

# **VISITING PROFESSORS IN ENGINEERING DESIGN FOR SUSTAINABLE DEVELOPMENT**

**Workshop at University of Liverpool**

**25<sup>th</sup> –26<sup>h</sup> June 2002**

The key objectives of this workshop were to investigate the limitations of current approaches in securing sustainable development, and illustrate, with road traffic as an example, the interconnectedness of the environmental, social and economic problems that comprise the issue, and to explore ideas to tackle the challenges of interconnectedness.

Report compiled by:

Heather J. Cruickshank CEng MICE, University of Cambridge

## **Session 1: June 25<sup>th</sup> 18:00**

Delegates were welcomed on behalf of the Royal Academy of Engineering (RAEng) by Jim McQuaid, Chairman of the Sustainable Development Education Working Group, and also Visiting Professor at the University of Ulster. He encouraged people to participate in the forthcoming workshop.

David Foxley, RAEng, Manager for Engineering Design Education, introduced Bernard Hon as host for the workshop and thanked him for his hospitality.

After some housekeeping matters Jim McQuaid took the chair for the evening and went on to introduce **Professor Robin Grove-White**, of the University of Lancaster Institute for Environment, Philosophy and Public Policy who was introduced as the keynote speaker for the evening. Professor Grove-White is a member of the Agriculture and Environment Biotechnology Commission, Director of the Council for the Protection of Rural England for six years from 1981, and an Executive Committee Member of the Green Alliance. He has also been a Board Chair of Greenpeace UK.

The Chairman noted that Professor Grove-White has vast experience in talking about the social dimensions of sustainable development and suggested that the talk and the following discussions with the delegates would enhance the deliberations of the workshop.

Professor Grove-White gave a thoughtful and stimulating talk to the delegates and provoked much discussion throughout the rest of the workshop on the issues raised in his lecture.

### **Evening Lecture and Discussion**

Professor Robin Grove-White began by thanking the Chairman and commenting that it was a privilege to talk to such a galaxy audience. He said that, on the subject, he aimed to be encouraging and inspiring, but also wanted to share his perplexities with the delegates. He noted that his talk would focus on the social and cultural perspective of sustainable development.

Professor Grove-white emphasised the vital need to integrate understanding of society, now, in 2002, into thinking about sustainable development initiatives. He suggested that practitioners were waking up to this necessity but noted that it has been neglected.

He commented that sustainable development is often pictured as having three legs (the social, economic and environmental legs) but suggested that the social leg points in two directions. First, seeing social issues as a set of further aims to be recognised. Sustainable development isn't achievable without account for social justice, freedom from crime, etc. and that Labour White Paper reflected this in its aims. Second, and more crucial, is the idea that sustainable development needs to embrace social reality as it really is, the concept, as in the Brundtland Commission report, Our Common Future.

The aspiration of the Brundtland Commission, as understood by Professor Grove-White, was reconciling future economic activity with security (carrying capacity) of the biosphere. But, he said, there was a limited capacity to ensure the biosphere unless initiatives are attuned to people. It is therefore important that people buy in to the ideas.

However, there is a climate of changing public sensibilities, new patterns of authority, power, trust and mistrust and insecurities and in regards to this change we need to address how to anticipate public responses to sustainable development initiatives in energy, water, housing, and planning, and we need to look at what buttons to press for public persuasion, now.

Professor Grove-White was very keen to stress the importance of the time we are in now and suggested that we should go back to look forward. He then went on to talk about the Brundtland Commission, beginning by saying that it was operating in a very different world, and that it was a historical construct of its time.

His broad analysis of the Brundtland Commission was that it was reconciling future economic needs with reduced environmental burdens and that this was challenging, but achievable. It involved a new model for economic development but was based on social assumptions of the early 1980s in the realms of governments, science, social stability and new technologies. These included the assumption that top-down government works in terms of legislation and regulation; that the best objective scientific analysis would command authority, again in a top-down manner; that necessary formal and informal connections in society are maintained through increasing wealth and equity; and that innovative power is there to be harnessed with regards to technological development.

Professor Grove-White suggested that by the time the Our Common Future report made public and political purchase at the end of the 1980s it was in a climate of high public optimism, encouraged by the end of the cold war. Following this trend, the Earth Summit in Rio de Janeiro in 1992 produced several important conventions including those on climate change and biodiversity and Agenda 21. In addition, many top-down innovations were undertaken by the UK government at this time, such as, the Sustainable Development Panel, the Sustainable Development Round Table and Local Agenda 21.

In the 'Brundtland Model', noted Professor Grove-White, industry and institutions integrated sustainable development discourse into thinking and there were significant, yet unevenly distributed commitments, but that these were often hampered by NGOs. Also at this time sustainable development started to appear in administrations, reflecting key cultural assumptions. He suggests that the social dimension was then grafted on in the late 1990s.

Professor Grove-White urged delegates to compare the mid-1980s top-down world with today's world in 2002. Vast economic movements, symbolised by the World Trade Organisation, have triggered enormous changes over that twenty-year period. Utilities have been privatised, markets have emerged in new places and global competitiveness has become a 'political byword' he said. It is now a world of wealth, optimism, and social improvement.

This is in stark contrast to the Brundtland Commission social assumptions. There is now, reduced purchasing by central government, governments have changed, and authority at the national level is diminished. There has been a price for sustainable development in terms of political leadership and a weakening of local government has meant the passing of Local Agenda 21.

Professor Grove-White stated that there has been increasing privatising of personal experience and social fragmentation. He also pointed to significant shifts to new patterns of who people trust or mistrust accompanied by a weakening of the authority of science in government. He also pointed to recent critique of risk assessments of large projects.

He noted that at Rio, NGOs were seen as influential social contributors, but suggested that they are now seen in a more realistic, limited role as 'institutionalised fire-fighters' rather than the 'vanguard of bigger social developers'

Professor Grove-White commented on the events of 11<sup>th</sup> September 2001 and noted that the fallout would be around for a long time, and that, as a result, there would be further preoccupations for governments, and new instabilities and insecurities.

He commented that the key sustainable development assumptions of the 1980s were not only tired, but no longer realistic and that we cannot rely on the Brundtland model any more. But, he said, fundamental contradictions identified by the Brundtland Commission are still with us, such as climate change; chemicals, old and new; depletions of the oceans; retraction of the forests; and biodiversity threats; and that they are still continuing as the Commission predicted. He commented on the difficulties when the tests come at the 'front line' such as the fuel protests, the use of cars and transport policy, and questioned how far we have come.

There is very little enthusiasm for renewable energy and other technologies, and a growth in packaging and weakness in recycling policy, Professor Grove-White said, and asked of this challenging situation, 'what to do?' In answer, he stressed that it is increasingly necessary to think about routes to sustainable development in different ways than Brundtland suggested and said that targets driven by indicators are not enough.

He proposed that we need to re-engage with where people are and went on to talk about some of the work carried out in the research centre in the University of Lancaster in the 1980s. This work, he reported, concluded that people approve of sustainable development principles, not just to avoid catastrophic degradation, but to encourage behaving prudently, seeking security, acting fairly and with parsimony, and respecting place. He noted that there is a wealth of local initiatives reflecting these values such as those funded by the Lottery Fund and reaching local level initiatives.

People, he said, have no problem with the values but have no confidence, belief or trust that there will be a commitment, so take the attitude of why should they be the one to do it. They are also baffled by government's actions. He went on to suggest that negative impacts, caused by the changes in wider society in the 1990s included, ineffectuality of local government, self-interest of industry, and inattentive national governments.

He said that, in light of this, people seek security in self-interest, while latently subscribing to values and used the car to illustrate this point saying that everything revolves around it - health, retail, employment - and that the result was turbulence, fragmentation and loss of control. He urged that this is the *social* that sustainable development cannot avoid grappling with, but we need to be realistic and recognise that there is no longer the trust in the institutions that the Brundtland Commission suggested.

New initiatives will have to be designed to assist sustainable development but they must be attuned to the latent values that people have and to their sceptical insecurities that are not far beneath the surface. Contributors need to have new capacities and need to listen and attend to where people are. New partnerships are needed and we need to not assume an understanding of society but to develop fresh skills of discussion, negotiation, partnerships and research.

Professor Grove-White used an example from his own research work with Unilever to illustrate that in general terms the public sees IT as being familiar because they are in contact with it on a daily basis, but they conversely experience biotechnology in remote and unfriendly terms and this affects the way the company can operate. He suggested that positive new listening capacities can be stimulated by controversy such as nuclear waste and genetically modified agriculture since the negative climate can lead to generation of creative responses and new ways of listening and negotiation.

The lecture was concluded with a reiteration of the current social context as being unstable and fragmented in a socially mutating world that is unlikely to become any less so in the future. Professor Grove-White stressed his prediction that fatalism, caution and weakened confidence in authority on-high will increase.

He finished by saying that new technologies are being generated and there are successful science and commerce partnerships, particularly in the fields of genetics, robotics, and nano-technology and there will be further new mutations added in future. His final question was whether these developments can be induced to go with the grain of sustainable development values and suggested that if they are to be successful in this way, they will need to better understand social responses. His closing comment was that the engineering disciplines might benefit from being included.

Professor Grove-White thanked the Chairman and invited questions.

The first question was posed by **Peter Gardiner** (University of Brighton), who began by saying that what he espoused was not what he practiced. He commented that we cannot wait for a catastrophe and that we need another reason to change. He suggested that we need to make 'greenness' not the area for the selfless, but to make it possible to be green and selfish. He said that we do not make it economical to be 'green' so we need something else. He proposed that we need to make it personal, to make it an issue about ourselves not our grandchildren, and, after saying that he had himself run for government, urged us to engage with politicians who, he said, already know the benefits of how to play on being selfish.

The speaker replied that Professor Gardner may well be right but that people have latent concern for others than themselves and that there is a well of untapped social conscience and aspiration which is unreflected. He asked whether the selfish hadn't already been tried.

**Barry Mould** (VP Brighton) commented that people won't vote for one pence on tax and that human nature won't be changed in the next 20 years. What is changing is corporate nature, he said, under pressure of corporate social responsibility and he hoped that this might trickle down.

**Paul Jowitz** (Heriot-Watt) continued by saying that it would be hard to find a 'credible' political party who will put one pence on tax, and people don't trust that it will be spent as promised. They have a presumption of risk, he said.

**Jim McQuaid** (VP Ulster) commented on Professor Grove-White's use of the words 'stable' and 'stability', suggesting that the stable state that Peter [Gardiner, Brighton] aspires to is different to the one we are in, and that we need to 'flip' between one and the other rather than execute a transitional change.

**Roger Duffell** (Hertfordshire) pointed out that people (including the speaker and Professor Peter Guthrie who gave the Unwin Lecture) have a responsibility to present a positive view, saying that we need positive signs.

The speaker replied by emphasising that there are many positive things, such as the very influential advisory group of the ethical investments fund. Also many new industry / NGO partnerships etc. that tap into new opportunities, such as those achieved by working with Unilever. He also used the example of genetically modified crops saying that in this field people are not 'unambiguously hostile' but cautioned that there is a need to enter particular domains in new ways and to replace the top-down model.

Bournemouth VP **George Howarth** joined the debate next, to say that corporations now do a lot of things for their staff that fall into the social sector, such as health and counselling, and asked how far should they be expected to go? He proposed that if corporations do too much for their staff, who make up the local community, then they can end up taking responsibility away from the government. He said that if there is such cynicism about governments, then shouldn't we be putting these issues in the government arena. He concluded his remarks by saying that we should 'play the political game'.

Professor Grove-White responded to this comment with reference to his knowledge of Unilever and BP saying that they need to learn more about the activity in the fine-grain of society and that there is a need to refocus government.

He said that companies such as these almost entirely see society as consumers and stressed that we are more than that and are in fact moral citizens as well as consumers. Here, he sees scope for far-reaching understanding of where the consumer bit fits into the bigger picture.

George Howarth continued by saying there had been attempts to bring people in to the process of product development.

The speaker responded saying that the way to understand people is to tune into where they are coming from. People live in radically different worlds but the way they see things is just as rationally constructed.

**David Slater** (VP UMIST) supported the speaker, saying that we need to refocus and that Professor Grove-White was offering a new perspective. He noted that we need to accept the reality of change and that engineers are pragmatists.

Professor Slater then went on to ask what does 'green' mean now? And in what ways is that perception different to in the 1980s? He also questioned, what does sustainable development mean? He suggested that it was now becoming a pseudo-religious area and commented on the speaker's use of the words 'faith' and 'belief' in his lecture. He proposed that maybe we need to give people something to rely on such as they used to have with religion, but that in today's less religious society, they are now lacking.

The speaker replied that he thinks we do not need to be religious in the recognisable old-fashioned way, we just need to think harder about what humans are. He warned that we have had very simplistic models and that the metaphysical picture of ourselves has diminished.

The final question was put by **Barry Mould** (VP Brighton) who first commented that the occurrence of different inward values to the evident outward actions have long existed and are nothing new, he used as example the Victorian's variable morals and the fact that social reform was still achieved, for example the anti-slave movement. He then asked the speaker what we can learn about social shifts.

Professor Grove-White answered this by saying that lots and no lessons can be learned from history because it is always different. He said that human nature doesn't change, but the aspects that we notice do change. We forget that there are other ways to focus on what we are and to shape our understanding of what a human being is.

The chairman (Jim McQuaid) thanked Professor Grove-White for his lecture, which, he said he had greatly enjoyed. He told the delegates that they had plenty to think about over the course of the workshop, and to discuss over dinner. He noted that the speaker had shown a very different approach to the Prime Minister when he spoke recently to the Royal Society, who he suggested, seemed to be twenty years out of date when he implied that people should be put to one side.

The delegates thanked the speaker and the presentation was followed by dinner in the staff house.

## Session 2: June 26<sup>th</sup> 09:00

The workshop host, Professor Bernhard Hon, opened the main day by giving an interesting brief history about the venue, the chapel of the Royal Infirmary, built between 1902 and 1911. However the hospital became derelict in the 1970s and remained so for eighteen years until the University of Liverpool bought the building from the NHS six years ago. Five years ago, money became available to begin the restoration and one wing was repaired at a cost of over £6 million. David Foxley added the story of replacement tiles being commissioned from the original manufacturer in Italy and said that this showed that some things are sustainable!

Following some housekeeping matters, Professor Jim McQuaid took the chair for the morning session. He welcomed the new arrivals and informed the delegates that he had invited Professor Robin Grove-White to write up his talk of the previous evening for inclusion in an edition of *Ingenia*, The RAEng quarterly magazine.

He said that the morning session would be an integrated affair, hopefully leading to something useful and that the main objectives would be covered in the syndicate session. He went on to introduce the speaker for the keynote presentation, Professor David Fisk.

Professor Fisk has held posts as Chief Scientist of Department of the Environment, and later DEFRA, and is now Chief Scientist in the office of the Deputy Prime Minister, and also DETR Research Professor at Imperial College Department of Civil Engineering, building on his early career looking at energy conservation in buildings for the Building Research Establishment.

### Keynote Presentation

Professor Fisk began his talk by setting out the key points:

- Definitions
- Dangers
- Systems
- Tools

He then discussed each of these points in detail.

#### Definitions: Why engineers don't need them.

Professor Fisk began by making the point that we don't have definitions for most things, for example a car, and yet we are still happy to work without one, so he asked, why was an all encompassing definition seen as being so vital for teaching sustainable development?

He then gave an illustration of how he imagined a lecture on sustainable development is often given, saying that it would start by quoting the Brundtland Commission definition, then having the lecture put up their own preferred definition, then going on to say what sustainable development means and concluding with details of the lecturers research. The speaker said that he felt this approach was not helpful.

Professor Fisk said that it was not the definition of sustainable development that is important for engineers, but rather what was the original World Commission on Environment and Development problem and what was the Brundtland Commission trying to fix? He cautioned that a lot of people, even those teaching sustainable development, have never actually read "Our Common Future" and that they know the definition by heart but have not read the additional ideas. He noted that paying dividends out of selling assets, which is an essential message from

the Brundtland report, is a human activity, not an accident, but agrees that we have been running down the stocks.

Professor Fisk made the point that he agrees with the Brundtland Commission assertion that the environment is a poorly managed asset. It is, he says, not owned by anyone, so it is easy to use. He referred to a recent newspaper article about Sothebys selling the world's most expensive Monet, and drew attention the irony that the painting is worth in the region of 10,000 times the cost of the real estate of the subject matter. He asked delegates to think about the prospect of the French driving a motorway through Giverny.

He said it is easy for us to dispose of assets that no one owns and made the point that future generations, a key stakeholder in the Brundtland report, are not there to defend their assets. He also urged delegates to consider the fact that at least one student from today's classes is likely to be alive in 2100. With these assumptions in mind intergenerational equity isn't such an issue, because for some it is within their lifetime. So, it becomes not about ethics, but about selling off the future. If several students are expected to see 2050-60, the predictions being made for that time are even more relevant.

Professor Fisk suggested that the definition problem is similar to a familiar boardroom row, which goes as follows: the firm has to make a profit to survive, and profit indicators are critical; but if profit is made from selling assets, then growth is not sustainable; and if there is a single focus on 'profit' indicators then there is a risk of missing the point about assets. This, he said, was the row between profit and loss versus balance sheet approaches. He also pointed to the German government non-asset-based accounting system as an alternative example.

He finished the section by emphasising that more could be taught if we stopped worrying about definitions and noted that Professor Peter Guthrie (Cambridge) had identified 500 definitions.

**Dangers: Why it is getting worse not better.**

Professor Fisk began by saying that sustainable development is not a new problem, that it is in fact four thousand years old, and it has been a continual problem for all civilisations. What we need, however, is a new solution to the old problem.

He went on to illustrate some notable failures from history in terms of systems thinking. Using the Mayan civilisation, he showed how certain actions, such as infanticide and sacrificing of virgins, became control functions. He also described how great engineering triumphs such as development of irrigation were unsustainable and contributed to the sustainability problem, whereby irrigated land increased crop yield and allowed increased urban population, but also led to salt deposition in the soil and sudden crop failure when crop tolerance to salt was exceeded. He also illustrated the Western Roman Empire, which he described as an, 'unbelievably dysfunctional' system that didn't have the benefit of 'modern liberal economics'.

Suggesting that transportation was a key field for development he noted that in the past we have got out of many problems by getting new transport solutions but that the old (lazy) solution will not work. He stressed that we are running out of 'sinks' rather than 'sources' and that we are in fact running out of renewables. Professor Fisk cautioned that we look after our oil resources more carefully than we look after the forests.

He also pointed to an unstable global money supply and suggested that in such a climate, environment isn't the only thing to 'pop'.

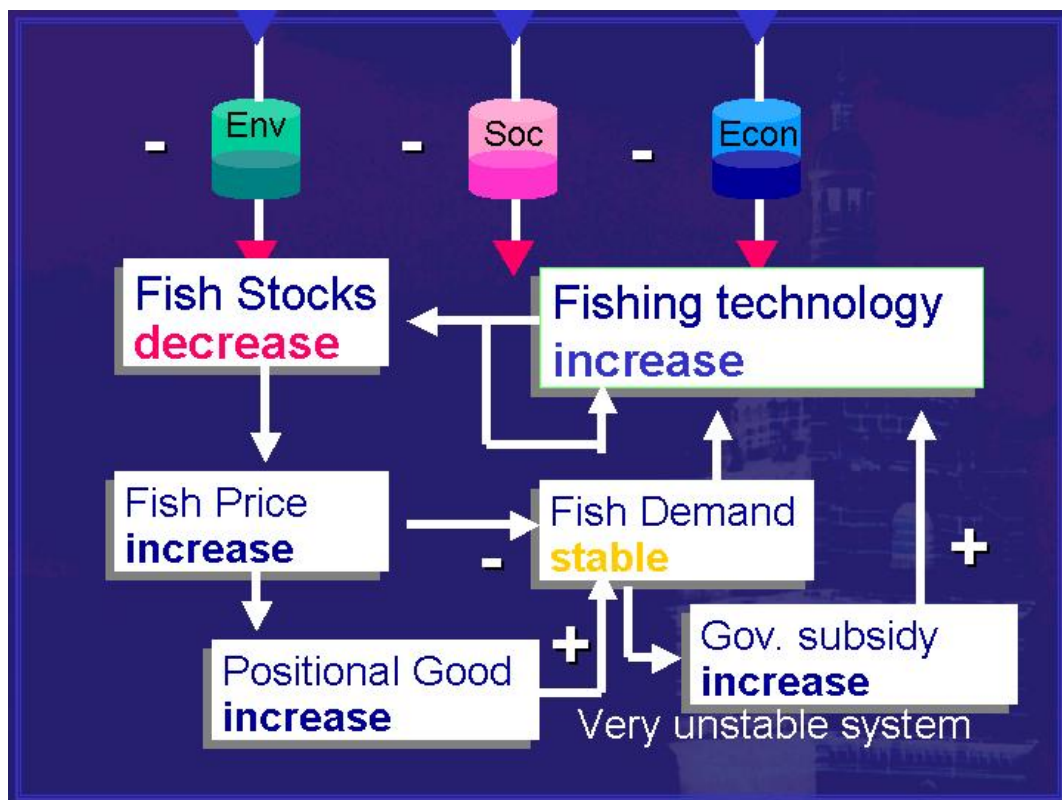
Professor Fisk finished this section with an alternative view-point, saying that we were running out of friends and that the energy of the future will increasingly be coming from what he called 'bandit' country (chiefly the former Soviet Republics).

**Systems: Why solutions need system thinking.**

Aircraft manufacturers use systems thinking, Professor Fisk said, and as an example, a Boeing 747 has 150,000 control loops.

The original Club of Rome model was processed using 8KB of computing power. We are about as predicted in terms of natural resources (based on consumption of oil), but we have already overshoot the estimation on population. The original Club of Rome research was about what happens when we ‘hit the buffers’ Professor Fisk said, and was interesting because it showed that, at one time, engineers led the debate.

He then went on to give a more specific example of systems thinking and illustrated a system of marine engineering.



Professor Fisk then went on to talk about what he called a ‘positional good’ and illustrated this using the example of a Rolex watch versus a mantle piece clock, saying you are more likely to spend on a watch than a clock because more people will see that you’ve got it, and that is the important point.

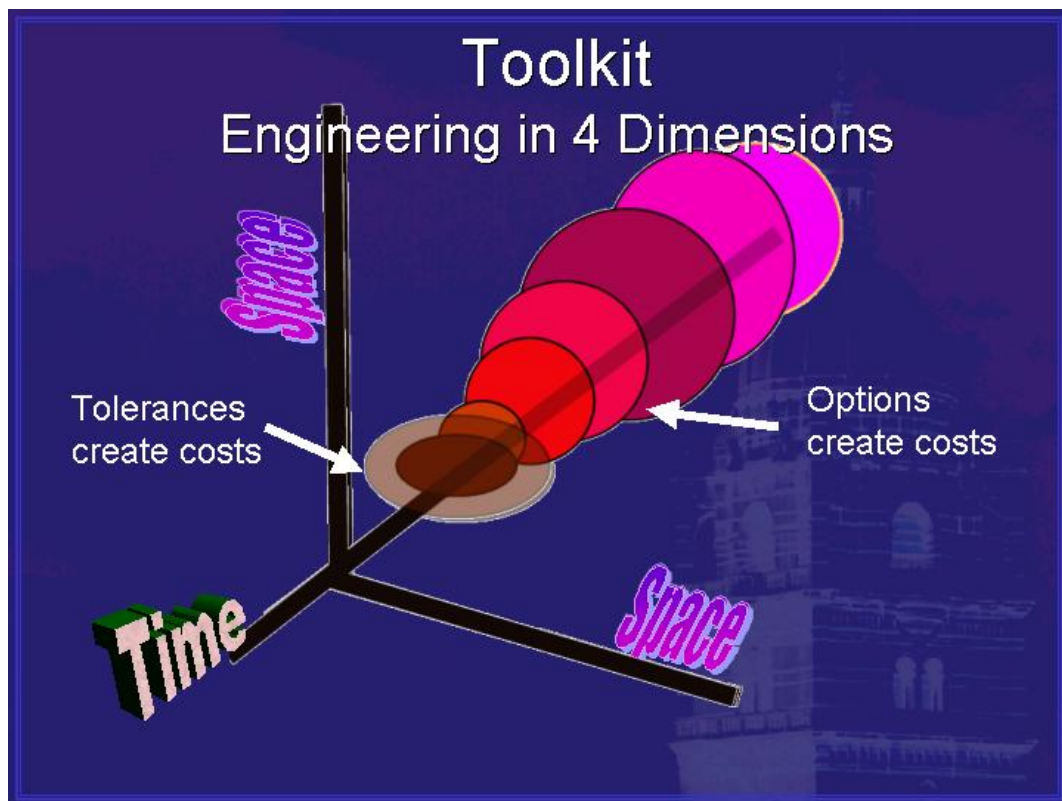
Bringing that back to the marine engineering example he pointed out the un-sustainability of making rare things desirable and said that as increased demand has led to increasing fishing technology and subsequently to over fishing, previously common stocks such as cod, have become rare, the cost of them has risen and they have become desirable as a speciality. He suggested the irony that cod, in the past seen as common and cheap enough to ‘feed to the cat’ is now being served for high price in top restaurants!

He suggested the possibility, if teaching marine engineering, that there may be great potential benefit from simply having students think through the system. He also suggested the possibility of designing a ‘concept trawler’ and exploring the possibility that engineering solutions could remove the un-sustainable feedback loops.

He emphasised that systems thinking may be a way in which engineers could enter the debate.

Tools: Why we need a tool kit.

In the final section regarding tools, Professor Fisk began by saying we could think of engineering in four dimensions.



Sustainable development focuses on what you put in and that tolerances can make a big difference but, he said, tolerances create costs and future options create costs. He used the example of the Wessex Water head office building, which he described as being such a bespoke building that future generations or directors would want to put their own mark on it. He questioned where in the design process we think about redesign. He also explained that there is no ideal tool for achieving all objectives and we therefore need a tool kit.

He then went on briefly to describe three useful tools: scope, strategy, and tactics.

Scope.

Scope, he said, included tools such as balanced scoreboards or dashboard presentations that identify the environmental, social and economic sectors. Displaying headline indicators so that everyone can see the concerns on one holistic sheet is useful for focussing attention.

Various forms of display can be used and may include headline time series, 'traffic lights' scale (don't need fine detail), and ranking within the team, and this can be used to produce a sustainable development profile. This method can be helpful to ensure time isn't wasted on things that are already being done well. Professor Fisk showed the balanced scorecard for the Eden project, which demonstrated good scores on water but poorer scores on transport issues.

The model is beneficial he said, but only at the scoping stage.

Strategy.

Life-cycle analysis, Professor Fisk said, is 'intellectually fulfilling' and addresses real questions. However, things such as ISO assuming that buildings will last for fifty years limit the strategy

with regards to sustainable construction. It becomes, says Professor Fisk, a ritualistic thing that the clients can detach themselves from. This leads to option values and asset valuation

Tactics.

Cost benefit analysis is a tactic that can be used to sell ideas to those concerned with finance matters.

Professor Fisk, thanked the chairman, who then invited **Jim Poole** (VP Cardiff) to give a supplementary presentation. Professor Poole is currently working as the Corporate Strategist for the Environment Agency Wales.

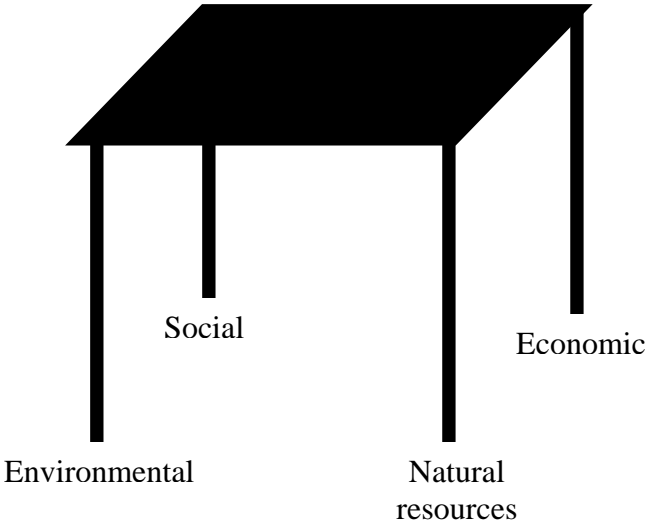
**Supplementary presentation**

Professor Poole introduced himself as a biologist by training who is ‘engineer friendly’. His career has included twelve years designing sewage works in terms of biological systems. Also nine years in corporate planning for National Rivers Authority, Wales. He has spent the last four years working in the field of sustainable development looking at local to global systems.

He made the point that the Environment Agency is ‘preaching’ sustainable development and pointed to key publications from other organisations such as Forum for the Future’s “Engineers for the Twenty-First Century” saying that there is an effort to get the issues into the decision-making process.

Professor Poole said that Wales was one of three administrations in the world (the others being Croatia and Tasmania) to have committed to a duty of promoting sustainability in everything it does. He said that there is a need to work towards ‘attacking the gap’ (the title of a publication produced by the assembly in 2000) and to learn to live differently.

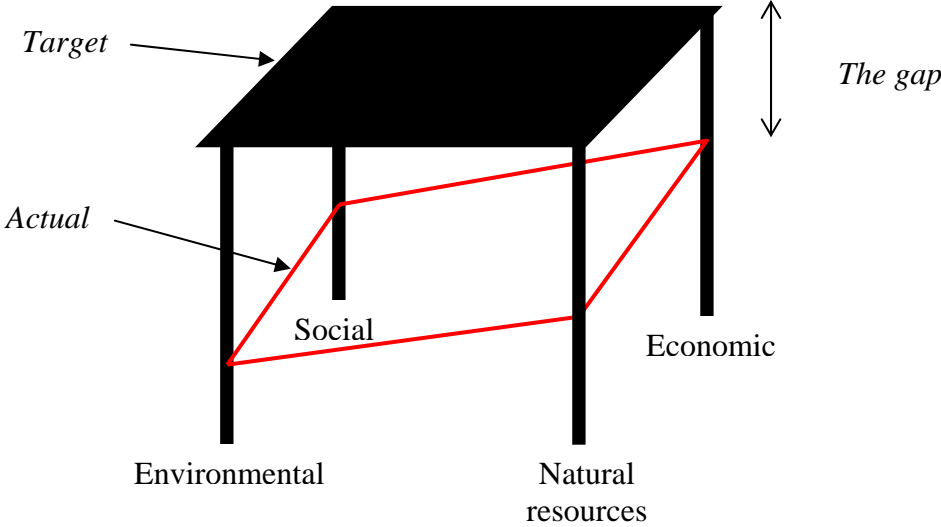
He agreed that we do not need a definition of sustainable development, but we do need a model. The one he has chosen is a four-legged table (see diagram below).



Professor Poole talked through the necessity to have this table level, and at the right height.

He also emphasised that places are different and have difference requirements. It is vital to acknowledge this, he said, for example, people do not come to Cardiff to go mountain climbing, and do not go to Snowdonia to see grand opera. The model can be applied to many contexts and the top of the table may be thought of as ‘quality of life’. We need to build links between theory and the technologists.

The UK government, he told delegates, uses one hundred and fifty indicators, and these have been used to calibrate the model.



There is a need to address all four legs, and to ‘attack the gap’ between the actual and the target levels. He also noted that everybody must look at everything, but that this model can be used for any application.

Professor Poole questioned whether the model had had an effect on the Welsh Assembly and concluded that, yes it had. He mentioned that the group was still in place and that they were affectionately referred to as ‘chums’ by the assembly. He said they were working on development of a policy integration tool and were looking at the effects of policy on all aspects of assembly plan and sustainable development aims. He said that the tool has shown that it is necessary to talk to people in other divisions.

The people we are teaching now, he said, will be working in forty years time and will be ambassadors for change.

Professor Poole then gave some journal examples of change. Forum for the Future magazine ‘Green Futures’ featured an article about making hospitals sustainable; CIWEM journal ‘Water and Environment Manager’ looked at factory planning processes with the joined-up process of democratic and technocratic processes working together; and ‘Modern Railways’ magazine commented on automatic train detections system, this item he discussed in more detail.

The article considered two options: A) rapid input of an automatic train detection system; and B) reaction of the rail industry. Professor Poole put up the following statistics:

	A	B
Rail deaths saved in 40 years	83	74
Capital cost £bn	6.0	3.6
NPV over 40 years	-8.7	-0.5
Rail capacity	-12%	+10%
Road deaths over 40 years*	+700	-300

\*Road deaths resulting from less or more journeys being made by rail

Professor Poole suggested that very distinguished people had proposed an option (A) that doesn't make sense because it is too constrained. Option B, he argued considered the modal shift and gets a very different answer. This, he said was an example of the need to think more broadly.

The chairman of the session thanked Professor Poole and invited questions. He began by asking the first question himself.

**Jim McQuaid** (VP Ulster) asked whether the Environment Agency operates to standards that have to be achieved.

Professor Pole confirmed that they did but commented that standards are often built on absence of knowledge, particularly at the environment / health interface. He said it was difficult to get the public to believe this, however, and they would still often ask 'why is this being built next to my house?' etc.

**Roger Venables** (VP Belfast) asked how to use systems thinking to change the planning system.

Professor Fisk answered this by asking whether a systems approach wouldn't get better answers and referred to Professor Grove-White's comment that the planning system takes a long time to get started.

Professor Poole then went on to say that you can talk about systems, but people talk to people and there is therefore a pressing need to get different disciplines talking together. He stressed the need to recognise the needs of decisions taken in different geographical areas and reported that the Welsh Assembly was developing a strategic spatial strategy to consider planning decisions taken in different geographical areas.

**Gary Acres** (VP Birmingham) asked about the 'average' person's reaction to technical appraisal such as the rail figures and whether the public (influenced by the media) values rail deaths higher than road deaths. He questioned how best to include that factor.

Professor Fisk suggested that average people are much better than the experts at assessing such issues as trying to compute expected average rail deaths. He commented that in such predictions no one includes the tail end of possibility. He noted that a denser rail network could be run with option A of the example and that after the last rail crash there wasn't a modal shift.

He said that sometimes the experts miss the concerns because they see the situation differently and it is important therefore to include stakeholders to add perspectives. For example, a community may not be concerned about perfect incinerators but may or may not be concerned because they know the operators!

Professor Poole questioned how to create the vision for the model and answered by saying that it must involve a combination of experts and stakeholders and they must be included at the earliest stages.

Professor Fisk added that sometimes the stakeholder doesn't want to play!

The chairman thanked the two speakers for their contributions and the delegate group split into syndicate groups to discuss the key questions of the workshop.

### Session 3: June 26<sup>th</sup> 11:45

#### **Syndicate Groups:**

Delegates were formed into six groups and each group considered one of three questions using road traffic for illustration. After a period of individual study, pairs of groups who had been looking at the same question came together to compare their results and present joint conclusions.

The three questions under consideration were:

1. What mechanisms can best facilitate the sharing and take-up of information and expertise between disciplines?
2. How can holistic thinking be encapsulated into the various stages of decision making?
3. Are there useful lessons to be learned from engineering expertise of modelling and managing other complex systems?

The conclusions from each pair of groups, in answer to these questions, are given below.

#### ***Groups A and D***

*Question 1: What mechanisms can best facilitate the sharing and take-up of information and expertise between disciplines?*

Presented by **David Bartholomew** (VP DMU) and **Jeff Hulse** (VP Newcastle).

- Joint projects including non-engineering disciplines
- Role play – conflicts
- ‘HAZOP’ – neutral chairman
- introduce ‘public’ – someone outside academic assumptions
- emergent understanding as well as communication of existing facts
- introduce neutral tools (not associated with particular disciplines) – avoid the ‘not invented here’ problem
- case studies

There are still barriers that need attention such as issues of basic literacy and communications.

- Main issues – rather than technical solutions
- Getting people together
- Super case studies – overlap
- Mission outside – e.g. in schools
- Sharing university experiences – maybe use of issues guidebooks to collate experiences and ideas
- Learning not teaching

**David Foxley** made the point that we need to move away from the loud voices and big sticks approach to mechanisms for transfer.

## ***Groups B and E***

*Question 2: How can holistic thinking be encapsulated into the various stages of decision making?*

Presented by **Alan Strong** (Ulster) and **Barry Mould** (VP Brighton).

Holistic

- Stakeholders – broad (other modes), values (effect on landscape), outside the box
- Barriers – political
- Systems – information deficit

Decision Making

- ‘Champion’ –
  - top-down and bottom-up – outline governments
  - Balance – war time vs life style –  
How much are we prepared to pay to buy ourselves out of our conscience asked Alan Strong.
  - Score card  
Barrie Mould noted the need to balance the score card and asked what elements need to be brought in? Also, what feeds the score card from below? And are we leading towards the right kind of Key Performance Indicator?  
Alan Strong also questioned whether we are using the right indicators.
  - Models needed – tools
  - Long-term
    - Social
    - Technical
    - Environmental
    - Economic
    - Political

Alan Strong concluded by saying that we need a vision. We must recognise stakeholders, champion the cause and have a long-term view. Professor Mould finished the presentation with the comment that if a green travel plan is going to work, the CEO of the company must be in support of the plan and there needs to be a catalyst to bring people in.

**Jim McQuaid** said that the values approach may not be easy to express, to which Professor Mould gave the question, ‘why do people travel?’

**David Foxley** noted that travel was the example, what is important is how engineers’ terms of reference and holistic view fit together.

## ***Groups C and F***

*Question 3: Are there useful lessons to be learned from engineering expertise of modelling and managing other complex systems?*

Presented by **Paul Jowitt** (Heriot-Watt).

Objective:

- “to allow people to travel as much as they want”
  - subject to maximum sustainable development footprint
  - transport system within a more global system
    - getting somewhere to do something
    - freedom or control? / freedom and control? / controlled freedom?
- “what buttons do we need to press to make people behave differently”
  - need to study people not vehicles
- “what is the best way for me to travel?”
  - lack of information

Issues:

- confused / conflicting objectives
- data
- no good examples of complex systems to address transport.

**Gary Acres** (VP Birmingham and Syndicate Group C) added that we need to seriously consider the public and social aspects and questioned whether engineering models adequately took those into account. He mentioned as an example, the public perception of the chemical industry. He suggested that if we are going to model, then we need data, for example, for the road traffic case, accidents and speeds etc.

## **Plenary Discussion:**

**David Fisk** (Imperial College) opened the plenary discussion reiterating that we don't need a sustainable development definition. He said all the syndicate groups had talked about components and that system thinking is a contribution to the debate. He noted that activated models are available but questioned what is the active agent. He urged that engineers ought to shout about successes and are able to contribute to the stakeholder dialogue.

**Jim McQuaid** (VP Ulster) referred to Question 3 and suggested two examples and reading materials:

1. The report: “Assessment of Complex Outcomes”, published by the Engineering Professors' Council in January 2002. It deals with the education of engineers focusing on the achievement of output standards. Its language is resonant with that in our discussions. He suggested that sustainable development can usefully contribute to systems integration in engineering education.
2. Heathrow T5: The planning process took ten years. It began as an engineering problem, and progressed to being more of a systems issue including human behaviour

aspects. These characteristics of projects are described in “Doing it Differently: Systems for Rethinking Construction”, by David Blockley and Patrick Godfrey: Thomas Telford, 2000. They adopt a terminology which classifies projects as:

- Tame- where project elements can be treated separately and added up.
- Messy- where interdependencies have to be taken onto account
- Wicked- where people’s behaviour can work against you

**David Foxley** commented on Charles Duff’s and Jeff Hulse’s Super Case Study suggestion saying that the RAEng is still keen to ‘close the door’ and, relating to Question 1, to have the roles survive independently. Commenting on Question 3, he said there was often a strong tendency to converge on a unique solution.

**Barry Mould** (VP Brighton) commented that we are all selfish animals and that bonus system companies have Key Performance Indicators linked to broader non-financial indicators. We can pay people to take ideas on board.

**Peter Gardiner** (Brighton) said on the subject of data, that the press and politicians need to understand our data and that we need to get the public to believe that they can be selfish and sustainable.

**David Fisk** (Imperial College) raised the issue of the boundary between the areas in which to aggregate and in which to model. He suggested that there was often a Byzantine approach. He said we should look at what components made people object and then look at compensation. He urged that we should question not just at what the boundaries are, but also how much can be aggregated in a linear way.

**David Foxley** commented on the Eden Project saying that in fact Cornwall County Council had a lot of involvement and that maybe they like the road congestion mentioned in David Fisk’s keynote lecture because it means there is a lot people spend money in the county!

#### **Session 4: June 26<sup>th</sup> 14:00**

After Lunch, **Richard Dodds** (VP Liverpool) took the chair for the afternoon session on Development of Teaching Materials, but before starting he asked for comments on the workshop so far.

**Roger Duffel** (Hertfordshire) commented on the acoustics in the room saying it was difficult to hear some of the speakers clearly. He also said that there should be a discussion about the value of the morning exercise.

**David Bartholomew** (VP DMU) agreed that it might have been more productive if it had been left blank.

**David Foxley** (RAEng) agreed that at future workshops a morning could be left 'blank' for the purpose of targeted networking between delegates.

**Jeff Hulse** (VP Newcastle) suggested that to make this time more efficient, each university could write a one-page summary of what they have done.

**Jeremy Purseglove** (VP Hertfordshire) said that the most beneficial outcome would be what could be gained from peers to allow improvement over the next year.

**Gary Acres** (VP Birmingham) said that brief discussions might have led to other discussions.

**David Foxley** (RAEng) said we should either exchange information or apply minds to the issues.

**George Howarth** (VP Bournemouth) said that the morning session was interesting but asked what, as a group, are we practically going to do?

**David Foxley** (RAEng) commented that case studies need to include more than just technical issues.

**Matthew Simon** (Sheffield Hall) said that there are many stakeholders involved, but we need to have strategies for the gap between how we teach now and the grand aims we are leading to.

**David Foxley** (RAEng) said that point would be addressed in the afternoon session.

**Sally Heslop** (Bristol) suggested that the brief for the syndicate session was not very well prepared and that it didn't tie back to the morning session.

**Jim McQuaid** (VP Ulster) said that there is a need for information sharing and that in addition to the annual workshop there is the half-way seminar with VPs only (no minders). He said the session was in response to feedback from selected VPs (all were approached, but only some responded!). He also noted that mindsets behind the Government's sustainable development indicators and The Academy's VP scheme are not aligned with the complexities of sustainable development, and somehow this issue needs to be recognised and tackled.

**David Fisk** (Imperial College) apologised for speaking too fast and said that the syndicate session was useful because six people, instead of two or three in a less formal setting such as at coffee, were able to discuss issues in depth, but noted that maybe the questions were too high level to be addressed in the short time available. He commented that we teach a wide range of spectrum of students and that we need to structure interactions.

**Richard Dodds** then opened the session on Development of Teaching Materials by introducing the first presentation.

## Development of Teaching Materials

### De Montfort University (DMU)

Presented by **David Bartholomew** (VP) and **Greig Mill**.

**David Bartholomew** began the presentation by saying that it was a re-run of the demonstration given at the previous VP Seminar in November 2001.

He then described the context of the work, which is based in the Institute of Energy and Sustainable Development (IESD) at DMU and teaches by distance learning to a class of which most are practicing professionals and two-thirds are studying part time.

The format of the presentation is a CD with pdf files. To date the first of five proposed case studies has been produced about the Built Environment but it is a double size study and will therefore count for two of the total. The case study has three key themes: energy, which is important; together with human factors and systems thinking, which are often widely neglected, Professor Bartholomew said.

Layers of additional information on the CD surround the core material and a lot of thought has been given to design and pedagogy as well as content. There are nearly one hundred pages with over two-hundred-and-sixty 'pop-ups' of extra data, two spreadsheets and one movie clip. In addition to this there is a library of background information totalling one-hundred-and-fifty documents and 100MB.

Significant benefits offered by this method of presentation, Professor Bartholomew reported, include: layering of information, navigation through data, making case studies work on screen, nine main sections and the library, second level pop-ups, visually impaired students can enlarge the on-screen text, and there are additional notes and further reading.

**Greig Mill** then commented on the project from the perspective of the IESD starting with an overview of the initial proposal, from October 1999 to September 2002. Initially, he said, four case studies were planned, with the first one due to be complete by June 2000. The result to date has been delivery of the double-length Queen's Building case study, and a plan to have two others in the next two years.

Greig Mill noted that there has been a strategy of 'added-value' and 'disengagement' after funding throughout the project but that in the beginning there were some staff problems (such as six months to get David Bartholomew into post). He noted that it was recognised that there is lots of new learning necessary in such a scheme, but that as a shared vision develops and with the help of a dedicated research assistant, enthusiasm grows. The project output will include the Queen's Building case study, plus others on the effects of climate change on Leicester and the wider issues of the urban environment.

Commenting on the role of supporting a VP, he said minders shouldn't be too senior, and they should coordinate and enthuse. Of the other members making up the team, he said the Research Assistant should have appropriate technical skills and plenty of time; and that contributors should have a belief in the concept and an understanding that belief will develop with use. The material, he said, is used mainly on the MSc programme and future case studies are planned. He urged that it is important to not just produce more case studies, but to get the maximum benefit from those that already exist.

Greig Mill noted that important factors in the success of the project included: funding from the National Energy Foundation, clear document design philosophy, and liaison with the computer school.

He warned that innovation takes time and requires team-building and that quality fosters enthusiasm. Of the many 'extra' benefits, he noted: flexible learning, cross-disciplinary elements, support from users, development of expertise, and useful tools.

**Sally Heslop** (Bristol) opened the questioning by asking how the material is used.

Greig Mill replied that it is used in electronic discussion groups with optional attendance workshops for distance learners in future.

**Adrian Long** (Queen's University Belfast) asked if there were any assignments on the CD.

Greig Mill said that there were not yet, but there may be in future.

**Richard Dodds** (VP Liverpool) asked how many person months of RA work there was and how was this paid for.

Greig Mill replied that the RA was paid for on the back of the wider benefits. In terms of time, he said the RA had been in post since February.

David Bartholomew added that there was a need to allow three months for the RA to get used to the software.

**Julia Stegeman** (Oxford) asked what were the other advantages of the CD format.

Greig Mill confessed to being initially sceptical but noted that the students responded positively to the novelty and flexibility offered by the CD.

**Sally Heslop** (Bristol) asked whether colleagues have been keen to take on the format.

Greig Mill said that there was some resistance to begin with, but that now everyone is coming round.

**Sally Heslop** (Bristol) asked about student feedback.

David Bartholomew answered that there was concern about text size and navigating but students found it attractive and interesting. The feedback, he said, was generally very positive.

## **Bournemouth**

Presented by **Maggie Hutchings**.

Maggie Hutchings introduced herself as a Social Anthropologist and said she was pleased to hear Professor Robin Grove-White's comments in his lecture, since, she said, working as part of a team is very important. She stressed that the work she was about to present was the result of a team effort.

She began by commenting on the educational challenges of web-based case studies in sustainable development and the need to implement sustainable development criteria and thinking in the design process. She noted we need to think about what can be used to engage students and that there needs to be an emphasis on learning rather than teaching.

She identified the important aspects as: thinking, novelty value, learning by doing, self-assessment questions and tasks, flexibility of web delivery (students can work at their own pace and in their own time), and pedagogical components.

For the purpose of the presentation, Maggie Hutchings proposed to look at six elements:

1. **Variety** – range of stimuli, illustration and diagrams, question prompts,
2. **Action** – learner to do things e.g. compare products,
3. **Application** – apply learning in another context (e.g. sauce bottle), environmental impact, life-cycle analysis, materials,
4. **Interaction** – change / comment on the context,
5. **Feedback** – reflection on what the learner has done and understood, self-assessment questions,
6. **Evaluation** – learner contributes to the learning design.

### **Variety**

Visual impact, use of colour ('organic' colours chosen), consistent look and feel to web-pages, short paragraphs (to minimise scrolling), illustrations and diagrams (as thumbnails), 'chunking' of information, questions and prompts embedded in the text, hypertext links to resources (kept to a minimum – all included in 'Sources of Further Reading' section at the end).

### **Action**

Illustrated examples of products and environmental impacts, charts and tables to appeal to different students, linear path at this stage (forward and backwards links) encourages students to work simply through the programme.

### **Application**

Index included at the end for review and reflection, home page for easy navigation, lecture notes, glossary, sources of further information, software tools, case study options.

### **Interaction**

Self-assessment quizzes (tick boxes and pull-down menu), Eco-packager for life-cycle assessment (ability to interact).

### **Feedback**

Feedback and assessment, instant feedback from SAQ, student progression dependent on competence level reached (students must attain a certain competence score band to progress to the next section) with guidance given on where to look for information, Eco-packager work submitted to tutor for formal assessment, direct email link, frequently asked questions section, discussion forum planned for future version.

### **Evaluation**

Student feedback questionnaire, closed statements with five-point scale (strongly agree to strongly disagree), open questions (e.g. 'I need more help in ...'), revise aspects of case study (improving learning design), on the whole feedback has been very positive.

As her closing remark, Maggie Hutchings made the point that established wisdom in the field emphasised that subject content and learning mechanism go hand-in-hand.

**Adrian Long** (QUB) asked whether the website was password controlled.

Maggie Hutchinson replied that yes it is password controlled outside Bournemouth University.

**Jim Poole** (VP Cardiff) asked if there were any controversial case studies.

**George Howarth** (VP Bournemouth) answered that the life-cycle analysis examples gave some surprising results. He said they try to ask the students what they think and that the answers can be unexpected and rather controversial.

**Matthew Simon** (Sheffield Hall) said that the CD and the website were polar opposites in terms of the way they are used. The website is more linear and less portable, he suggested. He asked whether there is a compromise to transfer the formats between universities.

**George Howarth** said that case studies used by Bournemouth are available for use by any of the VPs and all they had to do was phone for the passwords. Maggie Hutchings added that other design cases and issues can be used to better suit the teaching need.

**Richard Dodds** thanked the speakers for their presentation and opened the session to discuss the dissemination of case study work. He said that there was good material to be utilised but it was not readily to hand. He urged delegates to 'get going' and use the time to develop supplementary material, adding that there should be plenty of material available.

**Rodney Day** (Hertfordshire) informed delegates that the Hertfordshire website had been removed pending the installation of the RAEng website for exchange of material between VPs.

**David Foxley** (RAEng) pointed out that the RAEng was the sponsor not the workhorse of the scheme. He demonstrated to the delegates that in the RAEng website there is a 'Private Area' controlled by user name and password. Under the VP scheme there are four sections, pro-forma have been completed, general design philosophy has been established and there are key resources such as an electronic library containing reports of past seminars and presentations (including PowerPoint slides).

**David Fisk** (Imperial College) asked when the material is going to be open access.

**David Foxley** (RAEng) commented that Jonathan Porritt (keynote lecturer in 2001) was very candid about Prime Minister Tony Blair and this may have been sensitive outside the community. He said that people are reluctant to participate in a forum if it is open. He also said that case study material is a work in progress with a view to exposing through a public website, either the RAEng or a participating university.

**Bob Ditchfield** (RAEng) asked which system would be used.

**Roger Venables** (VP Belfast) suggested, 'as a new boy', that there was a need for access to already existing material.

**George Howarth** (VP Bournemouth) told delegates that they could have passwords accessed through the RAEng and the University of Bournemouth.

**Jeremy Purseglove** (VP Hertfordshire) informed that the Hertfordshire website had been moved to University of Cambridge.

**Sally Heslop** (Bristol) asked what is available.

**David Foxley** (RAEng) suggested using the links through the Hertfordshire website.

**Richard Dodds** (VP Liverpool) stressed that everyone is happy to share material but we need to work towards a process and how to get access to it.

**Barry Mould** (VP Brighton) said that we need to consider the issue of intellectual property rights and to look at documents already produced.

**David Foxley** (RAEng) agreed that IPR is a thorn, but not a show-stopper. The Ordnance Survey, he said, is a major issue, but every university has copyright. We also need to be careful about photos.

**Jeremy Purseglove** (VP Hertfordshire) said that he has managed to get rid of many photos without spoiling the material and he suggested during the design of material it is useful to remember to use personal photos or pay up!

## **Reach out activities**

**George Howarth** (VP Bournemouth) presented the next session that looked at the VP Birmingham Network collaboration between Birmingham, Aston and Bournemouth Universities.

The purpose of the network was to review case studies and talk about them in detail, with particular emphasis on finding out what works, getting to the ‘nitty gritty’ he said. The aim was to introduce the studies to schools and universities.

The Midlands Environmental Business Club is also involved and gives a regional perspective, also in the group is the President of the Business Council for Sustainable Development – North Sea Region. External speakers and a visit to the Technology Innovation Centre in Birmingham have been arranged through the network.

George Howarth emphasised the importance of networking both internal, for example, Aston University Global Design Initiative and Bournemouth University Business School; and external, such as the Industrial Symbiosis Programme (student project work and regional Higher education support both have scope for the VP to get involved), the Technology Innovation Centre (RAEng can provide experts), and the link between Birmingham University and Birmingham Council Advantage West Midlands scheme pursuing sustainable development policy.

Professor Howarth asked what we need from VPs and the RAEng, and answered that we need a simple list of material, audience, engineers etc. to encourage contacts. He said that we don’t need to repeat information, especially the basics, but that we do need networking with other universities and promotional materials to help us do this. He noted that there was not even a simple glossy brochure available to say what the scheme does. He also encouraged further external networking.

**Matthew Simon** (Sheffield Hall) said that he liked the idea of a list and there followed an overwhelming vote in favour from the rest of the delegates.

**David Welsh** (VP Bristol) suggested that the list should be circulated to check details before open posting.

**Richard Dodds** thanked Professor Howarth for his presentation and all the participants for their contributions.

## **Future of VP Activities.**

**Jim McQuaid** (RAEng) took the Chair for the final discussion session, looking at the future of VP activities post Academy funding. He introduced a brief summary of the scheme to date.

**David Foxley** (RAEng) began by saying that the first VP scheme in “Principles of Engineering Design” began in 1989 with significant funding for five years. This, he said, was intended as a kick-start and the RAEng was the driving force to keep the network going. In reality, the RAEng has been able to give £1000 per year as a token and 75% of the VPs remain. The scheme is seen as an ongoing activity to encourage interaction between practicing design engineers and universities.

He recognises that the scheme is a resource intensive activity and there is a need to produce good resources at low or minimum cost, that may reduce the ‘chalk and talk’. In terms of this specific VP Scheme the funding commitment was initially for three years and £20,000 per year and the first group began in 1998-9.

After the initial three-year period there is the possibility of a two-year extension and all the 1998-9 start universities have had extensions agreed but with slightly reduced funding, in keeping with the plan for disengagement after four to five years. The aim is that there will be more involvement by the university and less activity for the VP, so the cost should be less. The first VP (Barry Mould at Brighton) has completed four-and-a-half years and there were five universities in the first round.

The plan is that teaching activity should continue and David Foxley was keen to point out that the RAEng will not fund bad planning, bad management, or bad luck after five years. There are other calls on the money and after five years there should be a body of tested teaching material which should be embodied in the mainstream university activity rather than a fringe activity.

**Barry Mould** (VP Brighton) said that he had been trying to influence staff (as well as students), which is more difficult. He said there is a need to leave a legacy of champion and material with colleagues around.

**Charles Duff** (VP Surrey) said he agreed with David Foxley that there should be a critical mass of tested material covering all disciplines and dozens of cases. He said we should give serious consideration to third party funding such as government bodies, sustainable development research initiative and ESI. It is worth taking time to find options.

**Gary Acres** (VP Birmingham) commented that the Sustainable Development VP scheme has opened up possibilities for research that might also bring in substantial amounts of money.

**Rex Harris** (Birmingham) suggested that material should be adaptable for sixth forms and schools.

**David Foxley** (RAEng) confirmed that dialogue with schools began at key stage 4 and noted that case studies are just as applicable at different levels of detail.

**Richard Dodds** (VP Liverpool) proposed a vote of thanks to the RAEng for the scheme.

**Jim McQuaid** (RAEng) closed the workshop by expressing gratitude to Professor Hon. He thanked all the delegates for their participation and said he hoped the workshop had been worthwhile. He particularly thanked Heather Cruickshank for stepping in at short notice and agreeing to produce a note of the seminar; this would be distributed to all participants in due

course. He said he looked forward to seeing the VPs again at the half-way seminar and the academic colleagues at the next annual workshop.

**Adrian Long** promoted a Conference on Education in Engineering to be held at Queen's University, Belfast on 19<sup>th</sup> and 20<sup>th</sup> June 2003. He invited all delegates to participate.