Policy Foresight Programme

Director: Sir Crispin Tickell

JamesMartinInstitute for science and civilization

Record of the Workshop on

# A new look at the interaction of scientific models and policymaking

13 February 2008

James Martin 21st Century School

University of Oxford


THE JAMES MARTIN 21ST CENTURY SCHOOL UNIVERSITY OF OXFORD

# Introduction

On 13 February 2008, the Policy Foresight Programme, in conjunction with the TransAtlantic Uncertainty Colloquium, hosted a day-long workshop on "A new look at the interaction of scientific models and policymaking" at the James Martin 21st Century School at the University of Oxford. This document provides a record of the day's discussion.

Sir Crispin Tickell chaired the day's events, and began by noting how scientific models now play a central role in policymaking. Models are used to inform and frame political agendas, for example, over how best to deal with climate change. Yet few policy makers know how to handle the inherent uncertainties in models, and how to make best use of the information in them for policy making. At the same time, it is now difficult to find a meeting of modellers where discussion does not arise about how to integrate their work with policymaking. This workshop offered both scientists and policy makers the opportunity to raise their concerns and suggest ways forward.

# Policy Foresight, Models, and Uncertainty: The TransAtlantic Uncertainty Colloquium

## Prof Bruce Beck

Professor Bruce Beck began the day's programme, outlining the work that the TransAtlantic Uncertainty Colloquium (TAUC) has done to integrate United States (US) and European Union (EU) perspectives on the interaction of policymaking and modelling. TAUC received its funding from the United States National Science Foundation and Environmental Protection Agency, and has been active since 2005. Its purpose is to examine the social transactions that accompany the founding of policy on models that are inherently uncertain.

The different perspectives scientists have on policymaking was nicely summed up by a lively email communication that occurred in the TAUC community in the process of organising the seminar. The major views defended in those emails included:

- Scientists and modellers simply present the facts, speaking truth to power
- There are scientists and modellers who use the policymaker's lack of understanding about models in order to further their own ends, either knowingly or not. Those emails spoke of 'mischief amongst us'.

- Actually, it is not possible to separate the two. Scientists and modellers will always have a particular viewpoint, but that does not mean that there is no room for providing a balanced view to policymakers.

Beck raised the idea that models might better be viewed as tools than truth-generating machines, particularly because we are likely to encounter future environmental conditions that we have never experienced before. Thus, without historical data against which to evaluate the models, conventional measures of assessing their accuracy and reliability can be found wanting.

Without this standard scientific way of judging the design of a model (seen as a tool), how can its quality be assessed? Beck proposed that quality of design is in the eye of the beholder, but in this case there are many beholders, from other modellers to policymakers to the general public. Whatever the measure of quality, however, all would have to contend with the epistemic uncertainty that these models contain.

Beck also pointed out that it is not only the modellers bear the liability for uncertainty. Society and politicians are responsible for at least some of the vagueness, uncertainty, plurality of aspirations for the future of the environment (which policy is supposed to attain). Scientists are responsible for the uncertainties and unknowns in the science base, whereas modellers are responsible for the bits of the science base selected for inclusion in the model and accounting for uncertainties in the manner in which the attainability of policy goals is likely on the basis of the candidate policy actions.

Concluding, Beck proposed that we should ask not "whose forecast – personal opinion or model-generated – of the distant future is correct," but rather "what, under gross uncertainty, do we most need to know better – right now – in order to put one policy foot in front of the other, tomorrow?"

# Models and Uncertainty: a change in Dutch policy foresight

## Dr Arthur Petersen

Dr Arthur Petersen, Director of the Methodology and Modelling Programme for the Netherlands Environmental Assessment Agency, spoke immediately following Beck, and began by noting that science has never delivered ultimate certainty; theories were always limited in their domain.

Computer simulations have progressed greatly over the last 60 years. From their first applications calculating nuclear bomb design and predicting the weather, many can now provide reliable information. On an issue such as climate change, however, the uncertainties are of a different nature, since we are projecting into the future and we do not have the means to test these projections before history unfolds.

In 1999, there was a burst of media attention about the reality content of models and their use in policymaking. As a result, Petersen's current post, which deals specifically with uncertainties of science for policy, was created. His agency decided not to produce a protocol for how scientists should incorporate uncertainties into policy suggestions, but they have instead produced a set of guidance notes, which are available on the internet. These notes, developed from Ravetz's work on postnormal science (see Ravetz 1973; Funtowitz and Ravetz 1992), try to help scientists reflect on the following areas of uncertainty:

- problem framing
- involvement of stakeholders
- selection of indicators
- appraisal of knowledge base
- mapping of assessment of relevant uncertainties
- reporting of uncertainty information

Major concerns from scientists about this type of reflection are that policymakers don't want uncertainty, they want certainty. There needs to be education on both fronts.

Petersen drew out the different types of uncertainty that exist in different types of policy problems. When there is consensus on the relevant knowledge needed in the problem as well as the values at stake, uncertainty is generally only on the statistics involved. On the other hand, were there is little consensus on the knowledge needed or values at stake, such as with climate change, uncertainties take many forms, such as methodological unreliability and recognised ignorance.

In trying to make sense of the various policy choices available in dealing with climate change and unsustainable development, the Dutch government has, since the mid-1990s, made use of Cultural Theory (see Thompson, Ellis et al. 1990) and comparable sets of world views. Dividing solutions into whether they should be regional or global and whether they should be market- or government-oriented provides four general options policymakers can endorse, as shown by the figure below.

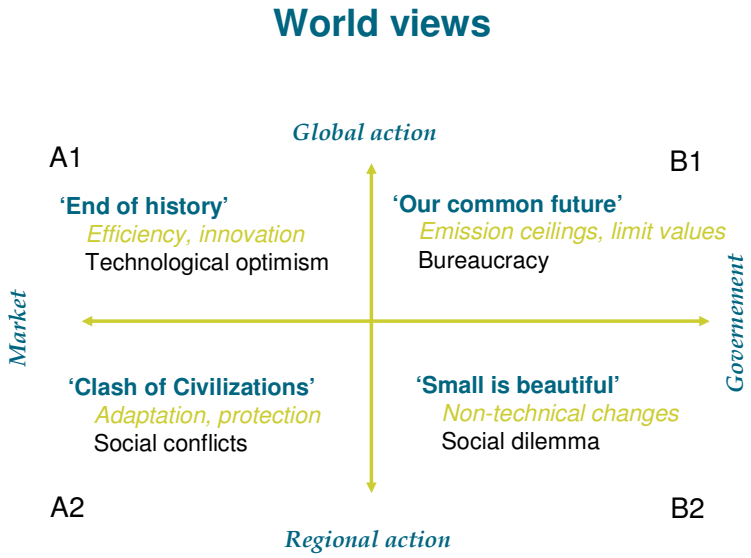


**Figure 1 - Options for Policymakers**

Petersen concluded by providing ten points for dealing with uncertainty in policy:

1. Forget the 'deficit' model
2. Be tolerant with respect to uncertainty
3. Consider uncertainty information as knowledge
4. Make a distinction between science, advice and policy, but do not rigidly separate them
5. Determine 'best use before' date of policy (review clause)
6. Perform 'extended peer reviews' on knowledge inputs
7. Maintain space for dissidents
8. Recognise the different types of uncertainty (resist the temptation to quantify all uncertainty, e.g. in a Bayesian framework)
9. Institutionalise attention for uncertainty (guidance's, courses, professional roles, ...)
10. Reassess where we all stand again in four years time

Useful References:

Funtowicz, S.O. & Ravetz, J. (1992), 'Three types of risk assessment and the emergence of post-normal science', in Sheldon Krimsky & Dominic Golding (eds), *Social theories of risk*. Westport, Conn.: Praeger.

Ravetz, J. (1973), *Scientific knowledge and its social problems*. Oxford: Oxford University Press.

Thompson, M., Ellis, R. and Wildavsky, A.B. (1990) *Cultural theory*. Boulder, Colo.: Westview Press.

In discussion, the following points were made:

- We must remember that one of the key factors in enacting policy is the ability to get along with the policy people at the top and being able to express oneself such that policymakers can understand.

- There was a call to make sure that data as well as models were connected to policy.

- Instead of focusing on the interval around a single sensitivity analysis (i.e. a single storyline), we should be considering a range of possible storylines, which hints at the increasing concerns to address issues where one cannot reduce uncertainty.

- The models currently in use were created using approximations of the core physics that exclude the possibility of mimicking truly chaotic behaviour , with its various bifurcations and surprises. They won't produce safe or unsafe levels. It was also pointed out that Working Group II of the International Panel on Climate Change (IPCC) illustrates the consequences that were projected, and that the IPCC Synthesis Reports make clear that it was completely a policy decision to decide what is a safe/unsafe limit.

# Models are wrong. Some are wronger.

## Pasky Pascual

Pasky Pascual said that it is not new that many models suffer from the problem of 'model identifiability', where different sets of model structures and parameters could be used to explain the data with reasonably similar descriptive accuracy. What is new is the legal landscape that these models sit in, at least in America. The importance of model results can be exemplified by petitions submitted by stakeholders to question models used by the government under the Data Quality Act. This act was passed in 2000 to enable stakeholders to file petitions to the government to ask them about the quality of the data, including data used in models.

Pascual noted that, when describing model uncertainties, we can only talk about model 'truthfulness', not whether the model is true. Models try to describe events that are heterogeneous over time and space. Modellers try to collect data that they believe are representative of the events they are trying to describe and develop a model to explain their parameters. There might be more than one model that is equally explanatory, and modellers must decide which models to use. The model uncertainties are exacerbated by the fact that models are developed using past information, while the regulations based on models are used prospectively. They can only hope that the models have captured reality enough to be able to predict what will happen in the future.

Under traditional notions of hypothesis testing, science assumes a truthful model of the world which describes a population distribution based on parameters. If data deviate from the expected distribution, then the model is rejected. This traditional approach does not apply to real-world situations, such as global climate change or town planning, in which the long-run frequency of identical events cannot be assumed. A more appropriate approach would be to use likelihood estimation, in which a model is approximated that best explains the observations. Formal methods exist, such as the Akaike Information Criterion, in order to evaluate which—among multiple, competing models—provides the greatest descriptive accuracy with the greatest parsimony.

Pascual put forward an argument by Richard Royall that, when thinking about uncertain scientific information, we are really conflating three types of questions: questions of belief, questions of evidence, and questions of decisions. For the first, Bayesian models are quite helpful, in that they can update our beliefs given new evidence; but they are insufficient because Bayesian inference says nothing about evidential strength. Questions of evidential strength may be addressed using some of the methods cited earlier, such as the Akaike Information Criterion. With repeated demonstrations of evidential strength, continued adherence to a strong prior belief may be adjudged to be increasingly irrational. Finally, with questions of decisions, formal techniques exist to establish the so-called "Value of Information," i.e. whether the benefits of regulatory action—despite continued uncertainty—sufficiently outweighed the costs of gathering new information and awaiting further evidence.

Counter to what Petersen said in the last presentation, Pascual argued for the need for formal protocols for model evaluation. He recalled that the economist Coase argued that negotiating parties reach an optimal level of natural resource allocation but that this optimal solution depends on reducing the so-called "transaction costs" associated with the negotiation. Much of these transaction costs arise from differing perspectives on the extent and cost of environmental externalities, which for the most part are based on models. Therefore, a shared approach to evaluating model truthfulness can significantly reduce the transaction costs associated with regulatory "games" (used in the formal sense attributed to von Neumann and Nash). He also provided a set of 'bottom-up' approaches to capturing the externalities associated with fossil fuel production and use; all of the examples hinge upon the use of models and therefore highlight the importance of integrating scientific evidence with legal policy-making through model evaluation. He cited Massachusetts versus the Environmental Protection Agency (EPA), where the Supreme Court told the EPA that it had to decide whether $CO_2$ caused endangerment, and a number of other court challenges which challenged whether the EPA had a rational basis for its policies regarding issues related to climate change.

Pascual concluded by saying that he would like to see greater access to and exchange of scientific information used in environmental models, using semantic web technology and shared metadata ontologies. This greater access, along with the alternative approaches to modelling, provide stakeholders with the greatest opportunity to hold their governments accountable for decisions that are purportedly based on the best available science.

In discussion the following points were made:

- In MA v. EPA, the Supreme Court held that EPA must make a finding regarding $CO_2$ endangerment based on the scientific evidence alone; if it finds endangerment, then it may consider policy options to determine how best to regulate $CO_2$.

- There was more elaboration on the divide among participants between whether or not it is a good idea to develop a set of protocols that state *the* way to evaluate models. Pascual reiterated his preference for shared protocols for model evaluation, because of the effect that ambiguous approaches to model evaluation has on transaction costs.

- While there was talk about how politicians might distort the evidence, the point was made that there could also be scientists who selectively put forward or withhold information, or even distort it, and the most likely place for that to happen is in model design and operation.

- In the US EPA, much of information used for regulatory models is open to the public, but to get data from the UK's Environment Agency, one could be charged £5000. To avoid future incidents like the Canadian foot-and-mouth outbreak, where the model used to predict the spread of the disease was wrong, it is vital that the data be in the public domain.

# Models, Risk Regulation and Legal Cultures: A Transatlantic Perspective

## Dr Liz Fisher

Fisher began her talk by stressing that there are strong 'legal cultures' within law, and those culture promotes certain understandings about models. To understand these culture, she elaborated on who uses models in legal settings, and why they do so. Models are used in public administrative bodies to manage environmental and human health risks. Taken from regulatory bodies, international organisations, or private actors, these models help form programmes of action, regulations, and individual licensing decisions. They rely on models for three reasons: establishing a relationship between the regulated and the risk to be avoided; helping to organise a large body of data into a 'reasonable' viewpoint for action; and facilitating multidisciplinary information being applied to an issue.

Legal cultures are systems of rules, philosophies in which legal practices are embedded. The US is dominated by a culture of adversarial legalism, while the EU has a whole range of cultures. These legal cultures are 'thick', and it is nearly impossible to move between them. They frame how we understand models in

administrative decision making, allowing administrators to show that their behaviour is 'reasonable'.

Fisher provided a table showing two ideal ways of understanding models, which is reproduced below.

| | **Deliberative Problem Solving** | **Sound Science** |
|---|---|---|
| **Public Administration** | Deliberative-Constitutive (DC) | Rational Instrumental (RI) |
| **Problems** | Complex, uncertain and socio-politically ambiguous | Assessable and Manageable |
| **Scientific uncertainty** | Inherent and Enduring | Transient and undesirable |
| **Role of Model** | Tool, analogy and metaphor | Representation of reality |
| **Purpose** | Aiding in the process of more rigorous reasoning | Proving a relationship between cause and effect |
| **Basis** | Analysis and judgement based on experience | 'Pure' analysis |
| **Accountability** | Assessing the model's contribution to reasoning | Proving the model's accuracy |

**Figure 2 - Two ways of understanding legal cultures**

Law imposes these paradigms through constituting how bodies are set up, by limiting the action those bodies can engage in, and by hold those bodies to account. It runs right through the decision making cycle, in both implicit and explicit ways, thus significantly affecting the ways models interact with policy. And yet, many lawyers do not have a strong understanding of models.

To illustrate this point, Fisher provided examples from the US and EU. In the US, most environmental legislation was on models were passed in the 1970s and could be interpreted in many ways, but the judiciary has interpreted in very Rational Instrumental (RI) terms. The Data Quality Act that Pascual noted above promotes a very RI view as well. In addition, the process of judicial review promoted models as 'sound science' and helped the rise of 'analytical opportunism', whereby a lawyer could poke a methodological hole in a model and thus establish that it was 'arbitrary and capricious', that being a conventional ground of judicial review.

The EU system is very different. For the Water Framework Directive, models were used in a Deliberative-Constitutive sense. However, there has been a shift to an RI understanding in places like the Draft Soil Directive. The courts are also now playing an increasing role in holding organisations to account, such as the Pfizer 2002 case or the WTO cases in beef hormones and biotechnology.

Rather than arguing that one understanding of models is better, Fisher argued that lawyers should develop a critical awareness of models. This would make lawyers more aware of how models are malleable and culturally embedded. Similarly, non-lawyers could benefit from understanding the legal cultures in which models must exist in their interaction with policy.

Useful Reference:

Fisher, E. (2007) *Risk Regulation and Administrative Constitutionalism* (Hart Publishing)

In discussion the following points were made:

- Policy makers do not need much of the detail that scientists often provide. It is important not to forget that there are a lot of politics at work. Policymakers have a much wider set of concerns to consider when incorporating evidence.

- The problem of integrating models into policy is one that has been handed over to public administrators by politicians to be 'managed', thus laying the seeds for the dominance of the RI understanding. It was a move to depoliticise models, but this talk has shown that that hasn't happened. An argument was presented that such depoliticisation is impossible.

- A good example of the disconnect between the two understandings of models was the BSE crisis in the UK. The modellers thought they were using their models to provide for more reasoned argument, whereas policy makers took the models as 'sound science'.

- What climate models do quite well at the moment is to give a sense of the kinds of challenges we are likely to face. What they are lousy at is saying what we should do at specific points in the future.

- Instead of thinking of models as tools, we could think of them as games, where they could be used all the way down to the individual farmer level, where he could use the model to play out what—if scenarios.

- Models are an invasive species in the way science is articulated in policy. They have taken over from many other ways that scientific advice could be given.

- One way to address the question of 'how do you decide if a model is reasonable?' is to encourage the development of the 'acting in good faith' paradigm, analogous to the 'rules of the courtroom', in modellers.

- The scientific basis for decision making is universal and anti-majoritarian. It falls on political entities to justify decisions that run counter to the evidence. Those unable to present a counter argument should suffer the consequences and be held accountable.

# Models can be useful to think with. Never mistake models for reality.

## Prof Steve Rayner

The afternoon session began with Professor Steve Rayner observing that civilization appeared to be in an Age of Assessment, where there was a very strong emphasis on science- and evidence-based policy. We should shift our thinking from models as discrete objects to 'modelling systems', communities where the model is an object people organise around.

Rayner pointed out a number of modelling metaphors that came up in the morning's discussion: tools, games, weapons in an arsenal (which highlighted power issues). Models are a way that craft skills and expertise get mediated through a technology; a technology that both objectifies and legitimates the sights the insight or wisdom of the practitioner. Modelling is thus the successor in a long tradition of oracles. It is a way for someone with expertise to present it in an impersonal way.

To provide examples of how models are the embodiment of expertise, Rayner highlights the flux correction debate in global circulation models in the early 1990s. If an expert didn't intervene to correct the flux while the model was running, it would not conform to the behaviour that the modellers knew the behaviour of the model ought to be. Global Climate Models have since developed so that flux correction is no longer needed, and thus the issue has receded, but at the time, the policymakers were completely unaware of the extent to which the experts were intervening in the models.

There are also examples where experts' judgement overrode what the models were telling them, but they coat-tailed their judgements on the models. One was the stability of the global average temperature increase for $CO_2$ scenarios. That temperature remained stable for over three decades over a great change in modelling capacity. When asked about it, climate modellers said that it was just expert judgement. That judgement was likely stabilised either because what they thought the policy makers could handle as an 'acceptable change' or because that was what they actually thought the most likely number was. The important point though, Rayner stated, was that the models legitimated these judgements.

Rayner highlighted once more the tension in modelling between prediction and systematic thinking, or as Fisher said between discursive and rational views of models. The discourse among scientists themselves changes depending on their context, whether they are talking to other scientists or to policy makers.

Another point he raised regarded the 'perpetuation of inappropriate expertise'. In a report on sudden catastrophic climate change written by modellers and economists, the authors said that the best thing to do was to increase societal robustness. However, the report's recommendations were only for more funding for research. What the modellers and the economists had done was to clearly point out that there

was a problem with society's ability to handle climate change. They could not, however, point out how to develop societal resilience.

At best, modelling can provide methodological frameworks for knowledge, reveal important gaps in understanding, and alert policy makers to a wide range of problems. On the other hand, models have been used as instruments of coercion, as has been shown in some town planning models. They can be used to reflect or focus blame, as for instance in flood models. They could also divert energy and funds from other scientific activities.

In discussion the following points were made:

- The fallacy of misplaced concreteness is one that is apparent when any science interacts with policy. A way out of it is to focus on the degree to which scientists disagree.

- The reason that weather forecast models were imported to climate change and town planning was because they became so successful at what they did. But these new environments are not ones where the data and the models can work together as they do in weather forecasts.

- Why is it in other areas of policy making – criminal justice, education, health – by and large there is a much greater readiness for acknowledging value judgements versus measurements? Part of the answer comes back to the scientific community; it is quite a prestige to be regarded as an oracle. If we were more humble and used modelling to open up discourse rather than shutting it down, that could go a long way towards encouraging more mature debate between politicians and the wider public.

- Climate science is held to a platinum standard much higher than economic models primarily because early modellers said, "if you accept the science, there is only one course of action." Politicians don't like to be told what to do, and by closing down their options, scientists shifted the burden of judgement much more onto their own shoulders.

# A final provocation

## Prof David Fisk

The final discussion was led by some comments by Professor David Fisk.

- Climate modelling is one of the few scientific endeavours where you cannot control over half of the parameters, particularly future emissions that you are modelling.

- One way to avoid all complexity is the 'Coase theorem' solution – simply allocate property rights. If feel nervous about climate change and want to stop coal emissions, you just buy out the coal plants. Since governments have not got that far in allocating rights to their citizens, what we have instead are environmental decisions that transfer resources, where in effect we are robbing someone to provide comfort for someone else. No surprise then that the rationale behind the decision is contentious.

- The political class should not necessarily be the judge on the final resolution of these issues – more a case of national consensus if not unanimity.

- It might be a good idea to force smug modellers closer to the camera to make them more accountable.

- How does the regulatory entity decide that its procedures are reasonable? Maybe there is too much reliance on a *single* model? In engineering modelling situations, say in designing an airplane, there are always at least three models at work. Can a regulatory agency be tasked with being its own quality regulator? Maybe not.

- Aiming to make the model as complicated as reality isn't always helpful because such a model would not let you work out the strategic relationships between what you want to put in and what you get out. Is it better to have several different simplified models than one complex one?

- Military planners have very large models that they deploy in modern battlefields, principally to determine irreversibilities – points of no return – in their operational plans. How do they handle the uncertainties in their models? Largely by identifying the 'real options' that can be 'bought' to increase flexibility when the situation becomes more clear. How can climate models focus more on finding points of no return like the onset of instability in the Greenland ice sheets?

- What happens next to the modelling output is important. The Stern review parodied the IPCC scenarios by using neoclassical economics – designed to predict events over 5 years – to cost what will happen over 50 years.

In discussion the following points were made, particularly in regard to how to interact with policy:

- Finding ways of saying what models do in a way that captures the attention of policy makers and senior civil servants who may only have 15 minutes to devote to the whole issue:

    - The climate change debate is still not a debate about what to do.

    - The media should learn how to dissociate different types of models to raise public awareness about when models may be abused

- There was a call to model how to shift India, China, and Africa off of their reliance on coal.
- A number of participants suggested that modellers are not the best people to interpret the models into policy advice.
- Most models in climate change are still pretty weak in modelling of social and political dimensions.
- The notion of expertise should not be "who has the most beautiful model?" but "who can give me options on what to do?"

- What kind of politics does the world need to make sense of the kind of social scientific insight that is relevant? We are stuck with binary politics: right/wrong, right/left. Anyone who takes a non-binary view gets pushed by both sides into the alternative camp.
- These and other points were further discussed by a number of participants at dinner in New College that evening.

Record prepared by:
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## Acknowledgements

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# Participants

(Speakers denoted with an *)

| | |
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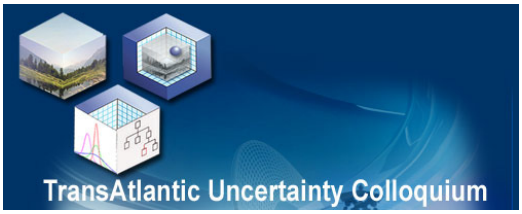
# Policy Foresight Programme

Director: **Sir Crispin Tickell**

The Policy Foresight Programme, part of the James Martin Institute for Science and Civilization at the University of Oxford, is designed to facilitate interaction between government, business, industry, the media, and academia on issues of science, technology, and the environment. The purpose is to identify leverage points in current policy that could have significant long-term benefits for civilization. Under the direction of Sir Crispin Tickell, the main activity of the Programme is to host up to six 1-day seminars a year, where around 25 people will engage in constructive debate to further integrative thinking on a particular issue. The emphasis of the seminars is to look anywhere from 10 to 50 years into the future to see what will be the major decisions we will be faced with then and what can be done now to direct policy along a resilient path. The Programme will cover all major areas of the James Martin Institute, namely: Tomorrow's People, Tomorrow's Technologies, Tomorrow's Planet, Governance of Technological Change, Technology and Inequality, and Tomorrow's Civilization.

www.martininstitute.ox.ac.uk/jmi/networks/Policy+Foresight+Programme.htm




# TransAtlantic Uncertainty Colloquium

Principal Investigators: **M B Beck (UGA), K Oye (MIT), K H Reckhow (Duke University)**

The TransAtlantic Uncertainty Colloquium (TAUC) addresses issues of handling uncertainty in models used at the Science-Policy interface. TAUC's research is currently organized around the life-cycle of an environmental policy: from the use of models in horizon-scanning and foresight-generating activities; through provisional policy formation and evaluation; and on to the processes of social negotiation and — as necessary — legal discourse, whereby provisional policy becomes actual policy. The project is funded by the US National Science Foundation (NSF) and Environmental Protection Agency (EPA), for whom a White Paper on promising areas of further research in this domain is currently being drafted. Motivation for the project arose from the differences in practices and procedures for handling uncertainties in models for policy and regulation within the US EPA, on one side of the Atlantic, and within RIVM/MNP in the Netherlands, on the other.

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# James Martin Institute for Science and Civilization

Director: **Professor Steve Rayner**

The James Martin Institute for Science and Civilization is part of the James Martin 21st Century School. The Institute focuses on identifying what have been called the "wicked problems" (those that are persistent and intractable) of the 21st Century; the "uncomfortable knowledge" which challenges existing institutional arrangements that are ill-prepared to deal with such problems; and the pluralistic institutional arrangements that encourage emergent innovative responses known as "clumsy solutions".

The Institute focuses these lines of inquiry in relation to four quadrants:

- Science, Technology, and Risk
- Futures
- Complex Social and Technological Systems
- Institutional and Behavioural Change

Each topic is approached in partnership with other institutes and centres at Oxford, and with an international network of collaborating organisations from academia, government, business and civic society.

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THE JAMES MARTIN
21ST CENTURY SCHOOL
UNIVERSITY OF OXFORD

# James Martin School for the 21st Century

Director: **Dr Ian Goldin**

It is likely that the 21st century will be an unusually challenging one in the history of mankind. The goal of the School is to develop strategies for responding to the most serious problems, some of which even have the potential to threaten the future of humanity itself. At the same time, we also seek to harness the most promising opportunities facing the world in the new century.

The James Martin 21st Century School, founded in June 2005 at the University of Oxford, is a unique collaborative research effort. The focus of the School is on stimulating Oxford's research, by giving the University's scholars the resources and space to think imaginatively about the problems and the opportunities that the future will bring.

The work must meet the best Oxford scholarly standards, must be original and additional to work done elsewhere, and is expected to have a global impact. The 21st Century School has been designed to:

- Initiate new and collaborative research and encourage members of the University to take up new areas and new styles of thinking
- Operate a research grant programme to stimulate innovative research at the Institutes
- Facilitate lectures, seminars and other teaching activities to encourage students and faculty to focus on future challenges. Workshops and other outreach will ensure ideas generated by the School inform public and private decision-making and that the School's work is informed by the global challenges facing governments and society.

The central hub of the School consists of the Director, Dr Ian Goldin, along with a small secretariat and a number of James Martin Fellows. It provides overall leadership and facilitates cross-cutting and interdisciplinary perspectives and supports the work of research Institutes. The Research Institutes, each undertake leading–edge research in their own subject area, and are typically funded for a number of years. There are currently ten Institutes, each of which is located in a department of the University: The James Martin Institute for Science and Civilization; The Environmental Change Institute; The Institute for Ageing; The Institute for Emergent Infections in Humans; The Institute for the Future of the Mind; The International Migration Institute; The e-Horizons Institute; The Oxford Future of Humanity Institute; The Programme on the Ethics of the New Biosciences; and The World Education Institute.

The School also has an affiliation with the Center for Nonproliferation Studies at the Monterey Institute of International Studies. The Center contributes its perspective on the dangers of weapons of mass destruction to the work of the School in exploring the potential consequences of emerging technologies that could shape the future of mankind.