FUTURE DIRECTIONS FOR SCIENTIFIC ADVICE IN WHITEHALL

Edited by Robert Doubleday and James Wilsdon

April 2013

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CONTENTS

ACKNOWLEDGEMENTS

Some projects have a long and painful gestation; others fall into place with remarkable ease. This was one of the latter. In July 2012, when we met with Jill Rutter (Institute for Government), Jonathan Breckon (Alliance for Useful Evidence) Simon Burall (Sciencewise) and Claire Craig (Government Office for Science) to explore a potential event series and publication on scientific advice, all agreed that it was a timely and worthwhile exercise.

Three factors combined to frame the context for the project: the Government's agenda of civil service reform; an increasingly sophisticated debate about the role of evidence in policymaking; and the imminent transition from Sir John Beddington to Sir Mark Walport as the UK Government Chief Scientific Adviser. Relying almost entirely on goodwill and improvisation, a partnership emerged, and we would like to express our deep gratitude to all those colleagues at the Alliance for Useful Evidence, Cambridge's Centre for Science and Policy, the Institute for Government, Sciencewise, SPRU and the ESRC STEPS Centre at the University of Sussex, who helped to make the project possible.

The event series ran from November 2012 to February 2013, and we want to thank the many speakers who participated, including Alice Bell, Paul Boyle, Lidia Brito, Rebecca Endean, Anne Glover, Duncan Green, Dipak Gyawali, Gemma Harper, Mark Henderson, Mike Hulme, Alan Irwin, Sir Roland Jackson, Lord Krebs, Melissa Leach, Geoff Mulgan, Jan Marco Müller, Chi Onwurah MP, Susan Owens, Miles Parker, Roger Pielke Jr., Jill Rutter, Suman Sahai, Ian Scoones, Rod Smith, David Spiegelhalter, Jack Stilgoe, Andy Stirling, Camilla Toulmin, Sir Bob Watson, Chris Whitty, Paul Wiles, Katrina Williams, Chris Wormald and Brian Wynne.

Agendas, speaker slides and, where possible, videos of those sessions are all now online, as set out in the following table:[1]

Event	Date	Lead partner	Online resources
Culture clash: bridging the divide between science and policy	20 November 2012	Institute for Government	www.instituteforgovernment.org.uk/events/culture-clash-bridging-divide-between-science-and-policy
Broadening the evidence base: science and social science in social policy	8 January 2013	Alliance for Useful Evidence	www.alliance4usefulevidence.org/event/future-directions-for-scientific-advice-in-whitehall-broadening-the-evidence-base-science-and-social-science-in-social-policy
Experts, publics and open policy	15 January 2013	Sciencewise	www.sciencewise-erc.org.uk/cms/seminar-3; soundcloud.com/timjhughes/experts-publics-and-open-policy-seminar
Credibility across cultures: the international politics of scientific advice	6 and 7 February 2013	STEPS Centre and SPRU (STEPS Symposium 2013)	steps-centre.org/2013/uncategorized/annual-symposium-2013/
Future directions for scientific advice in Whitehall	18 April 2013	Centre for Science and Policy	www.csap.cam.ac.uk/events/csap-annual-conference-2013/

These events would not have been possible without significant support from Jackie Ouchikh at CSaP, Eloise Stott at the Alliance for Useful Evidence, the IfG events team and Julia Day, Harriet Dudley and Nathan Oxley at the STEPS Centre. And we are of course grateful to all those who joined as participants, and contributed to a rich series of discussions and debates.

Several speakers developed their remarks into the essays that form this volume, and a few additional pieces were commissioned alongside. We are indebted to all of the authors for their generosity of engagement and the quality of their thinking, and we hope that the collection as a whole makes a lasting contribution to strengthening the theory and practice of scientific advice in the UK and further afield.

We would like to thank all those who have been involved in the production of the collection: Helen Durham and Jordan Junge at Nesta; and Mike Green at A3 Design. Thanks also to James Randerson, Ian Sample, James Kingsland and Alok Jha at *The Guardian* for encouraging us to preview extracts of a few of the essays on its 'Political Science' blog,[2] which has enabled them to reach a wider audience.

Finally, we would like to express our thanks to Sir Mark Walport for his encouragement at the start of the project, and to Claire Craig and Chris Fleming at the Government Office for Science for their advice and guidance.

Robert Doubleday and James Wilsdon

April 2013

Endnotes

1. For an overview of the entire series, see: http://www.csap.cam.ac.uk/events/futuredirections-scientific-advice-whitehall/
2. See: http://www.guardian.co.uk/science/political-science

HAIL TO THE CHIEF: FUTURE DIRECTIONS FOR SCIENTIFIC ADVICE

James Wilsdon and Robert Doubleday

It's all change at the top of UK science policy. On 1 April 2013, Sir Mark Walport took over as the government's chief scientific adviser (GCSA), the 11th occupant of that post - all of them men - since it was created by Harold Wilson in 1964 (see Table 1).[1] In a seamless transition worthy of Doctor Who (another early-60s institution which has survived through 11 incarnations), those who follow @uksciencechief on Twitter saw Sir John Beddington's trademark beard shimmer and then vanish, to be replaced by Sir Mark Walport's freshly-trimmed moustache. A new era was underway.

Sir Mark Walport arrives in Whitehall following a highly successful decade as director of the Wellcome Trust. He is a seasoned political operator who knows how to forge alliances and navigate the corridors of power. On his appointment, Sir Paul Nurse, president of the Royal Society, echoed the views of many in the scientific community when he said *"we have absolutely the right person for the job."*[2]

Table 1: UK government chief scientific advisers 1964 to the present day

Sir Mark Walport	2013 -
Sir John Beddington	2008 - 2013
Sir David King	2000 - 2008
Sir Robert May (now Lord May of Oxford)	1995 - 2000
Sir William Stewart	1990 - 1995
Sir John Fairclough	1986 - 1990
Sir Robin Nicholson	1982 - 1985
Sir John Ashworth	1976 - 1981
Dr Robert Press	1974 - 1976
Sir Alan Cottrell	1971 - 1974
Sir Solly Zuckerman	1964 - 1971

Advice to academic politicians

Not long after Sir Mark Walport was confirmed as the next GCSA, we spent a day with him at an event for biology students in Cambridge. In an engaging talk to his audience of young researchers, Walport began by warmly recommending *Microcosmographica Academica*[3] as his preferred guide to the politics of science and academic life.

Written in 1908 by Frances Cornford, a Cambridge academic, *Microcosmographica Academica* is a biting satire on universities, with relevance to many other institutions. It opens with a warning to a 'young academic politician' and goes on to describe two blocking tactics that will be wearily familiar to anyone who has worked in academia or Whitehall. First, the principle of the dangerous precedent: that 'every public action which is not customary, either is wrong, or, if it is right, is a dangerous precedent. It follows that nothing should be done for the first time.' Second, the principle of the wedge: that 'you should not act justly now for fear of raising expectations that you may act still more justly in the future.'

In essence, *Microcosmographica Academica* is a plea for a more honest approach to the limits and possibilities of politics, and a guide to getting things done, whatever obstacles others may place in your way. A century on, it remains an entertaining read; it may also yield a few insights into what makes Sir Mark Walport tick.

This book contains no shortage of advice to academic politicians. The appointment of a new GCSA creates a natural opportunity to take stock of relations between science, evidence, politics and policy, and over the past six months a number of organisations teamed up to host a series of events looking at the future of scientific advice in Whitehall.[4] These have fed into this collection, which brings together perspectives from current and former science advisers, civil servants, policy analysts and academics.

In this introduction, we draw out some of the most important threads from these contributions and weave them into a set of reflections on the prospects, priorities and dilemmas for scientific advice over the next five years.

Experts as intermediaries

One central theme of the collection is eloquently summarised in Geoff Mulgan's essay: 'the key role of a scientific adviser is to act as an intermediary and broker rather than an adviser…consequently their skills need to be ones of translation, aggregation and synthesis as much as deep expertise.' Sir John Beddington makes a related point, when he describes the role of the GCSA as 'a conduit of advice rather than a single expert opinion.'

From across the Atlantic, Roger Pielke Jr. observes that governments everywhere 'are chock full of experts, agencies and advisory mechanisms.' In his account, the role of the science adviser is a combination of championing the role of science in government, convening relevant expertise, helping decision makers to navigate wisely between the scope of available choices on a given topic, and supporting the quality of evidence and expertise in government by 'providing advice on advice'.

This emphasis on the 'expert as intermediary' is important in the context of a recent inquiry into chief scientific advisers (CSAs) by the House of Lords, which expressed concern about unevenness in the status, authority and influence of CSAs across different government departments.[5] Similar points have been made by the Campaign for Science and Engineering.[6] The Lords' report attempts to codify the 'essential characteristics' of a CSA that are required if he or she is to operate effectively. Foremost among these - the 'primary and essential characteristic' - is that CSAs 'must have standing and authority within the scientific community, nationally and internationally.' This phrase is not defined with precision, but is taken to imply that CSAs should be externally-appointed senior figures, drawn from academia or occasionally from industry, who are 'able to access a wide range of expertise' by dint of their seniority. It leads the Lords to criticise the appointment of Whitehall insiders to some CSA positions.

A cynic might observe that it is hardly surprising to find a committee of British peers, several of whom are themselves eminent scientists, arguing for an elite cadre of CSAs to be cast in their own image. And to be fair, the Lords report does go on to list a number of additional qualities that CSAs need to bring to the job. However, the focus is on getting the 'right' people in post, and then tinkering with departmental structures, budgets and reporting lines, to ensure that they are able to operate effectively.

The essays here suggest a different approach.[7] As Geoff Mulgan argues, what might be characterised as the 'clever chap' theory of scientific advice is outdated and inadequate to the task: 'Simply putting an eminent scientist into a department may have little effect…many who aren't well prepared for their roles as brokers, feel that they rattle around without much impact.' Jill Rutter acknowledges the value of a good CSA's networks but argues that their 'ability to cope with, and even relish, policymaking in a political environment needs to be as much of a test when they are recruited as their academic credentials.' And Roger Pielke Jr. reminds us that 'science advisers are not superheroes', capable in some unproblematic way of representing the 'authority of science as a counterbalance to the messiness of politics.'

Ecosystems of expertise

A focus on skills of translation, aggregation and synthesis requires us to shift our attention from the experience and status of the individual adviser, to the dynamics of the advisory system in which they sit. In some respects, CSAs are the charismatic megafauna of the science advisory system. As a result, they will always attract a lot of attention, but their role needs to be understood within a rich ecosystem of expert advice, which includes analytical professionals within the civil service, external advisory committees, policy 'tsars',[8] national academies, learned societies, universities, NGOs and civil society organisations - and many others.

The UK's current science advisory system is largely a product of lessons learned from the BSE crisis of the mid 1990s. However, several essays point to constraints in the current scope of the system. Brian Collins, himself a former CSA in two departments, argues that as more of the execution of public policy is outsourced to agencies or the private sector, Whitehall-based scientific advice fails to engage with the complexities of delivery and implementation. Chris Tyler makes the case that scientific advice to Parliament is 'poorly understood and systematically overlooked.' Dave O'Brien highlights wider changes in the culture, identity and capacity of the civil service, which need to be factored into these debates, and asks: 'who will make evidence-based policy a reality?'

In their essays, Jill Rutter and Miles Parker explore how the role of the civil service is changing, as it grapples with tighter budgets, heightened demands for accountability, and a reform agenda that promises to 'make open

policymaking the default'.[9] Parker is optimistic about the contribution that the science and engineering profession within Whitehall can make to this reform agenda, and charts the progression over the past 20 years towards more rigorous, multidisciplinary approaches to policy analysis. Rutter also detects signs of progress, but argues that more effort is required to ensure scientists and engineers rise to the very top of the civil service.

Sir John Beddington notes diplomatically that 'open policymaking is still a fluid term', and Jill Rutter reminds us that 'previous attempts at civil service reform have faltered as the initial impetus fizzled out.' But the 2012 reform plan points towards something more transformative. In their essay, Jack Stilgoe and Simon Burall argue for a more radical interpretation of openness, which draws systematically on engagement and dialogue with the wider public. They point to an uneasy settlement since the BSE crisis between old and new models of expertise, and ask whether open policymaking will be more about 'open doors, welcoming in new perspectives; open minds, reflecting on the limits of centralised control and predictability; or transparent but closed windows, revealing policy but maintaining control of its contributors.' Alice Bell describes how new forms of social media are changing the style and speed of interactions between experts, policymakers and publics, and suggests that the 'messiness' of such online discourse is how we create the capacity 'for more coherent exchanges, build trust, learn and digest.'

The science of scientific advice

From time to time, prominent voices within the scientific community call for science to be given greater authority in policy and political decision-making.[10] Such calls are well intentioned, but they sometimes fall into the trap of reinforcing what are misleading or inaccurate accounts of the relationship between science and policy. Fortunately, as Geoff Mulgan reminds us, there is 'a science as well as a craft of scientific advice.' A core argument of his and other essays is the need to learn more systematically from existing research and practice 'on why certain kinds of knowledge and advice are acted on, and others are not.' And as Mulgan says, 'perhaps the most important finding of almost all research on this topic in that demand matters as much as supply.'

Geoff Mulgan emphasises the importance of 'evidence about evidence.' As one example of this, in his essay, David Cleevely describes the ways in

which network analysis can inform our understanding of how scientific advice works in practice, and can assist in the construction of more intelligent systems of knowledge exchange.

In her essay, Sheila Jasanoff probes further into the foundations of scientific advice, distilling some of the insights that can be drawn from three decades of work in the field of science and technology studies (STS). She acknowledges that the questions raised by STS can sometimes be 'associated with unproductive wheel-spinning and relativism', but insists that 'the wheels, in my view, can spin with traction.' She concludes that the relationship between creators and critics of scientific advice is 'fraught but indispensable.' In democracies, no institutions should place themselves beyond critique: 'If judges may not presume to stand above the law, still less should science advisers seek to insulate themselves from the critical gaze of the science of science advice.'

Policy demand and the disciplinary mix

In a valedictory March 2013 evidence session in front of the House of Commons Science and Technology Committee,[11] Sir John Beddington ran through an impressive list of achievements from his period in office. He also expressed a few regrets, including the absence of a high-level champion for the social sciences within the CSA network - a role that had been performed by Paul Wiles, the former Home Office CSA, but which has been 'in limbo' for a couple of years. The post of 'national adviser' for the new network of 'what works' centres for evidence in social policy[12] will go some way towards plugging this gap, but Beddington admitted that 'my own view is that we need someone at the highest level from social research … that senior challenge function is really missing.'

The case for a chief social scientist is elaborated more fully in the essay by Cary Cooper and Stephen Anderson. They make some persuasive arguments. Finding solutions to cross-cutting policy problems - from obesity to healthy ageing, food security to climate change - will require insights from the social sciences, often in combination with the natural sciences; and the methods and approaches of the social sciences are sufficiently distinctive to justify their own seat at the 'top table' of evidence-based policy.

If, however, we accept the case for a chief social scientist, how far do we follow it through? Do we settle for one social scientist coordinating everything at the centre? Or do we instead push for a more ambitious, cross-departmental network, parallel to that of the CSAs? And why stop there? There are already chief economists in most departments, connected through the Government Economic Service to HM Treasury, the real heart of epistemic authority in Whitehall. How about a few chief philosophers, able to interrogate ministerial logic and pose deep questions about the purpose of government? And, as Rebekah Higgitt and James Wilsdon ask in their essay, what about the role of historians in providing what Lord Butler described recently as a 'rear mirror' for the policymaking process?[13]

Geoff Mulgan notes that historians have made important contributions to the field of 'evidence about evidence'.[14] Historians of science have a particular contribution to make to science and innovation policy. Given Walport's support for the medical humanities during his time at the Wellcome Trust, Higgitt and Wilsdon suggest that one way he could signal his commitment to the value of historical methods and insights would be to pilot a 'hindsight project' within the Government Office for Science's Foresight Programme.

Even under the more plural, interdisciplinary model of scientific advice that Sir John Beddington encouraged, there are still implicit hierarchies between disciplines, which are not properly explained or written down. If some departments benefit by appointing engineers and social scientists as CSAs, what is the ideal balance across the network as a whole? And if an engineer could one day occupy the top job of GCSA, is the same true for a social scientist?

This takes us back to our earlier point about experts as intermediaries. Creating stand-alone advisory structures for the social sciences, engineering or history is a clumsy solution, which ducks the bigger challenge of how to integrate an appropriate mix of expert advice from all subject areas. It is easy to understand why some academics prefer to view government through a university lens, projecting on to it the disciplinary silos and rivalries that remain a feature of campus life, and trying to build a stronghold for their own academic tribe inside Whitehall's walls. But this 'supply side' view makes little sense from the 'demand side' perspective of policymakers, who want access to the most relevant expertise, wherever it can be found within the university system, and beyond.

Proposals and priorities

In an editorial welcoming Walport's appointment, the journal Nature observes that one of the hallmarks of the GCSA role is its flexibility: 'to a great extent the job is what the holder makes of it.'[15] At the Wellcome Trust, Walport was a vocal advocate for genomics research and open access publishing. During his first year in office as GCSA, he will confront myriad competing demands for his attention. What are his likely priorities?

Here, we conclude with ten items that we would expect to find high on the incoming GCSA's 'to do' list. A few of these ideas will no doubt be ruled out as dangerous precedents; others as thin wedges. But we hope that some may prove useful to one particular academic politician, whose role has never been more important.

1. Build on Sir John Beddington's legacy

Walport's predecessor is widely judged to have had a successful tenure as GCSA; a recent Guardian editorial praised Beddington for having 'trodden a thin line with grace.'[16] Arguably his greatest achievement was to have extended the network of CSAs into every corner of Whitehall, and to encourage it to work in a more collegiate way across government, supported by a strengthened science and engineering profession (as Miles Parker describes). Updated guidelines were also produced for the use of scientific advice in policy[17] following the controversial sacking of Professor David Nutt in 2009. Walport needs to ensure that the CSA network is maintained, its disciplinary breadth extended and its connections deepened, and that the guidelines are taken seriously across government.

2. Position science within a leaner, meaner Whitehall

Walport is taking over at a turbulent time, as government departments contend with diminished budgets and pressure for civil service reform. With structures for scientific advice still fragile in some quarters of Whitehall, and departmental research budgets vulnerable to ever deeper cuts in the next spending review, Walport needs to position the CSAs and the science and engineering profession in the vanguard of Whitehall

reform - as a model of how to do 'open policymaking' that can provide an example to others. He should also tightly align them to broader efforts to promote evidence-based policy, including the use (where appropriate) of methods such as randomised controlled trials (RCTs) and the new network of 'what works' evidence centres.

3. Bang the drum (but an evidence-based drum) for investment in research

Making the case for research funding is not a formal part of the GCSA's remit, but as Roger Pielke Jr. reminds us, the scientific community will inevitably look to Walport for leadership on this issue, particularly in the run-up to the 2015 general election and subsequent spending review. Walport's own background as the head of a premier league funder, with vocal opinions on the organisation of the research and innovation system, make it even more likely that he will engage. The challenge here is to maintain the commitment to robust evidence that the GCSA is meant to bring to all areas of policy. Creating a UK equivalent to the US 'science of science policy' programme[18] is one way that Walport could strengthen the evidence base for investment. Former US science adviser John Marburger won plaudits for his willingness to ask frank questions about research funding; Walport should do the same.[19] He should also wield the collective clout of the Council for Science and Technology, with its reinvigorated line-up of business and academic leaders, to produce an agenda-setting report on the evidence for research investment ahead of the next election.[20] Importantly, these efforts should focus not only on the economic case for research funding, but also on its social and public value, and on opening up debates about research priorities and purposes to more diverse perspectives.[21]

4. Champion the full breadth of academic expertise

In recent years the network of CSAs has expanded to include a wider range of disciplinary expertise. The latest annual report from the Government Office for Science lists two engineers and four economists among the 22 CSAs.[22] Given that there is now widespread acceptance of the benefits that can flow from examining problems through an interdisciplinary lens, Walport has an opportunity to champion within

government the breadth of all that the natural sciences, engineering, social sciences, arts and humanities have to offer. Until recently, the recruitment materials for new departmental CSAs have indicated that successful candidates are 'likely to require a FRS or FREng, or equivalent standing in a commercial/industrial field'.[23] These criteria need to be rethought in light of a broader interdisciplinary model, and the crucial importance of intermediary, brokering and translational skills as emphasised by Geoff Mulgan, Jill Rutter, Roger Pielke Jr. and others.

5. Build towards a multidisciplinary 'government evidence service'

There has been encouraging progress in strengthening the science and engineering profession across Whitehall, and these efforts should continue.[24] However, as Miles Parker highlights, government analysts across the board are now working more closely with policymakers in multidisciplinary teams. The ultimate end-point could be a deliberate blurring of the distinction between the government economic service, the science and engineering profession and other analytical professions across Whitehall, and their replacement with a more integrated 'government evidence service', which blends disciplinary expertise as required and facilitates the pooling of analytical services between departments. Walport has first-hand experience of how to improve the translation of biomedical knowledge into practice; a similar focus in his GCSA role on 'knowledge brokering' to meet the needs of policymakers would give greater prominence to intermediaries and translators between different forms of specialist knowledge.

6. Keep a cool head in a crisis

Scientific advisers have to remain vigilant to the ever-present threat of the unexpected. Beddington handled a succession of crises - volcanic ash, Fukushima and ash dieback - with considerable skill. He also placed scientific issues on the National Risk Register, and managed to embed a new Scientific Advisory Group for Emergencies into the government's civil contingencies procedures.[25] At some point on Walport's watch, a crisis (or probably several) will flare up which will place scientific credibility on the line. Such situations will test his

judgment and leadership. As well as coordinating Whitehall's response, he will have to communicate risks and uncertainties to the country at large. Treating the public like grown-ups, acknowledging areas of scientific uncertainty or disagreement, and avoiding false reassurances are the hallmarks of mature crisis management.

7. Define agendas and broker solutions

Sir David King chose climate change, Sir John Beddington the 'perfect storm'; sooner rather than later, Walport is likely to want to choose a policy agenda that he can call his own. This is a good idea, though there is now scope for such an agenda to be collectively defined and advanced by the entire network of CSAs, and this could have even greater impact. Jill Rutter suggests the CSA network should follow the model of the Chief Medical Officer in producing a high-profile annual report. At the same time, Walport and the other CSAs should bear in mind Roger Pielke Jr.'s point that scientific advice is more often about helping policymakers to navigate options than it is about providing them with single answers. This is particularly important when commenting on controversial issues such as GM crops, fracking or nuclear power, when personal views or interpretations of evidence, however legitimate, can at times lead to the inappropriate exercise of scientific authority to artificially narrow debate or limit options. Leadership must be combined with humility, and a willingness to listen and learn from a variety of perspectives.

8. Strengthen foresight and move it closer to the heart of industrial policy

One of the most effective parts of the Government Office for Science is the Foresight programme, which looks in-depth at emerging technologies and topics such as computer trading in financial markets, global food security and flood defences.[26] Since the global financial crisis, there has been a renewed interest in the UK and other countries in the use of foresight processes to help identify technologies and sectors with long-term growth potential. As the UK teeters on the brink of a triple-dip recession, Walport should push for a more ambitious role for foresight in economic and industrial policy, and ensure that

it influences priorities for policy and investment. This should be part of a broader focus on the longer term, which as Natalie Day argues in her essay, is an increasingly vital - if politically difficult - lens for policymaking. In line with the recommendations of a recent Cabinet Office review,[27] Day describes how the GCSA could help to embed more systematic horizon scanning across government.

9. Advance the UK's science diplomacy

The GCSA has long been an important ambassador for UK science on the international stage. There is now a more sophisticated understanding of the contribution that science and innovation can make to diplomacy,[28] which has been reinforced by the appointment of a CSA to the Foreign and Commonwealth Office, and by the valuable work of the BIS/FCO 'Science and Innovation Network' which is spread across the UK's embassies and high commissions.[29] At a time when the 'UK model' of scientific advice is increasingly viewed as a template by others (for example in Australia, as Paul Harris describes in his essay), and when novel international advisory structures are being created (notably Anne Glover becoming the first Chief Scientific Adviser to the President of the European Commission, and the creation of new international assessment processes, as discussed by Mike Hulme and Sir Bob Watson in their essays), it will be important for Walport to continue advancing the science diplomacy agenda. He should also foster stronger international networks for the exchange of best practice. Currently, the main forum for this is the Carnegie Group of Science Advisers, which was established in 1991 to enable CSAs and science ministers from the G8 nations to meet annually. Its membership has expanded in recent years to include Brazil, China, India, Mexico and South Africa. But given the importance of scientific advice worldwide, a larger, more open network is now required, where CSAs and others with expertise to offer can meet to exchange ideas, discuss what does and does not work within national advisory systems, and identify opportunities for international collaboration. This network should include the leaders of international advisory bodies, such as the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

10. Mark the GCSA's 50th anniversary with a high-profile conference on 'experimental government'

Geoff Mulgan expresses the hope that we are entering a period of more 'experimental government',[30] where policymakers 'are willing to test their ideas out - to run RCTs and embed continuous learning and feedback into everything they do.' As Walport looks towards 2014, the 50th anniversary of Sir Solly Zuckerman's appointment as the first GCSA, he should convene an international meeting, bringing together policymakers, practitioners, 'scientists of science advice', and thinkers from around the world, to reflect on progress, share ideas, and chart future agendas for experimental government. Such a meeting could also define the aspirations against which the legacy of Sir Mark Walport's tenure as GCSA will eventually be judged.

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Endnotes

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1

EXPERTS AND EVIDENCE IN WHITEHALL

THE SCIENCE AND ART OF EFFECTIVE ADVICE

John Beddington

There are times when a government knows it needs science or engineering advice. Perhaps most clearly when the physical world asserts itself in dramatic ways: the crisis at the Fukushima nuclear power plant, the emergence of the swine flu pandemic, and the volcanic eruption in Iceland being recent examples.

Although the issues can be complex, such events are among the more straightforward situations for a government scientific adviser: there are willing recipients of the advice and the challenge is to collate the evidence and present it in the most effective way. What is more difficult is ensuring that science is brought to bear effectively on the questions which policymakers know matter but which don't present a single decision moment, or where it is less obvious that science can help. These include the "wicked problems" that cross departments, cross disciplines and have timescales longer than the lifetimes of governments. Obesity, mental health and flood risk are examples.

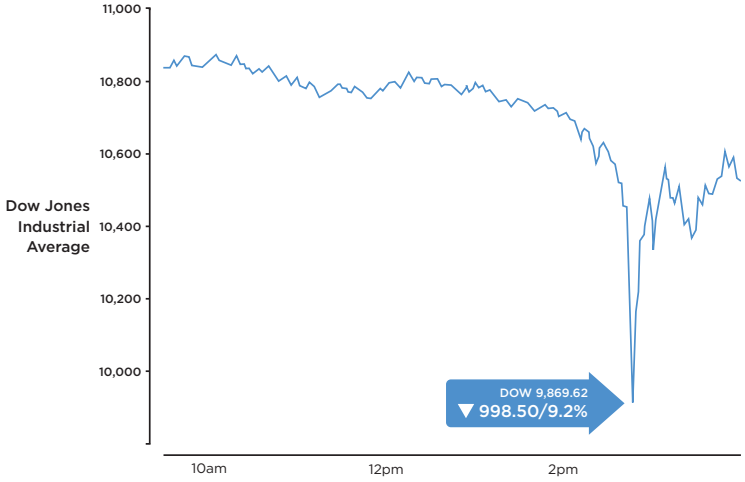
This is the challenge in the role of the Government Chief Scientific Adviser; to ensure that the best science and engineering advice is brought to bear effectively on all government policy and decision making. It requires navigating strategic long-term advice on one hand and the responsive marshalling of evidence for immediate questions on the other. It also requires ensuring that science and engineering capability is in place to underpin policymaking at all levels of government.

Foresight

Foresight is perhaps the most high-profile and sustained programme to draw government attention to what science has to tell us about long-term challenges. Foresight projects aim to provide new research where it is most needed, providing policymakers with clear and accessible advice, helping them to keep pace with technological change.

For example, the Foresight project on the future of Computer Trading,[1] which launched its findings in October 2012, took an authoritative and cross-disciplinary look at evidence on market behaviour, stimulated by the 'Flash Crash' of 6 May 2010 when the Dow Jones Industrial Average dropped 9 per cent, as one trillion dollars evaporated from the US equity markets only to be recovered in minutes.

Figure 1: **6 May 2010 US 'Flash Crash'**



Source: **http://tinyurl.com/d5vmx77**

The project found that computer-based trading, despite the controversy, has several beneficial effects on markets. Most notable among these are that transaction costs have fallen and that liquidity and price efficiency have improved. In addition, the project did not find any empirical evidence that high-frequency trading increases market abuse. Lastly, although no direct evidence showed that volatility had increased, the report did show that in specific circumstances the presence of computer-based trading can lead to significant instabilities, which often take the form of reinforcing feedback loops.

The project informed financial policy on a global scale. Its findings highlighted the gaps in current knowledge, and called for closer co-operation between the industry and the research community, with the long-term aim of translating greater access to data into evidence-based analysis and regulation. Other specific recommendations were grounded in cross-market co-operation, and were targeted at limiting possible future market disturbances and facilitating market surveillance. In addition, the project examined particular policy options that were part of the current regulatory debate, in terms of efficacy.

The benefits of Foresight often come from creating links across departments and across disciplines. Many Foresight projects have taken authoritative cross-disciplinary looks at the major challenges ahead due to drivers such as climate change, natural hazards and demography. In the Foresight project on Migration and Global Environmental Change,[2] we brought together around 350 leading experts and stakeholders from 30 countries across the world to look 50 years into the future. We examined how profound changes in environmental conditions such as flooding, drought and rising sea levels will influence and interact with patterns of global human migration. The report revealed that we have so far underestimated the major challenges associated with migration in the context of environmental change and that millions will be 'trapped' in vulnerable areas and unable to move, particularly in low income countries. We also showed how migration can help bring greater resilience to communities facing hardships. The report has had a marked impact at home and abroad, informing the work of inter alia the United Nations High Commissioner for Refugees (UNHCR) and the United Nations Department for Economic and Social Affairs (UNDESA) population division, who have used the report in a wide variety of ways to inform their work.

A rigorous approach gives us studies which can stand the test of time. The 2004 Flooding and Coastal Defence study[3] has had major international impact, not least as the basis of a four-year UK-China 'flagship' project on sustainable flood-risk management in the vulnerable Taihu Basin, which accounts for 3 per cent of the population and 13 per cent of China's GDP. On infectious diseases, a consortium of leading African organisations from five countries established the Southern African Centre for Infectious Disease Surveillance in Tanzania, specifically to realise Foresight project findings.

This Africa-led initiative has so far attracted over $10 million in support from international donors such as the Wellcome Trust, the Rockefeller Foundation, and Google.org to help ensure its success. The African Union commissioned Foresight's lead African experts to develop a Science and Technology Framework for the Detection, Identification and Monitoring of Infectious Diseases in Africa. This framework has been endorsed by the AU Scientific, Technical and Research Commission, and African national and regional stakeholders are a step closer to creating two new regional centres for infectious disease surveillance in Eastern and Western Africa.

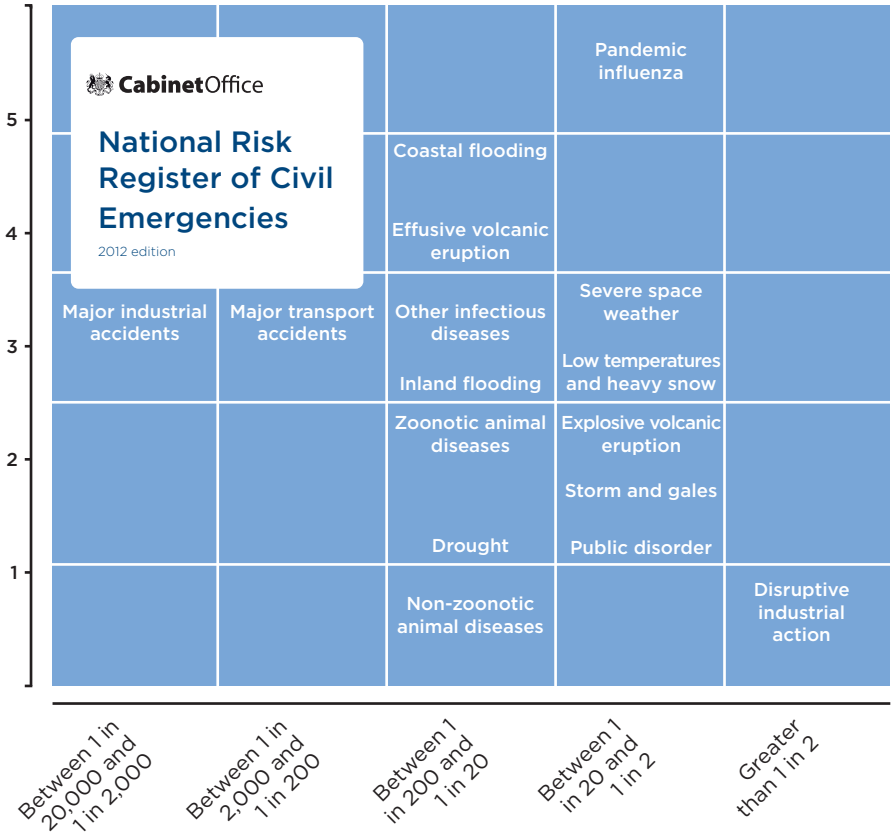
Advice at shorter notice

Whereas Foresight projects each take one to two years to publication and engage with several hundred academics and experts over that time, much advice has to be provided much more rapidly. On a timescale of three to nine months, I introduced the 'Blackett' reviews, named after Patrick Blackett, physicist and one of the founders of operational research. These typically tackle a more immediate challenge, often in the security or defence arena.

The most recent Blackett review examined prospects for improving the detection of biohazards. It brought together leading academics and industrialists from diverse disciplines including epidemiology, genomics, analytical chemistry, atmospheric physics and systems engineering who met three times over four months, reporting to the Ministry of Defence, Home Office, Department of Health, and Cabinet Office on improving UK capability in the short to medium term.

We established some quick wins and areas of research and action. A key recommendation was that government should assess the impact of developing an automated reporting system for biological hazards, integrating signals from a broad range of information sources and informed by an array of deployable sensors, to enable a near real-time response to a biological hazard. The benefits of such a capability are wide-ranging and could significantly impact on public, animal and plant health.

Figure 2: **National Risk Register of Civil Emergencies**



Sometimes, of course, the challenge is so immediate that we have minutes or hours to provide advice. During pandemics, the disruption to air travel caused by volcanic ash, and the emergency at Fukushima Dai-Ichi after the tsunami, I relied on the immediate advice of small groups of experts forming the Scientific Advisory Group for Emergencies (SAGE). SAGE, which I chaired, reports to the Cabinet Office Briefing Room (COBR) committee, chaired by the Prime Minister.

As GCSA, I worked with the Cabinet Office to ensure that not only do we give the best advice possible at the time, but that we also use each experience to embed improvements in future arrangements. We have linked these experiences with the increasingly strong use of science as part of risk-based assessments underpinning the National Risk Register.

Underpinning capability - networks of advice

Effective advice both on long-term issues or in response to emergencies begins with having the right people in the right place when they are needed most. For the first time we now have departmental Chief Scientific Advisers (CSAs) covering all government departments. In 2012, the House of Lords Select Committee report confirmed the immense value of this network and the Government's response consolidated it.[4] Between them, the CSAs have expertise in physical, life and social sciences, and engineering. They bring senior academic, business and Whitehall experience to the table. No two of them have exactly the same role. What they each do reflects the scientific and policy needs of their department, along with its structure, history and provision of all forms of analysis.

It is a network that is greater than the sum of its parts. Meeting regularly, CSAs have been able rapidly to exchange the latest intelligence, provide deep specialist science and engineering expertise and provide advice and impromptu problem-solving support to each other. Over the last few months alone, they will have discussed subjects as varied as ash die-back, growing threats from antibiotic resistance, the implications of the West Coast rail franchise affair, and how the UK can benefit financially from the science of the sea floor.

Of course, many leading scientists work in or closely with business. As GCSA, I have had the privilege of co-chairing the Prime Minister's Council for Science and Technology. During this time the CST's membership has broadened to include more senior representatives from R&D intensive businesses such as Rolls Royce and IBM. Drawing on its academic and private sector membership, the CST has presented on the science of genomics to the PM and contributed strongly to the development of the Life Sciences Strategy. It has also carried out complementary work on innovation in the NHS to secure the continued growth of one of the UK's most valuable industrial sectors.

I have also been glad to see the way in which working with or in government is increasingly valued by academics. In the Government Office for Science we have benefitted greatly from Research Council and other placements. We are increasingly working with universities and others supporting exchanges between government and academia. This interchange is happening organically but, at any one time and in addition to secondments, there may well be over 1,000 scientists working formally with government on councils, committees or projects.

Dialogue with the national academies has also reached a new level. It is not the only example of the many ways in which all the academies contribute to policy work, but last year's joint report by the Royal Society and Royal Academy of Engineering on the risks associated with hydraulic fracturing to access shale gas[5] illustrates how a relatively rapid response by the academies to a well posed question can directly inform government decision making. The working group, led by Professor Robert Mair of Cambridge University, took five months to make its report, which was delivered to the Secretary of State at the Department of Energy and Climate Change in time to inform policy decisions on the future of shale gas exploration in the UK, which were announced in December 2012.

Looking forward, and with so many environmental, social and economic challenges facing us, science in government matters more than ever. But sometimes it is not enough to consider issues and take action in the UK in isolation. This is particularly the case for the big global challenges such as energy security and climate change. I'd like to see the benefits of science advisers networking in the UK extended much more strongly abroad.

A small number of other countries have a GCSA-equivalent, most notably the US but also Australia, the Czech Republic, India and Latvia for example. Last year the EU, after many years' deliberation, appointed Professor Anne Glover to the role of European Commission CSA. Many other countries have mature and independent science advisory systems that are not based on a single GCSA-type role. Clearly, each country has to develop a model that works with the grain of its unique political and academic system. But it will help to ensure that we all get the best value from science advice if it becomes easier for scientists to work together across boundaries. Sometimes, for example, it helps just knowing who to call in a crisis.

I've particularly valued working with colleagues in the Office for Nuclear Regulation and elsewhere in the UK, together with colleagues in the Japanese government, to provide advice when requested on developing a new system for ensuring the safety of nuclear plants. The Japanese are also considering introducing a GCSA role. The UK GCSA has always benefitted from a close relationship with his counterpart in the US and John Holdren and I have discussed a wide range of issues over my time: most recently, for example, sharing information about assessing and managing the risks from space weather. More broadly, the GCSA abroad supports a wide range of UK government objectives, building relationships to support research collaborations, inter-agency agreements, and informing debates on global issues such as climate change, migration and food security.

Underpinning capability: the scientific civil service

CSAs depend on a wide range of scientists and engineers working at every level in the public sector. When I arrived in post one of my biggest surprises was that, although I was formally head of the science and engineering profession, no-one knew how many scientists and engineers were actually working in government departments. Whitehall doesn't collect information like that. So I invited scientists and engineers to step forward and form the Government Science & Engineering community. From a standing start, we now have over 3,500 members.

Towards the end of my tenure, I led a group including representatives from the policy and analytical profession, the unions and professional bodies, to review what government will need from the science and engineering profession in the future, and to take stock of the existing community. The review shows scientists and engineers come from a huge range of disciplines, work across all areas of the Civil Service, and are proud to be doing so. Ninety-one per cent of the thousands surveyed for the review were positive about declaring themselves to be scientists or engineers, and 61 per cent felt influential in their current role.

In broad terms, their roles are either those of the specialist 'practitioner' - the 'integrator' who works closely with practitioners and external academics procuring, managing or accessing research; or those of 'an informed advocate', senior decision makers or policy officials who act as a sophisticated client for science and engineering advice.

Figure 3: **Wordcloud of GSE members' own descriptions of their professional identity**

Source: Taken from the review of the science and engineering profession in the Civil Service 2012

Over the next few months, leaders in the community will use the findings of this review to improve talent management and leadership, create clearer career pathways, and enable the network to respond more flexibly, by working across departmental and disciplinary boundaries to meet Ministers' needs. As a pilot last year, scientists and engineers from a range of departments and disciplines got together with external experts to advise the Ministry of Justice on drug detection technologies to help reduce drug use in prisons.

Reflections on five years as GCSA

We are in a strong position to meet the challenges ahead because of the progress we have made. This is not just about shifts in how science advice is provided. It is also about the ways in which policymaking is evolving. Open policymaking is still a fluid term, but it clearly creates opportunities to further strengthen the provision of good science in government. On a daily basis, members of the Government Science & Engineering community are working with those who develop and deliver policy to ask questions, to be curious and innovative. They develop networks that reach into academic, NGO and business communities. They know how to call on these networks at a few hours' notice, and how to engineer new insights and solutions to complex issues over the longer term.

The UK as a whole punches above its weight in science: UK research is the most productive and efficient in the G8; we produce more publications and citations per pound of public funding than any of our major competitors. UK scientists are some of the best in the world, winning 76 Nobel Prizes for their scientific achievements. The UK is also number two in the world for university collaboration with business, according to a recent World Economic Forum report.[6] My hope and expectation is that, just as the UK punches above its weight in its contribution to research, so we will be world class at using science in decision making.

The key point, and a fitting one on which to conclude at the end of my term as Chief Scientific Adviser, is that ensuring government is properly informed by science is something that all scientists should be involved in. The role of a government scientific adviser, whether on long-term issues or in a crisis, is to act as a conduit of advice rather than a single expert opinion. It is that ability to draw on the ever-developing knowledge of the wider scientific community that ensures the best advice possible is brought to bear.

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EXPERTS AND EXPERIMENTAL GOVERNMENT

Geoff Mulgan

Governments should want and even crave the best possible scientific advice. With reliable knowledge come better decisions, fewer mistakes, and more results achieved for each pound spent. In many respects it's remarkable that only now are governments setting up and funding centres dedicated to assessing and communicating 'what works'.[1]

But knowledge is not always easy to use or to digest. The most authoritative advice may be uncomfortable, or at odds with what the public want. What's recommended may appear inordinately expensive, with uncertain benefits to be reaped in the distant future. Harassed ministers with a low tolerance for ambiguity may be frustrated when they're told how uncertain the knowledge is. And experts too, can be fallible, perhaps more than they would like to admit.

We should certainly want evidence to be more visible, more influential and better used. The drive to create institutions to promote evidence, such as the Alliance for Useful Evidence, and the new 'what works' centres, is a vital part of making government more competent, and more deserving of trust. But anyone concerned to promote evidence needs also to be attuned to the subtleties, and to the many reasons why the pure ideal of government guided by wise elders is neither possible nor desirable.

Evidence about evidence

To help us understand what kinds of evidence are most useful, and most likely to be used, there is, luckily, a science as well as a craft of scientific advice itself, although much of the commentary on scientific advice appears to be unaware of the extensive research on why certain kinds of knowledge and advice are acted on, and others are not.[2]

I'm one of the guilty, in that I was for many years a champion of rational advice in government, but only belatedly caught up with the evidence about evidence. As a civil servant in charge of the government's Strategy Unit, I

brought in many people from outside government, including academia and science, to work in the unit, dissecting and solving complex problems from GM crops to alcohol, nuclear proliferation to schools reform. In our work we promoted rigorous analysis, and wherever possible published surveys of evidence. We encouraged better skills of modelling and quantitative analysis. And we prompted departments to undertake more rigorous mapping of future possibilities.

All of these were valuable counters to the influence of spin doctors and tacticians. Some were well ahead of their time - including work on topics such as behaviour change, happiness and systemic change. But I also learned that it's not enough to bring clever people into government, or for advice to be rigorous and rational. Methods of this kind survive only as long as there is a political appetite for them, and the conditions in which they thrive may even be quite unnatural.

That prompted me to ask what was known about the role of knowledge in government. It's true that the science of scientific advice is patchy. There have been a few randomised control trials (RCTs) to test how knowledge is taken up within professions[3] (and why even apparently compelling evidence is often ignored). But the study of high-level advice has fallen more to historians and political scientists, and experts in the burgeoning study of knowledge itself.[4] From their work, a reasonably coherent picture of how knowledge is formed, exchanged and used in practice, both on the front line and within policy, has built up.

What their research shows is not definitive, but it is clear, and its consistent message is that the effectiveness of advice doesn't depend greatly on the cleverness of the person giving the advice or even the logical cogency of their arguments.[5] Instead it matters a lot who gives the advice - and whether they are trusted and reputable. It matters how advice is given, and in particular how it is framed[6] - preferably fitting the cognitive style of the receiver, and with a tone that is neither hectoring nor patronising. It matters when the advice is given - either in the heat of a crisis or emergency, or when an issue is salient. And it matters where the advice is given - the most influential scientists have usually installed their offices close to those with the greatest power, or ensured plenty of physical interaction (for example at conferences or on study trips).[7]

Advice on demand

Perhaps the most important finding of almost all research on this topic is that demand matters as much as supply. The most brilliant advice may go wholly unheeded if it's not fitted to the social context of decision makers, the psychology of people making decisions in a hurry and under pressure, and the economics of organisations often strapped for cash. What works for whom and in what circumstances are crucial factors;[8] and evidence and advice have to make themselves useful if they are to be used.

That demand is as likely to happen on the front line as in Whitehall. Evidence-based practice tends to matter more than evidence-based policy, which may be why NICE focuses exclusively on what doctors do and prescribe (though some use of evidence in shaping policies for the NHS might not go amiss). For a field like policing, it probably matters even more that police officers learn about evidence from the start, and engage with it throughout their careers, than that Home Office officials draw on evidence before they shape new laws. And for all professions it matters that there are opportunities - for example in study circles - for professionals to engage with recent research and discuss its relevance.

So how should advisers raise the odds of having impact - and of being useful? In my experience, the successful ones understand two fundamental aspects of the context in which their advice will be heard, both of which are radically different from the cultures they are likely to have experienced for most of their careers outside government.

The first is that they are operating in a context where there are often multiple goals and conflicting values. As a result, there may often not be a single right answer (though there may be any number of demonstrably wrong answers). Instead there will be right answers that are more or less aligned to the priorities of government (and of the public). The better the providers of advice understand decision makers' perspectives and needs the more likely they are to be influential.[9]

Take energy. I twice had to oversee reviews of energy policy and in each case the scientific analysis of such things as potential energy sources, current and future renewables or carbon scenarios, had to be linked to the very different goals of ensuring affordable energy, energy security, and protecting the world from catastrophic climate change. Scientific method

cannot tell us which of these goals is more important. This is a matter for judgement and wisdom - and as the study of wisdom tells us, wisdom tends to be context-specific, rather than universal like natural science.

The second vital, but not always obvious, point is that governments have to deal with multiple types of knowledge. A minister making decisions on a topic such as the regulation of pesticides or badger culls may need to take account of many different types of knowledge each of which is provided by a different group of experts. These include: evidence about policy, such as evaluations of public health programmes; knowledge about public opinion, and what it may or may not support; knowledge about politics, and the likely dynamics of party or parliamentary mood; intelligence, whether human or signals; statistics; economics; history; knowledge about Civil Service capacities; and performance data, for example on how hospitals or police forces are doing.

Trump cards and clever chaps

Formal scientific knowledge sits alongside these other types of knowledge, but does not automatically trump the others.[10] Indeed, a politician, or civil servant, who acted as if there was a hierarchy of knowledge with science sitting unambiguously at the top, would not last long. The consequence is that a scientist who can mobilise other types of knowledge on his or her side is likely to be more effective than one that cannot; for example, by highlighting the economic cost of future floods and their potential effect on political legitimacy, as well as their probability.

These points help to explain why the role of a chief scientific adviser (CSA) can be frustrating. Simply putting an eminent scientist into a department may have little effect, if they don't also know how to work the system, or how to mobilise a large network of contacts. Not surprisingly, many who aren't well prepared for their roles as brokers, feel that they rattle around without much impact.

For similar reasons, some of the other solutions that have been used to raise the visibility and status of scientific advice have tended to disappoint. Occasional seminars for ministers or permanent secretaries to acclimatise them to new thinking in nanotechnology or genomics are useful but hardly sufficient, when most of the real work of government is done at a far more

junior level. This is why some advocate other, more systematic, approaches to complement what could be characterised as the 'clever chap' theory of scientific advice.

First, these focus on depth and breadth: acclimatising officials and politicians at multiple levels, and from early on, to understanding science, data and evidence through training courses, secondments and simulations; influencing the media environment as much as insider decision making (since in practice this will often be decisive in determining whether advice is heeded); embedding scientists at more junior levels in policy teams; linking scientific champions in mutually supportive networks; and opening up more broadly the world of evidence and data so that it becomes as much part of the lifeblood of decision making as manifestos. Here the crucial point is that the target should not just be the very top of institutions: the middle and lower layers will often be more important. A common optical mistake of eminent people in London is to overestimate the importance of the formal relative to the informal, the codified versus the craft.

Second, it's vital to recognise that the key role of a scientific adviser is to act as an intermediary and broker rather than an adviser, and that consequently their skills need to be ones of translation, aggregation and synthesis as much as deep expertise. So if asked to assess the potential commercial implications of a new discovery such as graphene; the potential impact of a pandemic; or the potential harms associated with a new illegal drug, they need to mobilise diverse forms of expertise. Their greatest influence may come if - dare I say it - they are good at empathising with ministers who never have enough time to understand or analyse before making decisions. Advisers who think that they are very clever while all around them are a bit thick, and that all the problems of the world would be solved if the thick listened to the clever, are liable to be disappointed.

Experimentalist government

One reason that I'm optimistic is that in the coming period we may see a revolution in how evidence feeds back into decision making, thanks to the proliferation of data, new tools such as semantic analysis of social media, and the proliferating sensors of the Internet of Things. At the very least it's likely to become more natural for professions like teaching or the police to be influenced by data - whether it's the real time personalised

feedback on how individual pupils are faring, or data on crime patterns in neighbourhoods. Schools in places like Singapore already have journal clubs where teachers read, and discuss, the latest research. The Narayana Hrudayalaya hospital in India is famous for requiring doctors to meet weekly to discuss performance data - something that's normal in a Japanese car factory but oddly alien to many professions.

This is also an era when the scientific method is becoming normal well beyond the confines of the university. Firms like Amazon and Google use thousands of RCTs to evaluate new services; individuals monitor their own bodies; and everyday life is being reshaped by a flood of data and feedback. In this context, scientific advice has many allies, and is going with the grain of a more reflective, more data-savvy culture.

The authority of CSAs will often depend on how well they provide useful answers at moments of crisis; when a minister or Prime Minister needs to know how to cope with an epidemic or natural disaster. But advisers don't, and shouldn't, only offer answers. I remember Margaret Thatcher's CSA saying that she had told him that what she really valued were better questions more than better answers.

In optimistic moments, I hope that we are moving towards a period of more overtly experimentalist governance,[11] where governments are willing to test their ideas out - to run RCTs and embed continuous learning and feedback into everything they do. Experimentalist government would certainly be better than government by instinct, government by intuition and government solely guided by ideology.

In such a context, the old model of a clever man given a desk in Whitehall, sitting in a corner writing memos may be even more anachronistic. We certainly need highly intelligent, eminent experts to guide decisions.[12] We need to pay more comprehensive and sophisticated attention to not only the supply of useful knowledge, but also to how that knowledge is used. By doing this, governments and advisers can make more informed decisions, fewer mistakes and respond better to the complex problems they face. But let's be as serious in making use of the evidence about evidence, as we are about the evidence itself.

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A BETTER FORMULA: WILL CIVIL SERVICE REFORM IMPROVE WHITEHALL'S USE OF EXPERT ADVICE?

Jill Rutter[1]

Good policy needs the right blend of the technocratic and the political.[2] Both need to be present if a policy is to work. Ministers should want to know a policy is technically feasible, has a reasonable chance of working, and is the best available option; but, however technically robust, a policy also needs to be able to command sufficient political and public support to be implemented.

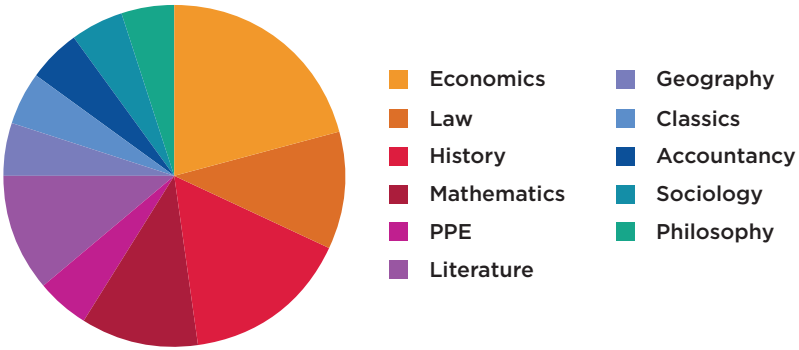
That is not the only dichotomy within Whitehall. Not all issues are equal. There will be some issues on which ministers have strong views, based on a mix of evidence and ideology; and those are likely to be the areas they are most keen to pursue in government. But much of the business of government is not about pursuing flagship policies; it's about finding solutions to problems that arise. The former No.10 adviser Steve Hilton observed that 70 per cent of the issues crossing ministers' desks were not in the coalition's 'Programme for Government.'[3]

Take my old department of Defra for example: few ministers arrived motivated by the desire to deal with a zoonotic disease (indeed they probably had no idea what one was before they got the briefing pack). However they may have held strong views on the importance of preserving the beauty of the countryside versus the desirability of promoting onshore wind power. On the first issue, they will give a large role to experts; on the second, evidence will take more of a back seat. This is the UK equivalent of what Roger Pielke Jr. describes as the divide in the United States between 'tornado' and 'abortion' politics.[4]

This is the environment in which experts have to operate if they are to influence policy. Few of the principal decision makers have a science or engineering background. Of the current crop of permanent secretaries in charge of departments, two have a degree in maths and one a degree in accountancy. The rest, as the diagram below illustrates, are drawn from the humanities or social sciences (though increasing numbers have a Master's

degree in economics.)[5] Not one has progressed to permanent secretary from the science profession within the civil service: so an issue that was raised in the 1968 Fulton report on the civil service remains as stark now as it was then.[6] The Cabinet ministers they serve are, if anything, less likely to have any sort of scientific or technical qualification.

Figure 1: **Degree backgrounds of permanent secretaries**



But Whitehall is undergoing change: radical downsizing combined with a programme of civil service reform, launched in June 2012,[7] which is designed to make it more unified, more accountable, more skilled and more professional. What will these reforms mean for the future of expert advice?

The starting point

Formal scientific advice has enjoyed a mixed decade. Under the last government, there were some notable steps forward with a gearing up of the chief scientific adviser network so that most departments had externally appointed chief scientists with genuine 'expert' credentials, and a clear rise in the profile of the Government Chief Scientific Adviser. However, in 2009, there was the notorious sacking by the Home Secretary of Professor David Nutt, chair of the longstanding Advisory Council on Misuse of Drugs, for expressing his views on the relative dangers of ecstasy and horseriding.[8] This episode raised fresh questions about the way in which government handled scientific advice.

Scientific advice is one subset of the wider class of 'evidence' that policymakers can draw on. The last government was committed, in principle at least, to 'evidence-based' policymaking.[9] The current coalition government has made some notable strides to embed independent evidence making in specific areas: the establishment of the Office for Budget Responsibility to take over fiscal forecasting from the Treasury, the Independent Commission on Aid Impact, and the Education Endowment Foundation, to test what works in tackling educational disadvantage.[10] On the other hand, the government's public bodies' reform programme has seen the abolition or status change of a number of expert advisory bodies, including high-profile casualties like the Royal Commission on Environmental Pollution.[11]

A smaller civil service

Departments have all had to commit to substantial staffing reductions, with numbers reduced by 12 per cent in aggregate since the 2010 spending review - and with deeper cuts of some 20 per cent in four departments.[12] The result has been considerable churn within departments, with teams spread thinner and potential loss of knowledge and relationships. A number of CSAs have been appointed at lower grades than their predecessors and been moved off management boards. In some departments, directors of analysis have double-hatted as CSAs.

These changes have led to concerns that CSAs - and thus scientific advice - are being marginalised. Yet none of these changes are science specific: top teams have been halved in most departments and management boards, now chaired by Secretaries of State rather than Permanent Secretaries, are supposed to focus on corporate management rather than policy issues. This was the basis on which the Head of the Home Civil Service rejected recommendations from the House of Lords Science and Technology Select Committee on the status of CSAs.[13]

The critical issue is access both to the early stages of the policy process and to final decisions. The Campaign for Science and Engineering (CaSE) produced a recent assessment of CSA influence. Most of its criteria made sense, and it ranked Sir Bob Watson at Defra and Dame Sally Davies as the most influential CSAs (scoring 5 out of 6).[14] But both of these CSAs fell down on one criterion - whether there was a record of their meetings with

the secretary of state over the past year. What the CaSE assessment failed to appreciate was that the most influential CSAs have far too many meetings to record. This depends less on grade than on the personal impact of the CSA - the openness of the department to engage them, and their willingness to get properly engaged in policy. The influential CSAs are those who can both bring expertise into the department through their networks and help ministers and senior civil servants apply it to produce policy - like Bob Watson, who had previously worked at the White House and World Bank (and was never shy of mentioning that). The CSA's ability to cope with, and even relish, policymaking in a political environment needs to be as much of a test when they are recruited as their academic credentials. They also need good support within the department so that they can rapidly become an integral part of normal departmental processes. CSAs who look equally eminent on paper have been variably effective in achieving this.

A reformed civil service?

The civil service reform plan recognises that the civil service needs to change if it is to be more effective with fewer resources. It emphasises the role of the Heads of Profession in strengthening capabilities: *"The 'Heads of Profession' operate as cross-Government leaders, and have an essential role in improving skills and maintaining professional standards. The Plan will boost the importance of their role in raising standards, departmental appointments, succession planning and talent management."*[15] The GCSA has already undertaken a review of the science profession in response.[16]

There are three other areas in the civil service reform plan that will affect the future of expert advice:

- Sharing analytical services.
- Open policymaking and transparency.
- Improving the quality of evidence.

1. Sharing analytic services

This is an area where work by the Cabinet Office is promised, but is yet to see the light of day. The models appear to be the Cabinet Office's Behavioural Insights team, established shortly after the election, which acts as a cross-government expert resource on applying behavioural economics to specific policy problems, and the Shareholder Executive, which manages government shareholdings in privatised companies or the nationalised banks. An alternative to this model of a centre of internal expertise would be to pool analytic services between departments, or between a department and its arm's length bodies. So far this model has not been developed further, but in his response to the House of Lords' Science and Technology Committee, Sir Bob Kerslake, Head of the Home Civil Service, noted that sharing CSAs was something which could *"bring real benefits."*[17]

There is potential for this model to act as a valuable counter to Whitehall's silo mentality: sharing analysis to give Ministers the best available assessment of the evidence, or designating a cross-Whitehall expert lead on an issue which cuts across departmental boundaries. But in a culture which still values presenteeism there is a danger that a shared, part-time, CSA, particularly where there is little synergy between departmental areas of concern, may simply lack impact in two departments rather than be effective in one.

2. Open policymaking and transparency

This is a much bigger theme in the civil service reform plan, with a promise to *"make open policymaking the default"*, recognising that Whitehall itself does not have a monopoly on expertise. The plan itself promises a new model of open policymaking and launches the 'contestable' policy fund, to allow Ministers to commission policy work from external sources including academics and think tanks. The reform plan gives some examples of new ways of collaboration - including crowdsourcing and policy labs (along the lines of Mindlab in Denmark) - but also stresses that *"the need to maintain a safe space for policy advice should not be used to prevent the maximum possible openness to new thinking or in the gathering of evidence or insight from external experts."* The government also promises to *"make more data freely available so experts can test and challenge our approaches effectively."*

On paper, this looks like a development with considerable potential to enable external experts to be involved in the policy process in different ways. But thus far, most of the examples of external involvement, which is in itself nothing new, have focussed on the involvement of practitioners, think tanks or the public, including the establishment of a 'Practitioners' Advisory Group'.[18] In September 2012, the government made its first (and thus far only) commission of external policy advice: a study by the Institute for Public Policy Research on accountabilities of ministers and civil servants.[19]

The potential for external experts to engage in policymaking depends on their capacity to work to the government's timetable. This can be a problem as a minister explained at a seminar at Institute for Government: *"I sat down with a research body the other day and they set out what they were planning to do. I said that 'do you realise that by the time you reach your conclusions, it will be far too late to be of use to anybody. It will be great history, but it won't help anyone make policy."*[20] This is why what government really values in external experts is not the latest research paper, but accumulated expertise based on long study of an issue, communicated in an accessible form, ideally with clear implications for action.

A more promising route to long-term policy influence may come through the commitment to transparency. Opening up big government data sets should allow much better applied academic work on the impact of government policy. But if these routes to influence are to be exploited, the next iteration of the Research Excellence Framework needs to do more to incentivise the production of applied research and the provision of expertise to policymakers.

3. Quality of evidence

The civil service reform plan makes two specific proposals in relationship to the quality of evidence in departments. First, it states that *"permanent secretaries must be accountable for the quality of the policy advice in their department and be prepared to challenge policies which do not have a sound base in evidence or practice"*. This is in line with a recommendation the Institute for Government made in our 2011 report, *Making Policy Better*.[21] If taken seriously, this has the potential to change the dynamic between civil servants

and ministers, and put permanent secretaries very much on the side of their expert advisers. It should also address concerns over the lack of access of CSAs to the policy process. Chris Wormald, the newish Permanent Secretary of Department for Education (and head of the 'policy profession' across government), recently commissioned Bad Science guru Ben Goldacre to look at the use of evidence in education.[22] More generally though, it is not clear that this element of the civil service reform plan is being taken that seriously - and it is likely to need some sort of institutional bolstering to be effective. It would be greatly reinforced if Parliament took a routine interest in the quality of the evidence base for policy by government.

For some topics that bolstering may come from a second commitment in the civil service reform place, which came to fruition in March 2013, when the Cabinet Office announced the establishment of new evidence centres on ageing, local economic growth, early intervention and crime reduction. These join the existing Education Endowment Foundation and National Institute for Clinical Excellence to form a network of six 'What Works' centres.[23] To be effective, these centres will need to build an evidence base for the policy framework as well as give best practice guidance to local commissioners, and there need to be adequate incentives to ensure policymakers seek their advice.

Science in Whitehall: prospects for change?

There are some positive steps in the civil service reform plan, but on their own they look unlikely to lead to a marked change in the way expert advice is handled in Whitehall. Previous attempts at civil service reform have faltered, as the initial impetus fizzled out.[24] Many of the problems around the integration of scientists and scientific advice into the civil service identified by the Fulton Report as far back as 1968 were echoed in the most recent report on the government science profession.[25]

But it is not a completely lost cause. The Fulton Report also identified a lack of economic and social science skills among generalist civil servants. That has changed radically. The last three Cabinet Secretaries have been trained economists, and the last two entered the civil service through the Government Economic Service. Economics is increasingly the language of Whitehall, with substantial crossover into senior policy positions. But there

is a contrast - economics brings a set of tools, whereas science brings both a way of thinking and also detailed knowledge. Most professional scientists in government seem to prefer to stay within their field of expertise, rather than broaden and apply the scientific approach to a wide range of issues. Moreover there is a gap in the science career structure - most CSAs are distinguished external recruits with one foot in academia. Chief economists tend to be promoted from within.

If Whitehall is to become more scientifically literate, there need to be more people with science backgrounds working on policy. At the same time, members of science professions need to understand the needs of decision makers, and be able to communicate and act as effective mediators between them and external experts. They need to understand trade-offs and opportunity costs. Policymakers without scientific backgrounds need to be supported to ask the right questions of their specialist advisers.

This still implies a model where the expert is on hand to advise when necessary, but does not help to set the agenda. This can mean that important issues get missed or undervalued. In his book *The Geek Manifesto*, Mark Henderson noted that the Government Chief Scientific Adviser was not consulted on the first National Risk Assessment, which is why it left the UK unprepared for the threat that materialised over Icelandic volcanic ash, at substantial cost to the aviation industry, travellers and the economy.[26] The Institute for Government has argued that the civil service needs to take more personal responsibility for the quality of policy, and scientific advisers and their teams are well placed to do that.

CSAs might also look to another, venerable model for bolstering their influence in government: the annual report of the Chief Medical Officer, which dates back to the 1850s. The most recent one recalled its aim:

> *"…to provide an independent assessment of the state of the public's health. Chief Medical Officers have produced their annual reports in different ways, but each with the aim of highlighting a limited number of issues which were, in their opinion, the ones that should be the current focus for policy and action to improve the health of the nation."*[27]

If the CMO can do this for health, there is no reason why the CSA community cannot produce a broader annual assessment of future

challenges for government. Such a move could help to set wider policy agendas, and move science advice out of the margins and into the mainstream.

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MAKING THE MOST OF SCIENTISTS AND ENGINEERS IN GOVERNMENT

Miles Parker

The establishment by Sir John Beddington of 'Government Science and Engineering' (GSE) as a profession to parallel the other evidence and analysis specialist groupings in Whitehall is one of the most important outcomes of his term of office as Government Chief Scientific Adviser (GCSA).[1] It is arguably the most important step forward for the recognition of scientists in government since the Fulton Report in 1968.[2] Fulton concluded that *"[m]any scientists, engineers and other professional specialists were not given the responsibility or authority they deserve..."* and recommended that *"these specialists should be given more policymaking and management opportunities, and training to equip them for their new work."* As with many of his recommendations, this was not implemented, probably because of cultural opposition within the civil service.

A recent review of scientists and engineers in government, published in January 2013, makes important recommendations to take GSE forward; it identifies the roles that scientists play and suggests how their effectiveness in policymaking and implementation could be improved.[3] The review found that the strengths of the current science cadre include its disciplinary diversity and expertise, its professionalism and accountability, and its openness to the wider science community. These are characteristics that will be essential in a smaller, flatter, more open civil service. In particular, the experience of scientists within government of engaging with the wider science community could serve as a model for aspects of open policymaking.[4]

At the same time, the review concludes that the government science community is not as joined up as it could be, and is too invisible to policymakers. Government scientists often lack the skills and agility to ensure that policy-relevant science is presented in politically effective ways. GSE was established to support the professional standards of scientists and engineers in government and the review makes valuable recommendations on training and development for agility, leadership and openness. A priority for Sir Mark Walport, as the incoming GCSA, will be to oversee an active programme of implementation.

Scientists in policymaking

The review identifies some 12,000 scientific posts in government and develops a typology, distinguishing:

- **Practitioners** (the great majority, mostly in 'arms length bodies' outside Whitehall, and often deep subject experts, applying science in analysis, inspection, advice and services).

- **Integrators** (managers or commissioners of science programmes, engaged in policy or operations).

- **Informed advocates** (scientists no longer practising their science but able to take an informed view of science advice in their policy or operational roles).

This three-part typology makes a distinction with important consequences. **Practitioners** - such as specialists in delivery agencies (e.g. Defra's Environment Agency) and public sector research institutes (e.g. Defra's Food and Environment Research Agency) - already have scientific career structures and professional development. However, the **Integrators** are a relatively small group and have to some extent been orphaned since the post-Fulton disappearance of the old Scientific Civil Service arrangements in the 1970s.

Within the **Integrator** group, a still smaller subset work directly within Whitehall; their functions range from commissioning research and other information gathering to its analysis and translation to policy advice, and in some cases to policymaking and even its leadership. Although small, this is an important sub-group on which I will focus in this essay. I want to consider the context in which this group operates, by reflecting on the changing role of scientists in policy advice within the Department for Environment Food and Rural Affairs (Defra) during my 11 years as its Deputy Chief Scientific Adviser (2001-2012).

Lessons from Defra

Defra grew out of the demise of the Ministry of Agriculture, Fisheries and Food (MAFF) in 2001, following the disastrous foot and mouth disease outbreak of 2000, and its merger into the environment component of the previous Department for the Environment, Transport and the Regions. This brought together two completely different traditions of science management, centralised in MAFF and integrated in DETR, and provided an opportunity to rethink how to deliver good science into evidence-based policymaking, in the context of the latest *Guidelines on Scientific Advice and Policymaking* (the 2000 version had just emerged).[5]

Over the last ten years, Defra has:

- Replaced the previous Director-level Chief Scientist posts with a Board (Director General) level Chief Scientific Adviser.
- Integrated science teams into policymaking teams.
- Developed multidisciplinary teams of science and other evidence and analysis specialists.
- Decentralised the management of evidence budgets to policy teams and strengthened strategic planning under the CSA.
- Introduced matrix management to support engagement in policy with quality assurance and professional development.

The Department of Environment had a long history of integrating science staff into policy teams, going back to Fulton's principles.[6] MAFF's scientists were centralised in a Chief Scientist's Group, and were more focused on research commissioning than analysis and advice; the MAFF model more closely reflected the thinking of the Rothschild Report of 1972,[7] which recommended that government departments hold and invest an applied science research budget. The aim of Rothschild's recommendations was to enhance government's ability to be an intelligent customer for the burgeoning science of the time. So the process of integration involved two cultural shifts for ex-MAFF specialists, away from a central team and a focus on R&D commissioning, a process aided by the substantial decline in departmental research budgets during recent government spending rounds.

It also helped that the demise of MAFF had been due in part to perceptions of incompetence in the handling of science advice through the controversy over bovine spongiform encephalopathy (BSE), which began in the late 1980s and lasted through the 1990s, and the outbreak of foot and mouth disease in 2000.[8] This gave Howard Dalton, the newly appointed CSA, greater status through the recognition of his importance to the new department's scientific, and therefore political, reputation. His position on the Board, especially in a period of budgetary stringency and almost continuous management review and downsizing, meant that he could argue the case for changes (specifically, those needed to implement the GCSA's guidelines) at the highest levels.[9]

Science and evidence

At the same time, the then Labour Government's adoption of the mantra of 'evidence-based policymaking'[10] was particularly helpful in encouraging a rethink about the relationship between disciplines in policymaking. 'Evidence' was clearly something more than just science, or just economics. Multidisciplinary approaches were self-evidently necessary for dealing with multifactorial policy questions, but came as a culture shock to quite siloed professions.

The move towards matrix management coincided with the arrival of Bob Watson as CSA and Richard Price as Chief Economist in the mid 2000s. Both Watson and Price recognised the need to bring all sources of evidence into policy discussions. The day-to-day engagement of science with policy was the responsibility of the policy leads, and Heads of Profession had oversight of the professional development and integrity of the analysts. At the same time, decades of pressure to enhance the department's social science saw the appointment of the department's first senior level Head of Social Science in 2007 reflecting emerging thinking about behavioural rather than regulatory policy options. Now, the CSA chairs a Heads of Profession group that oversees the professional integrity, standards and development of specialist staff as well as the direction of the Department's strategy for investment in evidence gathering and analysis.[11]

The integration of science staff in policy teams has been a long journey but has left Defra in a stronger place than its predecessors; reviews by both the GCSA's office and by the Head of the Home Civil Service over

the last decade have repeatedly emphasised Defra's excellence in handling evidence in policymaking.[12] Continued budgetary pressures are likely to lead to further changes in the relationships between the various elements in evidence gathering, notably in the relative emphasis on research and other forms of evidence gathering and analysis; however this simply continues a trend in which the Department has moved from a position of relative self sufficiency to one in which it has built strong partnerships with other funders.[13] This shift brings strong benefits in terms of more open gathering of advice for policy and helps the department avoid the classic policy trap of 'unknown knowns.'[14]

Open policymaking

It is interesting to speculate on future changes in the context of the Civil Service Reform Plan and moves towards 'open policymaking'.[15] This is emerging as a key response to what has seemed a hermetic and unaccountable Whitehall process. While protecting the space of Ministers to consider options without the pressure of unhelpful scrutiny, current models of policymaking have been ineffective in delivering the radical changes needed to address fiscal, social and environmental pressures.

The commissioning model introduced initially under Rothschild focused on the role of in-house specialists being the department's conduits to external expertise. In-house specialists combine a broad and respected knowledge in their discipline with a professional understanding of policy processes and excellent communication and networking skills. It is exactly these skills that will be important in developing open approaches to both the framing of policy problems and the design of options for solutions. Specialists can be valuable brokers between the policy world and academic and other sources of specialist research and analysis, helping to ensure that each side understands the other. Evidence-based policymaking will be more of a reality in a context where the policymaking process is more open to being informed and challenged by the widest range of sources of evidence.

Specialists and generalists

In closing, let me note that there is one cultural risk in all the gains that have been made. This is that the establishment of a multidisciplinary approach to evidence has within it the seeds of a new problem, a potential categorisation error between 'specialists' and 'generalists'. The distinction implies that, on the one hand 'we' (the specialists) provide evidence and 'they' (the generalists) don't, but correspondingly that 'they' make policy and 'we' don't. Neither is correct; on the one hand, specialists are increasingly directly engaged in policymaking and in some cases, where specialist understanding is important, lead it. At the very least, to be effective and useful, specialists need good policy skills, a point emphasised in Sir John Beddington's review.

Moreover, evidence is not solely derived from people with PhDs. While it is essential that experts remain expert (and that a multidisciplinary approach does not mean the loss of disciplines; on the contrary), we also need to recognise that the 'generalists' in practice have substantial expertise and knowledge. Much of this knowledge, of particular policy sectors (e.g. the agriculture, fisheries or food industries) or contexts (e.g. Europe, regional or local government) as well as of administrative law and practice, is tacit or experiential but it is just as essential, and needs to be subject to the same rigour as knowledge derived from the more formal disciplines.

Perhaps the next steps will involve recognising that policymaking is carried out not by individuals but by teams, sharing common policy skills, balancing aptitudes and competences, and bringing diverse mind-sets, experience and knowledge to complex policy problems. We can then replace the separate labels of specialist and generalist with the common name of civil servant, and finally implement one of the key conclusions of Fulton.

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12. See http://www.bis.gov.uk/assets/goscience/docs/science-review-defra/defra-review http://www.civilservice.gov.uk/wp-content/uploads/2011/09/DEFRA-phase1-Mar2008.pdf; also http://www.civilservice.gov.uk/wp-content/uploads/2011/09/DEFRA-phase2-Mar2009.pdf; also http://www.defra.gov.uk/publications/files/pb13755-capability-review.pdf
13. For example, Defra partnership with Research Councils UK and others on the Living with Environmental Change, and Global Food Security programmes.
14. I am indebted to Professor Roland Clift for this formulation. Donald Rumsfeld's three categories leave this one out; it is the category that gives rise to policy own-goals when others turn out to know things that the policymaker doesn't.
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CIVIL SERVICE IDENTITY, EVIDENCE AND POLICY

Dave O'Brien

Debates over the role and function of the civil service are nothing new. Politicians from left and right regularly complain that the civil service is a barrier to their agendas, while senior civil servants express concern about threats to their impartiality from politicisation or an erosion of the public service ethos. These debates crystallise around the question of whether the civil service is fit for purpose; capable of providing advice to ministers in the weighing up of policy options, and then delivering on ministerial decisions.

The promise of evidence based policymaking is that it will give a more central place to the type of rationality associated with the scientific method. However this promise must be fulfilled by actual people working in actual government departments. Here I want to consider an issue that is often overlooked: who will make evidence-based policy a reality?

Different groups construct this question in different ways. For politicians, the focus is on the day-to-day aspects of appointing staff or setting up structures that will enable their agenda to be delivered. For civil servants, keen to protect their impartiality and the autonomy it brings, it is often a matter of implementing organisational change, whilst preserving established hierarchies of oversight and control. In media discussions, the question of who will be doing evidence-based policy often seems to boil down to the need for a more prominent role for those with a scientific training within the Whitehall machine. All three constituencies share an implicit, but often unarticulated, interest in the identity of the civil servant.

This identity has in recent years undergone a change from what might best be described as the gentlemanly amateur, so endlessly caricatured, to a more technical identity capable of coping with evidence-based policymaking.[1] This change is central to understanding the prospects for a Whitehall capable of responding to the technical challenges of scientific controversies, and synthesising evidence in the economics-driven, cost benefit framework that characterises HM Treasury's preferred approach to policy development.

The many faces of the civil service

The civil service contains a range of roles with differing identities. Those most crucial in the use of evidence are the analytic professions of economists, social researchers and statisticians. It is possible to situate the professional identity of these analysts in relation to three ideal types; the gentlemanly amateur Whitehall civil servant, the technocratic bureaucrat and the social scientist. Each form of professional identity requires construction, negotiation and maintenance within the bureaucratic and political structures of contemporary Whitehall life, and each is intertwined and interdependent with the others.

These three forms of identity are useful heuristics for understanding how evidence is used in central government. They are also constructed forms of identity that are both the product of historical and contemporary realities, and resources for civil servants to draw on when thinking about their role (even if this is implicit or unacknowledged). Such 'social imaginaries' - in the case of the civil service, both the products of individuals' activities, as well as academic and popular narratives - act as 'resources used to perform, justify and legitimate both individual and collective actions'.[2]

The origins of the 'modern' civil service associated with the popular caricature of Sir Humphrey, or the less normative idea of the gentlemanly generalist, has its roots in the rise of the nation state in the UK at the end of the eighteenth century, driven by the need to create a governmental form capable of financing war and administering the national debt. As the modern bureaucratic state evolved, the Northcote-Trevelyan report of 1854 sought to separate the practice and identity of the civil servant 'both from the pull of political patronage and from narrow, specialised expertise'.[3] This further contributed to the creation of the ideal type of the generalist, admitted by exam and capable of general public management, associated with the English upper classes of the time. This identity was closely associated with the practices of the Oxbridge curriculum, providing the curious closed meritocracy that would dominate the civil service until (and beyond) the Fulton Report of 1968.[4]

This identity also underpinned the tradition of civil service neutrality, grounded in a sense of professionalism. This aspect of the civil service has been subject to extensive criticism, from both left and right, as a myth, concealing the real establishment or counter-reforming positions of the

civil service. However, that professionalism was not purely based on the generalist of the Victorian imagination, and has continued across a range of transformations in Whitehall.

Middle-class identities in a hollowed-out state

The rise of an alternative identity to the generalist civil servant was concurrent with wider changes to Whitehall and public administration that resulted from the post-1970s hollowing out of the British state. Aspects of this hollowing out include the dominance of non-departmental public bodies for the delivery of public services; a new 'public' face of the civil service for the purposes of transparency and accountability; the rise of a politicised cadre of special advisers; the application of management theory to the policy process; and a much more complex political relationship between politician and bureaucrat. Senior civil servants are now *"heavy-duty managers rather than the most penetrating intellects of each graduating cohort from the top universities, are there primarily to deliver policy rather than to formulate it or to police the boundaries of constitutional propriety, and are paid high-level corporate salaries in exchange for being in the line of fire for public blame when things go wrong."*[5]

The rise of a more technocratic civil service needs to be understood against the backdrop of social change in post-war Britain. Mike Savage describes how middle class identity broke away from traditional notions of status and *"emphasised instead the technocratic and scientific capabilities of the middle class…as key parts of an efficient and modernising nation."*[6] This went hand-in-hand with the reflexive role of social science in society, as social science concepts and findings were increasingly used by individuals to construct their identities.

Analysis of these dimensions of identify has often been overlooked in discussions of the civil service. Recent reforms, involving the development performance management regimes and market-based policy frameworks, would not have been possible without the associated identities to operate within these regimes. We see these dynamics too in key institutional moments such as the 1968 Fulton Report, and in the post-war work of the Colonial Office, which embraced the specialisation, rational planning and scientific methods more closely associated with the policy process of more

recent times.[7] By the time of Fulton, the emergence of technocratic forms of expertise is neatly summarised by David Edgerton's observation that *"only a profoundly technological nation could harbour the technocratic rhetoric of Harold Wilson."*[8]

Social scientists in suits

Traces of gentlemanly identity remain within the technocratic mindset that now characterises Whitehall. And a third identity has been added that is crucial for the analytic professions within government departments: that of the social scientist.

This reflects Max Weber's conception of social science in his essay 'Science as a vocation', where Weber attempts to draw boundaries around science's role in answering technical questions and its potential to assist in political decision-making.[9] This belief that the role of the analytic profession is to provide technical assistance to political decision-making is vital to understanding the identity of those who will be most directly involved in evidence-based policymaking. It is also an important aspect of the wider civil service identity. The longstanding division between political decision-making, and its counterpoint in advice and delivery, may find a new legitimacy by drawing on social scientific identity, in addition to technical identity, as a basis for the continued validity of the civil service's traditional, gentlemanly, sense of itself.

These identities are not confined to Whitehall. A recent study of social scientists in Wales' devolved administration found a complex diffusion of social science expertise and practices associated with the task of public administration.[10] The study suggests that social scientists do not draw directly on the disciplinary expertise associated with their academic qualifications, but that social scientific training still played a crucial role in project management, in assessing the quality of evidence, external research reports, and in their dealings with 'policy customers.'

Analysis of these changes in the identity of civil servants provides a more grounded, historicised explanation for who will be capable of actually implementing evidence-based policymaking. However broader questions remain about the future shape of the civil service. The Institute for Government has discussed the impact of attempts to cut Whitehall costs

by up to 50 per cent, through reduced staff numbers and other austerity measures.[11] The issue may, no longer, be who and which identities are necessary to embed evidence in policy. Instead we need to worry about the sustainability - and even survival - of technical identities in a context where those with the necessary skills are increasingly expected to find their vocation elsewhere.

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2
THE DISCIPLINARY MIX

THE SCIENCE OF SCIENCE ADVICE

Sheila Jasanoff

Institutions that play a watchdog role in society offer a persistent challenge for democracy: who shall watch the watchers? We shrink at the thought of unlimited police power or judges who place themselves above the law. Scientific advice is not immune to such concerns. Its role is to keep politicians and policymakers honest by holding them to high standards of evidence and reason. Arbitrary and unfounded decisions are anathema to enlightened societies. But who ensures the rationality of science advisers, making sure that they will be held accountable for the integrity of their advice?

That question may seem too trivial to be worthy of serious consideration. Aren't science advisers accountable at the end of the day to science itself? Most thoughtful advisers have rejected the facile notion that giving scientific advice is simply a matter of speaking truth to power. It is well recognised that in thorny areas of public policy, where certain knowledge is difficult to come by, science advisers can offer at best educated guesses and reasoned judgments, not unvarnished truth.[1] They can help define plausible strategic choices in the light of realistic assessments of evidence;[2] rarely can they decree the precise paths that society should follow. Nonetheless, it is widely assumed that the practice of science imposes its own discipline on science advisers, ensuring that they are bound by known facts, reliable methods, responsible professional codes, and the ultimate test of peer review. Seeing their role as apolitical, science advisers are not inclined to introspection in situations where their work fails to persuade. It seems more natural to blame external factors, from public ignorance and media distortion to the manipulation of science by powerful corporate funders or other large interest groups.

Science and technology studies

Ironically, there is one kind of science that science advisers rarely turn to for insights into how best to define their role in the policy process. That is the body of scholarship which has emerged from some three decades of research in the field of science and technology studies (STS).[3] STS starts

from the proposition that scientific knowledge is one of the basic means with which modern societies make sense of who they are, how they relate to the world around them, and what they can or should do in order to improve their conditions. It follows that societies also need to study the processes through which science and technology are made in order to understand how knowledge advances, what makes innovation happen, and why things do not always progress as hoped or planned. These questions assume greatest importance for human well-being when significant public decisions hinge on science and technology, as in today's urgent choices about how to cope with climate change. Accordingly, STS scholars have taken up the production of policy-relevant scientific knowledge as a specific, salient topic of investigation.

An early and generative focus of STS inquiry was the matter of scientific controversies.[4] If science is the closest approximation we have to reality, then science should end controversy, not prolong it. Yet, across a wide swathe of health, safety, environmental, and other social issues, science seems more often to serve as a lightning rod for disagreement. The easy explanation, which many still buy into, is that this happens only because science gets captured by political interests, canonically illustrated by the energy industry's sponsoring of climate research,[5] or, more notoriously, the tobacco industry's funding of studies debunking the connection between smoking and cancer.[6] It follows that the solution is to erect higher barriers around the conduct of science for policy, shielding science from corrupting influences.

Intelligent engagement with politics

STS scholarship, backed by detailed studies of science advice in action, has come to almost the opposite conclusion: that better science advice requires more intelligent engagement with politics. This observation may initially sit uncomfortably with advisers but should in the end lead to more accountable uses of their knowledge and judgment. The most relevant findings from STS research can be summarised as follows:

- First, 'regulatory science' (the science most relevant to policy) does not simply exist as such in the outside world but rather is the output of advisory processes which are themselves loaded with value judgments,

often in a form that social scientists call 'boundary work': for example, which facts and disciplines are relevant; when is new knowledge reliable enough for use; which dissenting viewpoints deserve to be heard; and when is action appropriate, even if not all questions are answerable on the basis of available knowledge. Accordingly, science advice can never stand wholly aloof from politics. The problem is how to manage its boundary-straddling role without compromising scientific integrity.

- Second, public refusal to accept the judgment of science advisers does not reflect intellectual 'deficits' on the public's part but rather the failure of decision making processes to resolve underlying questions of responsibility: for example, who will be monitoring risky new technologies after they have been released into the market, and who will pay if the consequences are unintended but harmful? Science advisers may consider these issues outside their remit, but publics have good grounds to believe that experts will take note of these contextual factors when they advise policymakers on matters of risk and safety.

- Third, science advice often tracks the promises and practices of science itself, attaching disproportionately greater value to what is known or can be learned than to what is unknown or outside the reach of the advisers' immediate consciousness. That tendency leads in turn to a relative disfavoring of hard-to-gather social and behavioral evidence, as compared to measurable facts about the natural world. It also makes the process of science advice inattentive to hierarchies of power and money, not to mention to cultural biases and global resource inequalities, which shape the problem framings and methods of investigation that scientists bring to bear on social problems.

- Fourth, science advice partakes of, and to some degree reproduces, salient features of a nation's or region's political culture, including a society's relative weighting of experts' technical knowledge, personal integrity and experience, and capacity to represent significant viewpoints in society.[7] In turn, those ingrained but on the whole invisible cultural preferences may affect an advisory system's own resilience and ability to learn from its past mistakes and false turns.

The uses of science and technology studies

The implications of these findings for the ongoing work of science advice, as well as for the broader relations of STS scholarship to policy, are not obvious, and this is why sustained engagement between science advisers and the scientists who study their work could prove beneficial for society. We can outline in the broadest strokes three kinds of roles that STS research could play in a more self-conscious advisory system: instrumental, interpretive, and normative.[8] Of these, the instrumental role has already been recognised as valuable in some advisory contexts, most notably the introduction of new and emerging technologies. The other two roles, almost by definition, fall outside the purview of advisory bodies and may even seem antithetical to the two prime mandates of advice giving: be timely and be policy-promoting. That apparent inconsistency, however, vanishes on more careful analysis.

Instrumental uses of STS expertise are not only inevitable but are to some extent justifiable in the interests of democracy. It is reasonable for societies to expect that knowledge leading to greater self-awareness should be put to use in reforming the institutions and processes of governance; in short, enabling societies to achieve their own best hopes for themselves. This expectation is all the more warranted when support for STS research comes from public resources.

Nevertheless, a few notes of caution are in order for both STS scholars and those inclined to draw immediately applicable lessons from their knowledge. Such transmission-belt models of 'use' and 'application' seldom question the deeper purposes for which knowledge is being harnessed. It is not uncommon these days for governments or their science advisers to call on STS scholars to design better communication practices between science and the public. Consciously or unconsciously, such reliance often rests on outmoded understandings of the reasons for controversy and rather reductionist views about how to make communication work better. Science, as understood by advisers, remains in the driver's seat; publics are cast as useful junior partners in the corporate enterprise of producing 'better science,' that is, knowledge within-the-frame that further embeds entrenched modes of thinking.

It is less usual for science advisers to ask STS scholars for their interpretive skills, to help redefine unfounded problem framings: for example, the widespread tendency to medicalise, even 'geneticise,' persistent social problems such as poverty and gender inequality; or to favour natural as opposed to behavioral models for explaining degradation of the environment; or, even more foundationally, to rely on notions of scientific objectivity that simply amount to enacting cultural preference by other means.[9]

We can well understand why policy advisers should wish to shy away from such uncomfortable insights, especially when they come from outside the zones of public decision making. They destabilise order at the most disturbing levels. They question authority, even when authority is essential for the orderly running of complex societies. Most troubling perhaps, a constant re-examination of taken-for-granted foundations seems to leave societies perennially off-kilter, without answers and without the will or capacity to build themselves afresh. The very principle of sustainability, after all, coincides with the aims of good historic preservation: to respect the footprints of the old while labouring to raise up the new.

Science advice: collaboration between creators and critics

These worries point to the third way in which the resources of STS could be used to further the goals of science advice, that is, through the field's potential to tease out the normative implications of producing regulatory science. One should not minimise the difficulty of such a collaboration. Work that probes into the foundations of knowledge making is sometimes associated with unproductive wheel-spinning and radical relativism, denying the very possibility of truth and progress. Yet the wheels, in my view, can spin with traction. The purpose of asking how we know what we know is not to tear down knowledge but to make it serve us better.

In its focus on making and construction, STS reflects the instincts of the good engineer, the rebuilder of societies. In a world that seems too often to be hurtling toward planetary self-destruction, we need the capacity - and will - to question our purposes deeply: to ask over and over how knowledge underpins institutions and policies that are sometimes serviceable but other

times perverse; and to explore how even esoteric social institutions such as scientific advice-giving can stay in touch with ongoing reflection on where we have come from and where we are going. Sustainable societies demand the possibility of querying their conceptions of the good - no less in pursuit of good science advice than in any other sphere of decision making.

It is one thing to lay out the merits of closer interaction between STS and science advice, quite another to imagine how those closer relations might come about in practice. Universities, in my view, bear a special burden, as training grounds for experts in most fields and as places in which reflective and interpretive disciplines such as STS can find a secure home. A recent report of the US National Academy of Sciences, *Using Science as Evidence in Public Policy*,[10] comes close to endorsing this recommendation. The report calls for increased research and education on the use of science in policy and points to the need for more courses in policy schools teaching *"an anthropological, sociological, or humanistic approach to policy making."*[11] But collaboration between the institutions of science advice and the scholars who study them cannot stop with academic training. There is need for a more continuous, empathetic, and professional interaction, through enhanced representation for STS scholars in key regulatory agencies, advisory committees, peer-review processes and public consultations.

The relationship between creators and critics is fraught but indispensable. Good critics pick at the flaws in a creative enterprise but they are also best placed to celebrate its genuine achievements. Science advice has become a vitally important site of knowledge creation in modern societies, a site in which knowledge combines with wisdom to everyone's benefit. It is time for science advisory systems to recognise that - to stay honest - they too need critics from the communities of research studying how knowledge and action are linked together. In democracies, no institutions of power should be beyond critique. If judges may not presume to stand above the law, still less should science advisers seek to insulate themselves from the critical gaze of the sciences of science advice.

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THE CASE FOR A CHIEF SOCIAL SCIENTIST

Cary Cooper and Stephen Anderson

In the UK, central government is a major commissioner and user of social science research. Many departments, including the Department of Health, the Department of Work and Pensions, the Department for Communities and Local Government, and the Department for the Environment, Food and Rural Affairs do this in a significant way (although amounts of spending are not always visible publicly). In addition, the Government Office for Science undertakes various multi-disciplinary pieces of analysis to inform science in government, and the Foresight programme engages in valuable horizon scanning. The Government Economic and Social Research services undertake their own analyses and research investigation. Autonomous units, such as the Behavioural Insights Team - the so-called 'nudge unit' - in the Cabinet Office, trial and promote particular interventions. There are close links through the Department for Business, Innovation and Skills with the Research Councils and other publicly funded bodies who undertake and fund a range of investigations independently, but whose outcomes are of interest and concern to policymakers. Finally, there are specialist Scientific Advisory Committees (SACs) who provide input on particular issues, which are frequently cross cutting and require a multidisciplinary approach.

There are many very able people engaged in all of these pursuits; but nowhere does social science come together functionally in a completely holistic way. It is true that the Heads of Analysis Group, chaired by the Permanent Secretary at HM Treasury, and a Departmental Directors of Analysis group, chaired by the National Statistician, work to bring some of this together, and perform a quality assurance and risk assessment function. The Government Economic and Social Research services have sponsored a number of cross-cutting analytical groups, on topics such as behavioural economics, the green economy and growth, localism, social cohesion, social impacts and social mobility. These develop intellectual capital and evidence to inform cross-departmental policy issues. But because neither grouping is chaired by a senior social scientist, the full benefit of these processes cannot be fully realised. Only a senior social scientist, trained in research methods and in touch with the profession on the latest thinking across a range of multidisciplinary issues, can fully bring this to bear.

Social science and the CSAs

There is a further issue. The government engages some 20 departmental chief scientific advisers with particular briefs for advising their own departments on policy development, analysis and the scientific evidence base. It is here that there is no social scientific adviser, following the retirement in 2010 of Professor Paul Wiles, previously CSA to the Home Office (and head of the Government Social Research service). It is at this level where access to ministers and the Government Chief Scientific Adviser occurs directly, where influence can be greatest, and where formal and informal discussions about policy arise.

Does this matter? The Academy of Social Sciences believes there are four reasons why it does, which are why we have lobbied for the appointment of a chief social scientist.[1] First, departmental scientific advisers are currently rooted in the physical, life and medical sciences. Inevitably, this restricts their ability to draw on the insights that the social science community can offer because it is not their area of expertise. There is a risk of not using social scientific tools to look at social issues - missing an entire branch of scientific endeavour. Second, the current CSAs do not have established or regular links with external communities of social scientists and are not fully conversant with the latest thinking or evidence on particular issues. Third, there is a lack of strategic oversight at the senior level about the social science information needs of government as a whole. Finally, there is a risk that social science evidence is used inappropriately or not at all and that insufficient weight is given to the insights it can offer.

The case for a chief social scientist was supported twice by the House of Lords Science and Technology Committee in recent reports.[2] The House of Commons went further to suggest that a senior government minister should have a particular responsibility for social science and be able to take a cross-government view in ministerial discussions, and respond to Parliamentary questions and reports from select committees.[3] The science spokesman for the Liberal Democrats has also taken up this call.[4]

A seat at the top table

Social science, with key contributions to make to some of society's most pressing and costly issues, such as climate change, wellbeing, social cohesion, children and ageing, is just too important in the national agenda not to have a seat at the top scientific adviser table where the real influence is felt.

We regard the March 2013 announcement of a national adviser to oversee the network of What Works centres as a welcome step in the right direction. The role of the national adviser will be more limited than that of chief social scientist. A reporting line into the Cabinet Office and the Treasury suggests a brief focused more on improving cost efficiency than increasing policy effectiveness, but the working out of all of this remains to be seen.

Crucially though, there is an announced commitment to the National Adviser reviewing the case for a chief social scientist with the social science community. A chief social scientist would be a much bigger role because the person appointed would work across Whitehall and oversee functionally all the various places where social science is done. It remains to be seen whether the What Works national adviser is a further step towards the restoration of the full chief social scientist role or is the end of the story for the moment.

Reading the riots

It is in the nature of social science that it is inherently provisional; the ongoing interpretation of evidence is vital. The chief social scientist has a key role to play in this process. The interesting conversations will arise when that evidence is counter-intuitive or contested. Diagnosing the causes of the riots which occurred in England in 2011 and framing appropriate media and policy responses is a classic case where senior level input from a chief social scientist could have helped politicians and police chiefs alike to a broader view than that these were simply acts of violence perpetrated by a criminal and feral underclass. Another example would be in respect of current plans to discontinue the census in its current form.

The most interesting conversations in public policy occur where research evidence comes up against political dogma. But that is precisely why there needs to be a chief social scientist to play a full part in those conversations, which occur in the first instance beyond the public gaze.

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ENGINEERING POLICY: EVIDENCE, ADVICE AND EXECUTION

Brian Collins

The evidence base from pure science is used at all stages of the policy lifecycle, but the use of applied scientific evidence in support of engineering-based policy execution has diminished in the UK in recent years.[1] A number of factors have contributed to this reduction, not least of which, in the UK at least, is the outsourcing of most engineering-based policies to agencies or to the private sector. This has resulted in the creation of a gulf between those responsible for the initiation of policy and those responsible for its execution. This gulf has particularly important consequences for the use of engineering evidence. Ensuring that a policy when designed is actually practicable is an essential feature of the policy framework if robust policy execution is to be achieved. Given the distance that has been created between those that design policies and those that execute them, this assurance of practicability has been severely weakened. Consideration of why this situation has come about is worthy of analysis.

I offer these reflections as a former Chief Scientific Adviser (CSA) in two UK government departments, transport and business, and earlier as a civil servant working as chief scientist and director of technology in another department. My main observation is that there has been a loss of policy execution expertise over the 50 years since the end of the UK's post-WWII rebuilding programme (in roughly 1960). This loss of competence has resulted in a lack of knowledge of how the 'world works' in the political classes and the civil service, both central and local. I experienced this shortfall in the planning for transport improvement programmes, in low carbon energy systems and in understanding the potential of modern manufacturing methods for stimulating growth. This is not to be critical of the motivation, loyalty and intellectual capability of the civil service and political public servants with whom I worked; just that their prior experience had not equipped them for delivering policies. Successful execution demanded engineering expertise. It should also be added that advice on how to do better was in most cases sought and gladly received.

Beyond market mechanisms

Taking a more analytical approach, the dominant approach to achieving efficiency in policy execution in the UK has been to exploit market principles and their associated success metrics. Yet unregulated markets have very simple success metrics: profitability, financial sustainability and return to investors. Public policy effectiveness is not in scope unless it is regulated to be so, or is in a contract. If a regulator's duties include the delivery of effective engineering solutions then markets can deliver policy execution as long as the regulations can be made compatible with this objective; this in turn depends upon regulators having the necessary skills, professional competencies and advice. If the means by which effective execution is achieved is via a contract or set of contracts, the contractual agreements must contain effective policy execution as a contractual obligation, which for complex packages of contracts can be very difficult to achieve.

If the risks of using competitive market principles to deliver effective policy execution are considered too great, one alternative is the use of collaborative public-private frameworks. This approach has been taken in some sectors in the UK, but usually only for the capital investment element of policy implementation, and not earlier in the design phase or later in the operational phase; in all cases there seems to be no institutional framework for independent advice being considered or evidence gathered to ensure the engineering feasibility of what is being proposed.

There is a systematic failure to seek evidence on how any given proposed solution can be operated and sustained in the face of changing circumstances, whether financial, environmental or social. It seems the risks have been displaced from the domain of the market and the regulator to the legal and contractual frameworks; but a significant risk of engineering and execution failure remains. Accountability for success and failure remains in the public sector, usually with politicians, even though the authority and responsibility has been 'outsourced'.[2] In most branches of management teaching, this separation of accountability and authority is not regarded as good practice, as risk mitigation becomes very difficult if not impossible.

Systems of systems approaches

The fruitful combination of systems of systems thinking and the recognition that the problem of policy execution is in the class of 'wicked' problems is generating fresh approaches. It is becoming increasingly clear that an embedded learning environment along with the continuity of expertise and personnel is crucial for the successful execution of policies where the outcomes are uncertain, the context is intrinsically dynamic and the emergent properties of the execution may or may not be desirable. Such a learning environment would enable lessons to be taken on board as they are spotted during a programme of policy development and execution, rather than waiting for the end of the programme. Lessons would be disseminated using the modern push-pull methods enabled by the worldwide web and opened to a broader community than those directly involved in any given programme. However, rapid turnover of key staff and diminution of expertise remains a risk factor which has to be taken into account. If such changes are inevitable then identifying ways in which expertise can be replaced with some level of handover, and hence greater retention of corporate memory, is essential.

This analysis suggests that advice to government on science and engineering should cover a much wider community that just the central government department that produces the core policy vision. Agencies, regulators and contractors and other actors in the 'theatre' could benefit from an evidence-based approach to policy advice, so that coherent approaches are taken not only to policy generation but also to policy execution, especially where engineering aspects are critical to success.[3] The fragmented approach currently in place can cause perverse outcomes to emerge from a package of policies and also result in friction and inefficiencies in execution, exactly the opposite of what is desired.

This approach would also enlarge the remit of advisers to government and add to advisory costs where budgets for such advice are measured in millions, but could result in lower risks to implementation and hence to smaller budgets for policy implementation and execution where budgets are measured in billions. This gearing ratio would be an effective way of using existing expertise to de-risk policy execution. An additional positive factor is that much of the expertise to be exploited is itself a result of government investment in scientific research and education. Ensuring this publicly

funded expertise contributes to reducing the risk and adding to the value that accrues from efficient policy execution therefore increases the return on government investment in science.

Spanning policy design and execution

Because policy implementation and execution in complex contexts has unexpected emergent properties it is essential to grow a learning environment around policy generation and execution processes. This learning environment should enable a transformation from a linear 'develop and approve and execute' process to one where modification can occur as a result of experience along the way; feedback loops must be explicit. The idea that it is possible to identify a policy purpose and design its execution ab initio in complex situations must be discarded. This hypothesis changes the way in which policy is thought about and changes the processes whereby it is executed.

The idea that policy development frameworks should be reconsidered in the light of new circumstances is not new; it has happened many times in the last half century in a number of policy areas. What is new about the current situation is the complexity of the context and the multiplicity of interdependent factors which need to be taken into account. Using outmoded ways of developing and evaluating policies results in inefficiencies and heightened risks or paralysis because there is no obvious way forward. But such changes to policy frameworks have risks in themselves and so have to be managed with care and consultation.

This analysis of the policymaking ecosystem implies a need for changes in a number of aspects of the policymaking 'machine', and these changes are potentially destabilizing if not treated holistically. Given that the responsibility for the 'machine' is distributed amongst a number of government departments in the UK and in most other western democracies, it is unlikely that a 'grand project' of policymaking reform would be successful, even if it was politically acceptable. But unless policymaking reform occurs, policy execution will continue too often to produce less than desirable outcomes, and on occasion very bad outcomes.

One route forward is to identify through research what elements of policymaking it is essential to improve to lower risk and propose pragmatic

programmes to improve those elements. Examples might be regulatory and planning coherence across a domain and between domains; the instantiation of cross-sector learning processes within disciplines such as engineering; and multifactorial assessment of value during the process of development of need. Embedded data and information collection should also be a prerequisite for all policy execution programmes so that effectiveness can be easily evaluated and the evidence-base improved.

Ingenuity in the service of better policy

These examples all come from my experience as a Chief Scientific Adviser in two government departments over a period of nearly five years, where I saw inadequacies in the policy process which resulted in plans for execution that were higher risk than desirable. In a number of cases, remedial action was possible in time to mitigate the risks, but as there was no learning 'apparatus' as described above, the lessons learnt have been rapidly dissipated as civil service staff, contractors and advisers - including myself - have moved on. Steps are being taken in a number of UK universities to further the research and teaching agenda on all aspects of policy. Engagement with civil service officials and leaders of other government bodies will be essential if the quality and effectiveness of policy execution is to be improved.

This engagement can take many forms: from seminars and roundtables, to short courses, executive education and Master's degrees. However since a considerable element of policy execution is and will be in the private sector it is also essential, if the whole ecosystem is to improve, that engagement occurs in a similar way with leaders in those companies that are major players in policy execution, and with the regulators that determine the scope of the licence to operate in and between regulated sectors. Other actors in the space include lawyers and accountants who also have a profound effect on the ecosystem dynamics.

The analysis presented here is not the only approach to how policy execution could be made more effective. Research is needed to see how other approaches based on anthropological, political, cultural and economic scholarship could add a richer perspective to the delivery of policies for the public good. No one discipline or branch of scholarship can have all the

answers and research is also needed in how to synthesise the deliberations from each contributing discipline into a framework for policymaking and execution that is sustainable, resilient and pragmatic.

Furthermore, allowing any one discipline to become dominant alienates those who practise in others and causes friction, even to the extent that paralysis occurs in taking forward any given policy objective. An evidence-informed synthesis of viewpoints will more often than not cause better outcomes, but idiosyncratically not always. There are a number of episodes from the past where the vision and even hunches of individuals has allowed leaps forward in the delivery of public goods; there are of course examples of where the reverse is also true. The argument between those who say 'we have always done it this way' and others who insist 'history proves nothing' is still alive and well. Wisdom may lie in the ability to see in which camp any given issue lies, and to determine policy accordingly. Such wisdom in support of policy decisions may well be critical given the stresses on the human species, the planet and its resources, and hence the urgent need to exploit our knowledge and our ingenuity, the origin of the word engineer, to the best effect.

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THE BENEFITS OF HINDSIGHT: HOW HISTORY CAN CONTRIBUTE TO SCIENCE POLICY

Rebekah Higgitt and James Wilsdon

It is easy to chant the mantras of evidence-based policy, but less straightforward to determine which forms of expertise and evidence should count. There is now a welcome recognition across government that many policy problems benefit from multidisciplinary perspectives. But implicit hierarchies between disciplines persist, which are rarely explained or written down. Economics has long been the primary source of epistemic authority in Whitehall, with its political powerbase in HM Treasury. The natural sciences enjoy a significant, and growing, role. Engineers and social scientists have now been welcomed into the club. But the humanities -including history - often remain out in the cold.

There have been several efforts to demonstrate its value of the humanities to policy in recent years, including helpful contributions from the British Academy, the Arts and Humanities Research Council and individual humanities scholars.[1] Some progress has been made, but as the historian Roger Kain put it in his October 2011 oral evidence to the House of Lords inquiry into chief scientific advisers (speaking on behalf of the British Academy): *"the term science and engineering seems at the moment to not exclude but marginalise the humanities and social science in relation to advice and expertise: culture, history, language, psychology, and political science."*[2]

The potential contribution of a number of 'marginalised' disciplines merits serious discussion. Here we want to focus on history, and call for the evidence and expertise of historians to be taken more seriously in policy - particularly science policy - alongside evidence from the natural and social sciences. Given Sir Mark Walport's support for the medical humanities and the history of science during his decade as director of the Wellcome Trust, we hope this is an agenda where he will want to demonstrate some leadership during his tenure as government chief scientific adviser.[3] And we suggest that one way he could signal his commitment to the value of historical methods and insights in science policy would be to pilot a small 'hindsight project' within the government's existing Foresight Programme.

Lullabies and rear-view mirrors

This is an argument with a history of its own. Most recently, it received a high-profile endorsement from Lord Butler, the former cabinet secretary, who published an article in March 2013 making the case for historical advisers in every department. 'Those who take major policy decisions in ignorance of relevant history,' he wrote, 'are like a driver who commits to some manoeuvre in the road without looking into the rear mirror.'[4] The Whitehall historian Lord Hennessy added to this by arguing 'a historian can inject an element of humility when the politicians are singing themselves lullabies.'[5]

Lord Butler's article contained echoes of an earlier call by Sir David Cannadine, in 2007, for a 'government chief historical adviser' and network of departmental historians. Its timing was also deliberate: with momentum building around the use of evidence in policy and new initiatives such as the Cabinet Office's network of 'what works' centres, historians feel they are in danger of being undervalued as an asset to the policy process.

Why history matters to science policy

In science policy, history often plays a role as example or justification, based on assumptions about how science is done or how innovation occurs that misrepresent our knowledge of the past. As Virgina Berridge notes in her study of history in health policy, there can be a 'totemic role' for historians,[6] where historical messages are 'misunderstood or used for particular policy purposes.' And history is often used without the mediation of historians, presented by 'other interests in the policy field.'[7]

Historians, naturally, have an interest in making sure that the history used in the public sphere is not completely divorced from their research, especially since most of it is publicly funded. That science policymakers should make use of scholarship in the history of science and other allied fields, including philosophy and sociology of science, is perhaps less obvious, as are the mechanisms by which historians would get their voices heard. Initiatives like History and Policy are focused on encouraging historians to see the potential relevance of their work and, through policy-friendly reports, aim to show that 'historians can shed light on the causes of current problems and even suggest innovative solutions.'[8]

Historians have occasionally found a role within policymaking through research focused on topics of recent history and obvious relevance. One example is Catherine Haddon who, having produced a thesis on Whitehall and Cold War defence, is now a research fellow at the Institute for Government, where she has co-authored reports on managing government transitions and dealing with minority and coalition governments.[9] Similarly, there was interest in historian Abigail Wood's work on foot and mouth disease, in the immediate aftermath of the crisis of 2001.[10]

Dispelling myths and challenging assumptions

However, there is a role for a broader input from the history of science, based on insights for which there may be general agreement within the discipline but sharper divergence from more popular accounts. Historians are good at judging the interests that lie behind differing interpretations of the past, as well as exploring their validity. One example is the work of David Edgerton, who has highlighted a number of areas in which common assumptions in science policy are shown to be problematic. These include challenging the perceived economic and technological significance of publicly funded research, and cherished notions of researcher autonomy such as the 'Haldane Principle'.[11]

Although Edgerton has shown that the so-called 'linear model' of innovation is a recent academic construct, created as a foil to better models, there is frequent recourse, both by science lobbyists and austerity-juggling politicians, to economic arguments for science funding that sound suspiciously similar.[12] The same is true for the argument that pure scientific research is the best means of producing new and unexpected technologies, a notion which dates back to the early 19th century and has been corralled into support for the increased state funding of science ever since.[13]

Historical research has shown that the processes and locations of technological innovation are largely separate, and have impacted science much more quickly and directly than the other way round. What is classed as 'pure' scientific research can often be seen as the product of research programmes focused either on specific outcomes, or existing within what Jon Agar has called 'working worlds' of 'projects that generate problems.'[14]

Historical myths, assumptions and analogies frequently find their way into policy announcements and, even if merely as throwaway devices to help frame a speech, can by repetition serve to cloud important issues. One example is the persistent myth of Britain being good at discovery and poor at supporting innovation, referred to in a 2010 speech by David Willetts, the minister for universities and science, as 'that old British problem of failing to make the most of our own discoveries and inventions.'[15]

That same speech begins with a nod towards Joseph Priestley, his experiments on gases and the application of such knowledge to the development of carbonated drinks. Willetts, bizarrely, casts the admittedly Swiss Johann Jacob Schweppe as a foreigner profiting from undeveloped British ideas. In fact, he had taken up a British product that had gone through several stages of development and already entered into an existing British market.[16]

Eyes on the prize

One opportunity for the input of historical expertise to discussions about science, technology and innovation is in the recently established Centre for Challenge Prizes within Nesta, the UK innovation foundation. As the 'Landscape Review' for this centre indicates, one of its activities will be research into the effectiveness of challenge prizes, past and present.[17] The historic context into which the review plays is immediately obvious: its front cover is adorned with an image of John Harrison's first sea clock 'H1', and the British Longitude Act of 1714 is set within a timeline of similar prizes or rewards. This and later initiatives have frequently been evoked as successful precedents, especially in the current climate of tight public funding, for the affordable stimulation of innovation through prizes.

A current AHRC-funded research project, based at the University of Cambridge and the National Maritime Museum, is examining the history of the Board of Longitude and is, therefore, well-placed to offer commentary on the use of the 1714 Act as an emblematic example of challenge prizes.[18] While the well-known version of the longitude story would seem to back claims about the efficacy of one-off inducement prizes, this new research underlines that in order to provide a practical solution to the problem of finding longitude at sea, the Board was necessarily much more flexible in

the range of funding mechanisms they used than the simple version of the story suggests. The research also shows the extent to which successful solutions and their sources had long been anticipated and developed.

Given the focus on challenge prizes as economically efficient, perhaps the most problematic claim is that they 'generate commercial activity.' It was the already-thriving commercial activity surrounding instrument making in 18th-century London that enabled production of potential longitude solutions, rather than the large reward acting as an incentive to commerce. Where the Board of Longitude was particularly significant was not in a one-off reward but through long-term support of longitude solutions, as they gradually became accepted, embedded and commercially viable.

The idea that financial risk can be limited 'by awarding a prize only when the challenge is successfully met' raises pertinent questions, which troubled the Board greatly, about how to judge success. As well as paying out smaller rewards for promising ideas, the Board paid Harrison a very large reward despite the fact that his single, expensive and complex product was a long way from solving the problem for every naval vessel. The lessons to be learned are that prize criteria must be drawn up with extreme caution, and organisers must be clear about how much money is worth risking on a potentially prize-winning but not problem-solving solution.

The Longitude case is one in which the history is partially known, in ways that are informed by erroneous assumptions about the nature of innovation. Familiar stories of remarkable geniuses who work alone to produce products that solve problems, more or less at a stroke, could hardly be less useful. Harrison was certainly remarkable, but he did not work in isolation and relied heavily on existing craftsmanship and expertise in London. The large reward was also not enough to allow sufficient R&D, and he achieved his results through longer-term financial support from government and elsewhere. Finally, his sea watch was neither a complete solution nor a commercially viable product. Decades more of active support of this method, and the necessary and complementary astronomical methods and infrastructure, were required. Similar stories can be unearthed about other, more recent examples of challenge prizes and should be incorporated into thinking about what can be expected from such initiatives.

Hindsight enriching foresight

Of course, historians are not likely to be welcomed to the party if their only contribution is 'but it's more complicated than that.' An ability to unpack assumptions, myths and the lost contexts in which particular policy ideas were formed can be particularly useful. Dealing with nuance and complexity in evidence, and how perspective changes its interpretation, are commonplace skills in historical research and could be invaluable for mitigating potential policy failures and controversies, for example around new and emerging technologies. As Geoff Mulgan argues in this volume, historians and political scientists have also made important contributions to the field of 'evidence about evidence', helping policymakers to understand how knowledge is formed, exchanged and used in policymaking.[19]

All of this leads to our modest concluding proposal. Sir Mark Walport knows well the value of the humanities and history of science from his decade at the helm of the Wellcome Trust, during which he launched the Wellcome Collection, in 2007, as a major public venue dedicated to the exploration of the links between medicine, life, history and art, and initiated new funding programmes for researchers in the medical humanities.[20] As he takes over at the Government Office for Science, one small but significant way in which he could signal his commitment to the value of historical methods and insights would be to pilot a 'hindsight project' within the existing Foresight Programme.[21] Adding one or two historians of science to the policy mix could provide the Government Office for Science, and the wider science and engineering profession in Whitehall with the 'rear mirror' on which, as Lord Butler argues, every good driver should rely.

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3

NETWORKS, PUBLICS AND POLICY

NETWORKS, NODES AND NONLINEARITY: HOW SCIENTIFIC ADVICE GETS INTO POLICY

David Cleevely

It is obvious how scientific advice ought to get incorporated into policy. Scientists should be called on to set out the implications of the latest discoveries or technologies, while policymakers, frowning with concentration, listen attentively, ask astute and penetrating questions, and then put together a policy firmly rooted in evidence.

It is equally obvious that this is not what happens. The process is nonlinear, sometimes generating policies that have scant regard for evidence, with occasional breakthroughs, and many delays or cul-de-sacs. Yet, oddly, instead of standing back and trying to explain what is observed in practice and using that practical understanding to create better processes, systems are created based on what ought to work. Scientists bemoan this messy system and insist that, if only it were rational and linear, how much better it would be. It is ironic that an area of human endeavour that is based on positive analysis should find itself making normative proposals. Before suggesting how the system ought to work it would be worth applying the scientific method to understanding how scientific advice gets incorporated into policy.

Let's be positive

Like Democritus, we should wake up and smell the baking bread. Our commonplace observations can help to explain what is going on and, with some serious thought, generate fresh insight and better ways to incorporate scientific advice into policy.

During the Second World War, the engineer Barnes Wallis wrote a report on preliminary trials for the bouncing bomb which he knew, despite positive progress, was likely to find little favour given prevailing support for strategic mass bombing. In the margin at the end of his report, he wrote "help, oh help". These words were read by the recipient who passed

the report to the most senior levels in government, with the result that resources were made available. The consequences were strategically important, and of great value for propaganda and morale.

What Barnes Wallis did was to break the governance rules: he exploited his network, as in turn did his correspondent. Anecdotes like this are commonplace. Those involved in policymaking and science can usually give first hand accounts of serendipitous meetings or communications which led to a better outcome. These could be regarded as policymaking at its best or at its worst. Best because they have a positive outcome and worst because they sidestep all the processes put in place to achieve rational decisions. Yet despite networks pervading all aspects of policymaking - and many participants regarding chance and connections as critical - it is surprising that they do not play a more central role in accounts of how scientific advice ought to get incorporated into policy.

Yes, but does it work in theory?

It is said that an economist is someone who, when they see something working in practice, cannot help but wonder if it would work in theory. In this spirit, let us consider a simple example of a model network to understand more about its properties and what these imply.

Imagine you drop 1,000 buttons on the floor, then pick up two buttons at random and tie them together. After you have linked the pair of buttons with thread, drop them again on the floor and repeat the process. At first you will almost always pick up buttons that are not linked to any other buttons. But at some point, you will pick up a button that is already linked to another button, and then this will happen with increasing frequency until the majority of the buttons you pick up are already attached to others. With 1,000 buttons this change occurs when you have picked up just over 600 buttons. By the time you have picked up 700 or so, every button you pick up is already connected to every other button.

There are several important observations that you can draw from this. Once you have connected enough pairs of nodes in a network, all the nodes become connected, even if you may have to go through a relatively large number of intermediate nodes. This transition from partially connected to fully connected happens very suddenly (what a physicist would recognise

as a phase change). There will be a few nodes with many direct links to other nodes, and many nodes with only one or two links. And before all the buttons in our network were connected together - say when 400 buttons have been picked up - then it would have been possible to observe a number of clumps in which tens of buttons formed small networks.

Does this tell us anything useful?

If we wish to use networks in order to help incorporate scientific advice into policy, then this model points to a number of specific recommendations. First, you need to work hard to make sure that there are sufficient pairwise links between the nodes. Second, you should expect that there will be a point at which suddenly, and almost magically, every node or person in that network will be connected to everybody else. At that point, the ability for people to communicate across the network will change because everyone is accessible. Third, you should expect to find cliques or silos with members connected to each other but poorly connected elsewhere.

Finally, there will be 'super nodes' in the network: people who are highly connected with many others. If you can enlist their support then you can communicate more quickly and effectively with the rest of the network. In practice this is very important; the 'super nodes' become well known (because they are very well connected) and everybody wants to connect with them. So in networks of people, instead of the nodes being connected at random (as in the example with the buttons) there is a bias to connecting to already well-connected nodes which makes them extraordinarily effective. If you want to influence what is going on, find the 'super nodes'.

Buttoned-down organisations

A great deal of effort in the theory and practice of management has been devoted to ensuring that information is shared effectively, and common goals are pursued. Whether it be the adoption of a new IT system or ensuring that a particular policy is implemented, most attention is paid to how the message is propagated through the organisation and in ensuring that the 'super nodes' are fully briefed and in agreement with the proposed course of action.

Seen from the perspective of organisations as networks, it is easy to see why effecting change and propagating information are difficult, and why those concerned with management pay such attention to it. Most organisations are partially connected, which means that many links may have to be used to get from any one individual to another. If members of a group share a particular view, and that group is poorly connected to the rest of the network, then it is easy to see how a network can maintain silo-like behaviour. Not only can we see how it could become difficult to have a common view across the whole network, but as ideas change, delays in communicating between the silos might lead to such a network never coming to a single coherent view.

When organisations were pure hierarchies (if such a moment ever existed) then decisions were taken and propagated downwards, and information was collected and propagated upwards. Both these happened in a regular and predictable manner because the network and the organisational structure were one and the same thing. In an age of email, Twitter, flat organisations and open innovation, formal organisational structures rarely reflect the networks being employed. Understanding and influencing the behaviour of these networks is becoming increasingly important.

Two examples help to illustrate this point. First, in a 2005 paper, Beck, Dickson and Asenova state that the bovine spongiform encephalopathy (BSE) outbreak in the UK *"led to the slaughter of 3.3 million cattle and estimated economic losses of £3.7 billion."*[1] They conclude that *"a centralized system in which government agencies control science for government is inherently vulnerable to alliances of experts and interest groups."* Second, in July 1985, the mechanical engineer Roger Boisjoly wrote a memo to his superiors, warning of a faulty design in the space shuttle's solid rocket boosters, which could lead to a catastrophic event. Six months later, the Challenger disaster occurred. In contrast to Barnes Wallis, Boisjoly's memo had been ignored, and he had no other path to turn to. In both cases, the structure of networks helps to explain how events occurred, and perhaps suggests how to do things better.

Let's do some research

If networks and 'super nodes' are critical for the incorporation of scientific advice into policy, are there some modifications to our current approach which it might be useful to adopt? One obvious, and perhaps controversial, recommendation would be that chief scientific advisers (CSAs) are recruited for their networking ability as well as for their knowledge. Whilst the skill of being able to understand and interpret scientific and engineering advice is of course essential for any such post, perhaps CSAs ought to be recruited for who they know as much as what they know.

But remember the word 'perhaps'… We should be asking ourselves about the evidence: what do we know about how networks operate; do 'super nodes' really play such a major role; can we form hypotheses based on networking and test them? We need a new research agenda, directed towards how scientific advice gets incorporated into policy, and how new technologies are changing our economic, governmental and social organisation. This research would need to draw upon graph theory, social anthropology, behavioural economics and many other disciplines.

Over the past three years, the Centre for Science and Policy at the University of Cambridge has helped to lay the groundwork for such an agenda.[2] The design of our network of Policy Fellows is based on inferences drawn from the theory of networks, and practical observations of what works and what doesn't. Better understanding of what does work should enable us to move on from naive and linear views of what ought to work. We need to understand more about how scientific advice gets incorporated into policy, and use these insights to support better governance.

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WINDOWS OR DOORS? EXPERTS, PUBLICS AND OPEN POLICY

Jack Stilgoe and Simon Burall

The addition of the phrase 'open policymaking' to the Whitehall lexicon would seem to be a straightforward step towards greater engagement between experts, publics and policymakers. The recent civil service reform plan sets out an aspiration to *"establish a clear model of open policy making"*, but what this means in practice is still to be defined.[1]

In this chapter, we describe recent movements that have opened up policymaking, particularly around issues involving science. These issues force experts, policymakers and others together in ways that can prove fractious. We should not pretend that there are not tensions between science and democracy. Nico Stehr has provided an interesting account of scientific frustrations with what he calls 'inconvenient democracy.'[2] But rather than providing an excuse for detachment, such tensions suggest the need for better engagement.

Since the 1980s, UK policymakers have abandoned a technocratic model in which experts were relied upon to settle policy issues away from the public spotlight. But, as we will describe, there is not yet a consensus on what the alternative should look like. We have seen institutional experiments in openness come and go, without clarity about what they are trying to achieve. Everyone accepts that transparency is important. The Freedom of Information Act provides just one of the new windows on the world of policymaking. But not all policymakers take openness to the next level, opening the doors to a wider range of advice and input. Over the last decade, the UK has built a rich experience of public dialogue on issues involving science, much of it run through Sciencewise.[3] Our view is that such work can and should provide a basis for robust, credible, open policy.

Institutions of openness

In the 1990s, a spate of science policy issues, such as those around bovine spongiform encephalopathy (BSE), genetically-modified crops and in-vitro fertilisation, led to the creation of new institutional machinery, including

the Human Fertilisation and Embryology Authority, the Agricultural and Environmental Biotechnology Commission, the Human Genetics Commission and the Food Standards Agency. These bodies all blended science with other inputs - from ethics, social science, interest groups and members of the public - in order to build more credible policy.

Much of this institutional machinery has since been scrapped or downsized. There is a danger that, as crises fade, administrations forget the importance and the complexity of building conversations between scientific experts, policymakers and the public. Usable, relevant, credible evidence for policy is very different from just expecting our scientists to deliver the goods when policymakers come knocking. Where we once relied on systems of national laboratories, intimately linked with government, most science is now devolved to our universities, complicating conversations with policymakers and making the job of intermediaries ever more important.

There is often confusion in policy, highlighted by the Council for Science and Technology with respect to nanotechnology,[4] between the science that we want - Nobel Prizes and papers in *Nature* - and 'the science we need' - locally relevant and commissioned for particular purposes. Both are necessary, but the relative detachment of science from other social institutions means less attention is paid to the latter.

In 2005, Sciencewise was set up to enable a range of government departments and agencies with responsibilities involving science to carry out public dialogue. Dialogue, as envisaged by Sciencewise, is an approach to involving members of the public in decision making which brings together a diverse mix of citizens with a range of views and values, and relevant policymakers and experts, to discuss, reflect and reach conclusions on complex or controversial issues likely to be important in future policies.[5]

Over 20 Sciencewise projects have been completed since the programme began. These have ranged across a wide variety of policy areas involving science and technology, but all have involved deliberations among members of the British public, policymakers, scientists and other groups. All have aimed to influence a policy under development at the time of the dialogue.

Public dialogue has a number of features that seem to fit well with an open policymaking approach:[7]

Table 1: **Features of public dialogue**

Informed	Participants are provided with information and access to experts.
Two-way	Participants, policymakers and experts all give something to, and take something away from, the process; dialogue is neither solely about informing the public nor extracting information from them.
Facilitated	The process is carefully structured to ensure that participants receive the right amount and detail of information, a diverse range of views are heard and taken into account and the discussion is not dominated by particular individuals or issues.
Deliberative	Participants develop their views on an issue through conversation with other participants, policymakers and experts.
Diverse	Participants tend to be recruited to ensure they represent a diverse range of backgrounds and views (participants are not self-selecting).
Purposeful	Dialogue engages the public at a stage in a decision-making process where the policy can be affected.
Impartial	Public dialogues are often convened, designed, delivered and facilitated by independent individuals or organisations to help ensure the process is not biased in favour of a particular outcome.
Expansive	Public dialogue opens up conversations rather than closing them down.

However, public dialogue usually involves a relatively small number of people at a particular moment in the development of a policy. At the same time as the dialogue is taking place, government is collecting evidence to feed into the policy using a wide variety of methodologies and information sources. The challenge for the policymaker is to absorb and synthesise the vastly different forms of inputs that are required to make a more informed decision. To better understand the role of public dialogue in open policymaking, we therefore need to look at moves towards openness in a more conventional advisory setting.

Openness and open-mindedness

One moment in particular marks a watershed for the rethinking of conventions of expert advice. More than two decades on, the shadow of mad cow disease still looms over discussions of expertise and policymaking.

In 1990, then environment minister John Gummer infamously dismissed uncertainties about a new disease in cattle. Four years earlier, BSE had begun to strike cattle, raising the question of whether this unknown disease might be transmissible to humans. Gummer, seeking to reassure the British public, farmers and the food industry that beef was safe, fed his four-year old daughter a burger for the benefit of the national media.

The Conservative government admitted its mistake in its final months, confessing that BSE was linked to the fatal variant Creutzfeldt-Jakob Disease. The Phillips Inquiry of 2000 eviscerated the structures and cultures of advice and decision-making that had allowed for what has been called 'the most serious failure of UK public policy since the Suez invasion of 1956.'[8] The Phillips report, in 16 thick volumes, remains the most important, forensic analysis of expert advice to government.[9] It is required reading (at least in its abridged form) for any chief scientific adviser and its insights have informed the various iterations of government guidelines for scientific advice.

The most important conclusions of the Phillips Inquiry as they relate to the question of openness are that:

- Trust can only be generated by openness.
- Openness requires recognition of uncertainty, where it exists.
- The public should be trusted to respond rationally to openness.
- Scientific investigation of risk should be open and transparent.
- The advice and reasoning of advisory committees should be made public.

Openness, according to Phillips, is not just about transparency. It also, crucially, is about being open-minded. Opening up expert advice means paying attention to scientific uncertainties, rather than obscuring them. It means opening up the inputs to scientific advice (who is allowed to contribute, how and on what terms?). And it means changing the outputs from advice, such that they do not offer single prescriptions but rather help to inform the range of available policy options.

In the UK, we have confidently left behind one model of expertise, but not yet landed on a satisfying and coherent alternative. We sit between two models (see box below). The old model, in which science and expertise are seen as trumping the values, preferences and knowledge of publics, is profoundly undemocratic. We have moved rapidly away from this, but the current state is rather confused. When we talk about being 'open', what do we mean? Are decision makers really interested in diversifying their sources of advice and expertise or are they more concerned with whether people trust them? Is it a case of, as one commentator put it, *"give 'em bread, circuses and a bit of open government"?*[10]

Old model of expertise	New model of expertise
• Closed	• Open
• Homogenous	• Diverse
• Hubristic	• Humble
• Demanding public trust	• Trusting the public
• Expecting expert consensus and prescription	• Expecting plural and conditional advice
• Managerial control	• Distributed control
• Presenting the evidence	• Presenting evidence, judgement and uncertainty[11]

We must not forget that Phillips's call for openness was not simply following a political fashion for transparency. The realisation, post-BSE, was that openness must also be about open-mindedness - realising the limits of conventional systems and engaging with new perspectives. Daniel Fiorino gives three main reasons for public participation in policy: first there is the normative - that democracy is a good thing in itself; the second reason is instrumental - that engagement might lead to greater trust and expedite particular policy measures; the third is substantive - that engagement, done

well, makes for better decision making.[12] It is easy for policymakers to fall back on the first two rationales in the heat of the moment. But they should not forget that public engagement is only worth doing if it has substantive benefits. Nothing looks more untrustworthy than efforts to build trust instrumentally.

Facts and values

The assumption behind 'evidence-based policy' is that there are 'hard facts' and 'soft values'. But all too often policy reality gives us the opposite. When BSE, SARS or avian flu arrived, there was scant evidence on which to build a watertight policy. There was a clear need for regulatory certainty, but the science was riven with uncertainty. The facts looked flimsy and the values, interests and politics were hard-fought.[13] The job of the experts in such situations is to help policymakers navigate these uncertainties. But as we saw with BSE, it is rarely clear who the most relevant experts are. Policy remains filled with politics, values and difficult choices. These demand open debate, but political cultures still harbour a technocratic reflex that tries to strip these things away. The new enthusiasm for openness has coincided with interest in evidence-based policy. While few would argue with the need for evidence, the use of the term 'evidence-based' can become a shield against criticism, shutting off important perspectives.

Supporters of public dialogue and other forms of opening up, such as lay membership of previously expert committees, have felt obliged to position their arguments in 'evidence-based' terms. So they contort 'public evidence' to fit it in the pile of facts through which policymakers purport to sift. This model feels unsatisfactory. Scientific evidence cannot just be weighed against 'social intelligence'. These things play profoundly different roles. They can point in different directions, revealing the multidimensionality of issues. For people who have been involved in public dialogue on emerging policy issues, it is often clear that the important contribution is not to the evidence base, but to the framing of the issue itself. Public dialogue can sometimes provide answers. But, more often than not, its value is in the questions that it places on the table.

If we take a contentious issue like genetically-modified foods, we can look back on a string of attempts to engage members of the public on

questions of whether GM would or would not be acceptable. But each was hampered by a narrow framing of the relevant question. If policymakers treat members of the public as a jury for particular technologies, they are likely to find that sometimes the answers that emerge are uncomfortable. If, however, we allow members of the public to help frame issues, we can build constructive conversations. So, rather than talking about GM, we can talk about the problems to which GM might contribute - such as food security - and assess the merits of a range of alternative options.[14] The Research Councils UK Global Food Security programme is aiming to do just this, drawing on a range of inputs from experts and publics.[15]

Openness and muddling through

Over the last 30 years, policymakers have rethought the contribution that publics and experts can make to policymaking. With both, we can see that the word 'open' is not straightforwardly defined. Are we talking about open doors, welcoming in new perspectives; open minds, reflecting on the limits of centralised control and predictability; or transparent but closed windows, revealing policy but maintaining control of its contributors?

If we adopt the instrumental rationality of 'evidence-based policy', we can tie ourselves in knots trying to work out how expertise, evidence and public inputs should all be 'balanced' as we assemble a justification for policy action. If however, we relax this view, and recognise that policy is often messy, surprising and responsive - what Charles Lindblom memorably called 'muddling through'[16] - then we can identify more constructive, sympathetic roles for these plural inputs. They all, in their way, help us make sense of the many dimensions of issues.

The motivations for open policy-making as currently expressed may be in tension. We should not deny that one of the driving forces behind recent moves is a need to cut costs at the centre of government. The assumption is that sharing policy responsibility involves outsourcing and therefore generates new efficiencies. The inconvenient lesson from BSE onwards is that new sorts of institutions may be required in order to build socially-robust, credible policy. Sciencewise provides one location for policy learning across various domains of science and technology. But others may be required if we are to avoid further surprises.

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THE POWER OF 'YOU': EXPERTISE BELOW THE LINE

Alice Bell

Time magazine's person of the year in 2006 was, famously, you. *"Yes, you"* they self-consciously assured; selling the story on the shift from the normal parade of *"the few, the powerful and the famous who shape our collective destiny."*[1] This is not *"you"* in a specific sense but a rhetorical you, a you-in-general, perhaps akin to what Mike Micheal refers to as *"publics-in-general"*.[2] Because *"America loves its solitary geniuses - its Einsteins, its Edisons, its Jobses - but [with the advent of the web] those lonely dreamers may have to learn to play with others"*.[3]

So far, so surprisingly egalitarian. Except those with a desire to share agency through society at large have much to be sceptical of here. If nothing else, it's worth noting that even the web version of this Time piece largely limits interaction to an invitation to a Facebook-branded 'like', or LinkedIn 'share'. There is no comment function, let alone anything as open as a "wiki" open editing option (where readers can edit text). Time magazine may deliver the message that 'you' have more power of media messages, but it is not inviting you to be part of making that message. We might also, following Jaron Lanier, question whether we really want to be an anonymous part of such a *"hive mind"*.[4]

I rehearse this story because the power of 'you' is increasingly being applied within and around science. Or at least, science policy debate is bleeding into social media. You can follow both @uksciencechief and @EU_ScienceChief on twitter, for example. Andrew Wadge, Chief Scientist at the Food Standards Agency, has a blog[5] and David MacKay, Chief Scientific Adviser at the Department for Energy and Climate Change arguably has the web to thank for the success of his book 'Sustainable Energy - without the hot air'.[6] The Department of Business, Innovation and Skills has even been playing with Instagram and Pinterest - http://pinterest.com/bisgovuk/ - where its images of the Farnborough Air Fair and Hadron Collider at CERN provide some balance to the site's tendency towards cupcakes and kittens.[7] We may still love our Coxes, our Walports, Nurses and Bell Burnells, but there is at least an appeal to play with others. This taps into a long history

of 'public engagement' but has, arguably, been given new energies online in recent years.

Networks of science blogging are now relatively firmly established within mainstream science news reporting, though not always comfortably, providing greater diversity of commentary and reporting, and often driven by a desire to drown out or at least rebut 'bad' science media.[8] We've also seen active online campaigning on issues to do with scientific work which play on a discourse of people against elite power, whilst also being an attempt to extend the powers of what are, arguably, elite institutions and interests: Science is Vital, on science funding, the anti-anti-GM 'Don't Destroy Research' and 'All Trials Registered, All Results Reported' (or the more 140-character-friendly, #alltrials). New science celebrities have developed online, or at least social media has played a role in constructing public profiles of prominent voices in science policy. Ben Goldacre is perhaps the best example. On a much smaller level, I doubt I'd have been invited to write for this collection it wasn't for social media

In terms of journalistic output, the relatively new space offered by the comments below the main body of web-published text can seem threatening. However, it can also play a constructive role in the making and discussion of science. The 'Arsenic Life' controversy is one powerful example,[9] or the collaboration set up by Ed Yong between a biologist and a farmer over a shared interest in a chimeric chicken.[10] Familiar friends and previously undiscovered experts dwell online, as well as those more mythical creatures such as trolls or flat-earthers.

As with the Time example, there's a lot to be skeptical of here. But it does also reflect new patterns of scientific power. It offers, perhaps, a chance for greater openness in lobbying around science; opening it to scrutiny, and making it more accountable and able to learn from other perspectives. It also offers us a new way round preoccupations with linear and deficit models, as online spaces 'below the line' enable publics to network with each other. As media scholar Henry Jenkins argues, online engagement is less about a back and forth between author and audience, and more about peer to peer.[11] Still, just because there are small moments of openness doesn't mean that the majority of power brokering in science isn't still esoteric, or even secretive and largely top-down.

Openness and allusions to ideals of public participation are often only rhetorically applied. Hashtags have histories and hierarchies; there are cultures and contingencies to consider. So here are three sets of questions I think we should be asking:

First, we should ask questions about the forms of expertise on offer here; which ones are being disrupted, and which we're happy to change. The participation of 'you' is one thing for music reviews, but different for physics. This is not to plead a special case for science, nor to dismiss the role of professional music journalism, but to acknowledge the equipment, time, prior knowledge and large networks of people required to do modern science. As Jack Stilgoe says, today's science is *"an expensive, equipment-heavy team sport"*; we're not about to see *"street gene-sequencing parties or the Women's Institute designing a particle accelerator"* any time soon.[12] The same is true of other areas of expertise. Just because scientists increasingly communicate directly with the public does not mean those same scientists can pick up the work created by falling numbers of specialised science journalists. Professional journalists bring their own expertise, skills, networks and critical distance. The way public relations activities sometimes try to fill this role, under the guise of directly bringing science to the people, is especially worrying.[13] This is not to suggest a defence of the status quo; simply that we should find ways to maintain the worth of scientific and journalistic skills online, whilst also using the web to critique, disrupt and share such skills.

Second, we should ask what we want openness to mean online, what forms we want to invest in, and how this should be organised. There is a lot more to open science than simply open access. Indeed, a preoccupation with the latter as a solution to social ills may well be a way of avoiding dealing with the former.[14] Further, how we choose to finance and manage forms of open access is far from straightforward. Whilst politicians, scientists, publishers and learned societies argue it out, the #icanhazpdf hashtag is gradually whittling away at current publishing models (used so people looking for paywalled papers can find those with institutional log-ins who are willing to be generous on their library's behalf). Scientists may feel persecuted by activists, especially if they engage in debates over climate change, alternative medicine or animal rights. They may also feel that when work flows into 'social media', even more of their private lives are being taken over by work. Online interaction can be tiring.

A related issue is whether the public can be trusted with science in the open. One might, for example, feel pleased when the Science Media Centre manages to keep a story out of the press (as when I heard senior scientists cheer in the case of a story about GMO food last year). Alternatively, one could follow the lead of the Cancer Research UK news blog[15] which accepts that stories they don't agree with will get published, but uses the more open spaces of the web to put extra context out there, hoping those who care will find it. One recent piece of research argues that the 'incivil' tone of web comments can derail evidence-based public debate on science, technology and especially environmental and health issues.[16] For all that I can personally relate to this (having uncomfortably found myself being incivil myself, as well as at the receiving end of incivility), such calls for polite behavior online leave me uneasy. Complaints about 'tone' are too easily used to quell dissent. Words like 'troll' can become a proxy for what is, at best, disagreement, and worst, class hatred. Moreover, there are other ways to view such spaces: Marie-Claire Shanahan's work on peer-to-peer communication under health news articles in the Canadian press suggests a privileging of scientific expertise.[17]

Finally, we should question allusions to public participation, or at least acknowledge when more traditional offline, esoteric forms of power brokering in and around science play a role. At the more extreme level, this can take the form of 'astroturfing' - a concerted effort to create the illusion of 'grassroots' public support, sometimes heavily funded.[18] There are also ways in which real publics are used by campaigns in ways that express the public voice without necessarily feeling a need to listen to it. In many ways, campaigns like Don't Destroy Research, Science is Vital, All Trials and the like are more about enumerating the actors of public relations than diffusing political power. Even if these campaigns draw in a lot of expertise alongside more passive 'clicktivist' support - from lawyers, lobbyists, designers or programmers - they don't seem to have any great interest in finding new opinions; merely to show there are people who have the same opinion as them. A campaign like Science is Vital also drew on decades of lobbying on science funding, and the networks and capacity of existing groups like the Campaign for Science and Engineering; it wasn't just a story of an inspired post-doc taking to the blogosphere.[19] This isn't necessarily a bad thing - we can have public campaigns as well as public debate and online campaigns can augment offline work - as long as we recognise the difference between public relations and public engagement, and recognise which spaces are left closed.

In conclusion, I'm unsure about celebrating the role of an all-encompassing public 'you'. It seems too broad, too bland, too easily applied to obscure the real faces of human interaction with science and technology policy. It's too clean. For all that online science policy campaigns have a grassroots feel, they usually promote rather traditional top-down expressions of scientific expertise. It is largely deficit model business as usual. The caricature of an upstart blogger takes on a slightly different hue when he's already a Fellow of the Royal Society. This isn't a bad thing. Arguably it's a brilliant way to share wisdom, and occasionally a productive disruption of the limitations of professional journalism. But we need to stay attuned to the power dynamics at play.

It is now 18 years since Bruce Lewenstein suggested a 'web model' as an alternative to top-down ideas of science communication in his study of the cold fusion controversy.[20] This networked view seems almost too obvious today, as gross a simplification as the deficit model. But it contains an important message that is increasingly hard to ignore: the simple messiness of scientific discourse. Although neater debate has its uses, especially in policymaking, that doesn't mean we should aim to tidy it all up. This mess is how we build capacity for more coherent exchanges, build trust, learn and digest. It is also where people can show dissent and support for science, both of which are important. We should be wary of being too spooked by the incivility or apparent lack of expertise online. As science policy debate bleeds onto social media, we shouldn't be scared to take a dip below the line, and take some time to look and listen. You never know what we might find.

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THE POLITICS OF POSTERITY: EXPERTISE AND LONG-RANGE DECISION-MAKING

Natalie Day

Four months into the UK's coalition government, the Deputy Prime Minister Nick Clegg gave a speech to the Institute for Government on *"governing for the long term."*[1] It wasn't a premature pitch for re-election; rather, the speech sought to highlight how a culture of short-termism pervades political life, and how *"the longer-term vision we are adopting in government will help to wipe the slate clean, and ensure that future generations can thrive."*

Clegg might struggle to make such a speech today. Difficult decisions such as those required on nuclear power, a third runway at Heathrow, House of Lords reform and Britain's place in Europe have been delayed, or are beset with uncertainty. The constraints of a fixed, five-year coalition agreement have been exacerbated by the erosion of Whitehall's capacity to think long term, through the scrapping of bodies like the Cabinet Office Strategy Unit, the Sustainable Development Commission and the Royal Commission on Environmental Pollution.

The Arab Spring, the Icelandic volcano and the Fukushima nuclear disaster are all examples of unexpected events that can demand immediate policy attention. But this is no excuse to be unprepared. Across a host of policy agendas - from coping with an ageing population, to ensuring a secure and sustainable energy supply, and coping with climate change - longer-term perspectives are required.

Short-term pressures, long-term challenges

Given the pervasive short-termism in our politics, exacerbated by the news cycle and the immediacy of social media, is it realistic to hope that governments and policymakers might look beyond the next election? The beneficiaries of painful policy choices today may not yet have been born, making those decisions difficult to justify to the voting public. Progress

on trade, climate change and many other issues requires international agreement, where progress is increasingly hampered by the absence of consensus and unclear accountability. Meanwhile, company reporting cycles and just-in-time production systems reinforce a short sightedness in the private sector, which can prevent constructive conversations about the future.

Several of the essays in this volume focus on the challenge of how to fit 'supply-side' academic expertise to 'demand-side' needs of the policy cycle. But there is also a critical question of how to extend time horizons within the policy world, and the role of expertise in highlighting both gradual trends and unexpected developments which merit serious policy consideration.

In this essay, I look at ways to overcome impediments to long-range decision making, by drawing lessons from a few iconic examples in recent UK policy history. I also consider the role of novel institutions and structures in the UK and elsewhere, which can provide a platform for longer-term perspectives.

Environmental enlightenment

In 1970, the UK Royal Commission on Environmental Pollution (RCEP) was created as an independent body, appointed by the Queen and funded by government, to consider environmental policy issues facing the UK and the world.[2] Over the course of four decades, RCEP is widely credited with having 'influenced the content, even the fundamental tenets, of policies affecting the environment, with a reach that often extended into the wider international arena'.[3] Over 30 reports were produced, on topics ranging from nuclear power and industrial pollution; to the environmental impact of housing; genetically modified organisms (GMOs); and managing waste. Although it fell victim to the 'bonfire of the quangos' in the coalition government's 2011 austerity drive, there is much to learn from the influence and effectiveness of RCEP over its long life.

RCEP was considered influential because it was an authoritative, autonomous and trustworthy body. Its independent status enabled the Commission to consider issues of its own choosing, and importantly, it took a longer-term view, often in areas 'where ministers and their officials might

hesitate to tread'.[4] In some cases, RCEP's policy recommendations were immediately accepted by government; for example, in relation to GMOs. In others, the acceptance of more radical recommendations had a longer gestation. It was more than 20 years after RCEP's original report that its suggested carbon dioxide emission reduction targets were endorsed.

Beyond its formal reports, Susan Owens (a former RCEP member who has also analysed its work) argues that the Commission's wider 'atmospheric influence' was powerful in promoting fundamental principles such as precaution and transparency in environmental policy over many decades. It was a significant source of 'enlightenment'; enabling knowledge and ideas to percolate gradually into policy over time through processes of diffusion that were only possible because of its longevity.[5]

The politics of pensions

The Pensions Commission,[6] led by Lord Adair Turner from 2002 to 2006, provides another example of the importance of creating novel institutions to bring expertise to long-term issues, even in politically uncomfortable terrain. Unlike RCEP, the Pensions Commission was set up specifically to confront one issue. In a highly charged political environment, it sought to depoliticise the pensions debate and build consensus through a comprehensive assessment of the future trends likely to impact an under-prepared and under-resourced UK pension system. In 340 fact-packed pages, its first report debunked a number of assumptions and highlighted how increased life expectancy, low predicted birth rates and a two-fold increase in the population over 65 by 2050 would place significant strain on the pension system.[7] Their analysis demonstrated that the existing offsets between private pensions and the 'relatively ungenerous public system' were not sustainable, and showed that 60 per cent of employees over 35 had inadequate pensions.[8]

The second report of the Commission, released in 2006 after extensive consultation, concluded that Britons needed to work longer, save harder and ultimately pay more tax to achieve a more secure pensions system. Describing these as *"clear and unavoidable trade-offs"*, Lord Turner argued that an increase in the state pension age, in line with rising life expectancy, was essential to keep the system affordable and fair between generations.[9] Remarkably, given the sensitivity of this recommendation, the Pensions Commission eventually received cross-party support. By May

2006, Tony Blair, who was passionate about pension reform, had set out a two-stage legislative programme to reform the UK system. Fast forward to 2013, and the recommendations of the Commission are still influential. A recent House of Lords inquiry, led by Lord Filkin, acknowledges the progress in pension reform as a result of Lord Turner's work, but argues that the government may now need to go further, citing Turner's recommendation that the pension age could be lifted to 70 years old by 2030.[10]

What lessons can we draw from this to inform today's policymakers? As highlighted in analysis by the Institute for Government, the Pensions Commission is an example of how independent commissions can be valuable, particularly when issues are politically sensitive, analytically complex and widely consequential.[11] By separating the diagnosis and prescription stages, it was easier to depoliticise the debate and establish authority. Extensive efforts in consultation, openness and public debate through the media and other channels were instrumental in shaping the Commission's response (and in galvanising support for its controversial proposals); whilst its longer timeframe was also instrumental in being able to affect change on such a complex issue.

Foresight and horizon scanning

The UK government's Foresight programme provides another useful template for longer-term analysis and horizon scanning. Established in 1994, Foresight is charged with 'helping government think systematically about the future' and reports to the government's chief scientific adviser (GCSA) and to the Cabinet Office.[12] From food, farming, floods, finance and future disasters, Foresight projects tackle diverse topics, and are well respected in the policy community. Each project typically runs for two years, guided by a high-level stakeholder group, chaired by a government minister. Day-to-day management is led by a small secretariat, located with the Government Office for Science, with expert advice provided by a Lead Experts Group, largely made up of senior scientists and social scientists. This structure is particularly important for building relationships and networks between a wide range of experts and policymakers.

Whilst the GCSA has the final say on approved projects, selection criteria include the need to be future orientated, looking at least ten years or beyond; to focus on areas of uncertain or rapid change; and to require inter-

disciplinary and inter-departmental approaches.[13] Department 'buy-in' is also deemed critical, particularly for successful impact and implementation. Some projects, such as Computer Trading in Financial Markets, work to a ten year horizon, but others, such as Flood and Coastal Defences, can look up to 80 years ahead.

Targeted primarily at the UK government, the research community and the third sector, Foresight's work also gains increasing attention internationally, with evidence of its methodologies and findings being applied in China, South Africa and the European Commission. Looking at the impact of the work closer to home, Foresight's work on tackling obesities in 2007 shaped the government strategy launched in January 2008, which included an additional investment of over £372 million over three years. Its 2004 project on future flooding substantially informed a cross-government 20-year strategy, and provided the evidence base to justify a doubling of government expenditure in this area by an additional £300 million.[14]

Beyond Foresight, the capacity for deep analysis and systemic review of longer-term issues across government is more patchy. A recent civil service review, led by the Cabinet Office, has acknowledged this and sought to improve horizon-scanning functions as part of 'the capabilities and structures used by the Civil Service to anticipate risk and identify opportunities over the medium-to-long term'.[15] The review called for better coordination of horizon scanning activity through a new Cabinet Secretary Advisory Group and, in a nod to political pressures, reminds the civil service of its 'responsibility to look beyond the parliamentary term' and ensure that 'day to day issues and short-term politics don't drive every policy agenda.'[16]

Nudging forward

Whether such recommendations will prove successful remains unclear. At a time of acute government austerity, longer-term perspectives can seem a distraction from the more pressing demands of the day. And there is a more widespread concern in Whitehall that - despite Nick Clegg's warm words in 2010 - this government has eroded strategic capacity at its centre. In particular, the decision at the end of 2010 to close the Prime Minister's Strategy Unit sent a worrying signal about the place of longer-term analysis in the new government.

The Strategy Unit, established by Tony Blair in 2002, was the primary source of futures thinking at the centre of government throughout Labour's period in office. Such units have been established and disbanded throughout recent political history, with an earlier incarnation set up by Edward Heath in 1971, only to be disbanded by Margaret Thatcher following the 1983 election. Blair's Strategy Unit carried out policy reviews, analysed emerging evidence and trends, and aimed to inject more long-term strategic thinking into core policy debates.[17] During its time, it conducted reviews across education, healthcare, energy, social mobility and risk. The unit's former director, Stephen Aldridge describes how it could *"step back a bit from the events of the day, the immediate crises, and offer a more considered view to the Prime Minister and Number 10 than would otherwise be possible".*[18]

Downing Street argues that these functions have now been absorbed elsewhere, within its now-enlarged Policy Unit, but it was a degree of separation between the Strategy Unit and the manic day-to-day pressures of No. 10 which seemed to be part of its success. In its place, there has been great interest in the government's Behavioural Insights Team or 'nudge unit', based in the Cabinet Office.[19] Building on the work of Richard Thaler and other behavioural economists, this unit seeks to apply those perspectives to a range of social policy issues and has also promoted the use of randomised controlled trials (RCTs) and other methods to improve the evidence base for policy.[20]

By their nature, however, 'nudge' interventions suggest modest, incremental change rather than large-scale, more visionary shifts in policy; which is symbolic of the perceived scaling back of this government's longer-term vision across the board. The nudge model is arguably well-suited to the pragmatic realities of fixed-term coalition government. There is a danger, however, that the UK nudges forward at the expense of bolder, longer-term action on challenges such as industrial policy, energy, infrastructure, climate change and ageing that all demand a longer-term view.

Far-flung futures

Outside the UK, there are a number of models aimed at embedding long-term thinking in policymaking which may offer useful lessons. Developmental states like China, India, Singapore and Malaysia have

long histories of conducting cross-government five-year plans, guided by strategic priorities in economic development. The rate and success of implementation varies, with some described as an *"exercise in wish fulfillment as much as anything."*[21] National planning commissions (NPCs) are another institutional model used in countries like India and China. South Africa established an NPC in 2010, with a mandate to lead, advise, mobilise and ultimately implement a long-term strategic plan leading up to 2030.[22]

Although this post has now been axed, Hungary's appointment of a Parliamentary Ombudsman for Future Generations, as an advocate for sustainability issues across generations, received some international attention. It was the inspiration for a call by the World Futures Council at the Rio+20 summit for the United Nations to create a similar role.[23] More promisingly, Finland's Committee for the Future is a cross-government parliamentary standing committee tasked with creating policy on the future, including assessment of technological developments and their consequences for society. Established in 1993, and now a permanent fixture, the committee's focus has ranged from healthcare, social capital and 2030 scenarios for Russia, to a recent report on 'crowdsourcing for democracy.'[24]

The extent to which these various models provide an integrated, enforceable and accountable system for long-term, strategic thinking is debatable. The most successful models provide appropriate incentives and institutional structures to ensure accountability, and display an openness and transparency that is usually required to mobilise long-term public support.

The politics of posterity

When we consider the complexity and gravity of global challenges, improving the evidence base and time horizon of decision making should be a priority for every responsible government. Understanding how best to engage with and empower experts as part of this process is also crucial, and there are lessons from all of the models above that can be usefully applied.

But more thinking about how to do this effectively is required. In September 2012, the Oxford Martin School established a Commission for Future Generations, chaired by Pascal Lamy, the director-general of the World

Trade Organization.[25] Frustrated by the gap between knowledge and action in relation to many of the most pressing issues of the 21st Century, the Commission will consider how countries and global institutions might look beyond the pressures of short-term crisis management to respond more effectively to global challenges. Due to report in late 2013, the Commission hopes to provide some insights and practical advice on how to remove impediments to action, drawing inspiration from examples around the world.

Nick Clegg spoke in 2010 of ensuring that future generations can thrive, without being burdened by the 'dead weight' of earlier policy failures. Our fear is that without appropriate action on critical longer-term issues, the burden for future generations will prove unbearable.

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SCIENTIFIC ADVICE IN PARLIAMENT

Chris Tyler

There is nothing easy about making public policy. It is rarely the case that one 'correct' answer exists to a given policy challenge, and even well designed and implemented policies usually have some significant downsides. People whose job it is to make policy have a bewildering array of options, opinions and potential outcomes to consider; and while they typically approach their jobs with the best of intentions and careful consideration, they always do so with incomplete information.

One important kind of information that can inform the policymaking process is evidence produced by scientific research. It is widely acknowledged, however, that much research that is highly relevant to policy - on topics ranging from health to defence, from engineering to education - often fails to find its way into the decision-making process. At first sight this seems to make little sense, defying the best efforts of many people who seek to foster a more productive relationship between science and policy.

In this essay, I argue that part of the problem of bringing research evidence to bear on policymaking is that a critical element of the science advisory system in the UK is poorly understood and systematically overlooked. At the root of this is the fact that the government (i.e. the executive branch of the UK's democracy) is only one part of the policymaking apparatus; policies are also debated and scrutinised in Parliament by more than a thousand MPs and Peers. These elected and appointed custodians of scrutiny and law-making receive a significant amount of science advice from parliamentary staff and elsewhere. Acknowledging the role of science advice in Parliament is critical to developing a comprehensive understanding of the relationship between science and policy, and to helping to ensure that research evidence makes a proper contribution to policymaking.

Government and Parliament have differing roles. Government focuses on the details of policy design and implementation; Parliament focuses on oversight and scrutiny. Science advice has a place in both, but because the role of Parliament differs from that of government, so does the nature of its science advice.

Science advice in government

In the UK, ministers appoint very few political staff, and are instead supported by a large, permanent and politically independent civil service. The civil service is organised into departments, each of which is tightly hierarchical, reporting to a permanent secretary who runs the department for a secretary of state. Only high-level policy decisions are taken by ministers; the bulk of policy detail is designed and implemented by the civil service, of which science advisers are a part.

In this context, science advisers are often required not only to provide information and analysis on scientific issues, but also to support one policy over another. Although it might be unusual for them to be proactive in making recommendations, challenging policy proposals is a routine part of the job. There are many - several hundred - science advisers across the various departments. Some have broad remits (e.g. home affairs or the environment), though more usually science advisers specialise in narrower policy areas (e.g. technologies to support the delivery of immigration policy or forestry policy). Either way, the role of science advisers is largely formalised into the highly structured system of policy formulation and implementation in the civil service.

Research evidence is fed into the civil service via a number of routes, including the professional and learned societies, lobbyists for business and charity sectors, and many well-established formal mechanisms. Large statutory bodies, such as the Food Standards Agency and NICE, provide evidence-based advice in support of policy recommendations and decisions in specific fields. Smaller scientific advisory committees (SACs), made up of independent scientists who give their time freely, provide advice on a range of matters. Some SACs are departmental (e.g. to the Home Office or Defra), while others are subject-specific (e.g. the Expert Committee on Pesticide Residues on Food); some are ad hoc (e.g. the Ad Hoc Nuclear Research and Development Advisory Board) and others are statutory (e.g. the Advisory Council on the Misuse of Drugs).

Science advice in Parliament

Parliament, by contrast, is made up of an enormous range of political views, policy positions and priorities. The parties exert some control, but the culture within Parliament is far less hierarchical than the civil service. There are 650 MPs in the House of Commons, and 400 to 500 Peers who regularly attend the House of Lords, participating in debates and contributing to the dozens of select committees and public bill committees that scrutinise the work of government and amend bills. This debating and scrutiny work is supported on the one hand by political staff (each member having one or two researchers, usually early in their careers) and on the other by permanent, politically independent parliamentary staff (including administrators and management, known as 'clerks'). These staff number only a few thousand - in proportion to the parliamentarians they support, a vastly smaller resource than the civil servants who support government.

These differences are reflected in a contrasting style of science advice. Parliamentary science advisers provide advice not for the benefit of a single minister, but to hundreds of MPs and Peers whose political affiliations are myriad. The advice, while thorough in its analysis and rigorous in the communication of research evidence, is given in the context of a wide range of possible policy options, not just the ones that the government advocates. To ensure that the advice is not only independent, but is also seen to be independent, it must always stop short of making policy recommendations.

The fact that parliamentary work is about debate and scrutiny, rather than policymaking *per se*, also affects the nature of science advice. For debate, advice must touch on those issues that are relevant across a wide range of political views. For scrutiny, it needs to equip Members with the tools and information to be able to ask searching and forensic questions.

Research evidence is fed into Parliament by the same sources that seek to influence government, but through different routes. Compared to the structured hierarchical system of government, Parliament has many 'moving targets'. There are important individuals such as those that chair select committees, but lobbyists also work through informal networks, groups and committees of which there are more than 600, ranging from large groups active in high-profile and broad policy spaces (such as the All Party

Parliamentary Climate Change Group and the Associate Parliamentary Health Group) to those whose subject coverage is narrower (such as the All Party Parliamentary Hepatology Group and All Party Parliamentary Zoos and Aquariums Group).

The Parliamentary Office of Science and Technology

The role of the Parliamentary Office of Science and Technology (POST) is to support the use of research evidence in parliamentary debate and scrutiny in both the House of Commons and the House of Lords, providing advice on issues as diverse as energy, the environment, health and infrastructure. It does so through its POST notes (four-page briefs, downloaded over a million times each year) and its regular events, in which leading researchers discuss scientific and technological developments with a parliamentary audience.

Through these activities and others, POST not only provides information, but builds capacity within Parliament to handle scientific concepts and appreciate the impact of new technologies on society. Its science advisers spend approximately 15 per cent of their time working with select committees to feed research evidence into scrutiny activities. Importantly, POST also builds connections between Parliament and the research community; every time it produces a POST note, approximately 15 new connections are made between Parliament and researchers, and hundreds of such connections are made annually.

As already noted, there are relatively few staff in Parliament, and this applies to science advisers too. POST is staffed by a director, six science advisers, two administrators, and a number of early-career researchers who each spend three months at POST writing briefing papers and organising seminars. By comparison, POST's closest equivalent in government, the Government Office for Science, is seven or eight times bigger. The House of Commons Library has a science and environment section, and also some statisticians and social scientists; and various select committees in both the Commons and the Lords have their own specialists as well as part time specialists recruited for specific inquiries. All told, parliamentary science advisers (depending on how you define them) number between 20 and 40. Because there are so few, the range of topics on which each of them provides advice is typically wider than in government.

More analysis required

Parliamentary science advice is, as I have argued, distinctively different in character from advice in government; but not only is it represented by many fewer advisers, it is also systematically overlooked and misunderstood by the research community. At the broadest level, the process and practice of science advice in Parliament is poorly studied. It would be of immense value - not least to the practitioners themselves - to have a better understanding of how science is used in parliamentary debate, a keener appreciation of how parliamentarians and researchers interact, and a rigorous assessment of what methods of science advice have the greatest impact in different policy areas.

A further observation relates to the progress of the science and society agenda in the past decade. While the research community has learned not simply to lecture the public, but to engage with it, the same lesson has not been learned when it comes to engaging with policy. All too often, researchers consider that politicians just need to be 'put straight' on the science, when in fact a process of engagement would be much more productive. This is particularly true in Parliament, where decision makers are more politically varied and autonomous than in government.

The research community should give serious thought to how best to engage with politicians. Training programmes for academics on the practical realities of politics and policy, and how to engage with both, would be a major step forward. Within this, there is a specific need for a better understanding of the way that research evidence is used in a parliamentary context. Those scrutinising government policy need access to research evidence, and assistance in interpreting it and in handling inherent uncertainties - all the more so because they are usually not expert in the particular domain from which relevant evidence is drawn.

Politicians, too, should be provided with opportunities to develop their skills in the sourcing, interpretation and use of research evidence, and should be incentivised to do so. They could also benefit from enhanced resources, with more and better qualified policy staff to help with research and briefing (though until we have a clearer understanding of how research evidence is used in parliamentary debate, establishing ways to improve it is difficult.)

My final observation addresses my own community of science advisers. A growing body of work exploring their role has predominantly focused on government and its agencies, and has been influential in professionalising science advice. The Government Science and Engineering network exemplifies how the roles of government science advisers have developed over the past decade. The same transition has not taken place in Parliament, but given the smaller numbers of people involved and the different role that science advice plays, a different approach is called for. Improving our understanding of the role that research evidence plays in parliamentary debate and scrutiny, and of how science advisers influence that role, will be critical to the future of high quality scientific advice.

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4

CREDIBILITY ACROSS CULTURES

LETTER FROM AMERICA: A MEMO TO SIR MARK WALPORT

Roger Pielke, Jr.

Congratulations Dr Walport on your appointment as the UK government's Chief Scientific Adviser. You join a select group. Since the position of chief science adviser was established in the US in 1957 (see Table 1) and in the UK in 1964, less than 30 men (yes, all men) have occupied the position. Today across Europe, only Ireland, the Czech Republic and the European Commission have formal equivalents, which also exist in Australia, New Zealand, and soon perhaps in Japan and at the United Nations.

Table 1: US presidential science advisers, 1957 to the present day.

Shaded names are those who participated in a series of visits hosted by the University of Colorado's Center for Science and Technology Policy Research from 2005 to 2013. Dates in parentheses are the year of death.

Eisenhower	James R. Killian, Jr. (1988)	1957 - 1959
Eisenhower	George B. Kistiakowsky (1982)	1959 - 1961
Kennedy	Jerome B. Wiesner (1994)	1961 - 1963
Johnson	Jerome B. Wiesner (1994)	1963 - 1964
Johnson	Donald F. Hornig (2013)	1964 - 1969
Nixon	Lee A. Dubridge (1994)	1969 - 1970
Nixon	Edward E. David, Jr.	1970 - 1973
Nixon	H. Guyford Stever (2010)	1973 - 1974
Ford	H. Guyford Stever (2010)	1974 - 1977
Carter	Frank Press	1977 - 1981
Reagan	George A. Keyworth II	1981 - 1985
Reagan	William R. Graham, Jr.	1986 - 1989
G. H. W. Bush	D. Allan Bromley (2005)	1989 - 1993
Clinton	John H. Gibbons	1993 - 1998
Clinton	Neal Lane	1998 - 2001
G. W. Bush	John H. Marburger III (2011)	2001 - 2009
Obama	John Holdren	2009 - present

In the United States, the science adviser is an assistant to the President with the formal title of Director of the Office of Science and Technology Policy, one of the many groups that sit in the Executive Office of the President. The OSTP was created in 1976, but the formal designation of science adviser dates from 1957, and informally from even earlier. All US science advisers (except notably the first, James Killian, who had a background in public administration) have been trained in some area of physics, reflecting the Cold War origins of the position and its historical connection to defence issues.

Since 2005, the Center for Science and Technology Policy Research at the University of Colorado has brought to our campus six former science advisers, spanning the administrations of John F. Kennedy to Bill Clinton, as well as the sitting advisers under Presidents George W. Bush and Barack Obama.

In this note, I distill what I consider to be the most relevant insights from their experiences, viewed through the lens of academic research on science and technology policy, to suggest five important lessons for any prospective chief scientific adviser.

Lesson 1. Science advisers are not superheroes

The US science adviser carries the weight of a mythology of extraordinary access to the President and of a portfolio which spans government. A 2013 profile of Anne Glover, science adviser to the European Commission, looked with envy across the Atlantic:

> *"John Holdren [is] the latest in a long list of éminence grises tapped to advise US presidents. At the annual meeting of [the American Association for the Advancement of Science] in Boston last month, Glover says that Holdren told her that he was in and out of Barack Obama's office up to four times a day in the run-up to important decisions."* [1]

The reality of the position is more prosaic and less glamorous than this (perhaps apocryphal) anecdote would suggest. The science adviser has never been all that central to presidential decision making. The position was created as part of President Eisenhower's response to the Soviet launch of Sputnik, with the appointment of James Killian. One historian of the

period commented that President Eisenhower *"saw more scientists in the two weeks following Sputnik than he had seen in the year before."*[2] Eisenhower contributed to the creation of a mythology when he said that Killian *"would enjoy wide latitude in action and guaranteed access to information in every corner of government."*[3]

But actions can speak louder than words. Eisenhower rushed Killian's swearing in ceremony to depart for a golf vacation in Augusta, Georgia. He also left office with a warning that *"public policy could itself become the captive of a scientific-technological elite."*[4] Yet as the realities of politics became apparent, Killian's successors began to look back at what they perceived to be a golden age of science advice. Jerome Weiser, who followed as President Kennedy's science adviser, characterised Killian as an adviser who *"rapidly became involved in matters of the greatest national importance involving education, defense, disarmament, space, and international cooperation."*[5] Recalling his term a decade later under President Nixon, Ed David observed that *"The old style science adviser, the distinguished person whom the president looked upon as his house intellectual, to be listened to on the complex and new issues… is not likely to recur soon."*[6]

The idea that science advisers can carry the authority of science as a counterbalance to the messiness of politics runs deep in the expectations of many for the position. Such expectations come from politicians (reflected, for example, in the recent UK House of Lords report on chief scientific advisers[7]) as well as from the science community (reflected, for example, in the recent book *The Geek Manifesto*, which calls for a greater authority of scientists in decision making.[8])

Despite such expectations, the science adviser is an adviser just like any other in government, with a limited portfolio of responsibilities and expectations for accountability. An experience of the EU's Anne Glover that is instructive occurred after she claimed in public that genetically modified foods were no riskier than their conventional counterparts. The ensuing controversy resulted in a soft rebuke from José Manuel Barroso, president of the European Commission, to whom she reports:

> *"The CSA reports directly to the President of the Commission and has the task to provide independent expert advice to the President on any aspect of science, technology and innovation…The CSA has a purely advisory function and no role in defining Commission policies. Therefore, her views do not necessarily represent the views of the Commission."*[9]

Science advisers are not superheroes with special access and supra-political authority. Making effective use of the position within government requires the scientific community to realistically calibrate their expectations for the role.

Lesson 2. 'Science advice' is a misnomer

These days, science advice and science communication are all the rage. Unfortunately, such discussions often fall prey to the so-called 'deficit model' of the relationship between science and decision making.[10] In its most basic form, the deficit model recommends the following logic to a would-be science communicator: once you come to understand the facts as I understand them, then you will come to share my policy preferences, if not my values.

Under such a model of interaction the emphasis is on sharing (or more commonly, arguing about) scientific facts or understanding outside of any political context. We have learned, repeatedly and sometimes at a high price, that efforts to separate science and politics in such a manner may diminish the role of evidence in policymaking, and can contribute to the pathological politicisation of science. Fortunately, many in the science policy community, both academics and practitioners, now recognise the pitfalls of the deficit model and have moved beyond it.

For instance, we asked Donald Hornig, who was science adviser to Presidents John F. Kennedy and Lyndon Johnson, to describe an instance when he was asked by the President to *"arbitrate on some scientific question or to provide some scientific advice on an issue that he was handling."* Hornig replied that he knew *"of no example of being called to arbitrate a scientific question."*[11]

The actual (as opposed to mythologised) history of the US science adviser position helps to place the role in a more realistic perspective. James Killian, often held up as the most successful postholder, was not even a trained scientist, having earned a Bachelor's degree in public administration. So if the science adviser is not actually advising on science what is he doing? The science adviser is part of government, and in the US is a presidential appointee, and as such is a political adviser. It just happens that the portfolio of responsibilities of the science adviser includes matters of policy for science, including government-wide R&D budgets, and science for policy, on topics as varied as food safety and terrorism.

Lesson 3. Political advice from a science adviser can take multiple forms

The science adviser is not unique in government in having specialised expertise or post-secondary education. Almost by definition, governing in the 21st century requires sophisticated expertise. Energy, food, conflict, economics, crime, education, environment, terrorism - the list of complex issues dealt with by governments that require the input and advice of experts knows no bound. In one sense, the phrase 'science advice' may already be redundant.

The idea of a science adviser serving as a 'house intellectual' is no longer a realistic expectation, if it ever was. Compare the perspective of William T. Golden, writing of the federal government in 1950: *"As to how many top echelon or key scientists there are...it would be difficult to decide where to draw the line. However, it appears that the number is probably somewhere between 20 and 200."*[12] In 2004, the US Governmental Accountability Office found that across government there were 948 advisory committees with 62,497 members. President Obama famously stacked his first term Cabinet with a science 'dream team', prompting the head of the American Association for the Advancement of Science to comment, *"We have never had quite this array of scientists in federal government leadership positions."*[13]

The rise of expertise in government means that the role of the science adviser has been constrained to a few areas, simply because governments are chock full of experts, agencies and advisory mechanisms. In our review, we characterised a set of specialised roles unique to the position of science adviser as follows:[14]

Budget champion. The science adviser is a co-ordinator, and at times, a champion for research and development funding across the federal government. The scientific community may look to the science adviser as its 'chief lobbyist' for greater public support. All of the science advisers that we spoke with expressed caution about taking on this role, as it risks eroding the adviser's authority in government. Nonetheless, it seems clear that many in the scientific community view the position in exactly this fashion, particularly when the size of the federal R&D budget is commonly invoked as a metric of science policy success.

Issue expert. The science adviser has a unique ability to assemble expertise to address specialised or cross-cutting policy issues. When a top scientist in academia or industry receives a call from the President's science adviser, it is certain to be returned. This power to convene can quickly bring together top experts to consider issues of national importance. For example, John Marburger, President George W. Bush's science adviser, described how his office was asked at short notice to prepare a briefing for the President on earthquakes and tsunamis after the 2005 Sumatran earthquake that killed almost 300,000 people.

Options Czar. The science adviser may also serve as what I have called an *"honest broker of policy options"*, helping the President or Prime Minister to understand the scope of available choice on a particular topic. Given the practical realities of high-level decision making, it might be difficult to imagine a President like George W. Bush, who relied on a close circle of political advisers, using a science adviser in this manner, but it is less difficult to envision a President like Bill Clinton doing so.

Institution builder. A fourth role is to oversee the institutionalisation of scientific advice across government. The provision of useful advice requires a commitment from policymakers to the use of evidence, but also to the creation and maintenance of strong institutions. The science adviser has a crucial role to ensure institutional integrity by providing advice on advice.

Lesson 4. Institutions matter

Professor David Nutt, chair of the UK's Advisory Committee on the Misuse of Drugs (ACMD) was famously relieved of his duties by the Home Secretary to whom he reported, following public comments that were

perceived to be at odds with government policy. What was rather lost in the fierce debate that followed was the importance of the underlying institutional arrangement for advice.[15] Independence is not enough. The specific work of the advisory body matters a great deal as well. Consider the following three recent situations:

Earlier this year, the Greek government brought charges against Andreas Georgiou, the head of its independent statistical agency Elstat, and two of his colleagues for allegedly overstating the country's debt in 2009. The debt calculations were a critical input to characterising the magnitude of the nation's financial crisis and the subsequent responses by the EU and the IMF. For his part, Mr Georgiou complained: *"I am being prosecuted for not cooking the books."* By contrast, Greek politicians argued that the statistical agency was *"too focused on the numbers and not enough on serving the country and the government."*[16]

Last year in L'Aquila, Italy, six scientists and one government member of the Italian National Commission for the Forecast and Prevention of Major Risks were sentenced to six years in prison for misleading the public about earthquake risks. At an ill-timed press conference held prior to the devastating 2009 earthquake, which killed 297 people, local residents were reassured by the experts that they should enjoy a glass of Montepulciano instead of worrying about earthquakes.[17]

In the United States, in the immediate aftermath of Hurricane Sandy, New Jersey Governor Chris Christie issued an executive order classifying the storm as a 'post-tropical cyclone' rather than a hurricane, preempting the scientific evaluation of the National Weather Service. Whether Sandy was judged a hurricane or not makes a big difference in insurance payouts to individual homeowners. If a hurricane, the payouts would be much smaller. In a letter to the Weather Service, New York Senator Chuck Schumer reminded the agency that its scientific judgments could cost his constituents a lot of money.[18]

Each of these seemingly different cases has a common characteristic, which they share in turn with the sacking of David Nutt. An institution - Elstat in Greece, the Major Risks Commission in Italy, the US National Weather Service and the UK's ACMD - was tasked with rendering expert judgment as an input to policymaking. In each case, that input was thwarted in some way.

Ironically, Elstat was created in 2010 to improve the provision of statistical data to Greek politicians. Prior to that, *"the practice was for the finance ministry's general accounts office to collude with the Bank of Greece to come up with deficit and debt figures ignoring surveys carried out by the statistical service,"* as one economist told the *Financial Times*.

In Italy, the earthquake experts stand accused of colluding with politicians to convey a message of complacency to the public via a 'media operation.' The message being sent was motivated, at least in part, by the experts' desire to discredit an amateur earthquake forecaster who had heightened public alarm by predicting a forthcoming big earthquake.

Dozens of US states have defined a tiered 'hurricane deductible' for insurance payouts, several of which rely on scientific judgments of the National Weather Service, an agency that was never established for such a purpose. Given the political pressure, it was no surprise that Sandy was ultimately not classified as a hurricane in the agency's final storm characterisation.

The challenges of utilising expertise in politics know no national boundaries and can be found across the political spectrum. Calls to cleanly separate science and politics fail to recognise that the challenge actually lies in their integration via institutions. If an advisory body exists to answer narrow technical questions put forward by policymakers, then this needs to be made clear via its terms of reference, and a formal process needs to be created to elicit questions from policymakers. An example of such a committee is the UK Migration Advisory Committee (MAC), which is mandated to answer only specific questions, according to a well-established set of methods and protocols.[19] It provides non-binding recommendations which government can adopt or ignore as it chooses. While the MAC's advice has been hotly debated in recent years, there have been no challenges to its legitimacy of the sort that plagued the ACMD.

A different type of advice focuses on policy options. Sometimes decision makers want to know what options for action are available to them. As Lord May, former UK government chief scientific adviser, explains: *"The role of the scientist is not to determine which risks are worth taking, or deciding what choices we should take, but the scientist must be involved in indicating what the possible choices, constraints and possibilities are … The role of the scientist is not to decide between the possibilities but to determine what the possibilities are."*[20]

Such honest brokering of policy options is sorely needed in a world where experts readily self-segregate themselves according to their political preferences, leaving few options for comparative policy advice. An expert body that clarifies, or even expands, the scope of choice will necessarily be comprised of a wider range of expertise than a panel of scientists who arbitrate scientific questions. Economists and other social scientists will almost certainly be necessary, as, in many cases, will broader forms of public engagement.

Rather than answering specific technical questions, or recommending a specific course of action to meet a narrow goal, an 'honest broker' provides multiple possible options to meet a specified goal, or options conditional on goals. One example of an honest broker is the US Office of Technology Assessment, terminated in the early 1990s, which would often produce reports with options for action rather than advocating specific policies. Other examples include the red team/blue team adversarial model used by the military, the German Federal Institute for Risk Assessment and some of the projects of the UK Foresight Programme. A key role for government science advisers in future will be to set up and evaluate such institutions, which are able to provide more systematic advice about how to provide useful advice.

Lesson 5. Politics is more difficult than physics

When Albert Einstein was asked why it was that we could discover how to split the atom but had difficulty in overseeing atomic technology, he famously replied, *"That is simple my friend: because politics is more difficult than physics."*

I was reminded of this phrase when we interviewed Ed David, President Nixon's science adviser. Not only did Nixon demand that David terminate all federal funding to MIT as retribution for campus protests against the Vietnam War, but he eventually terminated the science adviser position altogether, prompting its resurrection via Congressional legislation. Before that however, Nixon had another interaction with experts which reveals that while the laws of physics are unbendable, politics can be even less accommodating. David explained that in 1972, Nixon's White House was considering cancelling the Apollo 17 mission to the moon.

> *"That reason was essentially political…Apollo 17 was slated to launch about a month before the election day, early in November 1972. The big worry by the political forces in the White House was that if there was an accident on Apollo 17, it would bear heavily on the election outcome negatively. I suggested that Apollo be postponed, however, until December after the election…This shows you how science hangs by a string in such situations."*[21]

David explained to us that NASA at first resisted the schedule change, claiming that they would have difficulty keeping their staff in peak form during the delay. Based on the President's unyielding political agenda, David gave them a choice that they could not refuse: launch in December, or not at all. NASA quickly saw the merits of his perspective and adapted its mission planning.

Despite such political realities, scientists at times argue that science should carry overriding political authority and legitimacy. Of course, science does carry authority, which is one reason why it is so often invoked in political debates. However, care must be taken not to place science or scientific institutions in a situation of direct confrontation with political forces, as politics will almost always win out.

For instance, the 2012 House of Lords report on chief scientific advisers at times leans too heavily on the capacity of science's 'essential characteristics' to check the excesses of politics.[22] The report recommends that scientific advisers sit outside the Civil Service, but have direct access to ministers at the prompting of the adviser; have a reserved seat on departmental boards; be allocated their own 'ring-fenced' budget; and have a say in how departmental funds for science are allocated.

However, the notion of a completely independent scientific adviser proved problematic when the Lords' report sought to grapple with situations when a science adviser disagreed with a ministerial policy decision. The proper answer to this question is the same as for any government employee - either quietly accept the decision, seek change from within, speak out and suffer the consequences, or perhaps resign. When science advisers see their role change from providing advice to playing a formal role in the making of decisions, the science adviser is no longer an independent adviser, but has entered the democratic process as an unaccountable decision maker. Following the Lords' advice would lead to more cases like that of David Nutt, rather than fewer.

Einstein was right: politics is more difficult than physics. Securing effective science advice depends upon creating effective institutions with clear mandates that integrate expertise into decision making. Democracy is best served by recognising that advisers advise and decision makers decide.

Parting thoughts

Writing in 1963, the philosopher Stephen Toulmin warned that, *"Unless decisions about science policy are to be left to be made by éminences grises, we shall need a corresponding body of independent informed opinions about the natural history of science…research on the intellectual foundation of scientific policy."*[23] The good news for science advisers in the 21st century is that there exists a rich and growing field of research on practical questions that lie at the intersection of expertise and decision making.

The UK has more than its fair share of this expertise, which I encourage you to take full advantage of during your tenure. These experts can provide you with much useful advice on advice. Just as there are calls for policymaking across government to be more evidence-based, so too should science and technology policy.

Good luck!

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THE CROWDED CHASM: SCIENCE IN THE AUSTRALIAN GOVERNMENT

Paul Harris

The lead-up to the last federal election was a time of unusually high drama for the Australian government. Just two months ahead of the poll, the Prime Minister Kevin Rudd stood down after losing the support of his party, and was replaced by his deputy Julia Gillard, who became the nation's first female Prime Minister. Bitter debate raged about the science and politics of climate change, with Rudd having retreated from a planned emissions trading scheme. And an ambitious public service reform agenda, driven by Rudd and the Secretary of his Department, Terry Moran, was parked while the focus shifted to campaigning and voting.

In this context, the Australian Academy of Science issued its science policy election statement in August 2010. Among its priorities was an emphasis on the importance of science in government policy. According to the Academy:

> *"Relatively few Australian politicians or public service leaders have had formal training or background in science. This potentially compromises the proper consideration of scientific evidence as a normal part of administrative and planning practice."*[1]

First among the subsequent recommendations was an insistence that all major government departments should appoint a senior scientific adviser - an extension of what has come to be known by shorthand in Australia as the 'UK model' for scientific advice.

Quite how such a specific change might help to address perceived problems in the relationship between science, policy and politics, and contribute to the broader aims of public service reform, has never been spelled out. But since 2010, a great deal of attention, both in the research and policy communities, has been focused on the place of science in government in Australia.

Whether or not the Australian government needs a UK-style network of chief scientific advisers is one question. But a series of deeper questions is now being actively discussed. What is the actual problem that needs to be

solved? What do we need, and what do we already have, to link science and policy? What is the right mix of disciplines and perspectives? And, in a time of tight government budgets, what is actually affordable? Addressing these questions has the potential to lead to a better discussion about the place of science in the Australian government.

Australia's Chief Scientist

The Australian government does in fact have a Chief Scientist. The role was created in 1989, and its last few occupants have from time to time been caught up in larger political debates - for example attracting criticism for close links to industry and support of GM crops. On forming a government in 2007, the Labor Party changed the role from a part-time to full-time appointment, stressing the importance of science to the government and to society. However Professor Penny Sackett resigned from the position in early 2011, telling a Senate Committee hearing that she had not been asked to brief Prime Minister Gillard once.[2]

Professor Ian Chubb was appointed to the role in April 2011 and immediately set out an ambitious agenda. A neuroscientist by background, he had studied at Oxford before taking on senior roles in Australian universities, culminating in a decade as Vice-Chancellor of the Australian National University. In his first speech to the National Press Club in June 2011, he said: *"As Chief Scientist, I will speak up and be an advocate for science. I know that some of my work won't be visible… but I'll be around."*[3]

He has indeed. As Chief Scientist, Chubb has widened the scope of the work of his office, been a visible contributor to public debate, and assumed a central role in science policy within government. After opining early in his term that *"this is not the office of the chief climate change scientist"*, he has sought to broaden his role, and driven a strong *"policy for science"* agenda. His office has led significant initiatives examining the health of Australian science, and the state of mathematics, science and engineering education, which led to a $50 million funding injection in the 2012 federal budget. He has also taken the lead role in a new Australian Research Committee (ARCom), designed to improve coordination across government and inform the new National Research Investment Plan and the setting of strategic national research priorities.

Chubb has also spoken publicly about the importance of the role of science in policy, and of "evidence-based policy development". His office plays a role in coordinating and brokering scientific advice and expertise at the request of ministers and government departments. In his Press Club address, he said: *"Part of my responsibility is to ensure that the science is available… My goal is to ensure they [politicians] have no excuses for not having the relevant scientific advice in front of them."*[4]

But as Chief Scientist, Chubb has not advocated for a network of chief scientific advisers in every government department. Chief scientists in different countries clearly see their roles differently and prioritise accordingly. In late 2012, Chubb and his New Zealand counterpart Sir Peter Gluckman met with members of their staff to compare notes.[5] But it remains to be seen if any more structured international network is formed.

Perceived gaps between expertise and policy

Meanwhile, broader debate has continued about perceived problems with the integration of scientific advice and expertise with public policy, both in the research community and in government. Around the same time that Chubb was speaking to the National Press Club in 2011, Professor Peter Shergold - previous head of the Department of Prime Minister and Cabinet, and now Chancellor of the University of Western Sydney - wrote an influential article that summed up his frustration at the 'chasm' between research expertise and policymaking:

"Universities, then, are doing the research. Governments, and their public services, want the evidence. Why is it so difficult to get these two worlds to meet at an intersection of knowledge that can influence in significant ways the making of public policy? Why does Australia's large public investment in research and development contribute so little to addressing the political response to the nation's economic and social challenges?"[6]

This frustration at the perceived gap between research and policy also finds expression in the work of Shergold's successor, Terry Moran, and the review of government administration and subsequent public service reform agenda that he helped to deliver.

In May 2010, Prime Minister Rudd had accepted all of the recommendations contained in the report *Ahead of the Game: Blueprint for the Reform of Australian Government Administration.*[7] He said: *"We are committed to building an Australian Public Service with a culture of independence, excellence and innovation - in policy advice and service delivery."* The recommendations cover issues such as closer relationships between federal, state and local governments, a focus on skills through better workforce development and capability planning, and 'open government.' A senior leadership forum for the public service - the APS200 - was created, to bring together 200 of the nation's top government officials and strengthen a culture of leadership. Finally, there was a clear focus on strengthening strategic policy capability across government through enhanced 'relationships with academia and research institutions.'

The APS200 report

APS200 project teams - bringing together senior staff from a range of departments and agencies - were assembled to work on a handful of cross-cutting issues of importance to the government and the reform agenda. One of these projects, which began in 2011, was focused on *The Place of Science in Policy Development in the Public Service.*[8]

The final report of this project was launched in September 2012. It states that the project set out to *"systematically review the ways in which scientific evidence is used to inform policy development in the Australian Public Service (APS)"*, with the aim of achieving *"better government outcomes through facilitating the effective use of scientific input in policy development in the public service."*

The context and rationale for this is two-fold. The report describes the ways in which the APS is *"increasingly tasked with solving complex policy problems that require significant input from science"* and the aim of the public service reform agenda to strengthen a 'rigorous, evidence-based approach.' At the same time, the Australian government spends approximately $9 billion per annum in science, research and innovation programs, and:

> *"…has an interest in harnessing this investment… ensuring that interactions between the science community and policymakers operate effectively to support the transfer of scientific research into policy and decision-making."*

The APS200 report identifies five issues or barriers to more effective interaction: timeliness; cultural differences; relationships; timeframes; and access. It then offers recommendations that government departments and agencies can implement to overcome these challenges. These include:

- A more systematic and 'joined-up' approach across departments and government as a whole.
- A clearer articulation of government's science needs through strategic national priority-setting.
- Human capability development in both the research and policy communities, with researchers rewarded for engagement with government.
- Reviewing and enhancing existing 'science liaison functions' and science advisory mechanisms within government.
- Strategies for knowledge and data management to improve access for policymakers to publicly-funded research data.

The APS200 report, with its clear recommendations and network of engaged senior public servants across government, provides a strong platform for future work, addressing problems that prevent science from assuming its proper place in policy. But what exactly are these problems?

Issues such as differing timeframes, cultures, expectations, rewards and motivation are worthy of attention in seeking to more effectively connect science and policy, and are mirrored in other studies and contexts. Yet at a deeper level, the report shows that concerns about a gaping chasm between the worlds of research and government are misplaced. If there is a chasm between science and policy in the Australian government, it is an awfully crowded one.

Although there is not yet any systematic collection of data across government about exactly what 'liaison functions' and 'science advisory mechanisms' exist, the report clearly shows that there is a lot going on. It is not yet properly quantified, but a significant portion of the government's $9 billion annual investment can be mapped to activity that contributes to the provision of information and science advice directly to government. The

report lists 15 government science agencies and numerous programs. One senior official, interviewed as part of the project, commented that there was *"no sense that my department lacks access to technical expertise."*

And despite the lack of a central push from Professor Chubb, there is already more than one chief scientist in the Australian government. With only a little bit of investigation, it is possible to find staff with that title in government agencies in areas as diverse as defence, geoscience, food safety, agriculture and Antarctic science. During the visit of Sir John Beddington to Australia in October 2012, the government also announced the creation of a new chief scientist post in its Department of Education, Employment and Workplace Relations, with a particular focus on the social sciences.[9] But perhaps most striking has been the growing number of new chief economist positions in the APS, most recently in resource and energy economics, immigration and in the heart of science policy itself in the Department of Industry, Innovation, Science, Research and Tertiary Education.

Institutions over individuals

So whatever the problem, it seems that drawing attention to the 'gap' between science and policy, or calling for the adoption in Australia of the 'UK model' of CSAs is unlikely to be the solution. There are plenty of people in the Australian government with 'chief' titles, and while there is not yet a network to coordinate or bring them all together, science is not without a role or authority in the work of government.

The challenge is institutional rather than individual. The APS200 report makes a case for a clearer, more coordinated and more concerted approach to evaluate - and improve where possible - the appropriateness and effectiveness of what we already have. As in other countries, science in policy in the Australian government is not a blank sheet of paper. There is useful knowledge from both theory and practice that can be brought to bear.

Here the report provides another useful reference point, in the way it takes an admittedly simplified policy cycle model and sets out a typology of science, advice and expertise that might be most effective at different stages of that cycle. Evoking Roger Pielke Jr.'s matrix from *The Honest Broker*,[10] the APS200 report points to a possible way to flip this around from the

point of view of policymakers. This is the kind of framework that can assist researchers to better understand the workings of government.

By starting with desired outcomes instead of inputs, investments can be better planned, performance can be better managed and success better evaluated. The case study in the APS200 report of Australia's National Environmental Research Program highlights how, with thoughtful program management, it is possible to deliver high-quality science and useful knowledge, tools and information to policymakers, from a relatively small budget.

In seeking to improve science policy, more attention is needed not on 'science for policy' or 'policy for science' alone, but on the two-way links between them both. As Andrew Campbell, former head of Land & Water Australia, says - if you want to improve the connection between science and policy, it is important to 'fund the arrows' not just the boxes.[11] A more coordinated and systematic approach to this across the Australian government - with a focus on mechanisms and institutions, not just individuals - is a good start.

The persistence of politics

This is work that should continue. But those calling for more science in policy should remember that it will not 'solve' complex policy issues, or make the politics go away. Even when science plays a central role in policymaking, there is always more involved.

The debate in late 2012 about whether or not a fishing supertrawler should be permitted to operate in Australian waters is an example of this. The week before the APS200 report was launched, Australia's environment minister had banned the ship from fishing until an expert panel could further investigate its potential impacts. Science had - and continues to have - a central role in government decision-making about the large freezer trawler. But equally, concerns about overfishing, by-catch, jobs, foreign investment, tourism and recreation all played a role, as did a grassroots internet campaign organised by the not-for-profit advocacy organisation 'Get Up!'.

One leading scientist involved in the debate referred to the minister's decision as *"a slap in the face for science."*[12] But to characterise the issue

in this way hinders rather than helps. Science does not have a single face, and is not separate and superior to all other sources of information and advice that policymakers must take into account.

In 2013, as we look towards another general election in Australia, science remains central to many important national debates. But focusing on the 'chasm' between science and policy, or on an 'evidence-based' approach to the exclusion of all others will not help. We know some things about how to make better use of what we already have, and if we can put these into practice, and avoid pejorative rhetoric, there is great potential to enhance the role of science in the Australian government.

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LESSONS FROM THE IPCC: DO SCIENTIFIC ASSESSMENTS NEED TO BE CONSENSUAL TO BE AUTHORITATIVE?

Mike Hulme

One of the common public expectations of science is that it speaks authoritatively about the way the physical world works and thereby what the physical consequences of different human actions and policy interventions are likely to be. Science and scientists are believed to offer something different to public life compared to that offered by politicians, journalists, lawyers, priests or celebrities. But what is meant by 'authoritative'? And how does scientific practice best earn and maintain its authority in the face of public challenge and scepticism? In these few remarks, I want to explore one important dimension of scientific authority-building, namely the interplay between the ideas of consensus and dissensus. And I want to do this using the example of the UN's Intergovernmental Panel on Climate Change (the IPCC). The question I wish to answer can be put simply: does the pronouncement of a scientific consensus on an issue such as climate change increase or weaken the authority of science? And for whom exactly are such pronouncements effective - scientists, different publics, policymakers, politicians?

Claiming consensus

The IPCC has made a very specific claim regarding its consensus-making character, as too have many commentators outside the IPCC - whether politicians, lobbyists, advocates or critics. In the foreword to the Working Group I report on the physical science of climate change in the 1st IPCC Assessment, published in 1990, the Co-Chair Sir John Houghton wrote *"… peer review has helped ensure a high degree of consensus amongst authors and reviewers regarding the results presented."*[1] From the very beginning then, the IPCC has sought and rhetorically delivered a consensus on climate science. Thus we see in November 2007, just ahead of the publication of the IPCC's 4th Assessment Synthesis Report, the IPCC promoting the authority-making nature of its consensus processes: *"2,500+*

scientific expert reviewers; 800+ contributing authors; and 450+ lead authors; from 130+ countries; 6 years work; 4 volumes; 1 report. The core findings of the three volumes integrated in the most policy-relevant scientific document on climate change for the years to come." The sheer weight of expertise compressed into one report is itself a claim to authority.

This association between consensus and authority is then exploited, not surprisingly, by social and political actors outside the IPCC. The fallacy, pushed particularly by some of the climate change campaigning NGOs from the early 1990s onwards, is that the stronger the climate consensus, the easier it is for lobbyists to use science to advance their own goals and objectives. The front page headline from *The Guardian* newspaper on 27 January 2007, just before the IPCC's 4th Assessment Working Group I report was released in February, reflects this: *"UN's vast report will end the scientific argument. Now will the world act?"* Or again we can see political actors picking up cues about consensus equating to authority, as in this example from Australian Prime Minister Kevin Rudd. In a speech on 6 November 2009, just before COP15 in Copenhagen, Rudd announced: *"This is the conclusion of 4,000 scientists appointed by governments from virtually every country in the world … Attempts by politicians in this country and others to present what is an overwhelming global scientific consensus as little more than an unfolding debate … are nothing short of intellectually dishonest. They are a political attempt to subvert what is now a longstanding scientific consensus."*

Is scientific consensus needed?

But is the IPCC right to be aiming for a scientific consensus and are its promoters right to be proclaiming IPCC consensus as an end to argument? Or to ask the question more generally, when seeking to be authoritative on complex issues of public policy importance should scientific assessments be issuing consensus statements?

In his exploration of political theory, Jon Elster, the Norwegian social theorist, remarked: *"I would in fact tend to have more confidence in the outcome of a democratic decision if there was a minority that voted against it, than if it was unanimous".*[2] If this is true of a democracy, then could it also be true of science? Would non-scientists have more confidence in climate science if there was a minority view - for example about the

evidence of attribution or change to human influences or about future climate risks - that was officially recognised by the IPCC, rather than the existing mode of climate science being presented as an all-encompassing consensus? In the article in which Elster is quoted, philosopher of science John Beatty and political theorist Alfred Moore develop exactly this argument, and I believe it applies well to the case of climate change and the IPCC.[3]

In favour of consensus

The argument in favour of consensus as authoritative is that it reflects what science supposedly is uniquely disposed to be good at: applying rules of reasoning and inference which lead unambiguously and universally from evidence to conclusion. The same evidence presented to the same disciplined mind leads to precisely the same conclusion. In this view, a lack of consensus would undermine the authority of science because it might suggest either that conflicting conclusions had been reached prematurely or that personal or cultural biases and values had protruded into the reasoning process.

This is the position that seems to be implicitly assumed by many protagonists in the climate change debate, whether they be mainstream or critical voices. It was the view expressed by Sir John Houghton for example in the foreword cited above. His comments on consensus were immediately preceded by the observation that a minority of scientific opinion had been excluded from the report and that the resulting consensus therefore underwrote its authority: *"Although … there is a minority of opinions which we have not been able to accommodate, the peer review has helped ensure a high degree of consensus amongst authors and reviewers regarding the results presented. Thus the Assessment is an authoritative statement of the views of the international scientific community at this time".*[4]

It is also the view of many critics of the scientific mainstream who assert that science properly conducted - through unbiased reasoning processes - should lead to unanimous consent. By pointing out the mere existence of minority dissenting positions outside the IPCC's statements, ipso facto they undermine the authority of science in the eyes of the public. This of course reflects a very particular (purist) view of scientific knowledge which scholars such as Bruno Latour have described as the *'modernist illusion of science.'*[5] And yet it is one that offers a wide variety of protagonists a useful defence against cultural relativists.

Against consensus

But the argument against consensus as authoritative, at least in the context of wicked problems like climate change and at least in the way in which the IPCC has promoted it, seems to me to be compelling. Let me mention just three aspects of this argument (although Beatty and Moore expound others too).

First is an argument by analogy. Majority rule works very effectively in maintaining authority in social institutions such as parliaments and the courts, which involve voting MPs and juries. Consensus is not required for a ruling or judgement to carry authority in wider public settings. And whatever differences we might insist on between the nature of scientific enquiry and political (or jury) debate, we must recognise that scientific assessments such as the IPCC are established explicitly as social (i.e., deliberative) institutions which scrutinise evidence.[6] There are many other dimensions to the making of authoritative and trustworthy institutions than unanimity amongst members; for example, fair and agreed procedure, respect for dissent, acceptance of outcomes. Maybe the IPCC's authority - in the eyes of critics and publics, if not also in the eyes of politicians - would therefore be enhanced if it acted on its own rules for minority reporting in the *Summary for Policymakers* (which it never has).

Second, the requirement of consensus is pernicious - in order to protect the authority of the group it encourages agreement in a group of experts where there is none. Maybe the IPCC should more openly embrace the idea of expert elicitation, or even expert voting as has been suggested by David Guston: *"A scientific body that does not partake in … a politics of transparent social choice - one that hides both its substantive disagreements and its disciplinary and sectoral interests beneath a cloak of consensus - is not a fully democratic one."*[7] For example, such an approach to disagreement could usefully have been applied to the case of the sea-level rise controversy in the IPCC's 4th Assessment Report.[8] It makes disagreements explicit and better reflects the quasi-rationality of scientific deliberation. Another example of how this might strengthen authority would be the case of the IUCN's Polar Bear Specialist Group and the embrace of expert elicitation.[9]

And, third, the presence of officially sanctioned - even welcomed! - credible minority views, thereby revealing the extent of dissensus, actually enhances the authority of science. It shows that it is 'OK to disagree' and thus indicates that the deliberative procedures of a body like the IPCC

are fair and accommodating to the full range of accredited views. For science to be authoritative, it should therefore welcome - indeed seek out - its critics (see the attempts to do this, only partially successful, in the case of the International Assessment of Agricultural Knowledge, Science and Technology for Development).[10] In the case of large international assessments like the IPCC, and the newly constituted Intergovernmental Platform for Biodiversity and Ecosystem Services, the process should not just allow minority reporting in its rules of procedure, but ensure that minority reporting is actively facilitated. As Dan Sarewitz has argued: *"Science would provide better value to politics if it articulated the broadest set of plausible interpretations, options and perspectives, imagined by the best experts, rather than forcing convergence to an allegedly unified voice."*[11]

Climategate, consensus and the weakening of authority

The single-minded drive for an exclusionary consensus was the true tragedy of Climategate. Not that the emails from the Climatic Research Unit (CRU) revealed any fundamental faking of substantive data or fraudulent practice, but that they showed a scientific culture which was closed to criticism and which was resistant to the open sharing of data. When these practices were publicly exposed, the tenacity of scientists' defence of in-group/out-group boundaries paradoxically weakened the public authority of climate science rather than strengthened it. The outcome was the exact opposite of what climate scientists in CRU and elsewhere thought they were doing. As a consequence, climate scientists handed the scientifically-credentialed critics of climate science an easy target - exclusionary practices which run counter to the nature of open debate and criticism. And this in turn handed to politically-credentialed critics of mainstream climate policies a powerful diversionary strategy. It opened the way to convert the agonistic spaces of legitimate and healthy democratic argument about climate policies into distracting - yet attention-grabbing and entertaining - arguments about the authority of science.

The drive for consensus within the IPCC process, and its subsequent public marketing, has becomes a source of scientific weakness rather than of scientific strength in the turbulent social discourses on climate change. By refusing to embrace and legitimise minority reporting, the IPCC has opened the way for powerful counter rhetoric to emerge around the idea of consensus, as illustrated by these two examples: Robert Carter's

2010 book *Climate: the counter consensus* and Donna Laframboise's blog *No frakking consensus*, with the strapline: *"Climate skepticism is free speech. Alternative points-of-view deserve to be heard."*[12] The relationship between scientific evidence and public policymaking is sufficiently underdetermined to warrant large-scale assessments such as the IPCC finding multiple ways of accommodating dissenting or minority positions. They would be the more authoritative for doing so.

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SCIENCE ADVICE AT THE GLOBAL SCALE

Bob Watson

Human activities are altering the Earth system and impacting the environment at local, regional and global scales in ways that threaten human wellbeing and development. Changes in the Earth's climate and loss of biodiversity are undermining poverty alleviation, and food, water, energy and human security. At the Rio+20 summit, governments agreed to develop a set of Sustainable Development Goals (SDGs), which would complement the Millennium Development Goals, and integrate environment and development goals for all nations. The challenge of achieving a transition to global sustainability is urgent given the potentially catastrophic and irreversible implications of failing to do so. Harnessing human knowledge and ingenuity is necessary if we are to rise to this challenge in a cost-effective and socially acceptable manner.

Informed policy formulation, whether at the national, regional or global scale, requires state-of-the-art multidisciplinary knowledge. Relevant knowledge can inform policy through research programmes and assessments that involve decision makers and stakeholders throughout their design and delivery.

New comprehensive multidisciplinary natural and social scientific programmes are needed. At the international level, there is an urgent need to build on the successes of the International Council for Science's Global Environmental Change (GEC) programmes by implementing the 'Future Earth' programme.

Changing models of assessment

New assessment processes are also needed to inform policy at the global scale. These should be owned by relevant decision-makers, and include indigenous and traditional knowledge. To be effective, assessments should assess the consequences of action and inaction and the complementary roles of technologies, policies and behaviour change. They need to be credible, transparent, legitimate, policy-relevant but not policy prescriptive,

peer-reviewed, and involve the best experts from all stakeholder groups in their individual capacity. Assessments should provide decision-makers with a consensus view of the evidence in a digestible form, including what is known, unknown and uncertain.

Both research programmes and assessments should be underpinned by an understanding of the needs of society, decision-makers and the political context of decision-making. Consequently, it is crucial that decision-makers (governments, private sector, NGOs, media and civil society) are involved in the co-design, co-production and co-delivery of research programmes and assessments.

The science-policy interface for issues related to sustainable development, which has been well supported through a host of assessments, most notably the Intergovernmental Panel on Climate Change, is currently being strengthened in a number of ways: through the development of the Future Earth programme; the establishment of the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES); and the formation of a Science Advisory Board reporting to the Secretary-General of the United Nations. In this essay, I will examine each of these in turn.

Future Earth

Future Earth is a ten-year, multidisciplinary and integrated research programme whose scientific excellence will provide the knowledge required for societies to face the challenges posed by global environmental change and to identify opportunities for a transition to global sustainability.[1] It will support science of the highest quality, integrate the natural and social sciences, as well as engineering, the humanities and law. Its research will be solution-oriented and co-designed and co-produced by academics, governments, business and civil society.

Future Earth will address issues critical to poverty alleviation and development such as food, water, energy and human security, governance, tipping points, the economic implications of inaction and action, natural capital, technological transformations (including to a low-carbon economy), the sustainable use and conservation of biodiversity, lifestyles, ethics and values.

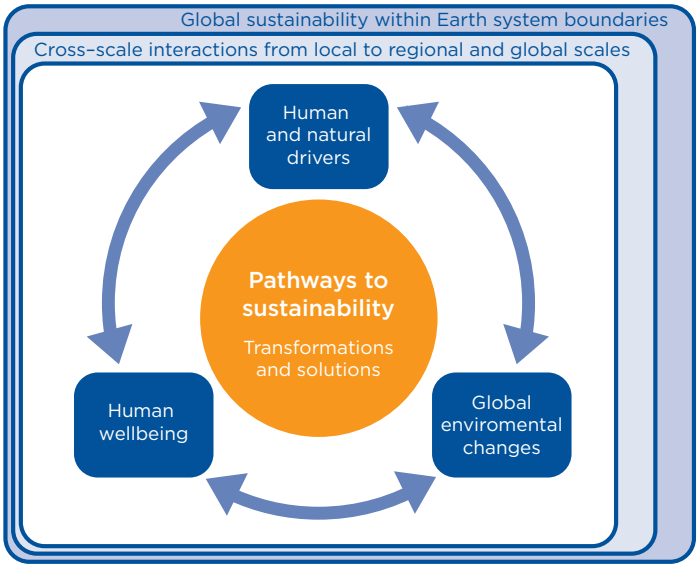
The research and other activities (including workshops, communications, capacity building and education) of Future Earth will be co-designed and co-produced by the broad community of researchers (natural sciences, social and economic sciences, engineering and humanities), in partnership with the users of knowledge (including governments, business and civil society) in order to close the gap between environmental research, policies and practices. Future Earth aims to deliver a step-change in making research more useful and accessible for decision-makers by, inter alia, communicating uncertainty, developing useful tools for applying knowledge, respecting and including local and traditional knowledge, and supporting innovation.

The conceptual framework for Future Earth (see Figure 1) will guide the formulation of its research themes. It illustrates the links between the drivers of change, the resultant environmental changes and their interactions, human wellbeing and the pathways to sustainability. The framework explicitly recognises that humanity is an integral part of the dynamics and interactions of the Earth System. It also encompasses the cross-scale spatial and temporal dimensions of the social-environment interactions and their implications for global sustainability.

Future Earth has identified three major research challenges: (i) understanding how planet Earth is changing due to natural phenomena and human activities; (ii) quantifying the impacts of human activities and environmental change on human well-being, peoples and societies; and (iii) developing solution-oriented science that enables societal transitions to global sustainability.

Given the major research challenges, and consistent with the conceptual framework, Future Earth will build upon and integrate the existing Global Environment Change Programmes: the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP), Diversitas, and the Earth System Partnership Programmes (ESSP). It will create, in partnership with governments, business and civil society, a set of solution-oriented research activities that are more integrated and international than current activities.

Figure 1: **Schematic of the Future Earth conceptual framework**



The organisational structure of Future Earth embraces the concepts of co-design and co-production. The Governing Council and its subsidiary bodies will, as appropriate, involve representatives from the full range of relevant stakeholder communities (research institutions and universities, science-policy activities such as the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES), funders (government and private foundations), governments (national and regional), international organisations (e.g. UN organisations and programmes), development bodies (e.g. World Bank), business and industry, civil society, and the media).

The Governing Council is the ultimate decision-making body and responsible for setting the strategic direction for Future Earth. The science committee will provide scientific guidance, ensuring quality and develop and suggest new projects. The engagement committee will provide leadership and strategic guidance on involving stakeholders throughout the entire process from identifying research priorities, co-designing research projects to disseminating results, and ensuring that Future Earth produces the knowledge society needs.

The Intergovernmental Platform for Biodiversity and Ecosystem Services

IPBES was established in Panama in April 2012 as a new independent international scientific body, following in the footsteps of the IPCC. The platform will seek to provide robust scientific understanding of the influence of human activities on biodiversity and ecosystem functions and services, with a focus on their implications for long-term human wellbeing and sustainable development.

IPBES will be relevant to a wide range of stakeholders, including governments (including through biodiversity and ecosystem services related Conventions, UN bodies, and intergovernmental organisations), the international scientific community, non-governmental organisations, civil society, private sector, indigenous people, farmer's associations, potential donors, and the media.

Its Plenary, comprising government representatives (currently over 100) and observers, is the decision-making body of the Platform. Its Bureau, comprising ten members (two from each UN region) is responsible for overseeing administrative functions. Its Multidisciplinary Expert Panel (MEP), comprising 25 members (five from each UN region), is responsible for overseeing the scientific and technical functions. Bureau members are observers of the MEP, as are the chairs of scientific bodies to biodiversity-related conventions and the IPCC.

Germany has been selected to host the secretariat of the Platform in Bonn. The United Nations Environment Programme (UNEP) is providing the interim secretariat and will administer the secretariat once established. The first plenary meeting of the Platform took place in Bonn in January 2013, and the second plenary meeting is anticipated in late 2013 or early 2014.

A number of issues were successfully resolved at the January meeting, including: the election of the chair, vice-chairs and other members of the Bureau, and members of the interim multi-disciplinary expert panel (MEP); key rules of procedure; the inter-sessional work program; and the budget. Dr Zakri of Malaysia will chair for the first three years. The governance and management of the IPBES has been designed to take on board lessons from the IPCC.

Potential assessment activities include: regular multidisciplinary assessments at regional (including sub-regional) and global scales; thematic assessments on policy-relevant issues; technical support and capacity building for national assessment activities; developing common frameworks and tools for assessments; and maintaining a catalogue of assessments.

Potential activities to support the policy process include: an overview of policy-relevant knowledge, tools and methodologies; partnerships to develop priority tools and approaches; promotion of effective tools through communication and capacity building; and policy-relevant (e.g. sector-specific) knowledge syntheses.

Potential capacity-building activities include: maintaining a list of capacity-building needs; specific workshops and training on assessment approaches; increasing access to data, information and knowledge for use in assessment; scholarships, fellowship programmes, mentoring; peer to peer exchange visits; and regional hubs supporting assessment and peer learning.

Potential activities in catalysing knowledge generation include: identifying and communicating gaps in knowledge - including from assessments; convening research and donor communities to agree on policy-relevant research priorities; and supporting peer learning and networks to strengthen generation of policy-relevant research.

A number of issues are still outstanding including European Union membership, the relationship of IPBES with the UN, and a detailed work programme. By learning from the experience of previous assessment processes, IPBES aims to deliver knowledge assessments relevant to decision makers at local, regional and global scales.

A Science Advisory Board to the United Nations

Prior to the Rio+20 summit, the UN Secretary-General requested that the Director-General of UNESCO, Irina Bokova, convene a small ad hoc group of senior UN officials and representatives of major scientific bodies to consider recommendation 51 of the UN Secretary-General's High-level Panel on Global Sustainability:

> *"Governments and the scientific community should take practical steps, including through the launching of a major global scientific initiative, to strengthen the interface between policy and science. This should include the preparation of regular assessments and digests of the science around such concepts as 'planetary boundaries', 'tipping points' and 'environmental thresholds' in the context of sustainable development…In addition, the Secretary-General should consider naming a chief scientific adviser or establishing a scientific advisory board with diverse knowledge and experience to advise him or her and other organs of the United Nations."*[2]

The ad hoc group recognised that full implementation of recommendation 51 presented a strategic opportunity to realise a sustainable world where decision-making is informed by the best available knowledge; co-designed, co-produced and co-delivered by relevant stakeholders. They also recognised that implementation of recommendation 51 should aim at integrating the economic, social and environmental pillars of sustainable development at the science-policy interface.

One of the recommendations of the ad hoc group was that a Science Advisory Board (SAB) be established to advise the UN Secretary-General and other organs of the UN system. The UN Secretary-General accepted this recommendation and subsequently requested the Director-General of UNESCO to establish and chair a Scientific Advisory Board. Its terms are still being formulated, but it is likely that its central functions will be to provide advice on science, technology and innovation for sustainable development.

The SAB will bring together in a coherent manner the collective capacity of all relevant scientific fields, with due regard to social and ethical dimensions of sustainable development. The fields will span a broad spectrum, from the basic sciences, through engineering and technology, social sciences and human humanities, ethics, health, economic, behavioural and agricultural sciences, in addition to the environmental sciences. The overall goal is to strengthen the science-policy interface in order to ensure that the best scientific knowledge is reflected in high-level policy discussions.

Visions, institutions and actions

As noted in a recent paper by a group of Blue Planet laureates,[3] our shared goal must be to have a world without poverty; a world that is equitable; a world that respects human rights; a world with increased and improved ethical behaviour regarding poverty and natural resources; a world that is environmentally, socially and economically sustainable. While this is achievable, current systems are deeply flawed and current pathways will not lead us there.

There is a need to address the population issue, break the link between production, consumption and environmental destruction, recognise the limitations of GDP as a measure of economic growth, address the serious shortcomings of the decision-making processes, and empower grass roots efforts. All of these challenges demand an increase in investments in education, research and systematic assessments of knowledge.

If we are to achieve a transition to global sustainability, the time to act is now, given the inertia in socio-economic systems, and the adverse effects of climate change and loss of biodiversity, which cannot be reversed for centuries or are irreversible. We already know enough to act. Failure to do so will impoverish current and future generations.

Sir Bob Watson is strategic director of the Tyndall Centre, University of East Anglia and was chief scientific adviser to the UK Department for Environment, Food and Rural Affairs from 2007 to 2012

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FUTURE DIRECTIONS FOR SCIENTIFIC ADVICE IN WHITEHALL

Edited by Robert Doubleday and James Wilsdon

Scientific advice has never been in greater demand; nor has it been more contested. From climate change to cyber-security, poverty to pandemics, food technologies to fracking, the questions being asked of scientists, engineers, social scientists and other experts by policymakers, the media and the public continue to multiply. At the same time, in the wake of the financial crisis and controversies such as 'Climategate', the authority and legitimacy of those same experts is under greater scrutiny.

To mark the transition in April 2013 to **Sir Mark Walport** as the UK's chief scientific adviser, this collection brings together new essays by more than 20 leading thinkers and practitioners, including **Sir John Beddington, Sheila Jasanoff, Geoff Mulgan, Roger Pielke Jr., Jill Rutter, Mike Hulme and Sir Bob Watson.**

In the context of the UK government agenda for Whitehall reform, and a growing emphasis on the use of evidence in policy, these contributors chart future directions for the politics and practice of scientific advice.

This project is a collaborative initiative of five partners: University of Cambridge's Centre for Science and Policy; Science Policy Research Unit (SPRU) and ESRC STEPS Centre at the University of Sussex; Alliance for Useful Evidence; Institute for Government; and Sciencewise.

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