



The Fifth Whitehall Lecture

**‘UK Science and Innovation Policy -
Three Barriers to applying research better’**

The Rt. Hon. The Lord Willetts
Chairman, The Resolution Foundation

given on
3rd November 2016



Cambridge University
Land Society

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The Cambridge University Land Society launched this important series of lectures in recognition of the part its members play in contributing to public policy issues. Society members are mainly alumni of the Department of Land Economy, but also from many other academic disciplines in the University of Cambridge. Many play important and often distinguished roles in many aspects of public policy that are covered by the work of the Department.

The Cambridge Whitehall Group is a forum of CULS and is a high level influential policy discussion group of well-connected Cambridge alumni, who are mainly members of CULS. In addition to its member events it also runs this distinguished series of policy lectures. The lectures will discuss major aspects of public policy that in one way or another touch on the disciplines of policy, economics and the application of land use.

Previous lectures in this highly regarded series have been:

1. Professor Sir Malcolm Grant, CBE, Chairman NHS England – ‘The Extraordinary Challenges of Future Healthcare and the Estates Implications for the NHS’ – Inaugural lecture given at the Royal Institution (March 2014)
2. Lord Deighton, KBE, Commercial Secretary, HM Treasury – ‘Infrastructure in the 21st Century: from the Olympics to High Speed Rail and beyond’ (January 2015)
3. Dame Kate Barker, CBE, Senior Visiting Fellow, Department of Land Economy, University of Cambridge – ‘How will we house our children? – The Future of UK Housing Policy’ (April 2015)
4. Professor Chris Ham CBE, Chief Executive, The King’s Fund – ‘What needs to be done to secure the future of the NHS’ (December 2015)

These lectures are published as an occasional series and copies are available by emailing fionajones@thecwg.co.uk.



WELCOME FROM THE VICE CHANCELLOR OF THE UNIVERSITY OF CAMBRIDGE



The Cambridge University Land Society is an exemplary society at Cambridge – for its longevity and for its level of engagement with a wide range of sectors and contemporary issues.

Over the last 50 years, the Society has built a membership base of nearly 1,000 alumni, spanning those who graduated from Cambridge in the 1950s who now hold senior positions in their fields to current students and recent graduates of the Department of Land Economy.

The number of disciplines and interests represented in the Society's membership – as well as the broad range of issues discussed at business and social events held by the Society each year – highlight what Cambridge does so well. We recognise that the challenges we face today are increasingly complex, multi-faceted and global in nature, and that they cannot be overcome with the expertise of just one area. This is why it is so valuable that the Land Society continues to bring together fresh and diverse perspectives from those studying and working in economics, land, planning, governance, finance, environmental resources and beyond on critical public and private issues. The Whitehall Lecture series represents a great opportunity to take this debate forward – and to build the Land Society's critical mass of expertise – and I wish it every success.

Professor Sir Leszek Borysiewicz, Vice-Chancellor, University of Cambridge.



WHITEHALL LECTURE SERIES, DOUGLAS BLAUSTEN, CHAIRMAN, CAMBRIDGE WHITEHALL GROUP

Douglas Blausten is a Consultant to Cyril Leonard Chartered Surveyors and Property Consultants. He looks after their major Corporate Clients, runs his own Corporate Real Estate Strategic Consultancy Company and is a Director of Cyril Leonard GmbH in Munich. He was Vice Chairman of NHS Property Services and Chairman of its Asset and Investment Committee until November 2015.



He is a Trustee of the Mental Health Foundation, a Centre Fellow of the Cambridge Centre for Climate Change Mitigation Research and a member of the Cambridge Land Economy Advisory Board. He has held a number of executive and non-executive directorships in public and private companies. Douglas is a Past President of the Cambridge University Land Society.



THE WHITEHALL LECTURER
THE RT. HON. THE LORD WILLETTS
CHAIRMAN, THE RESOLUTION FOUNDATION



The Rt. Hon. Lord Willetts left the House of Commons in 2015 after 20 years having served as a Minister in several Departments and as a Cabinet Minister and joined the Resolution Foundation as Executive Chair in June 2015. He is a member of the Advisory Council of the Centre for Science and Policy at the University of Cambridge. He is also a Visiting Professor at King's College London, Governor of the Ditchley Foundation, Chair of the British Science Association and a member of the Council of the Institute for Fiscal Studies.

In Parliament he was Minister for Universities and Science, attending Cabinet, from 2010–2014. Before that David worked at HM Treasury and the Number 10 Policy Unit. He also served as Paymaster General in the last Conservative Government. In November 2015 he became a member of the House of Lords.

Lord Willetts has written widely on economic and social policy. His most recent book 'The Pinch' was published in 2010.



INTRODUCTION TO 'UK SCIENCE AND INNOVATION POLICY - THREE BARRIERS TO APPLYING RESEARCH BETTER'

The University of Cambridge and Imperial College London are amongst the world's most important pioneering institutions in research, science and innovation and it is entirely appropriate that this important Lecture is held at Imperial.

When I planned this Cambridge Whitehall Lecture and invited Lord Willetts to give his paper, most of the world thought the UK was on its way to remain within the European Union. The Lecture would probably have been that much easier to deliver, as Lord Willetts has been the undisputed champion and pioneering Minister behind the Coalition Government's commitment to science and innovation in the UK, helping us to take and maintain a world leading position.

Before the June 2016 referendum, the House of Lords' Science committee warned that substantial EU research funds now flowing in to the UK were not likely to be covered by future governments if Britain left the union. The Committee stated in its report that the UK contributed nearly £4.3 billion for EU research projects from 2007-2013 but received nearly £7 billion over the same period. The excess was the equivalent to more than £300 million in research funds a year. 'You would be extremely trusting of the future Chancellor of the Exchequer to think that sort of funding would continue in the event of Brexit', said the Earl of Selbourne who was the co-chair of the Committee. We know the new Chancellor now has made a commitment about current project funding, but there is no strategy for long-term commitment here to replace the EU funding leaving many research teams in an uncertain state.

At the time of this Lecture we are in a period of extreme uncertainty and readjustment, and it is not a small issue. Anecdotally we fund these Lectures with substantial sponsorship. This one has been different and it is most certainly not because of the quality of the speaker or the subject matter but because of the Referendum result. Prior to the Referendum there was considerable interest



in sponsoring this event. After the Referendum, American, Japanese and global companies have, without exception, said ‘No’ stating the uncertainty about Britain’s future role outside the EU.

How much this new environment adversely affects the ground breaking measures of government over the last 6 years or more in setting up Catapults, Technology Centres, Catalysts, Launch Pad competitions, the Research Partnership Investment Fund, University Enterprises, and creating a vibrant dynamic environment for further innovation and development we cannot tell. Let us hope it does not.

We need to be very sure that Government support for innovation is contributing more to the economy than ever. As a Spotlight editorial report in the New Statement prior to the Referendum concluded: ”innovation has become harder and less effective because with each advance it becomes more complex....”

So the Lecture concentrates on government policy, which is not just about funding. We need the right political and cultural policy leads for academic research institutions, individuals and businesses to contribute and develop. We have had a strong tradition in this country of welcoming immigrants, who have made an enormous contribution amongst many other things, to the development of science and innovation, in a free-thinking, welcoming socio-economic environment. We need to be able to maintain and not lose that advantage.

Douglas Blausten, Chairman, The Cambridge Whitehall Group



THE WHITEHALL LECTURE GIVEN BY THE RT. HON. THE LORD WILLETTS

Thank you very much indeed for that generous introduction. I will try to tackle a British problem that we are all familiar with. Here is an example from the First World War. It is the recognition in a Government White Paper that in Germany, “science there has been more effectively applied to the solution of scientific problems bearing on trade and industry” (see fuller quotation on page 10). We seem to be less effective at application and commercialisation of science than we are at doing the original upstream research.

Pure science is protected by the Haldane principle that Ministers do not intervene in specific decisions on allocation of funding to particular projects and institutions. At the other end there is a commercial market place where by and large there is an open and competitive environment which isn’t controlled by the Government. It is that messy bit in between where there is, I believe, a role for government in helping science on its way to application and out into the market. That area between the protected research budget and the disciplines of the market economy is where there is a particular role for Government which successive Governments have found it hard to discharge. That is a key reason why we have this problem in commercialising and applying technology.

Professor David Edgerton would observe that for 50 years from 1920 to 1970 there was what we very neatly call a ‘warfare state in Britain’, when there was a large amount of applied R&D. But in the in the 70s and 80s we abandoned that model and now that old problem has returned. I want to offer today, my explanation as to what the problem is and how it can be tackled. It is not insurmountable and indeed there have been excellent initiatives over decades to try to do something about it. Too often we settle for vague cultural explanations that somehow we are not entrepreneurial or risk-taking. But that is a cop-out. There are three specific features of the way in which we fund and organise science and its application in the UK which help to explain our problem.



The British Problem

“Many of our industries have since the outbreak of war suffered through our inability to produce at home certain articles and materials required in trade processes, the manufacture of which has become localised abroad, and particularly in Germany, because science there has been more thoroughly and effectively applied to the solution of scientific problems bearing on trade and industry...A great part of all research will necessarily be done in Universities and Colleges which are already aided by the State...”

Scheme for the organisation and development of scientific and industrial research Cd 8005, July 1915. Paragraphs 1 and 5

I will go through each one of them in turn.

First problem – the omissions from the dual funding model

We are very proud of the dual funding model. We regard it as one of the great features of British research funding. It means that the bulk of the science or research budget is allocated in two ways. First there is research council funding, which tends to be for projects and programmes. Secondly there is funding from HEFCE for universities based on their research performance. One could put it crudely as project funding from the Research Councils and institutional funding from HEFCE. HEFCE funding was initially envisaged explicitly as an alternative to having an endowment. It is high trust patient funding for institutions, but has increasingly become based on performance over the past few years so it is perhaps rather less patient than it was.

We are so proud of this dual funding model that it has obscured the fact that it has a significant omission – there is little high trust funding for institutions outside universities. To be fair to the research councils, they can fund research institutes, but the pressures on their budget have meant that the research councils



focus on projects and programmes rather than fund institutes. They have tended to shrink their spend on institutes so as to spend more on projects. Moreover, the philosophy of many of the research councils is that they don't want to have permanent commitments to institutes that they are obliged to carry on funding, regardless of the quality of their research. They pride themselves on the fact they're always looking around for the smart new performer. No institute can presume that they will get funded in the future just because they were funded in the past. This is a striking contrast with Germany or the US where there are much more substantial networks of non-university research institutes. So, hidden behind the dual funding there is a gap – that there is dedicated funding for universities as institutions but not for non-university research institutes. That's the first problem. Despite dual funding sounding as if it covers all the options, it actually leaves a significant gap.

Dual funding

- Low trust transactional Research Council funding (£2.7b)
- High trust patient substitute for endowment from HEFCE (£1.6b). But REF increasingly demanding.
- A gap – no high trust funding outside universities.

Second Problem: Who is to be the purchaser of applied research

The second dilemma was captured in one of the most vivid reports on British R&D policy. One reason it is so vivid is it wasn't written for publication: it was only after Victor Rothschild had written his report in 1971 that they decided to publish it so that they could consult on his proposals. He proposed the customer contractor model of applied research funding.



He said that if you're going to have applied research you need someone that is purchasing it. He then identified individual government departments as the purchasers of applied research. He treated applied research as very different from basic or fundamental research, which would be the responsibility of the research councils and the science budget.

He was actually recreating the Haldane model. This was what Haldane had originally proposed back in 1918 with a science budget, doing up-stream research without political control. Haldane, like Rothschild thought that separately departments which needed research to carry out their functions were responsible for applied research. There is an interesting debate about whether you can really separate out applied and pure research, but that was the model. The idea is that if you want work on social mobility for example, the Department for Education should be funding it. If you want investment in agricultural practices that will boost the performance of the agricultural sector, that would be for MAFF to fund. Rothschild thought this responsibility had been lost as all the funding had ended up in the science budget.

The Heath Government introduced Rothschild's model and money was taken from Research Councils to go to departments to purchase applied research. There was a transfer of funding from research councils to departments so they could be custodians of applied R&D, but then departments proved to be very poor protectors of their own R&D budgets. When I arrived as the Science Minister in 2010, people in research councils were still saying to me, 'Whatever happened to the research money transferred to departments?' Over the decades those departmental R&D budgets were cut and cut. Departments behaved like short-sighted British businesses who cut the R&D budget whenever they are under financial pressure. So you have the customer who is supposed to be purchasing R&D regularly cutting their budget, leaving behind only the science budget which is allocated under a different model and protected behind the old Haldane because it is not really supposed to be for the applied stuff. The applied stuff is supposed to be departmental.

The minister who received Rothschild's report was none other than Margaret Thatcher who was then Secretary of State for Education and Science. It led to quite a Cabinet argument at the time. She then arrives in No 10 and in the 1980s the Rothschild doctrine that applied research requires a customer is taken to its next stage. Business not Whitehall is to be the customer. The argument was that businesses should be buying applied research. Near market research was the responsibility of business, and government should be focussing on upstream



Rothschild (1971)

“R&D with a practical application as its objective, must be done on a customer-contractor basis.....Basic, fundamental or pure research, called basic research in this report, has no analogous customer-contractor basis...”

Haldane Model: Science budget v Departmental R&D

scientific research in the science budget. This was based on the belief that departmental applied research budgets were being poorly spent because they did not have market disciplines. So instead, companies have to be the customers, and departmental R&D budgets fall yet further.

You end up with only a science budget as other applied research budgets have largely disappeared. As a result I was very aware, as science minister, of pressure to tweak the science budget, to use it for applied R&D for departmental purposes. In response, the science community understandably gets worried about erosion of the Haldane principle. But if you are sitting in Whitehall and just think all research is funded out of the science budget it appears a frustrating curiosity that it is all protected by the Haldane principle.

Agriculture is a good example because Rothschild himself has previously been the chairman of the agricultural research council. The MAFF R&D budget was cut over decades and you can see the effect. Britain used to be a world leader in agriculture. But applied R&D in agriculture has been close to zero and improvements in agricultural productivity in the last decade are also close to zero. I persuaded George Osborne to fund an agri-tech initiative to try to reverse that. We had DEFRA as a partner but they were not given the budget for fear they would cut it as soon as their departmental budget came under pressure. The NHS and the MOD are the only two departments with any surviving significant R&D budget.



The second problem therefore is that there is pure research and applied research and departments should be the custodians of applied research. When they fail to discharge that responsibility then it becomes companies that should be custodians of applied research. But that leaves a massive gap between the pure science that is publicly funded and the kind of applied, immediately valuable R&D that companies are willing to pay for. That makes it hard for government to work constructively with the private sector to promote the development and application of new technologies. By contrast that is exactly what is done by German Fraunhofer institutes and America's leading departmentally funded labs .

Third Problem: the burden of being in the public sector

The third problem is something that is of great significance in Whitehall but is rarely appreciated outside.

In Britain, universities are private sector institutions. In most of Europe they're part of the public sector. I had long conversations with British academics who wanted to emphasize the public value of the university and the university certainly does have a public value. They would say we carry out a public service. So I said to them: would you like to be in the public sector? Then they would have public sector pay rates and their borrowings would count towards the PSBR. When the implications of being in the public sector dawned, they were not so keen on the idea.

There are a small number of public sector research establishments which have survived the other two doctrines. Some of them are owned and operated by research councils, some owned and operated by departments. Unlike universities they are within the public sector. They fulfil a very important range of functions, which is not the same as doing brilliant up-stream research. The British Geological Survey for example is a fantastic resource keeping geological samples. Any geological samples drilled anywhere in the UK have to be deposited at the BGS. They have the most extraordinary filing cabinets that can each hold many tonnes of rock. They are essentially the nation's store for its geological samples. They have proved invaluable, for example, in helping industry identify sites which might be suitable for fracking. The National Physical Laboratory in West London is our custodian of measurements and standards.

These are public sector research establishments. We used to have a lot of them, and in the post war period they have steadily been reduced. I believe that you need these types of intermediate bodies that aren't university based, that may be accessible or



of use to business and industry as a source of applied research. But they have found it hard because they are in the public sector and subject to a host of constraints and rules. Having worked both as a civil servant originally and then in parliament, it is disappointing to say this, but life is very tough if you're a research establishment in the public sector. You will find for example that public sector pay rules apply but the university down the road can participate in an international competitive market for researchers whereas you are constrained.

Departments don't seem to be particularly interested in the research institutes they've got. Some of them have a wholesale policy of privatising them. In agriculture, a lot were privatised in the 1980s and 1990s. Another reason why we have a relatively limited ecosystem of these types of public sector research establishments is that a lot of them used to be run by nationalised industries. I was in the Treasury when we embarked on privatisation in the 1980s. I cannot remember any specific meeting with a minister working out how to privatise a nationalised industry when someone said we've got to preserve this R&D function because it is incredibly important. What had been historically quite often an important source of R&D is lost now because of privatisation. And the rpi-x regime for privatised industries was deliberately aimed to stop gold plating and over-investment. I used to have conversations with businesses in these key sectors urging them to do more applied research and they would reply that the regulator would penalise them for it. So we inadvertently constructed an anti R&D environment in key privatised industries.

All this means we have an unusually thin network of free-standing research institutes. For example a powerful report from the House of Lords about 5 years ago on how we handle the nuclear industry said there hadn't been any investment in core capacity for over a decade. No one had said, we need a national lab to be a source of expertise on nuclear. There was a very small one that had survived but only by virtue of getting funding from project to project. This is a poor reflection on public policy in Britain. Other countries maintain and grow their network of departmental research labs – look at what America has got with its Department of Energy, that's even before you get to the Department of Defence. Germany has a fantastic network. But in Britain being a research establishment in the public sector has proved to be very tough indeed.

I would discover attempts by Whitehall departments to close or privatise them often pressed on them by the Cabinet Office. I brought in something called the Manchester guidelines as a last-ditch attempt to stop the loss of these institutes.



It goes back to a piece of work by Manchester University. It was an attempt to introduce a decision rule before another was one closed down or privatised by asking: have you checked if it carries out a core function which may be necessary in the public sector? Mark Walport who shared these concerns was frustrated that we hadn't even got a taxonomy, a proper list of what all these were and the means of protecting them. BIS didn't have much of a capacity to protect them as most of them were not our direct responsibility. Indeed, my officials were worried that if we campaigned too hard for them we would be told to take them on to our budget. We were responsible for some science parks but had no capacity to look after them either. We ended up asking the Homes and Communities Agency whether they wouldn't mind being the landlord to look after these bodies.

The public sector has proved to be a poor protector of these research establishments. The result is that they all look to the safe haven of moving over to a university. The best thing that you can do as a research institute in these circumstances is to find a way of being embraced by a university, where you miraculously become part of the private sector. It looks as if all your problems have been solved. You are no longer subject to all these public sector rules. The universities say they'll look after you and they like the idea of adding your research publications to their REF submission and putting all our research in universities helps them move up the international rankings. But universities change; they have new policies; a new vice chancellor comes in and isn't interested in the same thing as their predecessor; the sexy research topic is elsewhere. They don't necessarily survive in the long run in a university environment.

The Unusual British Model

Three factors have therefore been very important in shaping the British environment:

- little funding for public sector research establishments because they do not fit neatly in to the dual funding formula;
- no applied R&D budget because that's what departments are supposed to do and over the years they've cut it back;
- for those PSREs that have survived, a tough environment in the public sector with private status in a university looking far more attractive.

Compare that with the network of research establishments in Germany.



The German Alternative

Max Planck

Leibniz

Helmholz

Fraunhofer

That is a more industry-friendly way of organising your research. It is not the only way of organising your research, and you shouldn't have all your eggs in one basket, but if you are working in a specific branch of German industry you are very likely to know a prominent big name research establishment, a Fraunhofer or Helmholtz institute, that is doing work that is relevant to you. It has probably been around for decades and it is accessible to you. Those of course are not universities, and that means that Germany's research effort doesn't help its universities rise up the research rankings, so in all the conventional global measures Germany looks like an underperformer compared to the UK. But we do well because we've got all our eggs in the university basket and that's what the rankings look at – universities and their research performance. We have ended up with a very unusual pattern of R&D activity in the UK as a result of this. We have much more of our R&D in universities than most other countries – and new estimates of these figures will be in my forthcoming book on universities to be published by OUP in November 2017.

My argument is that this unusual pattern of R&D spend in the UK is what makes applied research and commercialisation of technology, harder to do. It's not because universities are bad places, and they often use their best efforts to try to overcome these barriers, but it is unusual that we are an outlier in the way in which our research is distributed. And the incentives in the way their research is appraised are very much to focus on the academic end – it is citations in research



journals which are the key metric of performance. We have lots of research in universities, not much in other research institutes and not much public funding for applied research.

What do we get for our model?

We have relatively little public spend directly going on R&D on a customer contractor basis. Most of the public money going into universities is in the private sector so we score very highly on autonomy, which is very good for extremely creative scientific research. We have a very thin ecosystem of research establishments outside universities. That is one reason why applied research is harder to do. That so much of our research is based in our universities is good for our universities in the rankings, compared with other countries where the universities are a smaller player in overall R&D. But this model may be bad for innovation. There isn't some vague cultural problem that we're risk averse and don't want to do applied research. It is rational behaviour given the set of incentives and institutional arrangements that we have now got in this country. It is a result of the British model which has emerged as a result of policy decisions in the post war period.

What can be done - inside and outside universities?

So what can we do to promote innovation and applied technology in this environment?

There are two approaches. One is to look at the kind of things you can do with universities. Given that's where a lot of R&D happens, what more can we do to promote commercialisation and applied tech in the university environment? The second approach is to create a richer ecosystem with funding streams and institutional relationships that promote commercialisation outside the university environment.

First, what can be done within universities. Here we have drifted into a focus on university spinouts which are over rated. There are too many fragile non-viable entities that get spun out early on and exist in a limbo where nobody puts them out of their misery. They can't even necessarily afford to protect their own patents. Spinouts have become the metric of commercialisation for universities and I don't think that is a particularly useful metric. There are many other forms of university business links, including with larger companies. Universities can



for example do research programs on contract for business. The trouble is that useful applied research is not necessarily academically prestigious and by and large Whitehall attaches little value to the universities that do this kind of work. I remember one major business saying that they could not get our prestigious universities interested in a problem they had with the viscosity of hair shampoo but they had a great contract with a Million Plus university that took the project on with gusto. One danger from Nick Stern's proposal that all researchers be submitted for the REF is that the problem that this sort of research is not valued will be exacerbated. It risks creating a monoculture in our universities.

There are other practical things we can do with universities. I am a member of the board now of the National Council of University and Business and we are setting up something that I urged when I was a minister, which is simply an accessible database of every publicly funded research project going on in Britain. It's called Konfer. If you're an engineering company that suddenly finds itself dealing with a new metal or new alloy that you haven't come across before, you ought least to be able to go to Konfer and find if there is a place in Britain, probably a university, where the material science department is doing research on that metal or alloy. Shockingly, there was not previously a searchable database that was accessible. Konfer, which we are developing, enables that to be done. Modest things like that can make a difference.

The second way to tackle the problem is to do more to support innovation and applied research outside university. David Sainsbury's creation of the TSB, deliberately aimed to help plug the funding gap by funding innovation and applied research on a scale to match funding going in to science for upstream research. It is very important that they can deploy grants and not just loans. Models like the bio-medical catalyst help bring together the budgets of the Research Council and Innovate UK. It is excellent that the Chancellor has found further money for the bio-medical catalyst, linking MRC funding and Innovate UK funding so that the person working in the lab can see a route to the market place.

Above all I'm really keen on a stronger network of research institutes. This was the thinking behind the Catapults which were deliberately modelled on the German Fraunhofers. When my party was in opposition we commissioned James Dyson to do research on Britain's innovation problem. At the same time Peter Mandelson commissioned Herman Hauser to look at the issue. These two parallel reports both came out in 2009 with very similar solutions that we needed something like



a German network of Fraunhofers and that's roughly what the catapults are – an attempt, instead of seeing this ecosystem endlessly shrinking and thinning out, to create some more intermediate institutions, publicly funded and privately funded, doing applied R&D, and outside the university environment.

Industrial Strategy

Industrial strategy has waxed and waned, and it's good to see industrial strategy back.

There are different ways in which you can do it. One approach is to focus on business sectors. This tended to be Vince Cable's approach, and the big sectors he focussed on such as aerospace and automotive, benefit from the attention of government. You can focus on places, which was very much George Osborne's interest and is a keen focus of the excellent Greg Clarke – how do we boost economic performance more widely to promote the revival of cities and city regions. You could focus on challenges, which was the No 10 angle: we must have a challenge fund to tackle Alzheimer's or anti-microbial existence! Finally my main focus was technologies and the sectors which used them most such as life sciences or space. Although it looks messy to conduct Industrial Strategy around these four dimensions in practice you need them all and I believe the Coalition's shared endeavour on Industrial Strategy was proving successful. It is a great pity that Sajid Javid tried to remove so much of it and I am relieved it is now back. I hope Whitehall, despite its notoriously short institutional memory, is able to draw on lessons from a sustained effort that lasted from 2008 to 2015.

The Eight Great Technologies were not a personal whim and not a random list, I was drawing on the expert advice of the science and technology community to identify areas where Britain had a strong research lead, where there was a business opportunity on a global scale, and where some public funding could help promote these technologies. The list was systematic not random. It begins with dry technologies driven by the digital revolution – big data, robotics, space. There are also wet biological sciences – synthetic biology, regenerative medicine and agri-tech. Then there are advanced materials and energy storage. Although these kind of frameworks need to be refreshed, equally it would be wrong to tear them up and start all over again: I am very pleased therefore that they are referred to in the Industrial Strategy Green Paper

If you are a minister delivering Industrial Strategy and promoting the commercialisation and the application of technology, there are a range of things



you can do to help make this happen. Here is a shortened version of a list I put in Prospect last year. None of them are massively exciting on their own, but if you put all those things together for a sector or a technology, they become the practical bricks that enable you to run a strategy to promote an advanced technology for example.

They are things like:

- A leadership council, just using convening power to bring together round the same table academic researchers and business users, or business spenders in R&D.
- Commission an expert or a group of experts to write a technology road map, which starts as just a description of where the R&D budgets of the main business players currently go and where the research councils and other public funders are investing their money in R&D. You then find areas of overlap and also gaps. You start having a conversation in which the experts say, for £20 million we could do this technology and if the Government puts in £10 million this gap could be plugged with £10 million of private spending alongside. Although these things don't have perfect foresight, they can be very useful exercises.
- Although regulations can be a bad thing, when it comes to new technologies, new standards and regulations can be a good thing. They can be the precondition for spreading access to technology, the precondition for them becoming globally significant. And often one of the main advantages that we get from the quality of our science and research in Britain is that we've got people at the cutting edge who can help influence regulations across Europe or globally, take a lead in promoting some innovative standards for new technology. So, as a minimum you get a place at the table when the standards are being written at a larger scale.
- Funding especially for those innovative start-ups to get funding for proof of concept and proof of market: that can be useful.
- Smart procurement is one of our great frustrations. Public bodies should be willing to buy new technologies rather than playing safe. I've been at conferences in America where you ask an American entrepreneur how he or she is funding their company when it's highly speculative and they reply that they've sold the first 20,000 of their innovative new widgets to the Department of Defence. They may not even have made one yet, but the Federal Government realises that if they can successfully develop one then



- it could be just possibly of value to the armed services, so they've written a cheque to pay for the first 20,000 to be spent on developing it. That is non-dilutive finance, which entrepreneurs all love. America's technology strategy is that there should be no significant technology anywhere in the world where the US is not up there in the lead. And sometimes these guys will successfully develop their 20,000 new widgets, sometimes they won't, but there's not a terrible scandal if that widget doesn't work because there is a widespread consensus in the US that it's the kind of thing that federal money should fund.
- Skill shortages can also be a constraint but again you can get specific conversations going in which it becomes clear that if Government can put a bit of funding in to these education institutions in this region and it boosts the supply of people that are good at computer science or have specific engineering skills that brings more commercial investment.
 - The launch pad competitions that Innovate UK launched that helped clusters, can help promote immigration within geographically defined clusters, and also pitching to overseas investors.

CONCLUSION

I have tried to explain the crucial drivers of the British problem that we don't always commercialise and apply some of the great ideas emerging from our science base. It is not because we are unusually cautious or we have some vague cultural problem. It's certainly not that there are bad people in universities and universities should do better. Our universities do better than almost anywhere else in the world to promote innovation, but then they need to, because our British strategy as it has emerged has ended up with many more of our eggs in that particular basket than in most other advanced western countries. My key conclusion is that the real challenge is to refresh and extend a network, both a funding network and an institutional network that supported R&D outside the university environment, alongside what happens within universities as well. The Government has launched a review to promote patient capital. I hope we will also have patient policy to do just that.



IN SUMMARY

Professor Nick Jennings, Vice-Provost (Research), Imperial College:

Many of David's comments about being in government are absolutely something I recognise; I was the government's Chief Scientific Advisor for National Security for 6 years, from 2000 to the beginning of this year, and I recognise so many of the points he has made.

Some excellent points around expertise of staff within government, civil servants are amazing at what they do, they're amazingly dextrous at picking up new briefs, but deep expertise is not something you typically associate with civil servants. I also recognise the point about pay as a civil servant, it's a very different pay scales to universities. I think the Lecture has been really very insightful, and an excellent analysis of the landscape, the funding landscape, and it takes us on from what are really quite lazy assumptions that we're not very good at innovation or we somehow lack courage to do it, and to really put forward some ideas and some analysis and data as to why we have an ecosystem like we do. This Lecture has been insightful and exactly the kind of debate that we need to be having.



