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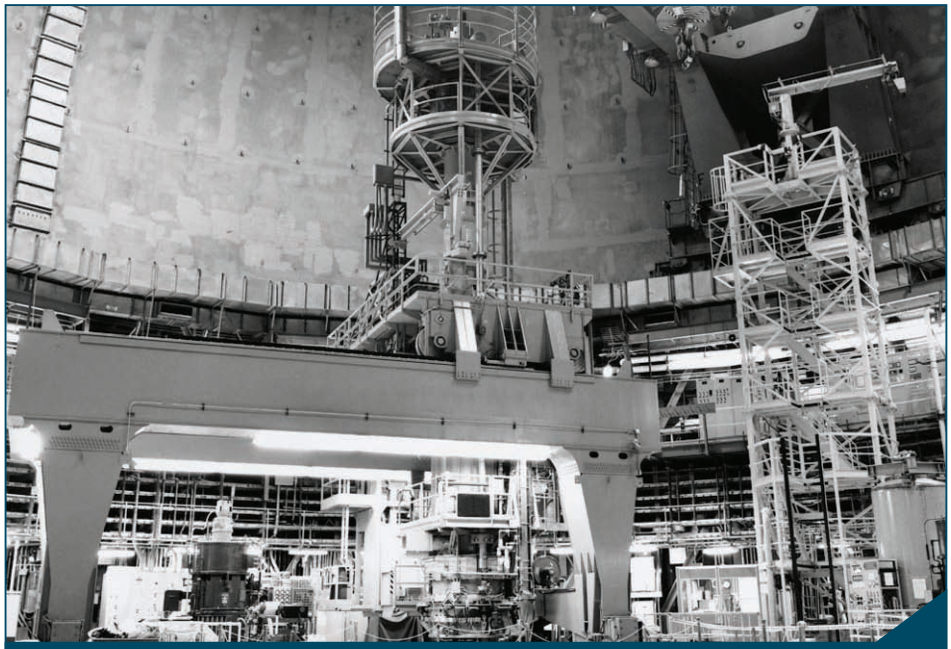

Photo: European parliament ©

Using military force against Iran's nuclear programme is likely to be very counter-productive

Iran's nuclear strategy – civil or military?

Iran is under scrutiny: Western governments claim its nascent nuclear power programme masks plans for nuclear weapons development. Frank Barnaby assesses the validity of the West's claims and argues that use of military force against Iran's nuclear programme will only make matters worse.

Iran has recently announced plans to seek bids for two new nuclear power reactors, each with a generating capacity of between 1,000 and 1,600 megawatts (MW) of electricity. Both will be partly fuelled with uranium dioxide produced indigenously in its uranium enrichment plant at Natanz. The rest of the nuclear fuel will be imported.

The new nuclear plants will be built at Bushehr, alongside Iran's first nuclear power reactor – which has just been constructed by the Russians. Iran says that it plans to build more nuclear power plants with a view to attaining a total generating capacity of 20,000 MW by 2020. Each 1,000 MW plant is expected to cost between US$1.4 billion and US$1.7 billion.

The West fears that Iran's civilian nuclear programme is a smokescreen for its ambitions to produce nuclear weapons. Iran insists that its nuclear programme is entirely for peaceful purposes. Many argue that because Iran has enormous reserves of oil and gas it does not need nuclear energy and therefore that its nuclear programme can only be driven by military ambitions. But Iran claims that it needs to export as much of its oil as possible to earn much needed foreign currency, that its oil reserves are finite and that nuclear power is a sensible investment for the future. Clearly, navigating through the political and economic arguments is not easy. But its importance is clear, given the looming threat of military action against Iran based on its assumed nuclear weapons intentions. What do the technical data suggest? This article, which draws extensively on an Oxford Research Group report[1], attempts to answer that question.

Iran has long experience in nuclear physics and engineering. Because it has been operating nuclear research reactors for some decades, it also has a

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A few words from the Director

It was probably too much to expect that the publication of the latest report from the Intergovernmental Panel on Climate Change (IPCC) – the top scientific body in this field – would be enough to silence those who deny that humans are causing climate change. One conclusion of the report is particularly striking in this regard: that it is 90% certain that most climate change observed over the last 50 years has been due to human activities (see p.12). So, it was not unreasonable to think that in the wake of this, the media would become rather more suspicious about the claims of the 'climate sceptics'. How depressing then, to see the broadcast of a Channel 4 'documentary' shortly afterwards and the credence given to it by many newspapers – ignoring the huge support among climate scientists for the IPCC conclusions. Even worse was the chatter in some of the engineering press, which also took the Channel 4 programme seriously. Perhaps what many don't realise is that most of the basic arguments presented in that programme were discredited over 15 years ago and since then, of course, the evidence about climate change has grown massively.

It is tempting, in response to such a programme, for groups such as SGR to spend a lot of effort trying to counter in detail the flaws in its arguments. However, it is important not to fall into the sceptics' trap of expending valuable resources on dealing with a marginal view at the expense of other climate work. For example, highlighting the stark conclusions of the IPCC or trying to convince governments to implement stronger policies on expanding energy efficiency and renewable energy deserve to remain high priority – as our recent activities in this area demonstrate (see right). It should be remembered that apart from occasional 'blips' such as the Channel 4 programme, the publicity that the sceptics get in the UK (as opposed to in the USA) compared with the mainstream view has generally been quite low. Indeed, last summer, while researching for a workshop for environmental campaigners on debunking climate myths, I was pleasantly surprised at the lack of recent high profile articles by climate sceptics in the UK press. I also discovered that a European climate sceptic lobby group – the European Science and Environment Forum – was now defunct.

Still, it is important to remind people of the extensive resources available that counter these 'climate myths'. *New Scientist* magazine has recently compiled a detailed guide of 26 common climate myths[1], while the *Media Lens* and *Real Climate* websites provide detailed critiques of the Channel 4 programme mentioned above[2, 3]. The notes from my own workshop are on the SGR website[4] and a summary of some common climate myths can be found on p.15. So please do pass these on!

Of course, it continues to be important to examine critically and, if necessary, to challenge mainstream views in science and technology. And it is especially useful to remind ourselves of the reasons why some of the mainstream views need to be questioned. Such a reminder is provided on p.11 where Helen Wallace discusses the problems of patenting in the biotechnology sector. She highlights the thorny issue of conflicts of interests and the continuing failure of significant numbers of scientists to disclose them. Thankfully the issue of patents rarely muddies the waters of climate science, leaving the peer-reviewed journal papers in that field far less susceptible to influence from the corporate sector.

Stuart Parkinson

References

1 Le Page, M (2007). Climate change: A guide for the perplexed. New Scientist, 16 May. http://environment.newscientist.com/channel/earth/climate-change/dn11462-climate-change-a-guide-for-the-perplexed.html
2 MediaLens (2007). Pure Propaganda – The Great Global Warming Swindle. 13 March. http://www.medialens.org/alerts/07/0313pure_propaganda_the.php
3 RealClimate (2007). Swindled! 9 March. http://www.realclimate.org/index.php/archives/2007/03/swindled
4 Parkinson, S (2006). Debunking the myths of the climate sceptics. Workshop notes. Camp for Climate Action, 27 August. http://www.sgr.org.uk/climate/CCampMythNotes_Aug06.html

Ethical careers programme

The careers fair season has again been busy for SGR. Since January, we have had a presence at a total of eight careers events. These included university careers fairs in Cambridge, Leeds, Limerick (Ireland), Manchester, Newcastle and at Imperial College London. Stuart Parkinson also gave three talks on ethical careers – at Imperial College (in February) and at Birmingham University (in March and June).

Stuart Parkinson and Vanessa Spedding

Climate change and energy update

With the launch of the conclusions of the three working groups of the Intergovernmental Panel on Climate Change (IPCC) in February, April and May, climate change has continued to remain high on the political agenda (see p.12). Similarly, the recent launch of several government consultations on climate- and energy-related issues, including the draft Climate Change Bill, proposals for new nuclear power and the White Paper on planning have kept these issues in the public eye.

SGR has undertaken several activities in these areas in recent months. Stuart Parkinson spoke at an international climate campaigners' conference in London on the impacts of climate change. Philip Webber spoke at the University of Edinburgh on local sustainable energy. Meanwhile an SGR article on the potential skill shortages in the energy sector was published in *The Engineer*. Martin Quick and Stuart Parkinson also put together an SGR response to the government's consultation on its draft Climate Change Bill, which will set legally binding targets for emissions reduction in the UK up to 2050. We argued that the UK needed to take on more ambitious targets than proposed – a cut of the order of 80-90% by 2050, rather than the proposed 60%. SGR was also one of over 20 organisations to sign a letter protesting about attempts to start a commercial 'geo-engineering' project in the Pacific Ocean which would involve iron fertilisation of plankton in order (theoretically) to soak up carbon dioxide from the atmosphere. We argued that it was unlikely to sequester large amounts of carbon, but did have the potential to lead to significant local impacts on the marine ecosystem. Finally, several SGR members complained to Ofcom about the extremely misleading claims made in the Channel 4 programme, 'The Great Global Warming Swindle' (see left and p.15).

Stuart Parkinson and Martin Quick

Preliminary announcement

SGR Conference and AGM 2007 • 6 October • University of London Union

The theme of this year's event is resource depletion and the potential for conflict.
Full details will be sent to all members soon.

Challenging Trident replacement

On 14th March, the House of Commons voted (by 409 votes to 161) in support of the government plans to replace the Trident nuclear weapons system. Few were surprised by the vote, but we were all still extremely disappointed. However, as Foreign Secretary Margaret Beckett has stated, this is not the final word on the matter, and it will still be several years before the final construction contracts are issued.

SGR continued to be very active in the run-up to the parliamentary vote. As part of the 'Rethink Trident' coalition, we contributed to a front-page article in *The Independent*, and took part in a high-profile breakfast lobbying event on the day of the vote itself with MPs, celebrities and peace campaigners (see photo). Stuart Parkinson also wrote a two-page opinion article published in *Physics World*; our material was used as the basis of an article in *The Ecologist*, and Martin Quick had a letter published in *Professional Engineering*. Stuart also spoke at a public meeting on the issue in Lancaster. We also circulated a letter to members via SGR's email-list, sgrforum, to send to their MPs urging them not to support Trident replacement. In the week following the parliamentary vote, we were approached by the satirical Channel 4 programme, *Bremner, Bird and Fortune* to help with some Trident-related research for that week's edition of the show. Finally, in the last couple of months, Philip Webber has been assisting a US-based film producer, who is planning a feature-length documentary film on nuclear weapons.

Photo: Mark Donne ©

Lobbying at the House of Commons: (from left to right) Stuart Parkinson, Colin Burgon MP, Anita Roddick, Jon Trickett MP, Kate Hudson (CND), Jeremy Corbyn MP, Katy Clark MP, Annie Lennox, Vivienne Westwood, Ian Gibson MP, Joan Ruddock MP.

Although there is widespread anger about the vote for Trident replacement, there is still the potential to stop the programme. Firstly, as mentioned above, the final go-ahead for the project is still a few years away. A large amount of preparatory work needs to be undertaken first by BAE Systems, Rolls Royce and other military corporations before the final contracts for new submarines can be placed. Secondly, nearly 90 Labour MPs voted against a replacement (with more voting to delay the decision), the largest rebellion on a domestic issue during Tony Blair's premiership. Indeed, discontent within the Labour Party over this issue is growing. Thirdly, other political opposition is strong, especially in Scotland where the nuclear weapons system is based. Fourthly, there is an increased potential for progress at upcoming negotiations under the nuclear Non-Proliferation Treaty (NPT), given the waning power of the Bush Administration. While it has to be admitted that we have an uphill struggle to stop Trident replacement, all these factors could yet work in our favour. SGR will continue to play its role in exploiting the opportunities for pushing for nuclear disarmament.

Philip Webber and Stuart Parkinson

Uncovering military involvement in science and technology: further progress

Since the last SGR Newsletter we have had further success with funding applications, which has allowed us to maintain the momentum with the military influence project. This has included more research on the extent of military involvement at UK universities.

We have completed the collection and further interpretation of data from a small pilot study that used the UK Freedom of Information Act to gather details of the extent and destination of funding from a number of military sources to UK universities. These sources included the Ministry of Defence, Defence Science and Technology Laboratory and military corporations, as well as the US military sector. This material will form part of a briefing, the preparation of which is nearing completion. This briefing will provide an update on the major changes that have occurred in military procurement, R&D and planning in the UK, USA and Europe since the publication of the SGR report, *Soldiers in the laboratory* (SITL), in 2005. It will also be used to highlight the continuing importance of this issue to professional, political and policy bodies in science and technology, as well as to the media.

Building on this work we have secured a grant from the Polden Puckham Charitable Foundation to embark on an expanded study of a larger sample of universities. We intend to assemble publication data from these universities, to interview those receiving funding from military sources and to look in detail at the various funding programmes in order to understand better the impact of such funding on research and teaching.

We have continued to network widely and have used the ethical careers briefing on military issues to good effect here. Recent media interest in our work has especially focussed on the issue of robotics and the military, with coverage including *The Independent on Sunday* and Southampton University's student magazine.

We have also continued to take part in external events. Stuart Parkinson ran two workshops on military involvement in science education at the Peace Education Network conference in Birmingham in March. He also ran a workshop on military influence on science and technology at a conference in Berlin organised by our international partners, INES.

The SITL report has continued to attract a lot of interest, with downloads averaging 80 copies a month for 2007 so far. The total number downloaded since its launch in January 2005 has now passed the 3,000 mark. Do make contact via email on <ChrisL@sgr.org.uk>

Chris Langley

Bill Cranston 1933-2007

Professor Bill Cranston, a longstanding member and sponsor of Architects and Engineers for Social Responsibility and SGR, died tragically on 14th March after being knocked down in a road accident. He was 73.

Bill was born in Edinburgh but brought up on Islay, and he developed a lifelong love for the island. He studied civil engineering at Glasgow University, and did a PhD and taught there before joining the Cement and Concrete Association, where he carried out research on concrete column design. He was one of the key people involved in developing the new 'limit state' code of practice for concrete design, which appeared in 1972. In 1988 he moved back to Scotland to become Professor of Civil Engineering at Paisley College of Technology (now University) and while there he worked with Queen's University in Belfast on the 'Limpet' wave power generator – which was constructed on the west coast of Islay. When he retired, he remained active in technical research and developed a keen interest in the different approaches to engineering education which have been adopted in various countries and at various times in history.

In politics, Bill was a Liberal Democrat, serving as a councillor in Slough and also on Berkshire County Council, and he was also a strong supporter of CND, Fair Trade and Make Poverty History. He joined Architects and Engineers for Social Responsibility and accepted an invitation to become a Sponsor, continuing in this role with SGR when the two organisations merged in 2005. Alongside all this, he developed a strong interest in the ideas of the French Jesuit Teilhard de Chardin and became Treasurer of the British Teilhard Association, while also looking after their membership and editing their newsletter.

I first met Bill in the late 1970s, when he came to hear what I had to say at a Concrete Society meeting about the new code of practice he had worked on and promoted. I was a young engineer asking awkward questions – and I found in Bill a knowledgeable, friendly sparring partner with a twinkle in his eyes, an irrepressibly lively mind and a great love of a good argument. Later, when I got involved in research on the design of slender concrete columns, we crossed swords technically again, as Bill's research was a key source of technical data but our conclusions differed. However disagreeing with Bill was not really a hardship – our arguments were always friendly and productive.

Over the years, we corresponded and talked about many things. With Bill, a simple phone call or question would often lead into a free-ranging argument-cum-discussion, which might extend into the small hours covering all manner of subjects, although often the original question was forgotten along the way. Bill's thoughts were always interesting and stimulating and his zest for ideas and life made it all enormous fun. It was also a real pleasure to meet his wife, Ness, at their homes in Slough and later in Largs – and to bump into the pair of them on CND demonstrations.

In later years our views on engineering issues became closer and at the time of his death Bill had agreed to work with me on a short paper tracing the technical development of structural codes of practice – including his irreverent anecdotes about what really happened on code committees. Sadly, like many of our conversations, this was still unfinished, a 'work in progress', when his life was so tragically cut short. Bill still had much to contribute to life and he will be greatly missed by his family and many friends.

Alasdair Beal

Stephen Hawking and Richard Rogers win prestigious awards

Two of SGR's most famous sponsors have won prestigious awards in recent months.

Physicist, Professor Stephen Hawking, has been awarded the world's oldest award for scientific achievement – the Royal Society's Copley medal – for his outstanding contribution to theoretical physics and theoretical cosmology. The medal's previous recipients have included Charles Darwin and Albert Einstein. Stephen Hawking is the Lucasian Professor of Mathematics at the University of Cambridge. His work has been essential in understanding and classifying black holes, and he has also popularised the subject through books including *A Brief History of Time*.

Architect, Lord Richard Rogers, has been awarded the Pritzker prize, regarded as the equivalent of a Nobel for architecture. His works, from the Pompidou Centre in Paris to the Welsh Assembly building, have had a profound influence on the profession. Notably, especially from the SGR perspective, he has been a champion of cities and buildings for people and has chaired the government's Urban Task Force and the Greater London Authority's advisory group on design.

Both Stephen and Richard are among those who have contributed to SGR's recent activities challenging Trident replacement (see p.3), for which we are very grateful.

Stuart Parkinson

References

The Guardian (2007).
http://arts.guardian.co.uk/art/news/story/0,,2045286,00.html
The Royal Society (2006).
http://www.royalsoc.ac.uk/news.asp?year=&id=5066

In brief

SGR has also undertaken a number of other activities over the past few months, including the following:

- Eva Novotny put together an SGR submission to the Department of Environment, Food and Rural Affairs (DEFRA) opposing its genetically modified potato trial in Yorkshire (see p.10). Eva also spoke at a GM event at the European Parliament in June.
- Tim Foxon gave a talk about SGR's concerns and activities at an event organised by the National Endowment for Science, Technology and the Arts (NESTA) in March.
- Alan Cottey ran a workshop on personal water consumption at an environmental campaigners event in Nottingham in April. An article based on the workshop has been published online.
- Stuart Parkinson took part in a panel discussion at Lancaster University on ethical issues related to a proposed science park there.

The potential of power from deserts

The ingenious use of mirrors and DC electrical grid technology could provide a significant new source of power from desert sunlight. Gerry Wolff explains.

Every year, each square kilometre of hot desert receives solar energy equivalent to the energy content of 1.5 million barrels of oil[1]. When multiplied by the total area of deserts worldwide, this amounts to several hundred times the entire current energy consumption of the world[2].

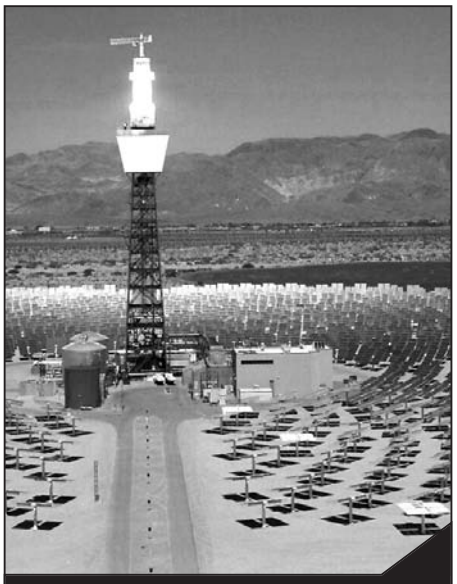
Given concerns about energy supplies and the need to cut CO_2 emissions, this startling statistic seems to be a cause for optimism. But, you may ask: can we tap into this enormous source of energy at a reasonable cost? Can we get it to where people are living? And, if those things are possible, what other problems might there be? The purpose of this article is to provide answers to those questions and suggest that any initial sense of optimism may well be more than a mirage.

The key technology for tapping into the solar energy of desert regions is Concentrating Solar Power (CSP). This is not some futuristic possibility but is the remarkably simple idea of using mirrors to concentrate direct sunlight in order to create heat and then using the heat to raise steam, which drives turbines and generators, just like a conventional power station. (In some variations, the heat is used to drive a Stirling engine that drives a generator.)

A useful feature of CSP is that it is possible to store solar heat in melted salts (such as nitrates of sodium or potassium, or a mixture of the two)[3] so that electricity generation may continue through the night or on cloudy days. This overcomes a common objection to solar power: that it is not available when there is no sun. Of course, this technology is not specific to CSP but, in conjunction with CSP, it has proved effective for short-term storage of solar energy.

CSP is different from the better-known photovoltaic (PV) technology and, with current prices for PV, it can deliver electricity more cheaply in situations where lots of direct sunlight is available[4]. However, PV may become cheaper in the future and methods for storing PV electricity are likely to improve—so the balance of advantage may change. (Note that CSP is sometimes used in conjunction with PV.)

The relative merits of different technologies and different versions of CSP will, no doubt, be the subject of study and debate for years to come. The key point for present purposes is that the technology works, it is relatively mature and has been generating electricity successfully in California since 1985. Currently, about 100,000 Californian homes are powered by CSP plants. New plants came on stream recently in Arizona and Spain, and others are being planned or built in other parts of the world.



Credit: Sandia National Laboratories ©

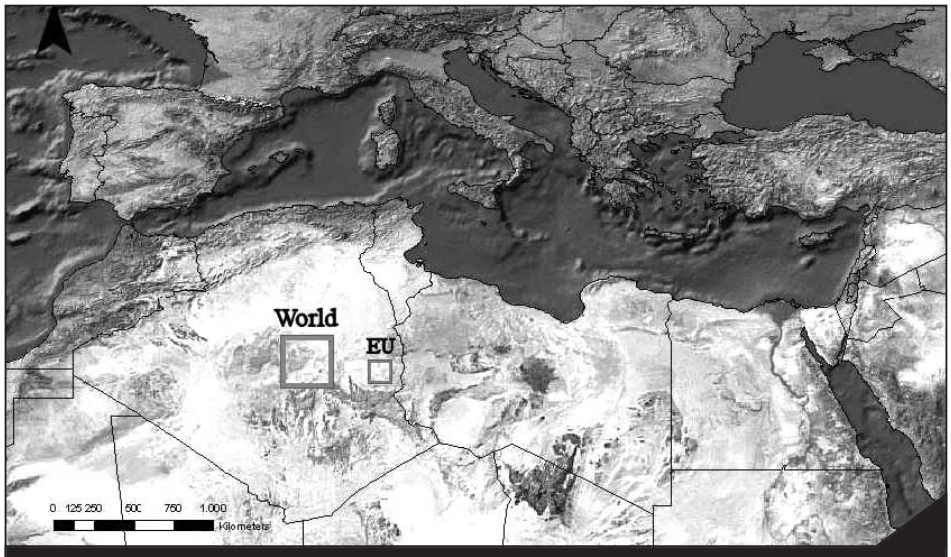
The Solar Two 'power tower' type of CSP plant at Barstow, California.

Getting the energy to where it is needed

Since not many people tend to live in desert regions, an obvious question is how to use this plentiful supply of energy. One possibility is to move energy-intensive industries such as aluminium smelting to desert areas. But even if this were possible, there would still be a need to transmit electricity to towns and cities elsewhere.

The high-voltage AC transmission lines, with which we are familiar, work well over relatively short distances but become increasingly inefficient as distances increase. It is possible to transmit electricity efficiently over very long distances using high-voltage DC (HVDC) transmission lines, a technology that has been in use for over 50 years. With transmission losses of about 3% per 1000 km, it would for example be possible to transmit solar electricity from North Africa to London with only about 10% loss of power. Considering that the 'fuel' is free, this level of loss compares very favourably with the 50% to 70% losses that have been accepted for many years from conventional coal-fired power stations, where the fuel is far from free.

To meet the need for long-distance transmission of solar power, the 'TREC' group of scientists, engineers and politicians[5] propose the development of an HVDC transmission grid across all the countries of Europe,



Credit: http://www.trecers.org ©

The larger square on the left shows a 254 km x 254 km area of hot desert that, if covered with concentrating solar power plants, would provide electricity equivalent to the current electricity consumption of the whole world. The smaller square shows a 110 km x 110 km area that would meet electricity demands of the European Union (when it included 25 countries).

A close up view of a parabolic trough solar mirror with a pipe at its focus containing heat-collecting fluid.

the Middle East and North Africa (EUMENA). There are other good reasons to build such a grid. For example, if there is a surplus of wind power or hydro-power in one area, it would be useful to be able to transmit that electricity to places where there is a shortage. And although wind power may be variable in any one location, it is much less variable across a large region such as Europe or EUMENA. Large-scale grids are also needed to take advantage of large-scale but remote sources of renewable electricity such as offshore wind farms, wave farms, tidal lagoons and tidal stream generators.

For such reasons, the wind energy company Airtricity has proposed a Europe-wide 'Supergrid' of HVDC transmission lines; others have proposed a worldwide HVDC transmission grid. Airtricity propose that all the HVDC transmission cables can be laid under the sea, thus simplifying construction and avoiding the visual intrusion of transmission lines over land.

How much will it cost?

While fossil fuels are artificially cheap (because they use the atmosphere as a free dumping ground for CO_2) and until CSP costs are reduced via economies of scale and refinements in the technology, there will likely be a need for price support via direct subsidies or market mechanisms such as 'feed-in tariffs'. Then, according to the 'TRANS-CSP' report commissioned by the German government,[6] CSP is likely to become one of the cheapest sources of electricity in Europe, including the cost of transmitting it.

Others take an even more positive view of costs. The legendary venture capitalist Vinod Khosla has suggested that CSP is poised for explosive growth, with or without public support[7]. In a report in *Business Week*[8], the CEO of Solel is quoted as saying, "Our [CSP] technology is already competitive with electricity produced at natural gas power plants in California".

CSP bonuses

A fascinating aspect of CSP is its potential for producing other benefits besides plentiful supplies of pollution-free electricity. For example, waste heat from steam turbines (used in the production of electricity) may be used to desalinate sea water. This could be a major help in alleviating water shortages in drier areas, a problem that is likely to worsen with rising global temperatures. Waste heat from electricity generation may also be used for air conditioning.

Another interesting side effect of CSP is that the area under the mirrors of a solar plant is protected from the harshness of direct tropical sunlight. These shaded areas may be useful for many purposes including living space, stables for animals, car parks and so on. And since it should still receive enough light for growing plants, it could transform previously infertile land into productive land. The water requirements for 'CSP horticulture' could, in theory, come from the desalination activity.

CSP has the potential to become a large new industry with obvious economic benefits. Many of the world's hot deserts are in countries that are relatively poor; CSP could be a welcome new source of income via taxes or earnings from the sale of electricity.

Plentiful and inexpensive supplies of electricity from CSP would open up interesting possibilities for taking fossil carbon out of road and rail transport. For example, the latest generation of plug-in hybrid electric vehicles (PHEVs)—with relatively large batteries—can, for many journeys, be run largely on renewable electricity from the mains. Batteries may also be topped up from photovoltaic panels on each vehicle's roof. Railways can be electrified and run on renewable electricity. CSP provides the means of avoiding the many disadvantages of nuclear power[9].

More generally, CSP can alleviate shortages of energy, water, food and land and reduce the risk of conflict over those resources (a risk that is likely to increase as climate change takes hold, as highlighted in a recent speech to the UN by Margaret Beckett, UK Foreign Secretary). And the development of a CSP collaboration amongst the countries of EUMENA is a positive way of building good relations among different groups of people.

Possible problems

It is rare for any technology to be totally positive in its effects. That said, I believe that there are good answers to most of the doubts that may be raised about CSP.

Security of supply

If Europe, for example, were to derive a large proportion of its energy from CSP, a reasonable concern would be whether supplies might be vulnerable to the actions of terrorists or unfriendly foreign governments.

In the scenario up to 2050 described in the TRANS-CSP report[10], there would be an overall *reduction* in imports of energy, an *increase* in the diversity of sources of energy, and a corresponding *increase* in the resilience and security of energy supplies. Imports of solar electricity would be an exception to the rule of reduced imports and would, in any case, be not more than 15% of European energy supplies.

Compared with sources of supply for oil and gas, a relatively large number of places have hot deserts. So, in principle, no country need be overly dependent on any one source of CSP. HVDC transmission grids can be designed to be robust in the face of attack, in much the same way that the internet was designed to carry on working even if part of it is damaged. Transmission cables can be buried underground or laid under the sea where they would be relatively safe from terrorist attack.

Inequity

It would be fair to ask whether CSP might become another case where rich countries take what they need from poorer countries leaving little for local people, except pollution.

There are reasons to think otherwise. Several of the benefits of CSP are purely local and cannot easily be exported or expropriated. These include local jobs and earnings, local availability of inexpensive, pollution-free electricity, desalination of sea water, and the creation of shaded areas for uses mentioned above.

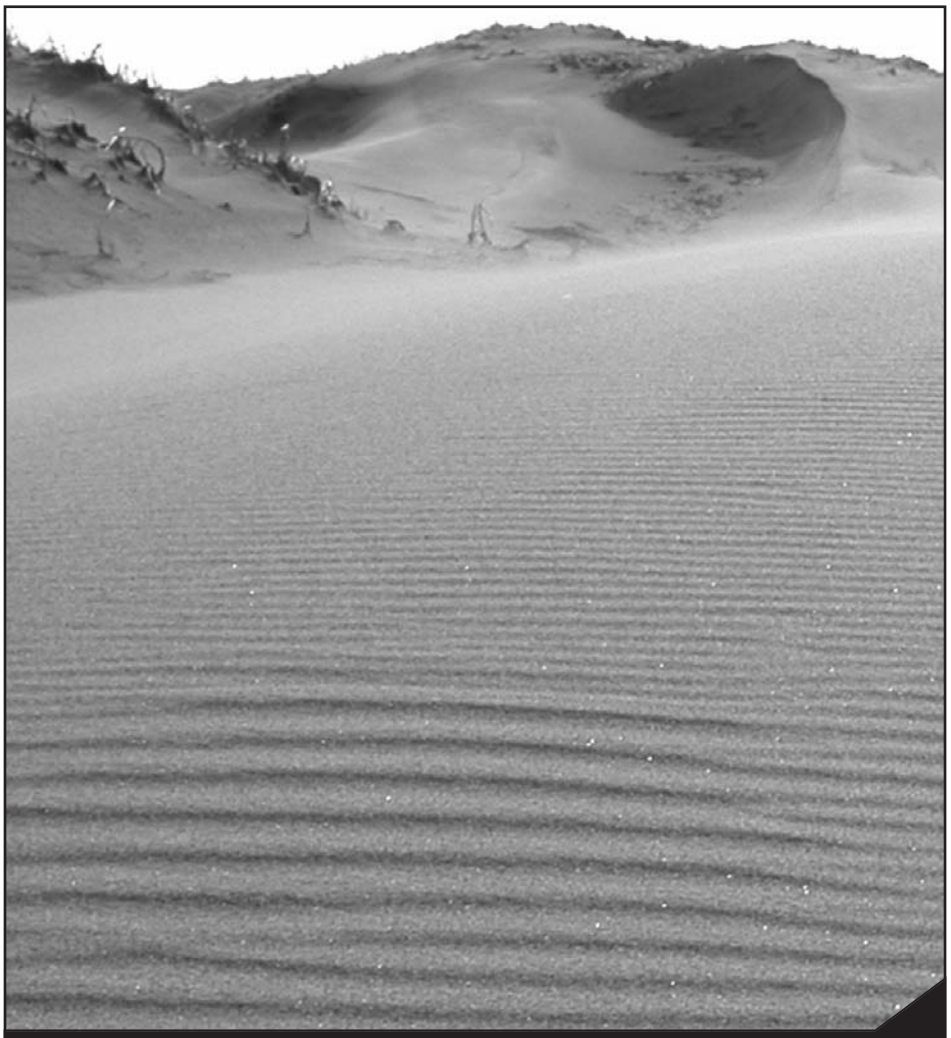
Desert ecology

We know that hot deserts have their own vibrant ecology. If the world's hot deserts were all to be covered with CSP plants, there would indeed be cause for concern about the animals and plants that live there. But less than 1% of the world's deserts would meet current world demands for electricity[11]. Even in pessimistic scenarios, it seems unlikely that more than 5% would be needed in the future. It should be possible for CSP plants and wildlife to co-exist.

Conclusions

There is no doubt that planet Earth's ability to support the human tribe is being put at risk by a combination of inappropriate technologies, huge and increasing material demands, and the sheer weight of human numbers. CSP is not a panacea but it could be a useful plank in the new ways of living that will be needed if we are to survive and prosper.

Dr Gerry Wolff is the co-ordinator of the UK branch of the Trans-Mediterranean Renewable Energy Cooperation (TREC-UK)[5].



Will hot deserts host a new generation of renewable energy technologies?

References

1. Trieb, F and Müller-Steinhagen, H (2007). Europe - Middle East - North Africa Cooperation for Sustainable Electricity and Water. Report from the German Aerospace Center, Institute of Technical Thermodynamics, Pfaffenwaldring 38 – 40, D-70569 Stuttgart, Germany. This is a summary of the 'MED-CSP' and 'TRANS-CSP' reports (see note 6), prepared as one chapter for the 'White Book' to be published by the Club of Rome.
2. Dr Franz Trieb, project manager for the MED-CSP and TRANS-CSP reports (see note 6), personal communication, May 2007. This information is derived from information in the reports but does not appear explicitly in those reports.
3. National Renewable Energy Laboratory (undated). http://www.nrel.gov/csp/troughnet/thermal_energy_storage.html (accessed May 2007)
4. MED-CSP report (2005), p 128 – see note 6. See also: ECOSTAR report (2005). http://www.trec-uk.org.uk/reports.htm or http://www.vgb.org/research_project252.html
5. TREC stands for the Trans-Mediterranean Renewable Energy Cooperation. Further information is at http://www.trecers.net and http://www.trec-uk.org.uk for the UK branch.
6. German Aerospace Centre (2006). Trans-Mediterranean Interconnection for Concentrating Solar Power ('TRANS-CSP'). http://www.trec-uk.org.uk/reports.htm or http://www.dlr.de/tt/trans-csp. See also: 'MED-CSP' report (2005). http://www.trec-uk.org.uk/reports.htm or http://www.dlr.de/tt/med-csp.
7. Khosla, V (2006). Presentation at the Solar Power 2006 conference, California. It can be heard via links from http://www.trec-uk.org.uk/resources.htm.
8. Sandler, N (2006). Israeli Solar Startup Shines. Business Week, 14/02/06.
9. Wolff, J G (2007). Why we don't need nuclear power. http://www.mng.org.uk/green_house/no_nukes.htm (accessed May 2007)
10. As note 6.
11. Dr Franz Trieb, personal communication, May 2007. "Multiplying an irradiance of 2400 GWh/km^2/y by 10% CSP efficiency and 35 million km^2 yields 8,400,000 TWh/y which is 466 times the present electricity demand of 18,000 TWh/y. That means 0.2% of the deserts would cover the present electricity demand."

We currently have a 'Vision Zero' approach to safety in air and rail travel: why not in road travel?

Vision Zero: time to put an end to death and serious injuries on our roads

Sweden is implementing a zero tolerance approach to deaths and serious injuries caused by road traffic. John Whitelegg argues that it's time for the UK to do the same.

Globally about 3,000 people die every day because they are either hit by a tonne of metal – in the form of a vehicle – or are in such a vehicle when it hits another vehicle or object. The idea that these deaths need not happen, should not happen and can be designed out of the system is difficult for many to accept but has been accepted and translated into official road safety policy in Sweden, called 'Vision Zero'.

On a global scale, these figures translate to 1.2 million people being killed on the roads each year and 50 million injured, some very seriously. These totals are forecast to rise by 65% by 2020. In spite of progress in reducing deaths in some countries, including the UK, there is increasing awareness that these deaths and injuries still present a major public health problem and like other public health problems (HIV, cancer, obesity, heart disease) require a co-ordinated public health response across all aspects of prevention.

Logically it can be argued that we currently have a 'Vision Zero' approach to health and safety at work, aviation and rail travel, which is to say that we expect that there will be no deaths caused by rail travel, flying or spending time at work. The assumption that this expectation does not apply to road travel is no longer justifiable. There should be a presumption that all deaths and serious injuries can be eliminated from the road environment too. The huge differences in spending and safety standards seen when comparing rail and road travel are anomalous: we need to put in place a new road safety paradigm to give this ambitious objective a chance of success.

The process of re-thinking road safety and dealing with expectations and anomalies has already begun in Sweden with its Vision Zero road safety policy. In this article I review the Swedish experience and make recommendations about its suitability for implementation in the UK, based on a research project carried out for the UK government's Department for Transport in 2005 by a team at the Stockholm Environment Institute in the University of York.[1]

The Swedish experience

Road safety is a significant source of concern to Europe's citizens and is the focus of a great deal of policy innovation and target setting, designed to bring about a reduction in the number of deaths and injuries on Europe's roads. The European Union (EU) mid-term review of road safety published in 2006 shows that not enough progress is being made when compared with the policy objectives.[2]

Adopted by the decision of the Swedish Parliament in 1997, the Swedish Vision Zero road safety policy marks a significant departure from traditional approaches to road safety. It puts road safety in an ethical context rather than an economic or engineering context and in effect says that the only acceptable level of deaths and injuries in the road traffic environment is zero. It then sets out to deliver this result by means of a rather more conventional model of specific interventions and measures supported by intermediate targets.

The core of the Vision Zero approach to road safety is the principle expressed by the architect of this policy (Claes Tingvall): *"It can never be ethically acceptable that people are killed or seriously injured when moving within the road system."*

Other observers of Sweden's Vision Zero policy have expressed the same sentiment using the words: *"The consequences of a mistake in the road traffic environment should not be the death penalty".*

The evidence from Sweden suggests that a key benefit of Vision Zero is its ability to re-focus the road safety debate, so that the effort to eliminate deaths and serious injuries becomes the primary issue, rather than design or finance. This stems from the assumption that this is the ethically correct thing to do, but inevitably brings in issues of design and robustness of the road environment too, in order that it can deal with 'mistakes' and not 'deliver a death penalty' if someone does make a mistake. Thus the consequences of mistakes are anticipated and 'designed out' of the road system.

These are important principles. The re-focused debate also brings in a psychological and an organisational focus. Swedish interviewees were convinced that Vision Zero binds together disparate stakeholders within a common, highly motivated, 'can do-will do' mentality. This leads to more focus, more cohesion and more targeted effort across all agencies.

People and perceptions

Vision Zero raises some interesting contrasts between so-called expert groups and citizen groups. As part of our investigation into the Swedish approach to road safety, we set out to explore the opinions that UK citizens have of Vision Zero, through focus groups, and also the opinions of UK experts, by means of a targeted online questionnaire aimed at professional groups.

The UK focus groups, which involved more than 200 participants, were very supportive of Vision Zero. The locations were selected to encompass broad geographical categories from central London to 'deep rural'. Even when doubts about achievability were expressed the overwhelming view of participants was that the emphasis on zero deaths and injuries was right and that a re-invigorated effort was needed to move more strongly in the direction of reduced deaths and injuries.

The UK stakeholder online questionnaire was aimed at professionals in government, transport, road safety, motoring, the police and politicians. We received 85 responses and the majority of opinion on Vision Zero was negative. Respondents expressed the view that Vision Zero was not helpful and that it should not be adopted in the UK. 76% of respondents thought that the current UK approach was "effective at reducing deaths and serious injuries".

So, overall, citizens were enthusiastic, supportive and welcoming of the policy and experts were of the opinion that it was 'unrealistic', pie in the sky, uneconomic and unacceptably restrictive of freedoms.

The Vision Zero research project also investigated the concept from the point of view of costs and benefits and made extensive use of published information on the cost-effectiveness of road safety interventions. The Swedish policy is explicitly based on the idea that road safety is not a matter of economics but a matter of ethics and human values (non-monetary). Nevertheless specific interventions are associated with specific costs and the cost variation is of value in prioritising policies to achieve Vision Zero objectives.

Vision Zero, if adopted in the UK, brings with it a potential ten-year stream of benefits that can be valued at £111 billion. These benefits accrue through the exploitation of road safety policies that need not necessarily be branded as 'Vision Zero'. The key public policy issue is the systematic nature of the interventions and the determination to reduce deaths and serious injuries to zero.

These benefits are larger than the costs associated with the interventions, pointing towards some very significant value for money and 'spend to save' investment opportunities. The absence of a Vision Zero policy does not, however, imply the absence of some level of benefits from other road safety policies. From a public expenditure and public policy point of view, we do not yet know the difference between the potential benefits attributable to Vision Zero and those attributable to a 'business as usual' approach. This requires further research.

What would be needed?

Our research project was intended to explore the possibility that Vision Zero could be implemented in the UK, and if so, what policies and measures would be needed to take it forward. We took the Swedish measures and interventions as our starting point but translated them into the UK context to take into account the differences between UK and Swedish traffic environments, driving behaviour and travel choices. This was explored in the focus groups.

The key policy interventions that we identified were:

- Speed control (20 mph in all urban areas) with appropriate enforcement and commitment to enforce. This means that every road in every urban area would automatically carry a 20 mph limit and it would be enforced.
- Accident investigation agency modelled on the Swedish experience and independent of the police.
- Law reform to deal with citizen concern about severe outcomes being dealt with "leniently".
- Road traffic reduction.
- Urban design to 'lock in' danger reduction for vulnerable users (e.g. reductions in road space for vehicles and increases for pedestrians and cyclists, physical barriers to prevent rat-running).

Vision Zero has public support. It has the support of key people in the EU and the World Health Organisation (WHO). It delivers a wide range of co-benefits in addition to reductions in deaths and injuries. It contributes to sustainable communities, reducing obesity and reducing traffic levels, as the alternatives to motorised transport are perceived to be safer, healthier and more attractive.

There are very few, if any, risks. Implementing the full policy would bring the greatest benefits. Many of the interventions made under a Vision Zero policy could be made in its absence but, crucially, some would be missed and the constant checking against a zero target would not be possible.

The decision to adopt Vision Zero in Sweden in 1997 was a political one and it could not be otherwise. Our report does not speculate about the possibilities that the UK parliament will follow suit. The over-riding conclusion of this detailed investigation of Vision Zero is that there is a great deal to gain from moving in this direction and hardly anything at all to lose. Moreover, it brings with it a very clear statement of the priorities and emphases of a civilised society. According to the WHO[3]: *"Road traffic crashes are predictable and therefore preventable … the time to act is now. Road users everywhere deserve better and safer road travel."*

If they are predictable and preventable then the appropriate policy instrument to deploy is Vision Zero.

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References

1. Whitelegg, J and Haq, G (2006). Vision Zero: Adopting a Target of Zero for Road Traffic Fatalities and Serious Injuries. Stockholm Environment Institute, University of York. http://www.sei.se/visionzero/index.htm and http://www.sei.se/index.php?section=implement&page=projdesc&projdescpage=99915

2. CEC (2006). European Road Safety Action Programme: Mid-Term Review. European Commission, Brussels COM. Also http://europa.eu.int/comm/transport/road/library/rsap_midterm/rsap_mtr_communication_en.pdf (accessed February 2006)

3. WHO (2004). World Report on Road Traffic Injury Prevention. World Health Organization, Geneva, Switzerland, p.164. http://www.who.int/world-health-day/2004/infomaterials/world_report/en/ (accessed February 2006)

GM trials return to the UK

GM potatoes are being trialled at a site in Cambridgeshire, with more planned. Eva Novotny explains why we should be on our guard.

The Farm-Scale Evaluations of four GM crops concluded in 2002 with the only successful contender – GM maize – failing to make commercial reality, and the UK enjoyed a respite from the looming possibility of commercial GM crops.

But the GM industry has not gone away. The German company BASF, which has entered the field as BASF Plant Science GmbH, is planning trials of GM potatoes engineered to be resistant to late blight, a serious disease resulting in large losses when it strikes. Late blight is caused by the pathogenic fungus *Phytophthera infestans*[1]. The principal inserted gene, which produces the disease resistance, comes from a wild Mexican relative of the potato, *Solanum bulbocastanum*. The three varieties of potatoes in the trials give rise to potentially 334 potato lines; BASF expects to choose some 80 – 100 of these for trial and, over several years, to whittle them down to a few with desirable characteristics, for approval and ultimately for the table[2].

BASF is already trialling these and other potato varieties in Sweden, and possibly Germany. Attempts to run trials in The Netherlands and the Irish Republic failed to overcome various hurdles and so BASF decided to go elsewhere –"elsewhere" being England. BASF has received approval for trials on land at the National Institute of Agricultural Botany (NIAB) in Cambridge and at Hedon, near Hull in Yorkshire. Planting has already taken place on the Cambridge site, where the trials began in April this year and are due to run for five seasons to 2011.

Given that there are already 24 non-GM varieties of potato that are resistant to late blight, the need for GM alternatives is hard to justify. Not only that, the rapid evolution of the blight pathogens compared with the long development times for new GM varieties throws the marketable lifetime of the final product into question.

Hazards to the environment

There is concern, too, for the environment, not least amongst gardeners and bee-keepers in the neighbourhood of the trials. The Yorkshire trials mentioned above have been postponed until at least next year; the farmer who was to host them is doubtful because local bee-keepers accustomed to bringing their hives to the nearby borage farms are concerned that their honey might become contaminated with GM pollen.

When the GM potato plants on the NIAB land come into flower, the flower heads will not be removed. Although this would be easy to do, ACRE (the government's Advisory Committee on Releases to the Environment) has not advised NIAB to do so and no funds have been provided; therefore NIAB will not do it[3]. Neither, by a similar logic, will the flow of pollen from the GM plants be monitored. This throws into question NIAB's claims that it is gathering scientific information to help make evidence-based decisions about GM crops and that it is concerned for the environment.

One study has shown that 31% of potato plants growing more than a kilometre away from another variety had been cross-pollinated by the other variety[4]. Yet NIAB itself is conducting other potato trials only 500m away from the GM ones and there are allotments also within 500m[5]. While the edible tubers of this year's potato crops would not be affected by cross-pollination with the GM lines, their seeds would, and could produce a GM variety in the following season.

Spread of pollen is not the only problem. Tubers, rather than seeds, are the usual means of propagation. These could be carried from the site by animals and deposited elsewhere to grow into more GM potatoes. The metre-high electric fence surrounding the NIAB trials may deter activists but might fail to keep out foraging animals.

The trials also risk harming soil organisms and micro-organisms essential for breaking down organic matter into smaller products, which become available to plants as nutrients. If these organisms are transformed by GM genes leaking through the roots into the soil (as has been observed)[6], soil fertility could be degraded. This degradation could spread as the organisms carrying the GM genes multiply[7]. The trials, however, will ignore such a possibility; NIAB has not been instructed to monitor for soil changes although the need to do so is well recognised.

How safe is genetic engineering?

Genetic engineering is still in its infancy. It is based on the principle that one gene controls one trait; but in fact not only can one gene participate in controlling more than one attribute, several genes may be needed to determine a particular attribute. Moreover, the functioning of a gene depends on its position within the DNA, something the geneticists are altogether unable to control. Many further complications arise[8].

A geneticist has commented on these trials as follows[9]: *"The risk assessment has been granted using the assumption that these are normal potatoes with a few predictable genes added. A characteristic feature of transgenic crops is that they do not behave in such a predictable fashion. The reason BASF is testing so many transgenic lines is precisely because transgenics are not predictable ... the documents show an astonishing reliance on assumption-based reasoning."*

The effects on the humans for whose dinner tables these potatoes are ultimately intended are uncertain. Allergenicity and toxicity are potential problems with GM plants. BASF says that animal feeding trials would be held before their potatoes are marketed – but not before they are trialled. Such tests could prove harmful to the organs, immune systems and/or the progeny of the animals[10]. In that case, the years of trials will have been useless. A worrying aspect of corporate behaviour is that unfavourable outcomes are sometimes hidden away behind 'commercial confidentiality'. The temptation must be strong when so much money and time have been invested in a product.

Interestingly, according to many anecdotes, wild animals and farm animals are reluctant to eat GM crops[11]. Polls show that the majority of consumers in the UK and Europe are also inclined to reject GM foods. There is much local opposition to the trials in both Cambridge and Hedon. The British Potato Council is opposed to the trials. If consumers' common sense about this premature technology prevails, perhaps the GM technology wave, which the UK government is so keen for us to catch, will eventually reach shallow waters, break and be dissipated.

Dr Eva Novotny is a former SGR committee member and has authored numerous SGR outputs on GM issues.

References

1. BASF Plant Science GmbH (undated). Notification for the release into the environment of genetically modified potatoes with improved resistance to Phytophthera infestans (2007 – 2011). Part A1. http://www.defra.gov.uk/environment/gm/regulation/pdf/07-r42-01-app-a1.pdf (accessed 10 June 2007)

2. Information obtained at a meeting between five Cambridge residents, a member of GM Freeze, BASF and NIAB (National Institute of Agricultural Botany, which will perform the trials) on 26 March 2007.
3. See note 2.
4. Skogsmyr, I (1994). Gene dispersal from transgenic potatoes to conspecifics: A field trial. Theoretical and Applied Genetics, 88, 770-774.
5. See note 2.
6. O'Callaghan, M and Glare, T R (2001). Impacts of Transgenic Plants and Micro-organisms on Soil Biota. New Zealand Plant Protection, vol. 54, pp. 105 – 110.
7. Suurkula, J (Ed) (2001). Genetically Engineered Crops – A Threat to Soil Fertility? http://www.PSRAST.org/soilecolart.htm.
8. Smith, J M (2004). Seeds of Deception: exposing corporate and government lies about the safety of genetically engineered food. Green Books Ltd., Devon. See Chapter 2: 'What Could Go Wrong – A Partial List'.
9. Personal communication from Dr Jonathan Latham, 25 March 2007.
10. Ho, M W (2007). GM-Soya Fed Rats: Stunted, Dead, or Sterile. Science in Society, vol. 33.
11. See note 8. Jeffrey Smith includes such anecdotes between the chapters of his book. See also Novotny, E (2002). A summary of Chardon LL Report I: Non-suitability of Genetically Engineered Feed for Animals. http://www.sgr.org.uk/GenEng/animalfeel_all.pdf

Patents and conflicts of interest: are scientists acting ethically?

Does the patent system encourage inappropriate commercial influence over biotechnology research? Helen Wallace argues that it does, and invites us to take part in an investigation to uncover and address the reality.

At its inception, the field of biotechnology proved a challenging development for the patent system. Patents allow applicants to claim a monopoly on inventions for 20 years or more. The idea is to reward the inventor – or whoever has invested financially in the research – by preventing competition, so that they can charge higher prices for the products of their research. In return, inventors must disclose information about their invention in the patent application.

But biotechnology exploits existing natural phenomena or entities, and discoveries about nature were not originally considered patentable. Patents were intended for novel inventions that had commercial uses. However, the strong commercial interest in biotechnology has since forced the scope of patentability to widen so that gene sequences, micro-organisms, cells, and plants and animals produced through genetic modification are now the routine subject matter of patent applications.

Such patents are controversial in principle because they allow discoveries about nature to be tied up in a restrictive commercial contract. They have also been criticised on the grounds that they may restrict access to useful products and research tools (harming both health and science) and, more broadly, because they reward only certain types of research and knowledge and encourage 'biopiracy' (the commercial appropriation of indigenous knowledge).

There is another issue – which is whether patents create conflicts of interest, for example by encouraging the scientists that claim them to hype the benefits of their research for greater reward. There is evidence to suggest that this may indeed occur.
GeneWatch UK's former director, Sue Mayer, conducted a survey of papers related to molecular biology and genetics that were published in the journal Nature over a six-month period between January and June 2005. Of the 79 papers considered, four had declared that certain authors had competing financial interests. Seven papers in which no financial interests were declared had authors whose names were also on patent applications that were based on the research in the paper or were closely related to it. Another paper had two authors with connections to biotechnology companies that were not disclosed. So, two-thirds of the papers in which the author might be considered to have competing financial interests did not disclose them[1].

Depending on the policy adopted by their institution, scientists who are named as inventors on patent applications may or may not benefit directly from any royalties. Either way, they may also benefit indirectly from being named on a patent application, for example through career advancement or further funding for research. Failure to disclose such interests may undermine the authority that science can claim for independence and impartiality.

In two of the cases in Sue Mayer's study, the published papers were accompanied by press releases claiming that the research would lead to new treatments and other applications.

Hype about biotechnology has been widely criticised for misleading the public and distorting research priorities. Although the media usually gets the blame for distorting science, a 2002 study of press releases from medical journals found that they did not routinely highlight the limitations of the studies publicised, nor the role of industry funding, and that data were often presented using formats that may exaggerate the perceived importance of findings[2].

It is time for scientists and journal publishers to take the issue of conflicts of interest more seriously. Self-policing is clearly not working; sanctions may be needed. One potentially effective sanction that the US Center for Science in the Public Interest has proposed is for journals to refuse publication for a certain period of the work of any authors failing to declare their interests in submitted papers[3].

In addition, we need a much broader debate about how science and research priorities are distorted by commercial interests including, but not limited to, patenting.

GeneWatch UK is currently conducting a major study on how corporations influence research priorities in the biosciences, in Britain and via the European Framework Programme. We are interested in how and why some research questions in health and agriculture are funded while others – often more important ones – are not.

Please contact me at <helen.wallace@genewatch.org> if you have useful examples or information about how the research funding system works. We hope to produce a report that helps SGR members and others to challenge and ultimately to change how research funding priorities are decided, and to encourage decision making that is more democratic and that acts in the interests of public health and sustainable agriculture.

Dr Helen Wallace is Director of GeneWatch UK.

References

1. Mayer, S (2006). The declaration of patent applications as financial interests – a survey of practice among authors of molecular biology papers in the journal, Nature. Journal of Medical Ethics, 32, 658-661.
2. Woloshin, S and Schwarz, L M (2002). Press Releases: Translating Research Into News. Journal of the American Medical Association, 287 (21), 2856-2858.
3. Goozner, M (2004). Unrevealed: non-disclosure of conflicts of interest in four leading medical and scientific journals. Center for Science in the Public Interest. Washington, DC.

Climate change – the latest findings of the IPCC

Stuart Parkinson outlines the stark conclusions that emerge from the latest report of the Intergovernmental Panel on Climate Change.

During the course of 2007, the Intergovernmental Panel on Climate Change (IPCC) – the scientific body that compiles the research on climate change for the United Nations – is publishing its Fourth Assessment Report (AR4). At the time of writing the summaries (and some of the detailed content) of the report have been published, with the rest due to appear by the end of the year. This article summarises the main findings demonstrating the ever-growing evidence base, the huge scale of the problem and the urgent need for more action.

The IPCC have published 'Assessment Reports', summarising climate change related research across the disciplines, every five to six years since 1990. AR4 has been compiled by three working groups, whose remits are as follows:

- Working Group I (WGI): The physical science basis[1] – which examines the evidence that climate change is happening, the extent to which humans are to blame, and the way in which our current and future activities may cause further change.
- Working Group II (WGII): Impacts, adaptation and vulnerability[2] – which examines the scale of the climate impacts on human society and ecosystems across the globe, the potential to adapt to climate change, and the vulnerability of different communities and ecosystems.
- Working Group III (WGIII): Mitigation of climate change[3] – which examines the policies, technologies and other measures to curb the greenhouse gas (GHG) emissions that are causing climate change, as well as the associated costs and time scales.

Over 3,500 researchers were involved in compiling AR4[4].

The findings from WGI – see Box 1 – show that the evidence that the climate is changing and that humans are the main cause has strengthened significantly since the last assessment report in 2001. Global warming is now "unequivocal", while climate scientists are now more than 90% certain that most of the warming observed over the last 50 years is due to humans. Warming over the 21st century is projected to be between 1.1ºC and 6.4ºC, with the upper end of the range associated with continuing high fossil fuel use and a large global population. The role of positive feedbacks – which could significantly amplify the warming – is more clearly recognised, but their quantification is still at an early stage.

The work of WGII – see Box 2 – deals with the impacts of climate change. The key conclusion of this analysis is that the greatest impacts will be felt by the poorest communities and the most vulnerable ecosystems. It highlights the extensive evidence that the first effects of human-induced climate change are already being felt across the globe. It then documents the wide range of future impacts likely over the coming century if action is not taken to curb GHG emissions, pointing to the huge numbers of people that will be affected, especially if the global temperature rises by much more than around 2ºC (above the pre-industrial level). It also stresses that adaptation to climate change is becoming more important as time lags in the climate system mean that the full effects of past and current emissions have yet to materialise. Again, the evidence base has increased considerably since the 2001 report.

The analysis of WGIII – see Box 3 – outlines the scale of the effort needed to curb GHG emissions. It documents how sharply emissions have risen in recent decades (and the inequality of these rises across different countries) and how much they are projected to continue rising without climate related action. It discusses the costs of mitigating these emissions – highlighting "substantial economic potential" for action – but presents clear evidence that the window of opportunity for action that will limit the rise to below 2ºC (above the pre-industrial level) is closing very fast.

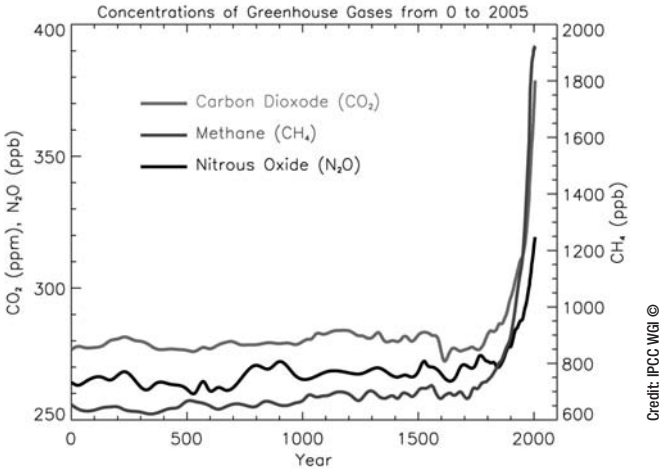

Figure 1 – Atmospheric concentrations of carbon dioxide, methane and nitrous oxide over the last 2,005 years (IPCC WGI)

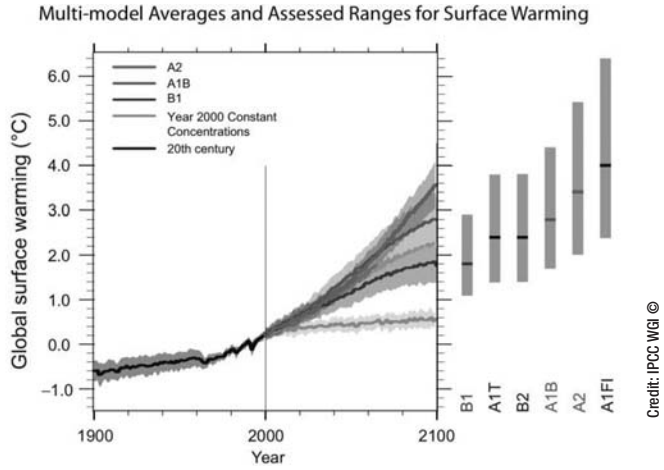

Figure 2 – Observed global temperature change (1900 – 2000) and projected global temperature change (2001 – 2100) derived from a range of IPCC scenarios and climate models. Temperature change is relative to 1990. In 2100, the full range derived from the six scenarios is 1.1 – 6.4ºC (IPCC WGI)

One important thing to bear in mind, when considering the IPCC report, is the extent of the scrutiny by both the scientific community and government representatives. The summaries in particular have to be approved line by line by all government representatives of the more than 100 member countries of the IPCC. This includes sceptical governments like the USA and Saudi Arabia. Hence, evidence that is especially uncertain or controversial is not included in the summaries. Some scientists have consequently argued that the present report is too conservative, especially in terms of potential damage from positive feedbacks (e.g. ice sheet melting)[5].

Even if the summaries of the IPCC report have been 'watered down', they still make stark reading. Evidence of the scale of the problem has continued to accumulate, and only the most blinkered can be left standing in denial. The potential consequences of not curbing GHG emissions will be very severe, especially for the most vulnerable – so we must act much faster to reduce emissions if we are to keep the impacts at a manageable level.

Dr Stuart Parkinson is Director of Scientists for Global Responsibility, and a former expert reviewer for the Intergovernmental Panel on Climate Change.

References and notes

1. IPCC WGI (2007). Climate Change 2007: The physical science basis. (Summary for policy-makers.) Working Group I of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/WG1_SPM_17Apr07.pdf

2. IPCC WGII (2007). Climate Change 2007: Impacts, adaptation and vulnerability. (Summary for policy-makers.) Working Group II of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/SPM13apr07.pdf

3. IPCC WGIII (2007). Climate Change 2007: Mitigation of climate change. (Summary for policy-makers.) Working Group III of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/SPM040507.pdf

4. IPCC (2007). Fact sheet. http://www.ipcc.ch/press/factsheet.htm

5. Pearce, F (2007). Climate change: What the IPCC didn't tell us. New Scientist, 9 February. http://environment.newscientist.com/channel/earth/climate-change/mg19325903.800

Box 1 - 'The physical science basis': WGI main findings

Climate forcing factors

- Atmospheric concentrations of the main greenhouse gases (carbon dioxide, methane, nitrous oxide) continue to increase – see Figure 1. The 2005 level of carbon dioxide is 379 parts per million (ppm), 35% higher than its pre-industrial level. This is higher than at any time for at least the last 650,000 years. Its rate of increase is rising.
- Human emissions of carbon dioxide, mainly due to fossil fuel combustion and deforestation, are accelerating.
- The main warming effect is due to carbon dioxide, and this has increased 20% in ten years.
- The net warming effect due to human activities is currently more than ten times that due to changes in solar activity.

Observed changes

- Warming of the climate system is "unequivocal". The global temperature increase since around 1870 is 0.76ºC. Again, the annual rate is increasing.
- Sea level rise during the 20th century was 17cm.
- The Arctic is warming at twice the rate of the globe. Since 1978, the summer extent of the Arctic sea ice has shrunk by 7.4% per decade.
- Observations show more intense and longer droughts (especially in tropics and sub-tropics) and more frequent storms over most land masses.
- An increase in the intensity of hurricanes has been observed in the North Atlantic.
- Temperature across the northern hemisphere is likely higher than for at least 1,300 years.
- Most of the warming observed over the last 50 years is "very likely" (more than 90% certain) to be due to human emissions of greenhouse gases. Extensive research using a range of climate models concludes that the observed changes in climate can only be fully explained by including the effect of human activities.

Future projections

- Projected global temperature rise over the 21st century is likely to be 1.1 – 6.4ºC – see Figure 2. (This range is broadly similar to that in the 2001 IPCC report, although the upper estimates are somewhat higher due to greater inclusion of positive feedbacks.)
- Projected sea level rise over the 21st century is 18 – 59 cm. (This is lower than in the 2001 IPCC report, but does not include some important positive feedback effects, such as falling ocean uptake of carbon dioxide or increasing melt rates of ice sheets.)
- The incidence of extreme weather events (droughts and storms) is likely or very likely to increase in the future (depending on the type of weather event). Hurricanes and typhoons are likely to become more intense.
- Sea ice will shrink in the Arctic and Antarctic. Some projections show that sea ice will completely disappear in the Arctic in late summer late this century.
- New estimates of the contribution of positive feedbacks – in particular climate-carbon cycle coupling – mean that GHG emission cuts will need to be greater than previously estimated.
- There is a lot of uncertainty in the magnitude and speed of positive feedbacks.

Box 2 - 'Impacts, adaptation and vulnerability': WGII main findings

Observed impacts

- Observations show that many natural systems are already being affected by climate change, e.g. earlier leaf-unfolding and bird-laying, poleward shift in ranges of plants and animals, and changes in polar ecosystems.
- Emerging climate-related effects include changes in heat-related mortality in Europe, loss of coastal wetlands, increasing damage from coastal flooding, and reduced growing season in the African Sahel.
- Of more than 29,000 high quality environmental data sets that show significant changes, 89% are consistent with the change expected due to a warming world.

Future impacts

- By mid-century, major changes are projected in river run-off and water availability. Water supplies from glaciers and snow cover will decline. Some areas, which are already water-stressed, will get drier. In Africa, by 2020, water stress is likely to affect between 75 and 250 million people. In Asia, more than a billion people could be adversely affected by the 2050s.
- Carbon uptake by forests and other land ecosystems is likely to begin falling by mid-century and may even reverse (i.e. they become a net carbon source).
- 20 – 30% of plant and animal species are likely to be at increased risk of extinction if global temperature rises by 1.5 – 2.5ºC above the 1990 level.
- Biodiversity-rich ecosystems, e.g. corals, mangrove swamps and tropical forests are vulnerable to the effects of climate change.

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Box 2, continued...

- At lower latitudes (e.g. tropics) crop productivity is expected to decrease even for small temperature changes. Larger temperature changes are expected to have a net negative effect on crop productivity across the globe.
- Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s. Numbers will be largest in the mega-deltas of Asia and Africa.
- Poor communities are especially vulnerable, particularly if they are already in high-risk areas.
- The health of millions of people is likely to be affected by climate change through, for example, increases in malnutrition, increased casualties due to extreme weather, and increases in many diseases.
- It is anticipated that nearly all European regions will be negatively affected by some future aspects of climate change.
- By mid-century, temperature and rainfall changes in eastern Amazonia will lead to a shrinking of the tropical forest area with a risk of "significant" biodiversity losses.
- Partial deglaciation of Greenland and West Antarctic ice sheets could result if a 1 – 4ºC temperature rise (relative to 1990) is maintained for centuries to millennia, leading to a sea level rise of 4 – 6 m or more.

Adaptation and vulnerability

- A wide variety of adaptation options exist, including technological, behavioural and policy, but all have economic, social and environmental implications. Some limited adaptation to observed climate change is already happening.
- Vulnerability of different societies to climate-related problems is significantly greater under future scenarios that feature high levels of poverty and/or population growth.
- Responses to climate change must include a combination of mitigation and adaptation activities. Failure to do so will increase the detrimental effects.
- For increases in global temperature greater than about 2 – 3ºC above 1990 levels, it is very likely that all regions will experience an increase in negative effects.

Box 3 - 'Mitigation of climate change': WGIII main findings

Greenhouse gas (GHG) emission trends

- Global GHG emissions grew 70% between 1970 and 2004, with the biggest increases in the energy supply sector and transport. Two of the major drivers of this rise have been global economic growth and global population growth.
- Average GHG emissions per head in industrialised countries are 16.1 tonnes of carbon dioxide equivalent (tCO_2eq)*, nearly four times the average in developing countries.
- Global GHG emissions up until 2030 – in the absence of further controls – are projected to increase by between 45% and 110%.

Mitigation across the economy until 2030

- There exists "substantial economic potential" for the control and/or reduction of global GHG emissions over the coming decades. For example, for less than US$100 per tCO_2eq, an emission reduction of 23 – 63% below the baseline in 2030 is projected.
- Controlling emissions in order to stabilise atmospheric concentrations of GHGs at levels between 445 and 710 parts per million of carbon dioxide equivalent ($ppmCO_2eq$) is estimated to cost between 3% of global GDP and less than 0% in 2030, depending on the stringency of the controls. These estimates do not take account of the benefits to the climate or other aspects of society resulting from emissions controls.
- Co-benefits – in terms of improvements in, for example, local air quality, energy security, agricultural productivity and biodiversity – could be large from action to mitigate GHG emissions.
- The largest and cheapest potential for reducing GHG emissions exists in the buildings sector. About 30% of the projected emissions of this sector in 2030 can be avoided with net economic benefit.
- Major opportunities to curb emissions exist in the energy sector. Energy efficiency is a particularly attractive option and has many co-benefits. Renewable energy could double its share of electricity production for carbon prices up to US$50 per tCO_2eq.
- In the transport sector there are many options for curbing emissions, but their effect may be counteracted by growth in the sector and consumer resistance.
- Improving agricultural practices and curbing deforestation can make significant low-cost contributions to reducing emissions.

Mitigation after 2030

- In order to stabilise atmospheric GHG concentrations, global emissions need to peak and then decline. For stabilisation at lower concentrations, mitigation efforts over the next two to three decades are especially important. For example, to stabilise in the range 445 – 490 $ppmCO_2eq$ – amounting to a global temperature increase in the region of 2.0 – 2.4ºC above the pre-industrial level – emissions need to peak in the period 2000 – 2015 and then reduce by 50 – 85% by 2050.
- Controlling emissions in order to stabilise atmospheric concentrations of GHGs at levels in the range 445 – 710 $ppmCO_2eq$ is estimated to cost between 5% of global GDP and -1% (i.e. a net gain) in 2050, depending on the stringency of the controls. Again, this neglects climate-related benefits or co-benefits of emission reduction.
- Early, stringent mitigation is economically justified if there are 'vulnerability thresholds' after which the damage costs of climate change rapidly increase.

Policies

- A variety of national policies are needed to help tackle climate change. Policies that provide a real or implicit price of carbon can lead to significant investment in low-GHG technologies and processes. Modelling studies show that carbon prices rising to US$30 – 155 per tCO_2eq by 2050 to be consistent with stabilisation at $550ppmCO_2eq$.
- Government support is essential for effective technology development, innovation and deployment. Yet, government funding for energy research is now at about half its 1980 level.
- The Climate Change Convention and Kyoto Protocol have established a global response to the problem, but action is still limited. There are many further options for international co-operation to reduce emissions, and these will help reduce costs.

Note:

* Carbon dioxide equivalent (CO2eq) is a standard measure that allows the combination of the effects of different greenhouse gases into a single metric.

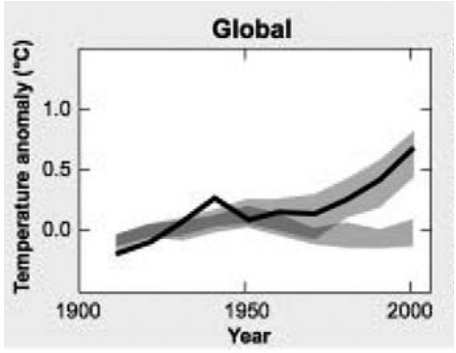
Common climate myths

Given the recent media attention devoted to climate sceptic views, Stuart Parkinson debunks some of their most common claims.

1. Human emissions of greenhouse gases are not enough to significantly affect climate, so current climate change must just be natural variation.

Sceptics generally accept that human activities emit billions of tonnes of CO_2 and other greenhouse gases (GHGs) into the atmosphere. However, they point out that the size of CO_2 emissions is much smaller than the natural exchanges of this gas between the atmosphere, the oceans and the biosphere. While this is true – for example, before human activities became significant, the land-based biosphere annually emitted (and absorbed) about 17 times the amount that human activities currently release – the key point is that the natural exchanges were approximately in balance[1,2]. With industrialisation, the emissions from human activities have become large enough to disrupt this balance, and this is shown by the sharp increases in the atmospheric levels of GHGs over the industrial period, measured directly in the atmosphere since 1958 and indirectly through, for example, samples of the gases trapped in ancient layers of ice (known as 'ice core data'). Figure 1 (on p.12) shows the sharp rise for the three main GHGs.

Some sceptics accept this, but argue that the warming effect due to these higher atmospheric GHG levels is negligible. This argument downplays the direct heat-trapping properties of GHGs and, most crucially, ignores the indirect feedback effects that enhance the warming. The most important of these feedbacks relate to water vapour levels (including clouds). As GHGs emitted by humans enter the atmosphere and trap heat, the level of water vapour that the atmosphere can hold increases. Since water vapour is itself a powerful GHG, this creates a positive feedback, which further increases the warming. Because the GHGs emitted by humans have a long average residence time in the atmosphere (tens to thousands of years), whereas water vapour only has a very short residence time (days), it is the levels of the long-lived gases that are most critical in determining the overall level of warming[3,4].



Credit: IPCC WGI ©

Figure A – Comparison of observed global temperature with results simulated by climate models using natural and human forcing. Black line is the observational record (decadal averages). Lower shaded band shows the range using only the natural forcing (solar activity and volcanoes). Upper shaded band shows the range using both natural and human forcing.

Estimates of the total warming effects of GHGs (and natural factors) can only be produced using mathematical models which include all feedback effects. Models are based on a combination of experimental physics and observations of GHG levels, temperature and many other conditions. The wide range of mathematical models used to produce the results in the IPCC reports and elsewhere show that the recent temperature changes are mainly explained by the higher atmospheric levels of GHGs caused by humans – just including natural effects in the models fails to reproduce the observed warming as shown in Figure A[5].

2. Current climate change is due to variations in incoming solar radiation, volcanic eruptions etc.

The Sun is obviously a very important factor in Earth's climate. Indeed, long-term cyclical changes in the Earth's orbit around the Sun – known as the Milankovitch cycles – lead to variations in the amount of solar energy reaching the Earth. These cycles drive the climate into and out of ice ages[6].

Some sceptics argue that historic variations in global temperature correlate well with changes in incoming solar energy and that this solar energy is now at a level higher than for several centuries. However, these recent variations in solar energy are too small to adequately explain the size of the current temperature changes. The latest estimate from the IPCC is that the net warming effect due to human activities is currently more than ten times that due to changes in solar activity[7].

Some sceptics have claimed that CO_2 emissions from volcanoes dwarf those from human activities. This is simply not true. Annually-averaged emissions from volcanoes on land are estimated to be equivalent to about a hundredth of current human emissions[8].

3. Global temperatures did not rise between 1940 and 1970 at a time when industrial GHG emissions were growing fast. Therefore GHG emissions cannot be causing warming.

It is true that global temperature did not rise between about 1940 and 1970 when GHG emissions were rising. However, there are two reasons why no warming was seen during this period. Firstly, there is a time lag between when the GHG emissions occur and when the full impacts on the global temperature become visible. Secondly, and most critically, human emissions of aerosols (especially sulphate particles) were very high during this period. Aerosols have a cooling effect on the climate, which cancelled out much of the warming around this time. As human emissions of aerosols were cut back – because they were a cause of local air pollution and acid rain – the global warming trend re-emerged[9].

Dr Stuart Parkinson is Director of Scientists for Global Responsibility. He holds a PhD in climate science.

References

1. Brahic C. (2007). Climate myths: Human CO_2 emissions are too tiny to matter. New Scientist, 16 March. http://environment.newscientist.com/channel/earth/climate-change/dn11638
2. FAQ 7.1 in: IPCC (2007). Frequently Asked Questions. http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Pub_FAQs.pdf
3. Chandler D. L. (2007). Climate myths: CO_2 isn't the most important greenhouse gas. New Scientist, 16 March. http://environment.newscientist.com/channel/earth/climate-change/dn11652
4. FAQ 2.1 in: IPCC (2007) – see note 2.
5. FAQs 8.1 and 9.2 in: IPCC (2007) – see note 2.
6. FAQ 6.1 in: IPCC (2007) – see note 2.
7. As note 4.
8. As note 1.
9. Brahic C. (2007). Climate myths: The cooling after 1940 shows CO_2 does not cause warming. New Scientist, 16 March. http://environment.newscientist.com/channel/earth/climate-change/dn11639

Further reading

Houghton J. (2004). Global Warming: the complete briefing (3rd ed). Cambridge University Press. http://www.cambridge.org/
See also references listed on p.1 in 'A few words...' article.

Building hope: global network tackles humanitarian problems

An increasing number of organisations are using skilled volunteers to provide practical help for humanitarian problems. Chris Medland introduces one such organisation, in the field of design: Architecture for Humanity.

The wealthy philanthropist George Peabody built houses for the poor of Victorian London. In the 1880s, brothers George and Richard Cadbury built the village of Bourneville for workers at their chocolate factory, also providing green spaces, schools, free medical care and, in 1901, an old age pension scheme.

Today, many people support charitable causes by donating money, but the age of practical philanthropy is far from over: there is a growing trend for people to offer their expertise and skills to practical projects. One organisation harnessing such contributions in the field of design is Architecture for Humanity (AfH), a winner at last year's Observer Ethical Awards.

AfH was founded in New York in 1999 with the aim of promoting architectural and design solutions to global, social and humanitarian crises. It brings together the expertise of individuals, groups and agencies alongside local experts to deliver quality practical solutions to communities in need. AfH makes sure that the local people are equal partners in the process and that they take ultimate control of rebuilding their homes and their lives. This means that projects use local, sustainable materials, and local expertise and labour. AfH made its name quickly with projects such as the design for transitional housing in response to the Kosovo refugee crisis and temporary shelters for the victims of the earthquake in Bam, Iran.

These projects, along with widely publicised design competitions, meant that AfH gained worldwide support from students, architects and designers alike. Small groups of these supporters, or advocates as they are known, began to meet and eventually took on projects of their own. By 2003 there were more than a dozen AfH chapters around the world, the largest of which outside the USA was, and still is, in London.

The UK chapter, AfH UK, has itself attracted attention for innovative projects such as the Crisis Open Christmas shelters in London. For this, fifty people in five teams worked with Crisis on its Open Christmas shelters, improving the layout of the spaces both through design and by helping with the build (see small photo below).

Photo: Architecture for Humanity ©

AfH helped design Crisis shelters

Another notable project implemented by AfH UK was a facility for drying arnica that was built in Girda de Sus, Romania (see large photo below). Working with the World Wildlife Fund, the team completed the installation on site in summer 2006. Arnica has potent medicinal qualities and is highly valued in its dried state; the facility enables the local community, which is one of the poorest in Europe, to add value on site to its harvest while also reducing the quantum of arnica cut.

These are just two of more than a dozen projects underway or completed in the last few years, all of which were achieved thus far by volunteers in their spare time (and the occasional surreptitious use of the office equipment of their employers!) – a group of like minded people pooling their skills to carry out work that otherwise would not be done, or at least not to the same professional standards. The work gives people the opportunity to be socially responsible while maintaining their everyday lives and professional careers. Volunteers gain satisfaction both from making a difference and from the recognition they gain through that process. For many the 'feel good factor' is a valuable offset to the work they do in their day-to-day jobs.

The catastrophic tsunami in East Asia in 2004 doubled the organisation's volunteer base within a week. In the years since the disaster, AfH has initiated, designed and built a number of community structures including schools, community halls, medical clinics and livelihood centres. All projects have been designed and developed under the Creative Commons Developing Nations License, which means that other NGOs and community groups can replicate and adapt the projects for use elsewhere without infringing intellectual property rights.

Also along open access lines, AfH has built an online space for collaboration. The Open Architecture Network is a gathering place for community designers and all those interested in improving the built environment.

In that same period, AfH UK has consolidated its own position by developing an administrative structure and registering as a charity. It now has a network of some 600 advocates.

Chris Medland, RIBA, is a Trustee of AfH UK and Associate of the Building Design Partnership, London.

Further information

Architecture for Humanity (AfH):
http://www.architectureforhumanity.org/
AfH UK: http://afhuk.org/
Open Architecture Network:
http://www.openarchitecturenetwork.org/

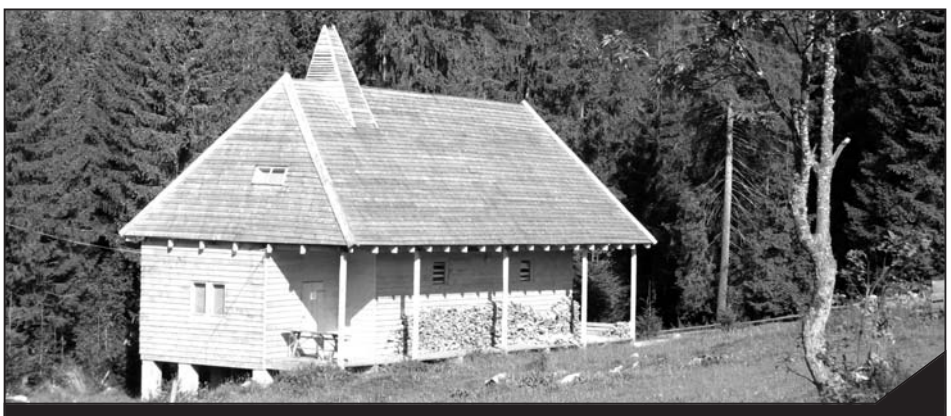


Photo: Architecture for Humanity ©

AfH volunteers helped design this arnica drying facility used by a farming co-operative in Romania

Walking in minefields

The SGR report 'Soldiers in the Laboratory' prompted Steve Wright to consider the real-life legacy of military involvement in science and engineering. Here he describes an eye-opening trip that showed him just what that means.

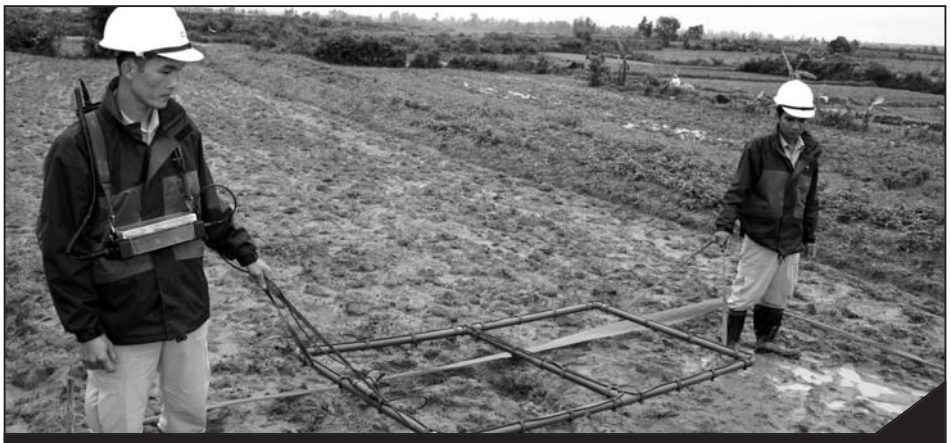
Each innovation in weaponry breeds a vast network of consequences, which become entwined with the future fates of mainly ordinary people, including children. While the influence of military funding on our research establishments is being exposed, it can still be difficult in our roles as scientists, researchers, engineers and technicians removed from the zones of conflict, to imagine what the effects of our work actually are. If those with military connections could fully conceive their ethical responsibilities and the implications for the innocents affected, they might need more than Horlicks to sleep at night …

A particular moment of reflection for me came with the news that the Israelis used 30-year old cluster munitions in last year's conflict in the Lebanon. Some of these weapons failed to explode, leaving war remnants with enough explosive power to turn kids' limbs to offal. I was struck by the hypocrisy of governments who crow about the 'war on terror' while supplying such horrendous weapons. Landmine Action documented the damaging legacy of these weapons and their ongoing effects on innocent Lebanese in their report, 'Foreseeable Harm'.[1]

Meanwhile, de-mining teams from the Manchester-based NGO Mines Advisory Group (MAG) took on the practical side of the problem. By the end of 2006, MAG teams had cleared more than 11,000 items of unexploded ordnance, making safe nearly 1.8 million m^2 of land. This continued through the winter snows into early 2007.

Humanitarian de-mining is inch-by-inch work that is essential for the recovery of local communities: the legacy of past wars imposes a terrible economic and human burden on prospects for future development, as evidenced by the munition-infested lands of Vietnam, Cambodia and Laos.

Last year, I was privileged to witness the MAG de-mining teams in action in Vietnam and Cambodia, where more bombs were dropped than were dropped by all sides in World War Two. Meeting the men and women who de-mine is a humbling but uplifting experience. Their job is literally to heal the land and make it fit for human inhabitation and agriculture once more.



Credit: Steve Wright ©

De-mining teams from the Mines Advisory Group work very carefully

Field research has a new meaning here; get it wrong and your legs are gone. Yet I saw de-miners clear paddy fields, knee deep in water, slowly, methodically sweeping and marking.

In Vietnam, MAG's work clearing unexploded ordnance (UXO) and cluster munitions returned land for schools, houses and cultivation. In Tatrach Commune, the headmaster of Botrach High School No.2 thanked MAG for de-mining their sports field. Over tea, he said the school had 1,680 pupils, of whom 13–15% go on to university.

In Dong Ha, I saw MAG locate and blow up bombs in a villager's garden. First one bomb, then another, feet away. I saw the effects of historical, so-called BLU strikes across an entire valley. These are essentially the live explosive remnants of cluster bomb sub-munitions dropped four decades ago. On one side, JCBs were digging tens of feet down to hunt for the sub-munitions; across the other side of the valley another MAG team, with an ambulance and medical backup on standby, marked out with paint the cluster munitions that remained on the surface. The soil here is laterite and the bomblets of over forty years ago have not sunk – they lie waiting for the unwary.

In Lochninh, there were scenes straight out of the film *Flying Daggers*: haunting tree-scapes and every so often a mausoleum. The Vietnamese have the right to bury their families where they wish and people meticulously care for the remains of their ancestors. We found an entire graveyard relocated in the wake of redevelopment following mine clearance to build an airport on previously mined land.

In Cambodia, MAG clears anti-personnel land mines, which remain live and primed. They are always destroyed *in situ*. The team humoured me by laying explosive charges around a collected set of unexploded ordnance and letting me press the button to blow them to pieces. It was a welcome catharsis from the tension of being out in the field, yet I was reminded that the de-miners do this work day in day out. They also train dog teams to sniff out the explosives, which have their own canine supervisor who checks that the other dogs have performed the location process efficiently!

MAG provides community education on the dangers of UXO, which here is literally a matter of life or death. Near the Thai border, I met a one-eyed child, his body mauled by shrapnel from an explosion that killed his friend, while they were searching for scrap metal.

MAG welcomes community support for their work and donations. They run various imaginative initiatives, including transforming minefields into football pitches and organising fundraising bike rides. Their web site details the possibilities.[2] Whether it inspires you to get involved, or to think again about getting the military out of science, it's worth a look.

Dr Steve Wright is a Reader at the Praxis centre and Senior lecturer at the School of Applied Global Ethics, both at Leeds Metropolitan University.

References

1. Nash, T (2006). Foreseeable harm. The use and impact of cluster munitions in Lebanon: 2006. Landmine Action. http://www.landmineaction.org/resources/ForeseeableHarmfinal.pdf
2. http://www.mag.org.uk/

Biofuels for transport – how far can we go?

Biofuels are the subject of heated debate. For transport in particular some say biofuels are unlikely to provide the environmentally friendly solution suggested by their promoters. Martin Quick looks at both sides of the coin.

In the Winter 2007 issue of the SGR Newsletter, Andrew Boswell[1] gave a rather negative picture of biofuels for transport. This article tries to give a more balanced view of the potential and the problems associated with this technology – again, specifically looking at biofuels for transportation purposes, not for heating or other uses. I must declare an interest in the matter – when possible I run my car on recycled vegetable oil. However, the quantity of fuel available from this particular source is unlikely to affect the global situation significantly!

Clearly there are some sources of biofuels that are undesirable. One example is palm oil from developing countries, the production of which often leads to the destruction of tropical forest. Some producer countries (such as Malaysia) point out that the proportion of their land area still covered by original forest is much higher than in most 'developed' countries, and say it is therefore unreasonable for richer countries to prevent them exploiting this resource. Given the importance of conserving tropical forests, not least because of their capacity for biodiversity and as carbon stores, this view needs addressing. One idea (mentioned in the Stern Review of the economics of climate change) is that wealthy countries should pay developing countries for the rainforests' preservation. A UN report[2] has warned that a hasty and excessive switch to biofuels could have major impacts by squeezing out food production and affecting food prices.

First generation biofuels

Currently, most liquid biofuels are produced from sugars and starches to give ethanol, which can be blended into petrol, or from oils (e.g. rape seed oil), for diesel. These are known as 'first generation biofuels'. The energy balance (energy return on energy invested) and the overall CO_2 emissions savings once the entire lifecycle is considered can be marginal for some types of biofuel, or even negative in some circumstances[3], but significant for others. The International Energy Agency (IEA)[4] suggests 'well to wheel' reductions of roughly 20–40% in CO_2 equivalent greenhouse gas emissions for corn (i.e. maize) ethanol compared with fossil fuels, and roughly 40–60% reductions for biodiesel from rapeseed. The variation is wide because for a given energy output, different crops require significantly different inputs and land area; their processing also uses different amounts of energy from various sources. For example sweet sorghum needs between one tenth and a quarter as much fertiliser as corn and gives around 50% more yield per hectare than corn[5]. In addition, it can be grown in a wide variety of conditions. Sugar cane also has comparable advantages over corn, which can be exploited where there is adequate rainfall.

The policy angle

In looking at the recent US effort to increase bio-ethanol production, mainly from corn, it should be remembered that the stated objective is to reduce imports of oil from the Middle East rather than to mitigate against climate change. The policy was strongly influenced by the US farming lobby and requires the US administration to accept that considerable use of other fossil fuels (e.g. gas to distil the ethanol from water) is worthwhile. Thus, the shortcomings of this policy in climate change terms should not be used as a general argument against all biofuel production.

Also, while sweet sorghum may offer an enticingly effective solution, any plans for its widespread industrial production in developing countries must be viewed in light of the potential risk from multinational agribusiness to local farmers' livelihoods and their ability to continue with their independent programmes of seed exchange and the maintenance of cultivar diversity[6].

The USA and other countries plan to increase imports of ethanol from sugar cane in Brazil. A Dutch report[7] on the sustainability of ethanol production in Brazil said that while there were uncertainties, "no prohibitive reasons were identified why ethanol from San Paulo in principle could not meet the Dutch sustainability standards set for 2007", but acknowledged that it could not judge the effect of future changes and increased production.

While examples such as the foregoing can be complex and hard to judge, there are some that appear to present a clear win-win scenario for biofuels for transport. For example, Jatropha, a crop currently grown in India and that can be grown on land unsuitable for food crops, produces a number of valuable products including an oil that can be used unprocessed in indirect-injection diesel engines (and possibly in direct injection engines with processing).

The ability to use by-products and the scale of the processing plant should also be considered. The by-products heat, electricity and cattle feed can improve the overall economics of the operation. Andrew Boswell's suggestion[8] that the use of by-product as cattle feed will lead to greater methane emissions from cattle seems misconceived, as this need not imply an increase in overall cattle numbers, just a corresponding reduction in the requirement for cattle feed from existing sources, which often involve destruction of tropical forests.

Second generation biofuels

Cellulosic biofuels, also termed 'second-generation biofuels', appear to offer great potential. They are still under development, and comprise liquid fuels produced from the cellulosic material in the plant biomass (e.g. leaves, woody matter and straw), which amounts to a much greater proportion than that represented by the sugars, starches and oils used in current production. These fuels are being developed by some large companies, like Shell and VW[9] for bio-ethanol and Choren Industries[10] with Mercedes and VW in Germany for bio-diesel. This casts doubt on the suggestion[11] that the fact that US private investors have steered clear of cellulosics is because of uncertainties in the technology required to scale up to commercial production. A more likely factor is the uncertainty of a quick financial return. Cellulosic

biofuels are claimed[12] to have a much better energy ratio than present biofuels (offering an energy yield up to nearly ten times energy input), to need fewer inputs and to produce greater yields for a given land area.

Importantly, cellulosics can be made from a number of waste products. In the USA it has been estimated that one third of current petroleum requirements could be met from the conversion of forestry waste, straw and the cobs from corn[13]. The claim[14] that GM technology is likely to be used to increase the yields of biomass for cellulosic fuel production or to create the enzymes used in some processes is also worth challenging: it is not clear that GM is essential to obtain viable yields and there are processes that do not use enzyme technology, for example via pyrolysis and the Fischer-Tropsch process.

Further research to ensure the sustainability of fuel production from biomass is being undertaken by the EPRIDA network in the USA[15]. It is claimed that one particular sequence of processes could actually be 'CO_2 negative'. The biomass is subjected to pyrolysis, producing hydrogen-rich liquid and gaseous fuels, and the remaining carbon char is sequestered in the soil, increasing productivity in certain tropical and depleted soil conditions, with other nutrients also being returned to the land. Soils in South America have been shown to retain carbon for a long period under the right conditions, as evidenced by carbon remains in the soil from forest burning that occurred thousands of years ago. Clearly, much needs to be done to prove all aspects of these proposals, but they could be important.

Quantities required and production potential

The EU has recently agreed that at least 10% of transport fuels in all EU countries should be from biofuels and that 20% of all energy should come from renewable sources by 2020. The UK Renewable Transport Fuels Obligation requires the incorporation into transport fuel of 5% biofuels by 2010. While it may be true that the proportion of biofuels that the UK could produce in relation to its demand is quite small, the argument should be considered on a wider regional basis. Taking the EU as a whole, the huge area of agricultural land added by the accession countries from Eastern Europe together with more productive use of set-aside would give a more favourable picture.

The vast majority of those concerned with sustainability accept the over-riding priority of providing adequate food for the world's population. Transport must be considered after that, which means that for sustainable transport, the first priority must indeed be to reduce energy demand, as Andrew Boswell has said[16] – by, for example, providing safe and pleasant pedestrian and cycle facilities, better public transport, greater energy efficiency of vehicles, better land use planning, and by supporting teleworking, teleconferencing, local sourcing, and so on. The approach of 'peak oil' and the increasing demand from countries like China and India will drive up oil prices, which will be a major incentive for greater vehicle efficiency. Particularly in the USA, where low fuel taxes mean that changes in oil prices are reflected more directly in pump prices, one can expect significant improvements in average vehicle fuel consumption.

Combining reduced fuel use with a proportion of renewable fuels should result in a significant reduction in the requirement for fossil fuels. Thus, if renewable fuels could satisfy one third of current demand, combined with a halving of demand, this would leave only one sixth of the original demand to be filled by fossil fuels.

Time scales for biofuels and alternatives

Andrew Boswell[17] implies that the timeframe for introducing biofuels is too long in comparison with the need for rapid reductions in greenhouse gas emissions. However, it is going to take time to make a major impact on transport emissions by any means (other than draconian levels of suppression). Low carbon alternatives to biofuels for transport include converting coal or gas to liquid fuels and using carbon capture and storage (CCS) – albeit with associated uncertainties – and the so-called hydrogen economy.

Low-carbon routes to producing hydrogen include electrolysis from renewably sourced electricity, and a surplus of this will not occur for quite a long time. Producing hydrogen from coal or gas with CCS, or using nuclear energy each has its own ethical concerns and uncertainties. The time scale for rolling out a completely new and novel infrastructure for storage and distribution and introducing a significant proportion of hydrogen fuelled vehicles (which still have major unresolved development issues) will be longer than progressive introduction of a reasonable proportion of biofuels. However, electric cars offer some potential, especially when powered using renewable energy sources, but again the scale of early CO_2 reductions will be limited by the availability of surplus renewable electricity.

Where do we go from here?

The EU and national governments should be selective in the sources of biofuels that they support. The UK government has commissioned reports into the feasibility of developing a sustainability assurance as part of the Renewable Transport Fuels Obligation policy. If producer countries object under WTO rules that their product should not be discriminated against on environmental grounds, the EU should insist that social and environmental issues must be taken into account, and not just the WTO imperative of unconstrained free trade. The development of second generation biofuels, which offer a valuable route to minimising greenhouse gas emissions in a sustainable way, should be supported.

In my view, we are more or less certain to suffer from severe climate change, but we still have the possibility of averting catastrophic change, given the political will. To achieve this will require a wide range of technologies, as well as significant changes in lifestyle. Andrew Boswell is right to remind us that not all uses of biofuels are beneficial or fully sustainable, but I believe they do have a role to play in the right circumstances.

Martin Quick is a chartered mechanical engineer with a background in the energy sector. He is also a member of SGR's National Co-ordinating Committee.

References

1. Boswell, A (2007). Biofuels for transport – a dangerous distraction? SGR Newsletter, No 33 (Winter). http://www.sgr.org.uk/newsletter.html
2. UN-Energy (2007). Sustainable Bioenergy: a framework for decision makers. http://esa.un.org/un-energy/ (accessed May 2007)
3. As note 1.
4. International Energy Agency (2004). As quoted in: RENEW, the publication of the Network for Alternative Technology and Technology Assessment, March/April 2007.
5. Grassi, G (2000). Bioethanol: industrial world perspectives. Renewable Energy World, Vol. 3, No 3.
6. GRAIN (2007). Sorghum: A crop to feed the world or to profit the industry? Seedling (April). http://www.grain.org/seedling/?id=468 (accessed May 2007)
7. Smeets, E et al (2005). Sustainability of Brazilian bio-ethanol. University of Utrecht, Copernicus Institute. http://www.bioenergytrade.org/downloads/sustainabilityofbrazilianbioethanol.pdf (accessed May 2007)
8. As note 1.
9. Glover (2006). Shell and VW to look into cellulose biofuels. Automotive Engineer, Vol. 31, No. 1, p. 42.
10. Choren Industries (2007). http://www.choren.com/en/choren (accessed May 2007)
11. As note 1.
12. Shell. http://www.shell.com/biofuels (accessed May 2007)
13. As note 9.
14. As note 1.
15. EPRIDA. http://www.eprida.com (accessed May 2007)
16. As note 1.
17. As note 1.

Iran's nuclear strategy – civil or military?

...continued from front page

cadre of trained personnel that could be switched to a nuclear weapons programme. Once Iran can produce the fissile material – highly enriched uranium or plutonium or both – needed for nuclear weapons, it could fabricate those weapons in a relatively short time. The question is: how close it is to producing that fissile material in significant quantities?

Analysts greeted the announcement earlier this year by Iranian President Mahmoud Ahmadinejad that the country had begun enriching uranium on an "industrial scale" (for use as nuclear fuel) with scepticism. However the International Atomic Energy Agency (IAEA) has recently updated its assessment of Iran's enrichment work[2] and acknowledged that significant progress has been made in recent months. Mohamed El Baradei, Director General of the IAEA, stated: "The Iranians pretty much have the knowledge about how to enrich. From now on, it is simply a question of perfecting that knowledge." El Baradei estimates that Iran is likely to take between three and eight years to acquire enough fissile material for a nuclear weapon, in the absence of serious technical hitches. It is not clear whether or not Iran can maintain its recent rate of progress, but it is apparent that it is pursuing a programme of activities in this direction.

Iran's current nuclear activities

Iran operates four small research reactors – not for production purposes. Three of these, supplied by China, are at the Esfahan Nuclear Technology Centre; the other, supplied by the USA, is at the Nuclear Research Centre in Tehran.

The 1,000 megawatt electrical nuclear power reactor at Bushehr, built by the Russians, is now complete. It is a light-water reactor, of the Russian VVER type, and will be fuelled by low enriched uranium (to about 3.5% in uranium-235, appropriate for power generation but not weapons production).

In addition to this reactor and the uranium enrichment facilities at Natanz, Iran is constructing a heavy-water research reactor in Arak, about 250 kilometres from Tehran. A heavy-water reactor provides a particularly efficient way of producing plutonium for use in nuclear weapons. Called the IR-40, this will replace the 40-year old Tehran Research Reactor and will be a 40 MW (thermal) reactor cooled with heavy water and fuelled with natural uranium.

Iran is also developing uranium sources and has identified Saghand as the location of its first uranium ore mine. The deposit reportedly contains between 3,000 and 5,000 tonnes of uranium spread over an area of roughly 130 square kilometres. It is constructing a uranium conversion facility at the Esfahan Nuclear Technology Centre to convert uranium ore (yellow cake) into uranium hexafluoride gas, suitable for use in the gas centrifuges used for the enrichment of uranium. The IAEA says that the uranium dioxide fuel elements for the IR-40 will be manufactured in the Fuel Manufacturing Plant being built at the Esfahan establishment.

Its Natanz-based enrichment facility comprises two gas centrifuge plants; one is a Pilot Fuel Enrichment Plant and the other is a large commercial scale Fuel Enrichment Plant (FEP). Components for gas centrifuges are produced and tested in workshops at the Kalaye Electric Company in Tehran.

A recent IAEA inspection of Iran's Natanz facility found that engineers were already running about 1,300 gas centrifuges to produce fuel, enriched to about 4.5% in uranium-235, suitable for use in a nuclear power reactor (but not for weapons). Iran has shown that it can produce gas centrifuges, and balance and spin them for a number of months at the high speeds necessary to make nuclear fuel in a cascade of 164 centrifuges; two such cascades are now operating in the FEP. Thus it has the capability to run the equipment needed to produce highly enriched, weapons-grade uranium. According to Iranian officials, the Natanz facility has 1,600 active centrifuges, and will soon have 3,000 operating[3]. It has said it plans eventually to install more than 50,000 centrifuges.

All these activities inevitably raise suspicions.

How suspicious should we be?

Iran claims that the purpose of the IR-40 reactor is the production of radioactive isotopes for medical and industrial uses. In theory, the IR-40 could produce about 8 kg of plutonium a year, enough to produce two nuclear weapons a year. It is estimated that about 85 tonnes of heavy water will be initially required for the IR-40 and less than one tonne will be need annually. Iran is operating a plant to produce heavy water at Khondab near Arak.

If Iran does choose the plutonium route, it will be necessary to separate the plutonium chemically from the irradiated reactor fuel elements. The Iranian government has acknowledged to the IAEA that it has irradiated uranium dioxide targets with neutrons in the Tehran Research Reactor and subsequently chemically separated the plutonium produced in the targets. According to the Iranians, only a small amount of plutonium was separated, but this is nonetheless a significant admission. Considering the current state of development, however, plutonium from the Arak research reactor is unlikely to be available before about 2014.

Given that plutonium is not a short-term option for any Iranian nuclear weapon ambitions, what about its capacity for producing enriched uranium?

A facility comprising 3,000 centrifuges (of the P-1 type currently deployed) could, if they are operating smoothly and continuously (and this is a big if), produce about 40 kg of highly enriched uranium per year – enough for two nuclear weapons (for which the uranium should be enriched to at least 90% in uranium-235; compared with 3 – 5% for use as fuel in nuclear power reactors.) It is estimated that it would take the Natanz facility at least five years (including remaining development time) to produce enough highly enriched uranium for a nuclear force of six nuclear weapons, the amount required if Iran were to be strategically significant in the region. (Note though that Iran is experimenting with the P-2 type gas centrifuge, which may be about twice as efficient; the status of the P-2 development is not publicly known.)

Assuming about 60% of the centrifuges are rejected as sub-standard (a typical figure), Iran would need to produce about 5,000 centrifuges to get this facility of 3,000 centrifuges running. Moreover, gas centrifuges break down frequently because of the mechanical stresses they are under, so there must be a steady supply of replacement machines. Iran will therefore need to produce many thousands of gas centrifuges to produce a strategically significant number of nuclear weapons.

The prospects are further impeded by a difficult technical problem that must be solved before significant amounts of highly enriched uranium can be produced at all. Iranian uranium is reportedly contaminated with large amounts of molybdenum and other heavy metals. These impurities could condense, and block pipes and valves in the gas centrifuges. This problem will not hamper the process required for the low enrichment levels needed for civil nuclear power reactor fuel, but will

prevent enrichment above about 20% in uranium-235. So, to produce weapons-grade uranium, the Iranians will have to remove most of the molybdenum. This would need foreign technical help – from, for example, China or Russia.

So, if Iran does succeed in setting up such a production line of highly enriched uranium, the technical requirements make it reasonable to estimate that it will be unlikely to have significant amounts – i.e. for an arsenal of six weapons – until around 2012, and possibly 2015 or later, even taking into account the observations from the latest inspections.

Given the challenges presented by uranium enrichment, if Iran does take the decision to have a nuclear weapon force, it may after all decide to wait until the IR-40 heavy water reactor at Arak is operating and use plutonium instead. They may find this preferable; about 5 kg of plutonium is needed to produce a nuclear weapon, compared with about four times as much highly enriched uranium.

Time still for diplomacy

The key questions are: how long could it take Iran to develop a nuclear weapons capability, were it to take the political decision to do so? And is it at all likely that a military strike might be an effective preventative measure (even before considering the ethics of such a course of action)?

In fact, there are many reasons why a military strike would be ineffective regardless of the real or alleged time scales of Iran's nuclear adventures – see Box right. But it is important to examine the time scales nonetheless.

As we have seen, the technical analysis suggests that plutonium from the Arak research reactor is unlikely to be available before about 2014, and enriched uranium is unlikely to be available in sufficient quantities until around 2012.

The US Director of National Intelligence, John D Negroponte, told the US Senate Committee on 2 February 2006 that Iran "will likely have the capability to produce a nuclear weapon within the next decade". David Albright, President of the Washington-based Institute for Science and International Security (ISIS) and an authoritative expert on Iran's nuclear programme, estimates that "Iran is not likely to have enough highly-enriched uranium until 2009".

And fuel is not the only requirement: the components for a nuclear weapon will have to be manufactured and tested, and nuclear warheads will have to be miniaturised for delivery by surface-to-surface missiles. These steps will take significant time, although Iran is reportedly developing three types of ballistic missiles that could deliver nuclear warheads, the Shahab-3, -4, and -5.

It must be emphasised that all estimates about the time scales are very uncertain. Many details about Iran's technical nuclear capabilities are not known. History shows, though, that it usually takes longer to produce nuclear weapons than estimates suggest. Since it looks likely that Iran will need at least five more years to build a nuclear weapon, and longer to put together a substantial capability, it appears that any claims of imminent nuclear threats from Iran are unfounded.

What is certain is that claims that military action against Iran is needed soon are not justified. A military attack on Iran's nuclear facilities, many of which are in urban areas, would inevitably kill a large number of civilians. It would be highly unlikely to destroy all Iran's nuclear facilities, instead stimulating a determined effort to use all available means to achieve a nuclear weapons capability as quickly as possible.

There is plenty of time – probably between five and ten years – for diplomacy to take its course.

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References

1. Barnaby, F (2007). Would Air Strikes Work? Understanding Iran's Nuclear Programme and the Possible Consequences of a Military Strike. Oxford Research Group. http://www.oxfordresearchgroup.org.uk/publications/briefing_papers/airstrikes.php

2. International Atomic Energy Agency (2007). Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran. http://www.iaea.org/Publications/Documents/Board/2007/gov2007-08.pdf

3. Middle East Newsline (2007). Iran reports 1,600 nuke centrifuges. (accessed 7 June 2007) http://www.menewsline.com/stories/2007/may/05_21_2.html

Why military strikes would not be effective

There are a number of factors that cast doubt on whether pre-emptive military air strikes could succeed.

Each nuclear site contains many targets. A large number, perhaps many hundreds, of aircraft sorties would be required if all the sites were to be targeted. There is an inherent contradiction in arguments that a military strike could both encompass all key nuclear facilities and be surgical and brief.

Many of these targets are in built-up, heavily populated areas, increasing significantly the risk of collateral damage and civilian casualties.

It is known that some of the Iranian nuclear facilities are underground. Over the past few years, Iran's Natanz uranium enrichment facility has been buried under more than 15 m of reinforced concrete and soil. There is a possibility that Iran has constructed secret facilities in anticipation of a military strike. It is also conceivable that Iran has built false targets as decoys.

Without adequate intelligence, it is unlikely to be possible to identify and destroy the number of targets needed to set back Iran's nuclear programme significantly.

Unless Iran's scientific and technological know-how is eliminated, it would only be a matter of time before technicians reconstructed its nuclear programme. It is anticipated that many key personnel could survive military strikes.

Furthermore, it is to be expected that the Iranian population, including the scientific community, would unite around the current government after a military strike from the West and support any subsequent moves to attain a nuclear weapon for deterrent purposes. If the Iranian regime did embark on a crash nuclear programme in the aftermath of an attack, i.e. withdrawing from the Non-Proliferation Treaty, committing itself fully to building a nuclear weapon using all available assets, including damaged nuclear equipment and materials, and purchasing additional supplies on the black market, it could probably achieve this in two or three years, possibly even less.

Therefore, it is possible that a military attack on the Iranian nuclear programme would not delay it by a significant time period, since the very anticipation of the attack and the increased resolve after it could speed up the programme by as much as the attack had set it back.

Cyberwar, netwar and the revolution in military affairs

Edited by Edward Halpin, Philippa Trevorrow, David Webb and Steve Wright

Palgrave Macmillan, 2006, 253 pp, £60, ISBN 978-1-4039-8717-4 (hardback)

Close collaboration between scientists, engineers, technologists and the military began in a big way during the Second World War. From 1939 onwards, achieving technological 'improvements' in weaponry became an abiding concern in most industrialised countries. At the height of the Cold War as much as 40 per cent of global research and development effort was devoted to military technology. The development of weapons systems has continued almost without pause to the present day, and shows how deeply embedded the military-industrial complex is within modern societies. It is about time this situation was seriously challenged.

Physicists had produced a source of enormous political power for the USA with the atomic bomb. Others in science had also shown their ingenuity and problem-solving capabilities to governments and so they became pivotal to the security apparatus. By providing the technical and scientific expertise, and trained personnel, scientists and their institutions – the universities – won a variety of resources that were at that time effectively denied to many others in society. The story continues – the next chapter being the Revolution in Military Affairs (RMA), with its high technology dependence, which was dreamt up by the Soviet Bloc and United States during the Cold War.

The Revolution relies upon computational techniques, information-gathering wedded to satellites to deliver many kinds of high explosive weapons largely in the service of the remaining hyperpower, the United States of America. Such high technology supports not only American 'full spectrum dominance' but also cements the UK-USA special relationship. The Revolution is one of the many strands of military thinking – the US 2020 Vision and the so-called cyberwars and netwar are others – which have been developed in response to perceived global threats and are explored in *Cyberwar, Netwar and the Revolution in Military Affairs*.

This collection of insightful essays is edited by four members of the Leeds Praxis Centre, all of whom bring disparate experiences in conflict resolution, peace and the pivotal role played in these areas by science and technology.

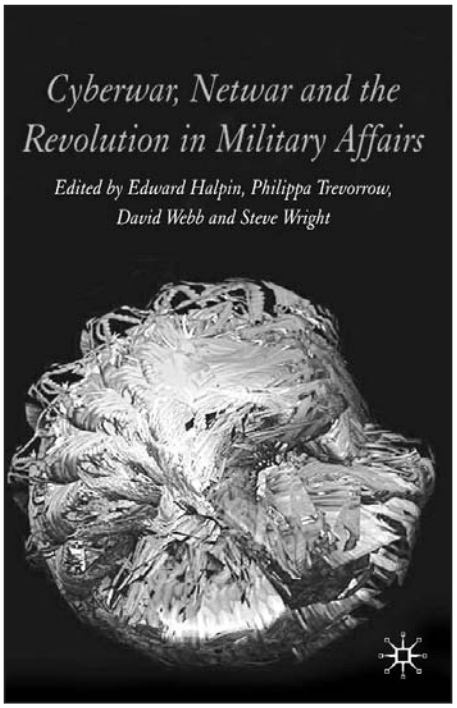
The book is arranged into four parts comprising fourteen essays together with a succinct conclusion. The essays all address the delicate balance between high technology security approaches and the maintenance of human and civil rights. This balancing is not only crucial in conflict but also in everyday civil society. We have seen many inroads made into our basic freedoms and rights in the name of the so-called 'War on Terror', many of which entail high technology surveillance and monitoring of communications, touched on in this collection.

The book opens with a clear and engaging account of the issues addressed in the essays that follow – basically the key technologies that have emerged to manage and direct security, wage war and create disruption to that which is pivotal in modern society, namely information, its 'ownership' and its flow. The focus of each essay is briefly described and the reader's appetite duly whetted. The succeeding four parts are entitled:

- Part I: Cyberwar, netwar and the revolution: defining the issues;
- Part II: Implications of the problem;
- Part III: Country perspectives; and
- Part IV: What is being done – or must be done?

All the contributors are well qualified to deal with the focus of these sections. The coverage of each essay is, in the main, appropriate to provide a sound grasp of the various issues that follow from new technologies, many of which change the face of modern society.

Part I comprises two essays that describe in detail the genesis of framing real war through the medium of war games and the critical information and communications context in which modern war is perceived and planned. Both essays are clear, well written and provide the necessary links to the research literature. Most importantly, both authors look outside national borders to describe how different countries use computer simulations to construct and contest the 'battlespace'. A major thread that runs through the book and is well described in this part is the pivotal role of the USA in the modern perception of war and how deeply embedded high technology is within our modern society. Both these essays should be brought to a far wider readership than those in the military and peace communities. The essays describe how vital surveillance is to the framing of security today and why we all need to seriously consider if the costs and benefits of such a surveillance society are in balance.



The six essays comprising Part II of the book trace the implications to us all of the paradigm of high technology security – ranging from the recent uses of RMA approaches to conflict, citing the disasters of Iraq and Afghanistan, to the US intention to weaponise space (a particularly clear and pithy essay by David Webb). The manipulation of information in war and the possible role of technology in destabilising some countries and therefore acting as a driver of conflict is also detailed. The essays are well constructed and link the weaknesses of technological approaches to security – especially the vulnerabilities inherent in large complex systems – with the effects of globalisation. As is pointed out in the pages of this section we need to know far more about the mechanisms that create and sustain terrorists (who are increasingly technology savvy). My only criticism of this part of the book is that Peter Neumann's contribution on the risks of computer-related technology is far too brief. I wanted more data and references to the research supportive of the contention that there are inherent security risks fundamental to modern society, which impact not only on conflict situations but during times of peace.

Part III comprises country perspectives, of Russia and the probable next hyperpower, China. The two essays that discuss the roads that have led to the involvement of the two countries with information

warfare and the RMA are nuanced and succinct. The account of the Russian version of RMA takes a markedly historical perspective of how the Cold War and its immense R&D drive in Russia and the USA laid the foundations for the still evolving reliance upon high technology for 'defence' purposes and what the consequences are.

Part IV comprises four essays, including a brief concluding chapter. The authors all take an international perspective and collect together the various features of RMA and its offspring to provide a perspective of what lies ahead and what we should all be doing to question the many assumptions packed into RMA. This part of the book not only looks at the use of space for military purposes but also describes the plans for full spectrum dominance that the USA has for the future. Mike Moore's excellent essay on 'A bridge too far' shows us what this stance means in global peace and security terms and how the weaponisation of space inflames yet another arms race. The growth in globalisation, aided and abetted by technological means to speed communication, has a host of unintended consequences, many of which are discussed by the essays in this book. But, as Gus Hasein points out in his engaging contribution, it is appallingly dangerous to assume that answers to national and international security threats, whatever they may be, call upon global 'solutions'. The crux of a sane response must be, as Hasein shows, a new way of controlling power politics and curbing the single-minded pursuit of national interests.

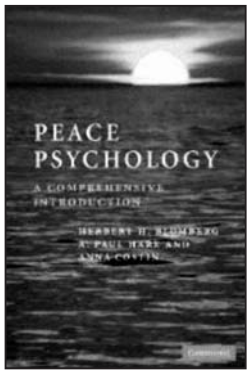
It must be clear to even the most ill-informed that peace and conflict resolution of any lasting value must be sought through a host of means including social justice and the proper control of new and powerful technologies. The continuing disasters in Iraq and Afghanistan clearly show that high technology power projection does not provide the foundations for peace, justice or stabilise local circumstances. We urgently need a full ranging debate on how best to build security and keep powerful technologies in check, ensuring that they play a more prominent role in non-offensive security needs. This fine, if expensive, book will be an essential tool to aid and inform this discussion.

Chris Langley

Peace psychology: a comprehensive introduction

Herbert H Blumberg, A Paul Hare and Anna Costin

Cambridge University Press, 2006, 379 pp, £21.99 ISBN 0521547857 (paperback), £60.00, ISBN 0521839149 (hardback).



This book covers "as far as feasible, the whole post-Cold War research literature for the practically and theoretically important area known as peace psychology". The result is 379 pages with about 1,600 references. Each of the 16 chapters is written by one or two of the authors, who each used the same computer search strategies to locate the material. Inevitably, as the authors acknowledge, the coverage is not complete (one suspects that chapters in books are especially likely to slip through the net), but the result is a compendium that must become an invaluable resource for research workers, practitioners and students.

'Peace psychology' is a category with almost non-existent boundaries, and no method of dividing the material would be entirely satisfactory. As a result, the nature of the material is such that the common features of the chapters in some sections are not easy to find. 'Interdisciplinary practice' (35 of the 250 text pages) includes Government policy, education, the feminist approach, and philosophy and religion; while 'Primary psychological topics' (42 pages) includes developmental issues, attitudes, psychodynamics, cognition and aggression, and language and communication. But the chapters on conflict resolution, crisis management and peacemaking hang well together, with sustainable development as an outlier (116 pages); and the causes and consequences of terrorism (43 pages) form an obvious duo. This is not a criticism but an indication that peace psychology demands eclecticism. Credit is due to the authors for bringing such diverse material together.

What the book does not do is claim to synthesise. In each chapter a few studies may be given two or three sentences, but the majority of the studies cited get only a cursory reference or a place in a list. This often results in a series of disconnected short paragraphs, with criticism and synthesis absent. Where a little more is given, the need for brevity poses difficulties. To cite but one example, a three-author paper is cited as maintaining that Transcendental Meditation can reduce tensions in a neighbouring country "not withstanding" criticisms of the methodology: the criticisms may be justified, but they could not have been available to the authors as they were published in the same year or later.

The heterogeneity of the material will be frustrating to some but can be stimulating if read with an open mind. For instance, studies of individual attitudes and characteristics taken together raise questions about the relations between them. Thus, what is the relation between individual aggressiveness and war? Does aggression cause war or war aggression? There are certainly influences both ways and the answer must differ according to the type of war and the definition of aggression. But inevitably such questions could not be addressed in a compendium with the policy of not covering general topics like aggression and attitudes.

Few will want to read straight through this book, but many will use it often for reference.

Robert A Hinde

Publication Reviews

The slow race: making technology work for the poor

Melissa Leach and Ian Scoones

Demos, June 2006, 81 pp, £10, ISBN 1-84180-162-3 (paperback)

"Citizen engagement is vital to ensure that science and technology respond to the challenges of international development…" announces the cover of *The Slow Race*. This pamphlet (written by two members of the Institute of Development Studies, University of Sussex: http://www.ids.ac.uk/) argues that if the application of science and technology are to make a contribution to developing nations it must engage with the needs and knowledge of their citizens. The pamphlet is published by Demos, a London based think-tank that includes among its programmes an ongoing study of the relations between science, democracy, ethics and globalisation. Since 2004 Demos has been advocating that citizen engagement in science planning and policy move 'upstream' to an earlier stage in science development.

At present, citizens are viewed either as benefiting from technology developed by scientific experts and provided by public funds, or as consumers of technology developed in the private sector and sold on the open market (p.59). This view of the relation between the citizen and science is now being widely challenged in the developed world, and the authors of *The Slow Race* argue that it must also be challenged in the developing world, that developing world citizens must also participate in deciding the policy and trajectory of scientific development. In contrast to the fast races – the race to win a share of global wealth for developing nations, and the race to find a technological solution to their health and food needs – we have the slow race – the time-consuming and localised engagement of science with the individual people and particular problems that are located in developing nations. The authors provide a rich supply of case studies to support their general claim that an important aspect of using science and technology to help developing nations lies in its application to local cultural contextualised problems that do not fit global categories of understanding.

The Slow Race argues the need for an interface between citizens and the science community and suggests the creation of citizens' commissions that would represent local and regional needs (p.67). In addition to scientists and technologists, these commissions would involve social and cultural experts who would study and articulate the local needs, and liaise between the local citizens and the scientific establishment – "helping scientists and policymakers to appreciate and understand the social and political dimensions of science and technology change" (p.61).

This pamphlet serves to extend the argument for citizen participation in science to citizens of developing nations and offers some practical suggestions about how this might be done.

Richard Jennings

Hard copies available from: Demos, Magdalen House, 136 Tooley Street, London SE1 2TU; or by phone on 0845 4585949. Available electronically as a pdf file from: <http://www.demos.co.uk/files/The%20Slow%20Race.pdf>

Dr Hadwen Trust science review 2006: showcasing successes in non-animal research

Dr Hadwen Trust for Humane Research, 2006, 22 pp

It is universally agreed that in animal experimentation the 'three R's' should be a leading principle – the replacement, reduction and refinement of animal experiments. For 36 years The Dr Hadwen Trust has been funding research on the replacement of animals in biomedical research.

This annual *Science Review* looks at some of the Trust's successes in finding ways to replace animal experiments. There are two reports on research in progress and three accounts of successfully completed projects. The section 'News and Views' reports on successful replacement projects not funded by the Trust.

The research in progress reports discuss advances in the growth and use of human tissue to study wound healing in one case and toxic intestinal bacteria in the other. The successful projects include an *in vitro* assay technique for estimating the activity of type A botulinum toxin – a technique (SNAP-25) that is more sensitive than LD50 tests and that has now been accepted for European regulatory testing. Other successes are a mass spectral technique for differentiating microbial pathogens as an alternative to using animals, and a method of maintaining cultured human synovium and cartilage – crucial for the *in vitro* study of rheumatoid arthritis. The greater sensitivity of the SNAP-25 test is but one example of the recurrent lesson that non-animal testing results in better models and better science.

'News and Views' reports the successful and increasing use of computer modelling in understanding physiological processes such as drug absorption, distribution, metabolism and excretion, as well as blood-flow dynamics in relation to disease states. A remarkable example of animal replacement is the micro-modelling of human metabolism on silicon chips. In one use of this device to test a toxin, "reactive metabolites from the 'liver' compartment caused glutathione depletion and cell death in the 'lung' chamber" (p.13) – showing the possibility of whole organism tests *in vitro*.

Given the obvious success in finding replacements for animals in biomedical testing it is a shame that the present government is doing so much to support animal experiments and so little to find alternatives – see: http://www.drhadwentrust.org/news/budget-ignores-non-animal-research.

Richard Jennings

Hard copies available from: Dr Hadwen Trust, 84A Tilehouse Street, Hitchin SG5 2DY; or by phone on 01462 436819. Available electronically as a pdf file from: http://www.scienceroom.org/downloads/Science%20Review%202006.pdf

Ove Arup: masterbuilder of the twentieth century

Peter Jones

Yale University Press, 2006, 352 pp, £25, ISBN 0300112963

"This endlessly doodling, whimsically rhyming, cigar waving, beret-wearing, accordion squeezing, ceaselessly smiling, foreign sounding, irresistibly charming, mumbling giant: Ove Arup, who changed the assumptions of architects and engineers throughout the world," says Peter Jones in his introduction to this fascinating biography.

Everything that Ove Arup set his mind to was infused with his philosophical ideas and in this book the author explores these ideas, quoting from letters, diaries and lectures covering over seventy years of ceaseless reflection. But these were ideas developed for a practical application to his work in his rapidly growing firm.

Essentially Arup believed that the application of science should be for the betterment of the people of the world and that, with the increasing complexity of projects, it was essential that these be undertaken by a multi-disciplinary team of consultants as no one alone could have all the knowledge required. To this end, he worked to overcome the resistance from both architects and engineers to the idea of team-working from the start of a project.

Arup was a family man, with a love for his family here and in Scandinavia and initially he treated his firm as his other family, taking on people only if he liked them. This combination of affection and strong beliefs in the need to combine architecture, art and philosophy was a great inspiration for all those who came to work for him. Of the many faithful colleagues he had, Ruth Winawer, his devoted secretary, comes across as a powerful commentator on all aspects of Ove Arup and Partners. Here is part of her comment on a management report commissioned from experts: "As clear as mud, as they say. I feel very strongly that people don't try hard enough to make what they have to convey intelligible. They seem to think that because they have a sort of jargon among themselves they can go on using it when they try to speak to people who are not in their profession…"

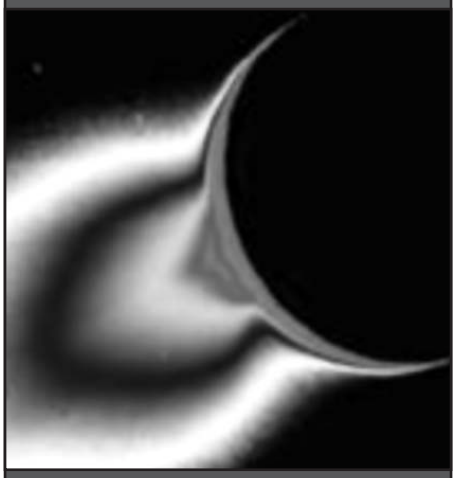
He worked initially for two Danish engineering firms and did not set up his own consultancy until he was 51. To begin with he often had to borrow from friends to pay his staff. In the first year, 1946, his turnover was £3,300. When he died in 1988 the turnover of the Ove Arup Partnership exceeded £100 million. The design and construction of Sydney Opera House with the architect Jorn Utzon was the event that made his name and the unfolding of this long drawn-out drama is covered in this book in some detail with information from hitherto unpublished documents. A fascinating counterpoint to Arup's beliefs on team-working!

From his early days working on commissions with Max Fry, Walter Gropius and Berthold Lubetkin, he was able to develop his ideal of producing solutions that were elegant, economic and beautiful. Together with his partners he inspired his staff with that philosophy and struggled to continue to do this even as the size of the firm grew. But as the work expanded worldwide, it became increasingly difficult for him to keep in touch with all that was going on. He had always advocated a greater awareness of environmental issues and deplored the stockpiling and sale of nuclear weapons. Following the Sharpeville massacre in 1960, the South African office was closed, and when he realised that work for the military was being carried out in Edinburgh office he took his partners and staff to task. In 1970 he gave a 'Key Speech' outlining the philosophy of the partnership. "Was this a remnant of a liberal tradition which is entirely unsuited to the present economic climate?" he asked them. Clearly he did not think so, and his philosophy became the office standard.

From the Mulberry Harbour D-day landing stages to Centre Pompidou and the Lloyds building, the success of the huge range of the projects carried out during his lifetime and continuing after his death is a testament to his influence on all who worked for him. In this book, the continued self-questioning of the man, his influence on world architecture and engineering and his powerful impact on the way a multi-disciplinary building team can work together, has been woven together by Peter Jones to give us an enthralling picture of the complex struggles that led to this success.

George Finch

Announcement



La science et la guerre: la responsabilité des scientifiques

(Science and war: the responsibility of scientists)

Edited by Daniel Iagolnitzer, Lydie Koch-Miramond and Vincent Rivasseau.

L'Harmattan, 2006, 265 pp, 25 Euros, ISBN 2-296-01402-X

(in French)

This book is compiled from papers presented at an international symposium which took place in Paris in September 2005. The event was sponsored by UNESCO, Euroscience, the French Pugwash movement and others to coincide with the 60th anniversary of Hiroshima and Nagasaki. The book brings together the thinking of some of the leading French and international experts (including SGR's Chris Langley) on the controversies inherent in science being used in the service of war. They discuss the ties between science and the military, and the progress of international law and arms control treaties, but also their limitations and their violations.

The question of the responsibility of scientists is explicitly discussed. But, beyond the experts of this book, the question to us all is: in view of the terrifying modern weapons and the remilitarisation of our society should we not remember our humanity?

Event Reviews

China's 'eco-city'

Institution of Mechanical Engineers, London, 20 February 2007

This packed meeting heard Peter Head, a director of the successful engineering/architecture consultancy Arup, speaking about the development of the design of the 'sustainable city' Dongtan, planned near Shanghai. The project has a very high profile, both in China and with the UK government. In short, the aim is to build a city, with an eventual population of 500,000 people, with the minimum environmental impact. The site is on an island, near a highly protected wetland reserve. The factors taken into account in the brief include human and environmental health, economic vitality and individual prosperity, energy, housing, nutrition, urban/rural linkages, communications, materials and waste, water and the overall ecological footprint.

His address was focused on the management of this hugely complex project, in particular the challenge of integrating inputs on a range of different aspects from a number of teams working in different countries on a very tight timescale. Electronic communication (email and video conferencing) was used, with all project data held on a single live project database, all written work being in English and Mandarin. Frequent bi-lingual workshops involving people with a wide range of disciplines helped to integrate the development.

Of great interest was the way the city has been developed to give 'virtuous circles,' wherein different design choices reinforce each other in achieving a low environmental impact. For example, the city is based on a high density, mixed-use plan, minimising transport needs, with good walking, cycling and public transport routes (nowhere being more than 550m from such a route) to minimise the use of cars, all of which, it is intended, should be from a car pool. Freight will be transferred onto non-polluting and silent delivery vehicles at a consolidation station, main freight being delivered by water. The absence of pollution and noise means that natural ventilation of buildings can be more widely utilised, avoiding energy hungry air-conditioning. Building energy use will be minimised, and all energy will be from renewable sources, including solar photo-voltaic panels (one third of total roof area being covered with such panels), wind turbines and combined heat and power using biomass including waste rice husks. Water of drinking quality will be supplied separately from water with lower purity requirements and, through waste water recycling, waste water discharge should be reduced by 88% compared with a conventional system. Nutrients will be recovered from the effluent treatment plants in a such a way as to eliminate pathogens, and will be used in local green vegetable production. Total agricultural production is aimed to be equal to that on the land before the city is built!

An additional encouraging point was Peter Head's statement that the Chinese president (an engineer) has put sustainability high on China's priorities, with four other new sustainable cities in planning, about which details are unavailable as plans are at a sensitive stage. We were told of the Chinese young people's tremendous enthusiasm and will to succeed. Not all aspects of the project could be replicated everywhere, however – for example, a green-field site leaves much greater freedom and the costs of photo-voltaics and a hydrogen infrastructure are currently high. However, the Chinese government is providing incentives to industry to produce the technologies needed to make Dongtan a zero emissions city. In providing these incentives they have a view to the export market. It is clearly intended that Dongtan will show the way for future cities in China. Given the Chinese system, a project like Dongtan is more easily brought to fruition than in countries with less tightly controlled economies.

Martin Quick

Oil and peace don't mix

Institution of Civil Engineers, London, 7 December 2006

This event marked the launch of a new report by Greenpeace. It featured a panel of senior MPs from the three main political parties and a Green MEP. They were broadly supportive of general thrust of the report.

The report points out that current UK defence policy is transforming the military into an 'expeditionary' force (i.e. one that fights in distant places), capable of fighting alongside the USA to secure vital elements: above all, oil. This is the rationale for the purchase of two massive aircraft carriers (the world's biggest outside the USA) and a large contingent of strike aircraft (from the USA) at a cost estimated at £31 billion (in practice, likely to be greater). The UK dependence on imported oil will increase rapidly over the next decade as North Sea reserves run down. The UK government is locked into the concept of security through military force, rather than a strategy based on cooperation and reducing the causes of conflict. Control of oil has been central to UK, French and US policy since the 1920s, and an important factor in the Iraq conflicts. On Trident replacement, it was pointed out during the meeting that given the UK's military stance in relation to Middle East oil supplies with the implied threat that nuclear weapons could be used in an extreme situation, it was not surprising that countries like Iran might seek nuclear weapons as a deterrent.

A further important point is that the use of oil and other fossil fuels is a major cause of climate change, and this is likely to be a cause of instabilities and insecurity as peoples and countries have their basic needs (fresh water, productive land, etc.) put at risk.

The report calls for a large reduction in the UK's demand for oil, principally in the transport sector, by means of increased energy efficiency of vehicles, alternative energy sources, encouraging more efficient modes of travel and reducing overall levels of travel and transport.

The conclusions of the report and of people at the meeting were very much in line with themes at last October's SGR conference on the need for positive security and for joined up thinking on all the issues, as also emphasised in earlier reports from Architects and Engineers for Social Responsibility.

Martin Quick

The Greenpeace report can be downloaded from their web-site, http://www.greenpeace.org.uk/media/reports/oil-and-peace-dont-mix

The social irresponsibility of scientists

Niels Bohr Institute, Copenhagen, 29 March 2007

"Science cannot develop unless it is pursued for the sake of pure knowledge and insight. It will not survive unless it is used intensively and wisely for the betterment of humanity and not as an instrument of domination by one group over another."
Victor Weiskopf

The umbrella organisation International Network of Engineers and Scientists for Global Responsibility (INES) – of which SGR is a member – has, as one of its projects on ethics, initiated a series of lectures with the purpose of investigating what it entails to be a socially responsible engineer or scientist. The first of these lectures was given by Jean-Jacques Salomon, Emeritus Professor of Society and Technology at the Conservatoire National des Arts et Métiers, Paris.

According to Salomon pure science, as defined in the statutes of the Royal Society ("not meddling with divinity, metaphysics, morals, and politics"), no longer exists. Science has become a profession, and most scientists serve a special function. They are "experts, strategists, diplomats, soldiers, businessmen, industrialists, traffickers, mercenaries [and] some researchers are entirely at home in the corridors of power, in military HQs and/or boardrooms – at the heart of the decision-making centres of the military-industrial complex."

Many scientists hold on to the pre-industrial image of science. They see science as an activity concerned with pure intellectual speculation, a love of truth and disinterestedness. But they confuse this scientific ideal with how mainstream science is actually done, and hence repress the fact that the scientific institution is "closely dependent on industrial capitalism, supplying its innovations [and] updating its weapons systems". Many scientists live in a culture of denial. On the one hand they say that science is not meddling with morals and politics, etc. On the other hand they work actively on military or industrial projects (and hence serve special interests rather than the general public).

Salomon's explanation of this schizophrenia is a psychological one. He argues that the community of denial is supported by a hedonistic search for pleasure: the subconscious mind will not allow the (potential) pleasure gain from solving technically sweet projects to be put at stake on moral grounds.

In his lecture Salomon encouraged scientists to take responsibility over the short and medium term consequences of their research, and hence follow the examples of Hussein Al-Shahristani, Norbert Wiener, Erwin Chargaff, Linus Pauling, Joseph Rotblat and Bertrand Russell.

Scientists can exercise their social responsibility by consulting the public when they choose their research questions: will a research project serve the general public or will it rather promote an agenda of a special interest (such as the military-industrial complex)? If a project harms the general public, a scientist should not undertake it. But "nowadays, the vast majority conduct their research in laboratories in industry or for the military, and it is not easy for them to resist the pressures from the military-industrial complex whose needs they meet and on which they depend."

Jean-Jacques Salomon's full lecture can be downloaded as a pdf-file as well as in mp3-format at http://inespe.org/lectures.

Tom Børsen Hansen

Institution of Mechanical Engineers annual dinner – Palestine protest

The Grosvenor House Hotel, London, 22 November 2006

I attended a demonstration outside the hotel to protest against the main speaker, Mike Baunton CBE, an Institution Fellow and Vice President of Caterpillar Inc. whose machinery is used by Israel in the Palestinian territories. The demo was organised by the Palestine Solidarity Campaign (PSC) who are a long established organisation campaigning for the rights of the Palestinian people.

As an IMechE Member I wrote a letter before the dinner to our journal *Professional Engineering* to say why I was disappointed at this choice of speaker. I said Caterpillar machines have been used by Israel in the occupied Palestinian territories to help destroy around 12,000 houses and 200,000 fruit trees, to build over 200 housing settlements for Israelis, to construct a highway system to link these settlements to Israel and to construct the separation wall on Palestinian land. All this is ongoing and in violation of many UN resolutions, human rights laws and a ruling of the International Court of Justice. I pointed out that the Church of England bishops at a Synod debate on investment passed a motion saying Caterpillar equipment was involved with activities in breach of international law. War on Want has produced a booklet to show how these activities conflict with Caterpillar's impressive Code of Worldwide Business Conduct. I asked readers to remember the death of Rachel Corrie, US peace activist crushed under a giant Caterpillar D9 bulldozer when trying to prevent it destroying a Palestinian home. My letter was not published.

About 70 people were at the demonstration, with banners and even a band! I was allowed by the police to hand out copies of the above letter (on which I had written "Not published - debate suppressed"), together with a leaflet produced by PSC, to guests as they arrived. Some guests had received an email of mysterious origin in advance of the event, warning of possible trouble and advising the use of the hotel rear entrance, where we were not allowed. This email was unfair but it did give us good extra publicity. Mr Baunton jokingly referred to us in his opening remarks but surely he must at least have been annoyed.

The issue is difficult. Based on the company's engineering excellence and the number of Institution members they probably employ, the choice of speaker was justified. The same would also apply to the builders of our nuclear submarines. It is good that the Institution's new chief executive later told me that my views will be carefully considered when their ethical policy is reviewed.

I first saw a Palestinian refugee camp by chance in 1963. Tragically it is still there, with 58 others in several countries having a total population of about 1.3 million. I have twice been to the West Bank in the last two years and have shared with Palestinians some of the daily hardships and witnessed some of the brutality they suffer under the occupation which Caterpillar Inc. contributes to. This demonstration will have done just a tiny bit to raise awareness of the injustice.

Desmond Goodier

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Editorial Issues

The editorial team for this issue of the SGR Newsletter was:

• Vanessa Spedding • Stuart Parkinson
• Kate Maloney • Jane Wilson

The opinions expressed within, and any inserts, do not necessarily represent the views of SGR.

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