FAN Club Newsletter

OCTOBER 2009

Strategic Shocks

Strategic Shocks were the theme of the FAN Club's October 14 meeting. 67 people found their way to the Rutherford Appleton Laboratory, part of the Science and Technology Facilities Council and one of Europe's premier science centres, to hear about them in a packed and highly varied programme of talks.

We arrived at the room after a drive past radio telescopes, laser facilities and other high-technology equipment, and some of us got the chance to see them in close-up later on.

Brian Brader of the Foresight Horizon Scanning Centre began the day by discussing some recent British shocks that have disrupted the system in one way or another. His examples were flooding in 2008, the 2005 Buncefield fire and the subsequent disruption of aviation fuel supplies, and the 2009 parliamentary expenses scandal, a big disruption to the democratic system. But alongside these rapid shocks are slower ones, such as climate change, epidemics and terrorism. These are harder to spot. We tend to like information that confirms our view of the world rather than challenging it.

Key conclusions of the meeting

Sudden shocks are not just theory, they do happen: bank collapses, Buncefield fire etc

They cannot be predicted, but **society can become more resilient to them**

Some gradual effects such as climate change are not shocks, but **can give rise to shocks** such as droughts and floods

National security and geopolitical issues are an **especially fruitful source of possible shocks**

Analytical tools are available to allow us to think more clearly about rare events

Wild cards can be good as well as bad

Professor John Womersley

Leading edge science

Our first speaker was also our host for the day. Professor John Womersley is director of science programmes for Science and Technology Facilities Council (STFC). His talk illustrated everything the STFC does to help the UK cope with future surprises.

As John sees it, the STFC has the "least transparent" name of the seven research councils, and also the most complex role. It funds research in fields such as astronomy and particle physics, and also runs big equipment to allow other people to do long-term, large-scale projects. John's view is that this science helps develop human capacity. He points to surveys proving that topics such as astronomy bring people into science and engineering careers, and although this is a "bait and switch" he is completely unashamed of it.

At the moment, one of STFC's highest-profile tasks is being the UK participant in the Large Hadron Collider in Switzerland. The LHC is testing predictions such as the existence of the Higgs Boson, invented to account for mass. Experiments there will show how to repair the equations of physics, says John, which on our current data yield probabilities of more than one for certain events. Other STFC machines include devices to test cosmology and astrophysics by detecting gravity waves and dark matter.

While some of this equipment is in the UK, STFC buys into overseas projects to fill gaps in its own portfolio. An example is nuclear physics. Here the UK is rebuilding lost skills, partly to advance science and partly in the knowledge that the UK will need nuclear physicists if nuclear power is to be revived. STFC is also the UK arm of world astronomy projects. These include the Square Kilometre Array, a massive radio telescope which will be built in South Africa or Australia to investigate dark matter and energy in the universe, and the Extremely Large Telescope, which would use a 42m mirror to view the sky.

John explained that STFC's research facilities at RAL and at Daresbury in Cheshire can help the UK meet possible future shocks. One way they can do this is by developing new sources of energy, allowing us to avoid depending on "parts of the world where they are fighting each other," and also avoid carbon dioxide emissions. The Central Laser Facility at RAL allows pressures at the centre of Jupiter to be recreated, but it may also open the way to a new fusion power technology alongside the one being developed at ITER in France, using laser confinement rather than ITER's magnetic confinement approach.

Another area is security and new scanning technology is especially relevant here.

In terms of epidemic disease, equipment run by STFC is giving us the ability see and model virus molecules. You can only do this, John says, by using "big stuff to see small stuff," in this case the £400 million Diamond X-ray light source at RAL. A later-generation source will use a strobe effect to see chemical reactions as they happen, though the cost of big facilities like this can be "scary".

This focus on challenges means, says John that STFC is starting to think less about physics, chemistry and biology, and more in terms of Earth observation, climate change, energy and biomedicine. It also means that the STFC labs are

more open to wider society, including universities and business. An example is work with the NHS on accelerators in hospitals for cancer treatment.

In answer to questions, John agreed that this sort of shift in focus can be complicated by the fact that scientists often are driven more by the esteem of their colleagues, not the respect of the outside world. As he said, there are plenty of “old, comfortable guys” who would “rather be pure and poor than rich and broad.” This calls for culture change. It also calls for better media and political engagement. He sees growing international and cross-party agreement on the importance of the science base.

See John’s presentation **here**

John Elliott

Shocks from a policy perspective

Our next speaker, John Elliott, is chief economist at the Home Office. He took the bold step of showing us equations, and even managed to explain what they meant. His theme was the policy perspective on shocks. As an economist, he said, he is adept at telling government why the forecast he gave them yesterday did not work out. But he is now working with the Smith Institute, London on improving on this state of affairs.

As John explained, a shock is a low-probability, high-impact event. Deterministic systems can produce them sometimes, as his diagrams of the progress of a simple set of equations over time showed. Small changes in the terms can mean big fluctuations later.

These disturbances can be unexpected and can happen fast.

He explained that one valuable tool for working with government is the cone of possibility, familiar to many FAN Club aficionados. It helps correct the tendency of people in government to look at the far horizon without considering how we might get there. For example, the UK population is now about 61 million. The forecast for 2080 ranges from a high of 110 million to a low of 62 million, via a central forecast of 87 million **[1]**.

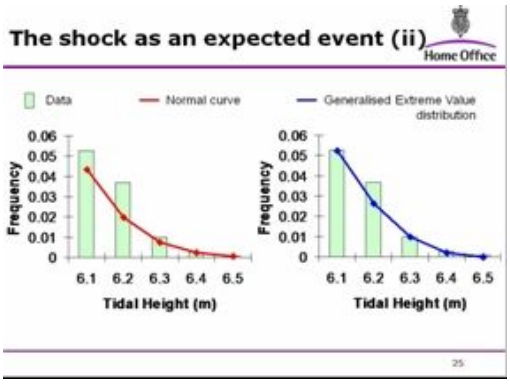
Although this range is wide, the extreme values are approached over a long period, allowing time for anticipation and policy responses. The same applies to the possibility of the Gulf Stream slowing down and lowering UK temperatures by several degrees. There would be severe consequences, especially for agriculture, but again it might take years to happen.

A true shock might be the release of massive amounts of methane from the deep oceans and the arctic tundra, which could happen rapidly and would have big effects on the UK, from flooding and other hazards.

This possibility is worth thinking about, John believes, because of the decisions it requires. These include mitigation, such as bigger flood barriers, corporate strategies to improve resilience, and new approaches to cost benefit analysis and resource allocation as new priorities emerge.

A future shock, John says, can be inside or outside what we regard as the cone of possibility. Those that are inside the known distribution can be analysed with tools such as the Poisson Distribution or Extreme Value Theory, while those outside it may be analysed with Bayesian methods.

As an example, he showed how many days in a three-year period in London had one, two, three, or four murders (none had five or more). The graph is a perfect Poisson distribution. This shows that, if the underlying process generating these events is constant, four murders on a single day over a three year period would be predicted by the statistical model. However, his graph excluded the July 7 bombings in London, a true Black Swan event from outside the range of normal expectations.



John then explained Extreme Value Theory, using as an example the problem of deciding how much flood defence investment is needed at Newlyn in Cornwall. There is a vast abundance of data on tides at Newlyn, running back many decades and in some cases at 15-minute intervals. But Extreme Value Analysis allows only the tides over 6m to be analysed, so that it shows the outliers better than a standard method would. Even then, warned John, there are two drawbacks. This method would not cope with a Black Swan event such as a tsunami. And it assumes that the future is the same as the past, perhaps unwise in the era of climate change and sea level rise.

Tides are a simple property of the solar system. By contrast, says John, Bayesian methods allow us to look at shocks that might emerge from complex sources. Planes sometimes crash. The weather is sometimes bad. But do more planes crash in bad weather? A quick look might suggest that they do. Bayesian methods use a network of data on crew quality, available technology, traffic volume and other factors to find the factors that lead to crashes and near misses, and at the response when there is a near miss. Bayesian analysis can show the effect of all these factors, including the weather, on the likelihood of a crash.

He adds that there is increasing interest in methods which can capture emergent rather than established behaviour. The social sciences are now following the physical sciences in recognising that a small change in initial conditions might mean a big change later on, or indeed quite quickly, but this change might not be hostile – it could equally well be benign, depending on the process under consideration. We should not view such events as “unexpected”, unless they are truly out the realm of our current experience. In the Earth sciences, we have long known that there is a power law relationship governing how common more or less intense earthquakes are. Now we know that a similar graph captures the death tolls in wars and conflicts in Iraq, Colombia and Afghanistan and in terrorist attacks. This emergent behaviour can be modelled by agent-based systems.

John's message is that "shocks are unpleasant but we don't just have to roll with them." They do fall within knowable patterns, despite the existence of Black Swans such as some terrorist attacks, unpredictable floods or the acts of rogue nuclear powers.

Asked whether globalisation has made us more or less prone to shocks, John replied that the modern world is far more complex and interconnected than in the past. This means more scope for initial conditions that can create vulnerability. But complex systems can also average out unexpected events and reduce their size. However, as the world financial meltdown showed, globalisation does not build in checks and balances. The problem was caused in part by people buying parcelled-up mortgage debt without knowing exactly what it was. Bayesian analysis might help us understand problems like this, but Bayesian analyses are not straightforward. They demand a high level of understanding of the initial data. If it works, it is rewarding because it encourages judgement, which means that is can help policy makers develop their thinking.

At this point, it was time for lunch. Animated chatter and networking occurred in a room filled with reminders of high points of British and European space exploration.

Harry Woodroof

Futurecope: disruptive strategic shocks

The afternoon session began with Futurescope. By now a FAN Club fixture, this involves Harry Woodroof, acting director of the Horizon Scanning Centre, setting out a problem we may never have considered.

His theme on this occasion was possible shocks, and his presentation was based on work carried out by Foresight and Outsights. Some of the shocks he pointed to may seem unlikely, but as he said, that would have been true of bank nationalisation just a couple of years ago. We now know both from theory and from events that complex systems produce unanticipated and unpredictable results, and that the effects they generate are long-lasting.

Echoing John Elliott's presentation, Harry's first big shock was the possibility of much faster global warming than has been anticipated so far. This could lead to a plunge in UK temperatures as the Gulf Stream switches off. As Harry said, taking a more pessimistic timescale than John, people in the UK are not used to Canadian or Siberian weather, and it could be just a few years off.

Shock two is resource disruption. In this scenario, Russia is turning into the world's gas monopolist. How will it use this power? There have already been political controversies on this issue, added to those accompanying oil from OPEC. World energy demand is forecast to double in 36 years, adding to the pressure which Russia can exert. Food and water may be the focus of other resource crises.

Shock three: gridlock. Transport mileage has trebled in the past 50 years. We need new technology and behaviour to cope with this.

Shock four is pandemic disease. One study suggests that a future pandemic will kill 1.4 million people and cost $330 billion in lost economic output.

The fifth shock is the destruction of privacy – think of all those Radio-frequency identification tags. As Harry sees it, this may mean reverting to the conditions of 200 years ago when nobody had any privacy. Non-western cultures are more comfortable with this idea. And what of the data tsunami? Can we track all that information? How much of it is true? Where inside it do the damaging viruses lurk?

Sixth: biometric data on everyone. Even if the intention is a good one, fighting crime and terrorism, the unintended consequences may be large.

Number seven is the ageing society and the power of the grey panthers. Unlike the young, they actually vote in elections.

Eight is declining trust in government, allied with representative government losing legitimacy.

Ninth is the segmented society - we may all end up inhabiting me-world where we think of our own interests and we-world, a community linked digitally rather than by neighbourly contact.

Tenth is enlightenment: supernatural belief, whether in long-established religion or alternatives, is more common than ever.

Number 11 is the decline of the west. Will research and the production of new knowledge be outsourced to Asia as we lose interest in science?

Number 12 is the future of the UK, if any. Sinn Fein, Plaid Cymru and the SNP are already in power in Belfast, Cardiff and Edinburgh.

Thiteenth is the international balance of power. Will China really dominate the world? Will the US go isolationist?

And finally Harry said, Outsights had pointed to a possible big financial crisis in the 2006 analysis which he was now using. At that rate, all 14 crises will have materialised by 2051.;

Harry then asked us a simple question: what had he missed? One answer was a severe disruption to communications caused by a severe solar storm. Another was a crisis caused by the interdependence of big systems such as energy, food, transport and the internet. All these contain very little slack and depend on each other.

Harry's conclusion was that we cannot predict the future and it is dangerous to try. Better to reduce our vulnerabilities and plan for resilience instead. This might involve trading off short term economic performance against sustainability.

See his presentation **here.**

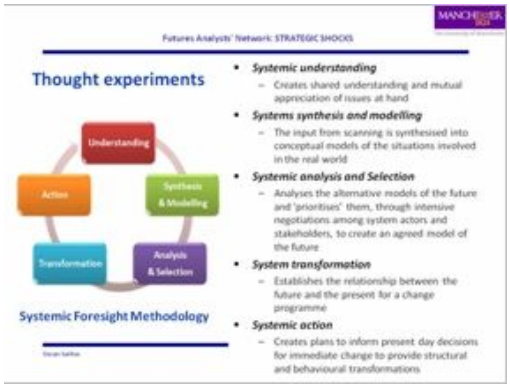
Ozcan Saritas

Seeing the big picture: scans, networks and scenarios

The day finished with two presentations by speakers from the Manchester Institute for Innovation Research, part of the University of Manchester. Ozcan Saritas and Rafael Popper are working on an EU project on the use of Foresight in policy. As Ozcan said, it already seems that Foresight is changing to adapt to a faster-changing world. His project is looking at Foresight as an external influence on organisations, and at how its insights are filtered in-house by organisations that use it.

Ozcan pointed out that when they consider a major future driver such as technology, organisations tend to ask what is feasible and what is possible. They are less good at asking what is desirable. They should do this more often, because values are becoming more important in decision-making.

Their project has developed a system called Systemic Foresight Methodology. It allows users to map influences on systems, pointing to distractions to avoid as well as important issues to concentrate on. Its use leads on to a transformation phase at which the findings can be applied "to lead to a better world."



This activity, Ozcan explained, uses a large amount of input data such as trends, drivers, shocks, wild cards, weak signals and discontinuities. They have been developed by asking experts, mainly from government and academe, and from Asia Pacific and North America as well as Europe, what they thought were the most significant processes at work to shape the future. Many of the experts had over 15 years of experience in the field.;

There was a consensus that key trends include environmental and sustainability awareness, alternative energy and steadily advancing science and technology. Technology and globalisation were the top drivers, whilst wild cards include wars, natural disasters and epidemics. Possible discontinuities include political change, the growth of renewable energy and resource scarcity.

An analysis of all these shows that it is geopolitical and security issues that generate most wild cards, science and technology that produce most discontinuities, and society and culture that produce most weak signals hinting at the future. It is in Europe and North America that we see most concern about ageing societies, equal opportunities are mainly a western concern, and green issues have resonance all over the world.

In terms of timing, the experts consulted by the project regard environmental and financial crises as the biggest issues for the period from now until 2016. Population ageing takes over from 2016 to 2025, while climate change and resource scarcity are the biggest current concerns for the period beyond then. These views have allowed the project to assemble three broad evolutionary scenarios for these different timescales.

See Ozcan's presentation **here**.

And if you have anything to publish in this area yourself, Ozcan added that he is editor of the **Foresight Journal** and is always on the lookout for material.

Rafael Popper

Mapping wildcards and weak signals and foresight

The final speaker of the day was Ozcan's colleague Rafael Popper. He discussed an EU project on wild cards and weak signals which forms part of the Framework 7 research programme and which is intended to help shape future science priorities. The aim is to produce a more interactive version of the Sigma Scan. Wild cards, he said, are one of the least understood areas of future studies. We need to know more about where to find them and how to classify them.

Asking about them at conferences, in surveys and by other methods has revealed the need for some consistent process. Asking an open question about them produces a large amount of unclassifiable material, but the policy makers need something usable and structured. Better structure also allows us to make sense of the wide variety of responses that come back if we ask different audiences – maybe the public, artists, scientists and civil servants – for their views. The project has built up a list of over 70 wild cards and over 80 weak signals which need to be classified.

How we do this and at what stage in a project is a question Rafael aims to answer. One approach is to divide wild cards into those that tell us that the future will be like the present, and others that suggest it will not. Gradual climate change effects, or a war in Europe, might be in the first group, and severe oil shortages, or a shift to renewables, in the second. The most difficult wild card to build into any idea of the future is one that has a totally new technology or paradigm.

Rafael urged us to avoid too many ideas about "good" and "bad" change. As he said, the extinction of the dinosaurs was bad for them but ideal for us. Terrorists might regard an attack as a success. More ambiguous are ideas like genetic engineering. We might want to wipe out genetic defects, but what about reengineering babies so they don't commit crime? That idea certainly emerges in the science fiction literature.

From wild cards, Rafael moved on to weak signals, which he describes as "observable warnings that implore us to consider new interpretations of issues." An example is the former US plan for an anti-missile system based in Poland

and the Czech Republic. The US regarded it as an investment in threat reduction, but Russia, Iran and the UK all had their own views of its meaning. In the end these rival views led to its cancellation. Its cancellation is in turn a signal about the Obama administration's policy intentions. Continuing on this theme, Rafael mentioned President Obama's Nobel Peace Prize – a wild card open to a massive number of interpretations.

On their hunt for wild cards and weak signals, Rafael and his colleagues have scanned over 3000 EU projects before moving on to magazines, journals, blogs and the Sigma Scan. Now they are having workshops with a wide range of experts working on major global issues to find out what breakthrough in their area would help most to solve their problem. The plan is to have a bulletin on the 50 top issues after the present analytical stage. There will also be an online tag cloud of key words and terms, the iKnow Oracle, which people can use like a Wiki version of the Sigma Scan to get at the issues.

See Rafael's presentation here and the project web site **here**.

At this point a completely predictable event, the ticking of the clock, meant that we ran out of time. Is this a tame card? In any case, some delegates headed for the station whilst others took a tour of the lasers, beam machines and other high-tech pleasures of RAL, with thanks to STFC for its hospitality.

If you were at the RAL meeting, you will have received are about to receive an email request for feedback: please complete it

[1] Taken from ONS projections