scale of the problem. This clearly cannot be done by any one nation alone – even Russia, on whose doorstep the most serious symptoms have been seen.

If the AMEG analysis is confirmed, then the second stage is urgently to identify and implement the necessary counter-measures, which also need to be carried out as an international project. There are a number of methods to tackle the problem if action is not delayed: they may be grouped as either geo-engineering or local intervention solutions. Financing these is something which simply has to be done – without long delays and political wrangles. It is an almost impossible challenge to implement the counter-measures quickly enough to prevent the possible collapse of the Arctic sea ice in summer 2013, but this challenge has to be faced as an international emergency.

It should be added that there have been other reports which suggest that there may be less urgency – though they do not disagree with the existence of the problem. However, this is a case where I believe the precautionary principle must override such doubts. The precautionary principle was invoked during the 1990s to justify international action (such as the Kyoto Protocol) on global warming at a time when the scientific evidence for man-induced warming, though strong, was not totally certain (at that time, for instance, only CO_2 was being monitored, not methane or nitrogen oxides). The wisdom of that was borne out by the fact that the scientific evidence has become absolutely overwhelming. Doing nothing, in my opinion, is not an option. Delaying action is as bad as doing nothing. If we take action and it proves to have been unnecessary then a lot of money will have been spent – but not altogether wasted even so, as we shall understand these feedback processes much better. If we do nothing and find that action was required, then the future of civilisation is at serious risk, if not worse.

The Arctic Methane Emergency Group is an ad hoc international group, chaired by geoengineering expert John Nissen, whose members include Peter Wadhams, Professor of ocean physics at Cambridge University, Stephen Salter, Emeritus Professor of Engineering Design at Edinburgh University, and Dr Brian Orr, former Principal Scientific Officer, Department of the Environment. Further information can be obtained from http://www.arctic-methane-emergency-group.org

A document from AMEG has also been placed on the P&SC web site giving much more information, in language that should be accessible to non-scientists.

WHAT IS THE PUBLIC UNDERSTANDING OF RISK?

Meeting of the Parliamentary and Scientific Committee on Tuesday 13th December

ENGINEERING, ETHICS AND RISK

Dr Chris Elliott FREng
Pitchill Consulting Ltd

The public has no difficulty understanding risk. My evidence for that assertion is to look at how people deal with, for example, a three horse accumulator bet. People are quite capable of understanding odds and alternative outcomes, provided they have trustworthy, accurate and impartial information. For horse racing, all they have to do is pick up the Racing Post.

However, the question is not whether the public is capable of understanding risk but whether they do actually understand it. For many of the risks that they have to deal with, there is no equivalent of the Racing Post.

An extreme example was Andrew Wakefield's allegation of a link between autism and the MMR vaccination. Wakefield was at least incompetent and possibly dishonest but the real harm was done by the news media that reported his work sensationally. Poor risk decisions by parents meant that children were not vaccinated, with a consequent loss of "herd immunity", and it is highly likely that some have died as a result. Did any of those newspapers print as big headlines after his work was discredited? How can lay parents take a sensible risk-based decision when confronted with such poor information?

My understanding of juries and work I have done with focus groups leads me to trust the proverbial "man on the Clapham omnibus" provided we treat him or her like a grown-up. That leads to my first conclusion: **The public is perfectly capable of understanding risk – if given trustworthy, accurate and impartial information on which to make an informed decision.**

The following cutting from the London Evening Standard quotes an Assembly spokesman saying that driverless trains are "perfectly safe". That is nonsense; nothing is perfectly safe. Every human activity brings good and bad consequences, not all of which can be accurately predicted. We decide

Underground could be running driverless trains as early as 2018

Dick Murray

THREE out of four Tube trains will be able to operate without drivers by 2018, Transport for London directors have been told.

These include trains on all lines except Piccadilly, Bakerloo and Waterloo and City. A report presented to the TfL board said that once the new stock of trains for the sub-surface lines is complete it is "unlikely" Tube bosses "will ever again buy a fleet of passenger trains with conventional drivers' cabs", and upgrading the signalling systems meant "by 2018 ... some 70 per cent of the network will be automatic".

Plans for driverless trains across the network from 2020 were revealed by the Evening Standard last week.

London Assembly Tory group transport spokesman Richard Stacey said: "It makes total sense. Thirty cities around the world have driverless trains. They are perfectly safe."

But Caroline Pidgeon, leader of the Assembly Lib-Dem group and the transport committee, said the Assembly would need "absolute guarantees" about safety.

that a risk is acceptable if the likely harm is outweighed by the likely good.

Equally absurd is the call in the final paragraph for "absolute guarantees". Safety is a result of a trade-off. When you hear a Managing Director or a Minister after an accident saying, "safety is our highest priority", you can be sure of one thing. She or he is lying. If safety were the highest priority they would not fly the plane, drive the train or sell the medicine. Safety has to be traded with speed, effectiveness, comfort and many other properties *including* cost.

That leads to my second conclusion: **Risk has to be managed, it cannot be avoided**

We are seeing attempts to avoid it in the response to Fukushima. Much of that has been driven by fear of the hazard without consideration of the actual risk. A hazard is something that has the potential to cause harm; risk is a measure of the likelihood that it will arise and the consequence that would follow. For example, a penknife blade is a hazard but, if I fold it into the handle, the risk that it presents in my pocket is tiny. Nuclear hazards are very easy to detect but what is the level of risk? Let's be clear – no-one was killed by the nuclear failure (compared with over 25,000 in the tsunami). The worst affected people were probably the fire-fighters. On average 25% of us die of cancer (1 in 4); according the WHO those fire-fighters now have a risk of 26%. That is about the same risk of dying at work as "white van man" in the UK. I'm not dismissing a 1% risk of death and I hope they were well rewarded but the reaction of many governments, to end nuclear power, is hardly rational.

It's even less rational when they do not also do anything to reduce demand. We still want our air conditioning and dishwashers, which need electricity. We can generate it with oil – the Macondo accident killed eleven people, as well as its environmental impact. We can use coal, maybe for the Japanese from China, but last year the Chinese authorities admitted to 2433 mining fatalities. Coal mining also has collateral damage – remember Aberfan?

Objectively nuclear power is one of the safest ways of generating electricity, and it does not release carbon from fossil fuel, so why aren't we clamouring for it? Maybe we are not receiving trustworthy, accurate and impartial information. There is an interesting exception. I usually rely on the Daily Mail for examples of sensationalising and distorting risk, for example in its outrageous coverage of the impact of road safety on speed cameras, but its reporting post-Fukushima has been balanced and calm.

We, by whom I mean engineers *and* politicians, have an ethical duty to deal properly with risk, delegated to us by the public because engineers have expertise and knowledge to assess benefit and harm and politicians have the responsibility to chose the "least-bad" option. It is not easy to choose between unpleasant options – nuclear power, coal mines or lights out – but we have to do so, ethically and courageously. For me, the ethical test is quite simple: would you be happy if someone whom you respect saw how you had decided? If you like, what would Jiminy Cricket say? If for example nuclear power is the right solution, it then takes political courage to say so in the face of hostile fear of the hazard and to do what you believe is right, not just popular.

Adam Smith is quoted on the £20 note explaining that society is built on the division of labour. The public, who can and do understand risk, has delegated to engineers the duty to find out the best way to solve practical technological problems and delegated to politicians the duty to put them into effect. That is the third conclusion: **We have a duty to take decisions about risk on behalf of other people.**

Let me return to automation; it's an emerging risk issue that has not been thought through. Despite the whipped-up concerns about driverless tube trains, the public is very comfortable with automatic transport. The picture is the Heathrow Pod. I signed its Safety Verification Certificate before it entered service. Since then, we have found that people love it and they're intrigued, not frightened, by the lack of a driver.

But what about what the Press calls "killer drones", pilotless military aircraft or vehicles? REAPER is an unpiloted surveillance aircraft in service in Afghanistan and under development are so-called mules – driverless trucks that can resupply troops under fire or evacuate casualties. Why should we not want to keep our troops out of harm's way? Is there a real issue, perhaps about where we should draw the line?

Is ground support by a piloted Tornado different from support by a remotely controlled aircraft, where the "pilot" in a bunker in Nevada orders the weapon to be released? What if an autonomous aircraft is told what a target looks like and then finds and engages the enemy with no further control?

This raises legal as well as ethical questions. If that autonomous aircraft mistakenly attacks an ambulance, is it a war crime and who committed it? An enemy combatant who shoots down one of our pilots hasn't committed a crime, but what if he shoots the "pilot" going off duty in Nevada where he's been "flying" a drone 5000 miles way?

The challenge is not just about weapons. What about a robot surgeon? Do we want a remotely controlled knife that's more accurate and doesn't get the shakes but which has a real surgeon on the other end of the joystick? How about taking away the surgeon and tell the robot to take out the appendix? What about self-driving cars? 95% of road accidents are caused wholly or in part by human error. Wouldn't it be better to eliminate the least reliable component, the nut on the steering wheel?

These are difficult ethical questions and they are no longer theoretical. All those technologies are either with us now or credible in the foreseeable future. How do we – the engineers and politicians to whom the public has delegated responsibility – reach ethical decisions about the risks?

RISKY BUSINESS: RISK AND REWARD ASSESSMENT IN BUSINESS DECISION MAKING

David Simmons, Managing Director, Analytics, Willis Re

INTRODUCTION

As a young maths graduate in 1980 I looked around for a career that would offer general business experience but with an element of mathematics. I rejected being an actuary, then life and pensions only – too many exams and too dull, but general insurance seemed ideal, "the risk business". It was a big mistake. I found myself in a bloated bureaucracy where insurance rates came out of a dusty book that looked as if it had been handed to Moses on Mount Sinai; in truth parts probably dated back over 50 years. Over time I drifted towards a more actuarial career, moving to Head Office to get involved in reserve setting and budgeting. But even there, the understanding of risk was low. I recall one early report written for the board which mentioned standard deviation, a common measure of volatility. The paper was returned as the board could not be expected to understand such a term.

By 1985 I had moved to the reinsurance market, the insurance of insurance companies, partially motivated by the higher salaries it offered but mainly because I thought it must offer a more rigorous analysis of risk – the amounts of cover bought were in the hundreds of millions, the premiums huge, the risks very uncertain. But I was wrong. The market worked on shared knowledge and used simple rating algorithms. But quickly things would change and that change would be profound. The market now is unrecognisable from the one I joined. Twenty–five years ago I was the only mathematician working for a London market reinsurance broker developing risk analysis systems. Now my company alone has over four hundred analytical staff, approaching twenty per cent of the overall personnel total.

Risk is now embedded in the decision making processes of all UK insurers, from the smallest to the largest. Directors of insurance companies are now expected not only to understand what standard deviation means but also to have a broad understanding of the risk models used in their business: their assumptions, strengths and limitations. The relationship between risk and reward is considered before every major decision is made – is the cost of this strategy worth the reduction in risk it brings? The cultural change has been enormous. I will seek to explore why this happened, what the benefits have been, what problems have been encountered and what lessons there are, if any, for government and wider society.

WHY HAS THIS HAPPENED?

Technology

The mid-1980s saw the emergence of the IBM PC. By the early 1990s the power of these machines had increased, and software had emerged, to make stochastic simulation modelling possible on the desk-top. More data about the risks was gathered and that data was more easily accessible. For the first time, rather than modelling a best estimate or worst case, it was possible to attempt to model all possible outcomes of loss causing events, individually and in combination with each other. It was thus possible to show the impact of a particular strategy, for example the purchase of a reinsurance treaty, on an insurer's results not only on average but also at extremes. This opened the door to new pricing and decision making algorithms.

National Competition

New firms developed to take advantage of the new technology and better data to, for example, target properties in low risk areas which the crude rating models of existing companies systemically over-rated, cherry-picking the best risks. This lead to a drive by all UK insurers to improve their data, their risk understanding and their analytical techniques. Reinsurance brokers were at the forefront of this revolution, developing the first probabilistic UK windstorm and flood models and decision support systems for their clients use.

International Competition

The Lloyd's market, the world's predominant reinsurance market in the 1980's, was coming under attack from "professional reinsurers" in Europe and then Bermuda. These companies aggressively used risk analysis and technology to accept and rate business. For example, by the mid 1990's Bermuda reinsurers were beginning to use marginal capital methods. The impact of each new catastrophe risk presented, for example hurricane reinsurance, would be assessed not only in terms of expected profit but also in terms of how much additional capital it would require. The London market had to up its game if once again it were not to lose the better risks to competitors.

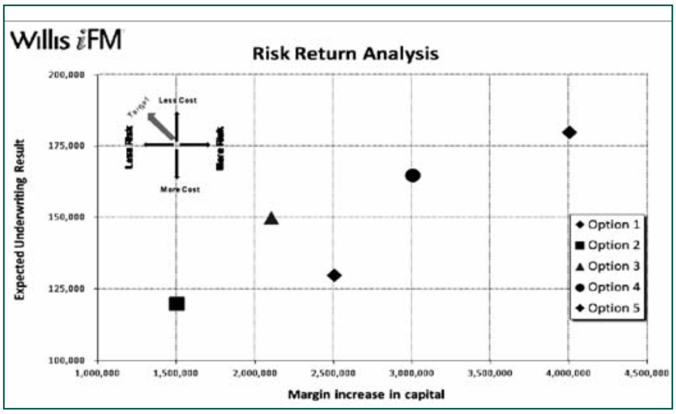
Regulation

Risk based insurance regulation began to emerge. In some cases such as Australia, this was prompted by market failure, in others by advances in banking regulation. With the formation of the FSA, a unitary regulator, a Basel II type regime, Individual Capital Assessment (ICAS), was introduced in 2005. Insurers were required to identify, manage and quantify their risks; most interpreted this as a need to build a stochastic capital model. Solvency II, the European risk adjusted insurance solvency regime was announced around the same time and should go live in 2014. The ICAS experience leaves the UK industry much better prepared than its continental rivals but it remains to be seen how level a playing field Solvency II will be.

HOW DOES IT WORK?

Risk/return analysis

The aim is to compare the cost of an action or a strategy with its impact. A common tool for doing this is a risk/return chart. Typically on the vertical axis is a measure of average return, for example how much money is made or how much the action costs. On the horizontal axis is a measure of risk, something which needs to be minimised. That risk could be the probability of missing a target, the probability of a loss exceeding £x or y lives etc. An example is given below:



In this example, the return measure is expected underwriting result, the y axis marginal increase in capital (perhaps measured by increase in the 1 in 200 year loss expectation). Ideally the insurer would want to be at the top left of the chart, high return but low risk. Sadly, that is impossible unless within a monopoly. To make money an enterprise needs to take risk (and so have higher capital), to minimise risk (and resultant capital) they must accept a lower return.

On this chart 5 options are plotted as possible strategies. What does the chart tell us? Firstly it tells us that option 5 is sub-optimal. Assuming (and we will return to this) we are happy that our model is correct, why follow option 5 when option 3 has a better return and lower risk/capital? But which of options 1 to 4 should the company follow. It depends on its relative attitude to return and risk. Option 1 provides maximum additional income but for maximum capital usage. Option 2 gives a much lower return but also much lower additional risk and thus capital usage. The modelling does not provide the answer but provides the framework for discussion.

HOW DOES IT WORK?

Marginal capital analysis

In this example, assuming each option is a contract which we could accept onto our books, we can use marginal capital methods. Say the company's return on capital target is 10%. We can look at each contract to see if it meets or exceeds that target.

All options fail the 10% target, though option 2 is the closest, option 1 the worst. Based on this test all contracts would be rejected. In reality of course other considerations may apply: existing client relationships, market condition etc. Again, the model provides a framework for discussion.

WHAT BENEFITS HAVE ACCRUED?

Undoubtedly there is now a much greater transparency about the decision-making process. To model risk, assumptions about risk behaviour have to be captured, perhaps assumptions that have been commonly assumed but never previously been open to examination and challenge. Arguably, the UK insurance industry is stronger, certainly more professional, probably better capitalised and more resilient. It is true that in the early days of modelling a “the computer says no” attitude prevailed, models were often allowed to lead decision making rather than inform them. However, now a more adult and mature attitude prevails. Models advise, but models do not, and should not, decide. A balance between model complexity and model comprehensibility has to be struck. Better a simple model where the flaws are known to all than an apparently more comprehensive one where the flaws are buried deep and understood by no one.

WHAT HAS THE ORGANISATIONAL IMPACT BEEN?

There are not enough actuaries in the world to meet global demand. The insurance industry has become far, far more technical. The staffing profile of insurers and brokers has changed radically and continues to change. Numerate science graduates are now sought. Every significant UK insurer now has a board level Chief Risk Officer – a position unknown 10 years ago. Boards now need to be numerate to meet regulatory demands, there are too few grey-hairs of the right background to meet demand for appropriate non-executive directors. But the UK is in a good position. We are a net importer of actuaries but are now arguably the global centre of insurance capital modelling expertise. There is concern about the cost of the risk management and Solvency II compliance, estimated at over £400m for the Lloyd’s market alone, but at least UK insurers have the people and the systems in place. Many in Europe do not. Solvency II is a European initiative, but Solvency II-like risk regulation is spreading world-wide through the International association of Insurance Supervisors. The UK is well positioned to be a global centre of excellence.

DOES THIS BENEFIT THE CONSUMER AND UK POPULATION?

Undoubtedly yes. Insurers are stronger, better capitalised, more fit for purpose. Regulators are more efficient and better informed. More internationally competitive insurers, brokers and consultants benefit the UK economy and create UK jobs. But not everybody is a winner. Greater risk analysis means that some lose. Insurers can more readily identify poor risks. Premiums, say, for those in a flood plan with poor flood protection may increase. Some countries, such as France, nationalise some areas of risk to ensure “solidarity” with the same flood premium regardless of whether you live at the top of a mountain of the bottom of a valley. But appropriate risk pricing encourages appropriate risk behaviour. For example, should local authorities grant planning permission to properties in a flood plain with inadequate protection? The lack of availability of insurance will surely concentrate minds. Similarly pollution risk insurance rate analysis allows well managed companies to reap immediate benefit for demonstrably better risk management.

WHAT LESSONS ARE THERE FOR WIDER SOCIETY?

As a mathematician I have big problems with woolly thinking. For example, what on earth does reasonable doubt mean in law? Does it mean there is a 1 in 1000 chance the defendant is not guilty, a 1 in 100 chance, a 1 in 10 chance, a 1 in 5? Now clearly we cannot measure probability of guilt to these levels of accuracy, but we should be clear which target we are aiming at. The chance of any two jurors having the same understanding of reasonable doubt is virtually zero. Now business is not the law, but the insurance industry’s adoption of probabilistic decision making tools has certainly brought more objectivity and transparency to decision making. In truth it is equally difficult to quantify capital requirements at the 1 in 200 level, as regulators require, but at least everybody is aiming at the same target and forced to explain their thinking.

There is no reason why such tools should not be used in government. Is it better to spend £x to make the railways safer, saving 5 lives a year on average, reducing the risk of a media friendly crash with multiple fatalities, or spend the same money on road improvements saving 20 lives a year, although these will be mostly single fatalities which are missed by the news media. For politicians this is a difficult call, but being able to call on an unbiased risk/return analysis can only improve decision making and justify where the taxpayers’ money is best spent. Arms procurement is another area which would seem ideal for such an approach.

But it must be emphasised that all models are hugely assumption-dependent. Resist the temptation to say “the computer says no”. Politicians, like insurance company executives, cannot hide behind experts. They need to judge the advice they get and make a decision; it is their decision, they are responsible. Models advise, they do not decide.

There are clearly implications here for educational policy. Are we turning out school-leavers and graduates with appropriate levels of numeracy to understand basic concepts of risk? How do we encourage more students to study mathematical and scientific subjects?

The real value of a risk/return approach derives from the transparency, understanding and challenge which should flow from the risk quantification process. Objectives should be clearly stated and options compared to these objectives. All assumptions behind a decision can be seen, discussed, challenged and stressed. Stakeholders can understand how and why decisions have been made. In this brave new world there can be no more hiding behind woolly assessments and woolly thinking.

POWER LINES AND PEOPLE
A case study in differing assessments of risk

John Swanson
National Grid

Academic research on risk psychology has established a good understanding of how the public perceive risk. Can this understanding be successfully applied to a practical, and pressing, real-life example, that of high-voltage electricity power lines?

Many coal-fired and oil-fired power stations are reaching the end of their useful lives, and the UK is connecting new renewable energy and nuclear power stations as low-carbon alternatives. This requires a programme of investment in new infrastructure and extensions to the National Grid on a scale comparable only to the initial building of the supergrid in the 1960s. The resultant requirement for new routes and especially for new overhead power lines creates public opposition (not forgetting the opposition to existing power lines, either).

Some of the opposition is on visual grounds, but some is on grounds of health concerns over the magnetic and electric fields produced by power lines (along with all other uses of electricity). Thirty years of research has not established that there is any risk from these fields; it is probably fair to say the weight of evidence is against health effects; but research has found a persistent statistical association with, in particular, childhood leukaemia. The World Health Organization classified magnetic fields in 2001 as "possibly" carcinogenic as a result. The Health Protection Agency state "the overall evidence for adverse effects of EMFs on health at levels of exposure normally experienced by the general public is weak. The least weak evidence is for the exposure of children to power frequency magnetic fields and childhood leukaemia."

It is, however, no surprise that members of the public generally regard the risk as greater than this scientific assessment would suggest, both the likelihood of its being real and its potential severity. We know from the previously mentioned research on risk psychology, by Slovic and others, that there are well established "fright factors". These are attributes of a risk that lead the public to regard it as more serious; and power lines, and the magnetic fields they produce, trigger many of these fright factors:

- It is not found in the natural environment and is seen as something new, unfamiliar and invisible.
- It is seen as imposed, in that people perceive they have limited choice over the presence of a power line close to their home.
- It is seen as not bringing any direct personal benefit. While electricity networks as a whole bring the benefits of secure and affordable electricity supplies to society, the link is not a direct one between a power line carrying bulk power long distances and the person living near it.
- It is seen as inequitable, in that only a small fraction of the population live near high-voltage lines, and that may further be seen as a consequence of decisions made against local wishes by more powerful sections of society.
- There is uncertainty in the science of health effects.
- There is disagreement among supposed experts, with scientists adopting views to both sides of the mainstream.
- Any risk involving childhood leukaemia would affect children and involve a dread disease.

These "fright factors" are deeply embedded in human culture. Regardless of our scientific education, we probably all unwittingly as well as consciously accept higher risks, whether in transport, leisure activities, or food and drink, if we feel it is something we have chosen because it brings us a benefit and that we have control over. So it is unavoidable that there will be considerable public concern at power lines, more than the scientific evidence on its own might justify.

However, it would be foolish to respond to this by saying that we scientists come up with the true magnitude of a risk, and that if the public disagree, then they are wrong. It is foolish because at one level, in a democracy, the public are right, if not about the facts of a risk, then certainly about whether it is deemed acceptable or not. But it is also foolish because it ignores the reasons why the public treat risk differently from scientists. It should be a good assumption that, as the product of evolution, there are often sound reasons for human instincts, and that includes our perception of risk. The public perhaps have, not a deficient understanding of risk, but a richer understanding.

So the wiser approach is to engage in a dialogue with the public about how the risk looks from where they are. In the course of that dialogue we may well be able to provide better information, which may help to better inform their understanding of the risk. But we will be successful in this only if we start by listening, not by lecturing, and we will certainly fail if any sense that the public are wrong or do not deserve to have a voice comes through from our approach. In the words of Thomas Jefferson: "I know no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them but to inform their discretion by education."

Examples of how National Grid have tried to do this in the context of proposed new power lines include:

- **Uncertainty:** it is human psychology to dislike uncertainties and instead to see them more as "definitely yes" or "definitely no". But there are also too many examples of reassurances given about supposedly unlikely risks that turned out to be unjustified. There is some basis for the public presuming that risks will often turn out to be more serious than they are told by authorities. As far as we are able we try to work with and from the public perception, specifically when it comes to adopting appropriate precautionary policies.
- **Risk comparisons:** comparisons are effective only if the public view the risks as comparable. A comparison to an exposure to magnetic fields (e.g. from a domestic appliance) that is chosen by the individual will not provide reassurance about an exposure seen as imposed (the power line), even though the former can be bigger. Likewise, telling people that exposure to magnetic fields is like drinking coffee (both classified in the same category on strength of the evidence for carcinogenicity by WHO) is ineffective. Enabling people to place things in context is valid and helpful, but it is ineffective to force it on them.
- **Choice, benefit and control:** We may never be able to produce a direct benefit for a person living near a high-voltage power line from that specific line. But at the societal level, electricity networks are integral to the incalculable benefits that secure and affordable electricity brings to quality of life, health, communications etc, and increasingly, through enabling low-carbon electricity, to the nature of the lives our children will be able to live. Given how central these attributes of risk are to risk perception, we have to get better at telling that story at the societal level.

Some people affected by one of our proposals will inevitably still feel disempowered and may well dispute that communications have improved. However, we, while recognising that the decisions that finally have to be made are often still unpopular ones, believe that progress has been made away from "decide, inform, defend" to more genuinely consultative approaches. This is very much encouraged by the new planning regime for major infrastructure projects, which emphasises more consultation and at a much earlier stage.

We will never persuade the majority of people to like power lines. Nor can we eliminate health concerns; indeed, nor should we even try, as long as the scientific uncertainty remains, and a separate strand of National Grid's approach to this issue is to support high quality scientific research to try to resolve the issue. But we can make a difference by the style and approach of our communications about risk. As with so many risk issues, we tend to start by thinking that the correct outcome is determined solely by the facts: all that matters is to "get the numbers right". We progress to realising that we need not just to get the numbers right ourselves, but to communicate the numbers. Then we realise that for this communication to be effective, we have to explain the numbers and to put them in context. All of these stages are necessary, but in our experience with power lines, reinforcing experience from many other issues, risk communication only becomes its most effective when, rather than "telling" people anything, we trust people and let them arrive at the answers for themselves, with us assisting but not directing.

Managing a scientific risk in a societal context is as much, if not more, an issue about people rather than about numbers.