchildren.

In today's runaway world, we can't aspire to leave a monument lasting a

thousand years, but it would surely be shameful if we persisted in policies that denied future generations a fair inheritance. Thank you very much.

(APPLAUSE)

**SUE LAWLEY:** Martin Rees, thank you very much indeed. Well you heard it here first: the President of the Royal Society confessing to being a nerd. (LAUGHTER) Well we have an audience here at the Open University in Milton Keynes, and we'll do our best to give voice to a cross-section of them. Let me ask for a first question from Alkisti Alevropoulou-Malli. She's a Cambridge PhD student.

**ALKISTI ALEVROPOULOU-MALLI:** There's a lot of qualified scientists leaving research careers to find work elsewhere. Post-doctoral jobs are transient, and actual career advancement is limited. As a result, many people feel disillusioned and find that academic research lacks the job stability and career advancement other professions offer. What do you think could be done to make an extended career in academic research more appealing to researchers facing these concerns?

**SUE LAWLEY:** Martin?

**MARTIN REES:** Well I think this is a very genuine concern, of course - especially when the future does look a bit uncertain at the moment. But I think it's important that we should bang on to our politicians about the importance of us in the UK maintaining an edge in science and technology because if we don't get smarter, we get poorer. We've got other countries in the world which are catching up, and if we lose the one advantage we had in the past, that'll be bad

news. So I think it's very important that we do do everything possible to ensure that we remain attractive to students and scientists from all over the world.

**SUE LAWLEY:** But if one of your talented students tells you that he doesn't fancy a career in science research because he wants to go into the City, what do you say to him, Martin?

**MARTIN REES:** Well if it's a matter of the City, I say, "If you go into the City, then don't call it the real world. Faffing around with financial derivatives is further away from anything that matters than being a scientist, engineer, teacher, doctor or anything else.

**SUE LAWLEY:** What about the Himalayan salary you mentioned that you might be tempted by?

**MARTIN REES:** Well it is tempting, and I think all we can say is that they won't get the respect that goes with it. (LAUGHTER)

**SUE LAWLEY:** Not from you anyway.

**MARTIN REES:** No.

**SUE LAWLEY:** Even if they're you know helping build the economy, even if they're creating money that might be put into the funding itself?

**MARTIN REES:** *(over)* Well I think Adair Turner has made some very wise remarks on the social value, or otherwise, of the financial sector.

**SUE LAWLEY:** How much might you earn, Alkisti, if you went on to get a post-

doctoral post? What would be your annual income?

**ALKISTI ALEVROPOULOU-MALLI:** Well I think it varies between 25 to 30 grand a year.

**SUE LAWLEY:** Yes, which wouldn't compare too well, I think, with a City salary. I know sitting next to you, you've got your tutor. Nick Gay, isn't it, Professor of Biochemistry at Christ's College, Cambridge.

**NICK GAY:** There's another question that I wanted to raise here, and this is the difference between the culture of science in the United States and in the UK because in my experience they tend to be much more aggressive in terms of seeing it as a way of creating wealth, whereas we tend to take a much more ideological approach to it. And I was wondering whether in order to be more successful, we'd need to be more entrepreneurial in our approach to science?

**SUE LAWLEY:** Martin?

**MARTIN REES:** Well I think the contrast is less. Not all people with PhD's are going to <u>want</u> to teach in universities. They may want to go into some start-up company, etcetera, and it's good many should. And I think it's important and, as I said in my lecture, this is happening in a place like Cambridge - that there is a movement between universities and start-up companies and people can move around. They can have a secure base in Cambridge or similar centre where there's a major university, and they can be secure personally even if their companies fold because they can move to another one. And I think we do need to develop this, and it is happening. So the gap between the UK and the US in terms of these perceptions is changing. But the problem there is not only to provide the

encouragement and the mindset, but also to provide the venture capital for start-ups.

**SUE LAWLEY:** I'm going to bring in Dr Daniel Glaser, who's Head of Science Projects in Public Engagement at the Wellcome Trust.

**DR DANIEL GLASER:** Lord Rees, I'm a bit worried about scientific genius. I think there's a problem with it in the sense that science is supposed to be reproducible; things are supposed to happen the same everywhere. But some bright spark coming up with an idea challenges that notion, and I wonder you know whether you fully countenance the worry that genius presents for science. It shouldn't just be driven by bright blokes with bright ideas. It should be arising in a more systematic way, shouldn't it?

**MARTIN REES:** I don't understand your concern. I mean obviously people come up with ideas in all kinds of ways, but what is important is the response of the community to those ideas. I mean an idea doesn't become part of the scientific canon as it were until it has been accepted, and how the idea comes about is secondary. And some people we know are more creative and original than others. Sometimes people come up with a discovery accidentally, but I think it's clear from all the science that we know that they think very differently.

**SUE LAWLEY:** Let me ask you a question you'll hate, which is have you had … Well I know you've had Eureka moments, not least early on in your career when you discovered a very interesting and hitherto unknown characteristic of the Quasar. Can you put into words that thrill of the moment when the fog lifts as it were?

**MARTIN REES:** Well people have that moment - a sort of aha, Eureka moment -

but it's no different qualitatively from what everyone gets solving any kind of puzzle. I think problem solving is something which everyone appreciates at some level, and that's a key part of engineering design, it's a key part of most of science. I don't think that the way scientists think is all that distinctive. They think in a variety of ways, just like everyone else does.

**SUE LAWLEY:** I'm just trying to entice you to encourage more people to want to stay in science - you know to say that it isn't just … Because it is 95 percent grind, isn't it - reproducing the same experiment, testing, proving?

**MARTIN REES:** No, I wouldn't say so. I think it's really doing your own work, but also taking part in a debate. I think what I've enjoyed most in my scientific career is being part of an ongoing debate, which has gradually clarified mysteries and led to a far greater understanding. So I think social interactions are a crucial part of science.

**SUE LAWLEY:** Let me bring in John Zarnecki who is Professor of Space Science here at the Open University. Professor Zarnecki?

**PROFESSOR JOHN ZARNECKI:** Martin, in a few days time, I shall be travelling to China. This will be my third trip there in the last eight months. And I have to come clean here and say that apart from representing you know British space science and the Open University, the main reason I'm going is that after thirty years of flying scientific instruments on European and American space missions, I see the best chance in the next five or ten years to go to interesting places is actually with the Chinese. Am I along the right lines? And, if so, should we see these as opportunities or is it a threat to our scientific endeavour?

**MARTIN REES:** I think it's an opportunity. Science is not a zero sum game. It's

fairly clear that in the second half of this century, the centre of gravity intellectually of the world is going to be in Asia. That's where all the people are, and so I think we've got to accept that four centuries where Europe and the United States have dominated intellectually is changing. This is not that we're doing any worse; it's just that the world is far more fascinating and far wider. So I think we should welcome the fact that China is catching up and hope that other developing countries follow China's example.

**SUE LAWLEY:** We've got a question from Lord Haskins handed in, Chris Haskins.

**LORD HASKINS:** Yes. I mean there does seem to be a paradox going on here between the way competitiveness keeps coming up and, at the same time, sharing science with the world. I've been a competitor in the yoghurt business all my life, trying to knock ten bells out of my competitors and hoping they'd die. (LAUGHTER) The concept in science of competition where there are winners and losers doesn't seem to me to be very appropriate. And if we continue to attract doctors and scientists from Africa in order to remain competitive, we are playing a pretty irresponsible game.

**MARTIN REES:** Well I think there are two different points there. First, I think that for every scientist or medical person who is removed from Africa, we should pay enough money to train at least two more, okay? But that's separate from the issue of migration between the developed countries. What concerns me about the last two years is that the relative attractiveness of the UK compared to the US has diminished because the rhetoric of the Obama administration and the substance has made America seem more attractive to someone say in Singapore or Eastern Europe than was the relative situation two years ago. It's that that worries me, and that which could be remedied by political action.

**SUE LAWLEY:** I'm going to call Tony Hirst. Just getting a microphone to you, Tony Hirst. Tell us what you do.

**TONY HIRST:** I'm Tony Hirst. I'm a lecturer at the Open University. And my question was you mentioned that a lot of children in primary school are interested by science, but they lose this interest at some point - presumably in the transition to secondary education. Do you have any thoughts on why that might be?

**MARTIN REES:** Well I think it's the lack of fieldwork and hands-on experience, but also of course it's the inadequate number of teachers of those subjects. One of the big problems, of course, is that the number of good science teachers is not enough to ensure that every secondary school pupil gets exposed to one, and this is a difficult problem to change. I think in the short-run there are two things we can do. One is we can encourage mid-career transitions, so that people move into teaching in mid-career. And, secondly, we can make better use of the web and distance learning of various kinds. But I think that is the problem - that people get turned off science because they find the curriculum uninspiring; partly because the teaching's uninspiring.

**SUE LAWLEY:** Do you agree with that, Tony Hirst?

**TONY HIRST:** Yes, I do. I've spent a lot of time working with children, and a lot of practical activity I think helps keep them inspired, but increasingly that practical engagement with science and with experiment is being denied them.

**SUE LAWLEY:** Let me bring in Dr Hazel Rymer who's a Senior Lecturer in

Environmental Geophysics at the Open University. She's a vulcanologist.

**DR HAZEL RYMER:** Martin, research is international and interdisciplinary, as you've said. Here at the Open University, we're launching a new Open University BSc in natural sciences, which will be available globally online. But there are increasing numbers of organisations offering perhaps rather dubious online qualifications. How do you think international standards for education could be set, as they have been for research in this interconnected world?

**SUE LAWLEY:** Are you suggesting they would be sub-standard, some of the things on offer online - or bogus even?

**DR HAZEL RYMER:** Some might be.

**SUE LAWLEY:** And that's your fear? Yuh.

**MARTIN REES:** I think the general problem with the web obviously is that if you just google any topic, you get a mixture of stuff that is good and stuff that's very dubious or ropey in various ways, and so it's not just a problem in your particular context. I mean if you have some disease, you don't attach equal weight to everything on the internet. You take the views more seriously if they're by some accredited practitioner. And similarly one should react that way in science. But it's very difficult to do this. We need some sort of kitemarks in different areas, I think.

**SUE LAWLEY:** I'm going to bring in Noel Sharkey who's a Professor of Artificial Intelligence and Robotics at the University of Sheffield.

**PROFESSOR NOEL SHARKEY:** At the beginning of your lecture, you discussed the great benefits of the new technologies, such as the internet. Then later you extolled the virtues of having clusters of scientists in the same physical location. But the new technologies are bringing us closer and closer together digitally every day. So don't you think that physical location may become increasingly irrelevant with the further development of the global communities in cyberspace?

**MARTIN REES:** Well I certainly think from my own experience that I can collaborate over the internet or by email with someone who I already know. But I think if you don't know the person, then you need to meet them for real to get the collaboration started.

**SUE LAWLEY:** Do you accept that Professor Sharkey?

**PROFESSOR NOEL SHARKEY:** Well I think it's partly generational. I don't mean to cast aspersions on your age (LAUGHTER) but it's partly generational. And I have a lot of colleagues in the United States that I've never met, but I've been in communication with for years. And we also use Skype nowadays or all kinds of video mechanisms, and it's getting better and better and better. And we've even got technologies …

**MARTIN REES:** *(over)* Well I think when we have better video links, then I think my point will get weaker because then you will feel you can really get to know people.

**SUE LAWLEY:** What happens …

**PROFESSOR NOEL SHARKEY:** But I can even hug people on the internet now.

**SUE LAWLEY:** You can what? You can hug them?
**PROFESSOR NOEL SHARKEY:** Yes. There are technologies now, so that you're connected to people with body suits, so you can actually hug them. (LAUGHTER) So I don't know how close you want to be to your colleagues.

**SUE LAWLEY:** I'm going to call Professor David Cope who's Director of the Parliamentary Office of Science and Technology, whose job it is to advise Parliament on science and technology policies.

**PROFESSOR DAVID COPE:** I'd better say that I'm speaking in a personal capacity. Right at the very end, you criticised what you see as a dominant short term and parochial thinking about many of the issues that you have outlined to us both tonight and in earlier lectures. And you called for change in that. How to do that? What institutions can deliver that? Do you think that the existing institutions that we have can be reformed and refocused? Or do we really need to start again and have a complete set of new institutions that will be able to pick up that enormous challenge which you've outlined?

**MARTIN REES:** Well, I mean as you know better than me, there are some institutions already that are performing a useful role and it is sometimes said there need to be others - for instance some sort of World Energy Commission to actually address global issues in that arena, etcetera. But I think the main point is that more and more of the issues that are important to us are global issues and we have to realise that in politics the global context is more important, just as the scientific input is more important. And I think that's a reason why science education is more important than ever, and I think we hope that our politicians will gradually get this. I certainly would say that there were certain ministers in the previous government - I'd say Hilary Benn and the two Milibands who were

in charge of ministries with this sort of agenda - who were both committed and well informed. And I think if we have high quality politicians, then we in this country can have an influence; and small though we are, this country can perhaps have some sort of leverage.

**SUE LAWLEY:** This is a theme that's run throughout your lectures really, Martin, if I may say - that you know you are absolutely confident that the scientists can step up to the plate and can provide solutions and can show a way forward. Your fear is, or your lack of faith is, that the politicians and the sociologists and the people who are going to make it happen won't step up to the plate similarly. There is a lack of faith there, isn't there?

**MARTIN REES:** Yes. It's not the politicians. I think it is really engaging with the public because the politicians respond obviously not to the scientists as such; they respond to the general pressure from the public. And I think all we can do - and this is done by the media - is to raise consciousness of these issues, so that they <u>are</u> an important part of electoral politics, and the important thing is to ensure that people become aware of these long-term environmental threats before they become disastrous and it's too late to do anything about them.

**SUE LAWLEY:** Martin, thank you very much. Thank you, too, to our audience here at the Open University for being properly testing of our distinguished lecturer. But then we knew you would be. Thank you, Martin, for a series of lectures which have been at once thrilling, disturbing, enlightening and challenging. You've been over the past four weeks, as you've delivered this series, a true merchant of light in the best scientific tradition and we're very grateful. Ladies and gentlemen, the BBC Reith Lecturer 2010: Martin Rees. And from the Open University, goodbye.

(APPLAUSE)