



The Royal Academy
of Engineering

ENGINEERING ETHICS IN PRACTICE

Church House, Dean's Yard, Westminster

Wednesday, 13 June 2007

Chair: John Uff, CBE, QC, FREng

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(Evening Session)

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Speakers: John Armit, CBE FREng
Sara Parkin, OBE

John Uff: Good evening ladies and gentlemen and welcome to this event, which is Part 2 of a day organised by The Royal Academy of Engineering into Engineering Ethics in Practice, and many of you will have been at the event at The Royal Academy during the day. Tonight we have two very distinguished speakers and an opportunity for a Panel session and for you to put questions, and I hope a number of people are already thinking of the interesting and difficult questions they are going to bowl over.

The programme gives me 10 minutes in which to introduce the event, which I shall use to the full. Having welcomed you all here the next thing is to thank the sponsors who have contributed to the funding of this event; they are all up on the board but I will mention them: EC UK, British Computer Society, Higher Education Academy Engineering Subject Centre, and the Institutions of Civil Engineers, Engineering & Technology, and Mechanical Engineers. The importance of that sponsorship is not merely the financial element, for which we are of course grateful, but it is the fact that they are all involved and integrated within this new document, the Statement of Ethical Principles.

That leads me to the next important point: today marks the launch of the new Statement of Ethical Principles, which I think most of you – indeed I hope all of you – have in this new card form. You can fold it over into A5 size, but the really impressive thing is that the whole thing fits on one sheet of A4, and you certainly can't say that for the Code Napoléon. It is an impressive document. I was asked a few days ago to write a short piece for *The Engineer* magazine; one or two of you might have seen it, although I suspect most of you have not, but I was asked to say something interesting and perhaps topically relevant about the Code. In introducing it I pointed out that it was drafted in collaboration with the bodies that I have just mentioned, and that it deals with the level of performance to be expected in terms which are called 'accuracy and rigour', the moral duties undertaken by engineers under the heading 'honesty and integrity', the focus of the engineer's duty under the heading 'respect for life, law and the public good', and the duties implicit in professional engineering which is referred to as 'responsible leadership, listening and informing'. The

article goes on, 'The SEP is a document with which engineers can associate themselves with pride and confidence', but then I asked the question 'Is this enough?'

In the 18 months since the SEP's initial launch no major ethical engineering issues have hit the national headlines. The debate on industry issues has continued in the trade Press and professional journals, and we have all read about the usual incidents on the railways and in the petrochemical industry, but engineers have not noticeably changed their lifestyles or attitudes to safety, the environment or the well-being of society. 'Could it be', the article asks, 'that the new principles of engineering ethics are failing to engage with events in the real world, and will the SEP manage to persuade professionals that their established practises represent the best ethical standards anyway so we don't need to do anything?'

I hope that potentially provocative question will be seized on by our speakers, whom it is now my pleasure to introduce, and I do so in reverse order. The second speaker will be John Armitt; I will not say that the speakers need no introduction because I am about to introduce them. John Armitt you will all know has had one hot seat after another. He has had a succession of positions as Chairman or Chief Executive of heavy construction firms – John Laing followed by a spell with Union Railways followed by Costain followed by Railtrack. The latest move currently is that he Chairs the Engineering & Physical Science Research Council and in July is about to take up yet another baton; when he leaves Network Rail he will become Chairman of the Olympic delivery authority. John I think exemplifies the fact that if you want something properly managed don't simply go for a project manager but for someone who actually knows how to manage some of the most difficult projects there are around. We certainly wish him well with the Olympic Games.

If I come to the first speaker, Sara Parkin is Founder Director of Forum for the Future. Sara started her career in the medical industry, if I can call it that, and then moved to environment issues. She became the leader of the UK Green Party, and not content with that has been involved in setting up Green Parties on a world-wide basis, and we can all see the obvious success of that venture. Her current interests include higher education, particularly the establishment of a Masters degree in sustainable development. So we have two speakers with very interestingly contrasted backgrounds but both in a perfect position to tell us their views on ethics, engineers and the Statement of Ethical Principles.

Ethical Principles in 21st Century Engineering

**Sara Parkin OBE
Founder Director
Forum for the Future**

I am absolutely delighted to be here on this auspicious occasion, and I am going to talk about Ethical Principles in 21st Century Engineering. I want to reflect on a piece of work which is on-going in the Forum; since 1999 we have run an initiative called 'Engineers of the 21st Century' which is working with employers of engineers and young (and young-ish) engineers, to look at the sort of challenges facing engineers and engineering as we go into the twenty-first century. Much of the stuff that comes from here about ethics and values comes from the 2000 report that was published, but it is an on-going initiative and is in its third phase now.

I want to have a look at where ethics and practice meet, which is very relevant to the sort of things we have been talking about today, the application of the ethics, and perhaps in a more global context. I don't know whether you have been doing case studies today but I want to take some large-scale case studies. I am going to use energy and waste, simply because there have been a couple of White Papers that have come out very recently on energy and waste, and then to end I shall talk about implementing your ethics, putting them into practice, and what will be important about the next 10 years.

The background to the Engineers of the 21st Century project: it was an attempt to jump-start the profession into taking sustainable development seriously and to ratchet up their engagement with it, because of the urgency but also to position engineering as one of the careers that any young person aspiring to contribute to doing something about the unsustainability of the way we are doing things at the moment, will look upon as a really serious career option.

Slide "we had nothing to do with the religion or political principles of each other. We were united by a common love of science, which we thought sufficient to bring together persons of all distinctions, Christians, Jews, Mohametans, and Heathens, Monarchists and Republicans."

Joseph Priestley, 1793

As I have said most of the things I refer to come from the report, but before we go on I thought I would reflect on a previous generation of engineers for whom ethics, values and principles meant a very great deal. The word 'engineering' as everybody knows means

making something come about, and the word 'scientist' was not coined until 1830, and in the time of Joseph Priestly everyone was a moral or a natural philosopher and very much engaged in turning ideas into practical inventions. You will be very familiar with some of the names of the engineers at the start of the last Industrial Revolution, and James Watt, Matthew Bolton, Josiah Wedgwood and Erasmus Darwin are just some of the people who, with Joseph Priestly, belonged to the Birmingham-based Lunar Society at the beginning of the nineteenth century.

As well as steam engines, opticals on other instruments, electrical devices, medicine, biology, these people championed democracy, they campaigned for the end of slavery. They were committed to an inter-disciplinary approach, and there were no disciplines in those days so it was much easier than it is today. Experimentation was their main way of finding out new things and they were devoted to collaborating on each other's research projects, and they would be actively out there looking for solutions to some of the difficulties that their colleagues were having. They also had fun; Erasmus Darwin liked to say that they often had long and uproarious meetings, and he would call it 'engaging in philosophical laughing'.

Royal Academy of Engineering Statement of Ethical Principals

The Statement of Ethical Principles has been launched today, and many congratulations on that. I am absolutely thrilled, and those of you who know me will not be surprised to hear, about the explicit inclusion in there of references to sustainability and how important it is for serving the wider society in everything that you do. In my comments I will try and illuminate what it will mean to put some of these key points into practice.

Engineer of 21st century Ethics : overarching conclusions

The Engineer of the 21st Century initiative looked at ethics and values and they came to some overarching conclusions, and these are three of them: individual responsibility was absolutely at the heart of everything they discussed. Employers find it very important to be able to provide a value and ethical context for employing young people today, because there is a real increase in young people who want to mirror their own personal values in the workplace. We have done some research in Forum for the Future with young people applying for university degrees, and we find a very high level of concern about the environment and social justice. Young engineers felt very strongly that there is no 'them' when it comes to sustainable development, there is nobody elsewhere on whom we can wait to do something about it; each of us has an ethical responsibility to act.

The second bullet point and the quote refers to the participants recognising that the marketplace as it is currently structured, and the way it rewards success, allows the financial bottom line to trump systematically the social and environmental one and to favour

competition regardless of social and environmental consequences. When they explored the opportunities for collaboration they agreed that if we are going to address sustainability it is the mother of all collaborative ventures, and it needs the structures and incentives that are going to reward it.

The ubiquity of ethics was something that struck them very strongly too, and the report leads with their review of ethics and values and their role in engineering. They feel that this explicit, seamless engagement of an ethical position can enable the modern engineer to make decisions in the context of the larger world, to apply their specialist human skills in a world that is very difficult and often with conflicting objectives.

I will return to another ubiquity, which is the way so many people, not least the designers of said waste and energy policy, think and plan in defiance of the laws of physics. It was a French engineer, Sadi Carnot, who launched the whole theoretical work and set down the universal principles that apply to kinetic energy from heat, and it was others including Albert Einstein who contributed to what became known as the laws of thermodynamics. But how many policy-makers know and understand the laws of thermodynamics? Clearly not those who were writing those two policy papers. CP Snow famously said in the 1950s that even in highly educated gatherings no-one could say what the second law of thermodynamics was; they were quite shocked to be asked what it was about, when it is the scientific other side of the question 'Have you read any Shakespeare?'. Nobody is shocked to be asked that. However in 50 years not a lot seems to have changed.

Engineer of the 21st Century ethics : key points

Some key points that came out of the project: dealing with conflict was quite a concern because young engineers felt that very often they were being asked to do things that were in conflict with what would be sustainability outcomes. This puts quite a responsibility on to not just employers but the professional bodies to be more explicit about sustainability as a goal. It is about the profession putting itself into the service of the public as well as into service of members, standards, benefits and so on. Being viewed either as a trade organisation or a learned body depends on what you do.

Expanding the idea of the stakeholder was also very important in being able to take an ethical approach to complex challenges nearby, because that means you can take into consideration stakeholders who are people in other countries, future generations, the environment and so on, and being able to ask the right questions, 'Who benefits? What is it that the client values? What is it they are after?'. Often it was the service of something that was required: a healthy, comfortable workplace, a car with good acceleration or attractive and comfortable floor covering. They are not necessarily that concerned about whether the

car is very heavy or light, the different ways in which they might be able to get the comfortable building. Edison sold lighting services, not bulbs, and interestingly – and I only discovered this not very long ago – Bolton and Watt gave away their steam engines and received payment in the fuel saved by the client. That is very redolent – of how Interface carpet, the biggest carpet manufacturer in Europe works (and this carpet here is probably one if we think about it), they rent to their customers the warm, attractive, utilitarian or whatever floor covering and then take it away and replace it when it is worn out. They do not sell a carpet, they sell its services. We probably do not want to own carpets either but we do want the services.

The other thing that came up is that ethics can be subject to rigorous analysis. Ethics are often derided as ‘soft’ as opposed to the hard science of objective facts, but ethics can be subject to arguments, reasons, and to experience. The provenance of ethics is important, which is why these particular ethics are very important in their provenance, but also examples of how they shape actions and how breaches are sanctioned, because ethical principles as John has already said are only valuable and worthy of respect according to the rigour with which they are applied.

21st century global challenges

What is the Number One challenge that we face at the moment? No surprises again coming from me, there is just one and that is unsustainable development. We can run away from the words, and there is now a lot of talk about one planet living which Defra favours, for example, but that does not obviate the need to do something about it. It is a deeply moral and ethical issue. As the quote from the young engineers points out the evidence is that we clearly do not care enough about the environment or social justice to ensure that they are at the heart of the way our society develops, or progresses. It is a survival issue, because as far as our environmental degradation and social justice go the overall trends are all in the wrong direction at the moment, which is why I think it is really excellent that you have explicitly embedded the responsibility for the environment in your statement. But if I had been in there at the drafting I would perhaps have liked you to firm up on the words ‘due regard’, ‘minimising’ and ‘justifying adverse impacts’. I would have liked something a bit stronger given the mess we are in.

Unsustainable development

This is the mess we are in. We are burning so much fossil fuel, we are so degrading the environment, that it is unable to mop up the consequences of our pollution or to handle the amount of biological take that we use each year in our economy, which is about half the biological product of the natural world. Not only are we doing that, which diminishes its

capacity to mop up the consequences of fossil fuel use, but we are shrinking it. Each year what are ostensibly renewable resources, like forests, like grasslands, like rivers and so on, become non-renewable because they are so damaged they do not regenerate. You don't need a PhD in economics to see an increase in demand on a shrinking supply base and what that means: the persistent poverty, injustice and inequality that we have despite thinking that what we had was a system of progress and development that was fair for everybody.

There is a vital ethical point here, because if you look at what is happening now we are in danger of stripping climate change out of the larger picture of unsustainable development, and disconnecting it from poverty relief, and confounding it with energy security. Unless we can meet the whole challenge we will not meet those different parts. In March last year Gordon Brown announced that what he wanted was a new synthesis which was to achieve economic growth, social justice and environmental care, together recognising that we would not achieve each of them unless we did address them together, and that is as near as damn it my definition of sustainable development.

A high-level taskforce headed by Chris Patten, Chancellor of Oxford University, published yesterday a very robust critique of the Government's current policy chaos. "The wrong energy policy, misaligned with goals on climate change and global poverty, risks creating new enemies for Europe, new threats to energy supply create damage through climate change, and worse, poverty in the poorest part of the world". That is a really powerful and swingeing attack on what is at the moment policy chaos in relation to unsustainable development and all the various elements of it.

Forum for the Future (Millennium Ecosystem Assessment 2005)

We have to remind ourselves of these big trends; 15 out of 24 ecosystem services are in trouble and we are nowhere near likely to meet the millennium development goals, particularly for the poorest. It is making those connections which is really important.

There is at the moment quite a dash for bio-fuels and that raises big ethical considerations, because as we have seen we are shrinking the availability of the biological resources as it is, and if we move more into bio-fuels we will further handicap the ecosystems from doing the mopping up and providing the life-supporting systems that we need, and it is already impacting on food prices and that is impacting on the poor. There were riots in Mexico because of a 400 per cent increase in the price of tortilla flour because of the demand for corn for bio-fuels.

Global and local impacts

We know also about the global and local impacts. It is nice to sit and think and talk about our being saved in Europe because we are rich, well-off, it will be the poor who are most impacted. Yes, there will be a disproportionate impact on the poor – but because we live in a densely populated, high-energy and resource-dependent society, we are not invulnerable. We are very vulnerable to extremes of climate, movement of people, pests, diseases and so on; for example in 2005 when it was very, very hot indeed several French nuclear power stations reported reaching near-critical temperatures and were not able to do sufficient cooling from the rivers. They were very near closing down which would have had quite a significant impact, not just in France but in the other EU countries.

I = PxCxT in 2050?

What do we have to do? This maths is quite easy, it is a formula that has been around for a long time. The first set of numbers were put in in 1995 and they hold good today. We need to reduce our impact on the environment by 50 per cent, we have to give back to nature control over her ecological processes, and that means we need to have a nine-fold improvement in the efficiency of the way we use energy and raw materials in our economy. Nobel Prize winner Harry Kroto likens SUVs today with Newcomen's 1712 basic steam engine, but points out that we do not have the 60 years that James Watt took to come up with a condenser to make it much more efficient. We need a modern-day analogue that will do a similar job for the way we use energy and raw materials and get it into widespread use. We do know we can have 200 to 500 miles per gallon vehicles, so why are they not ubiquitous? That is an ethical question.

Global emissions by sector

These are the overall global emissions, 42 giga-tonnes of carbon dioxide equivalents, and stabilisation at any level means bringing the level of emissions down to a balance with the earth's capacity to mop them up harmlessly. According to the recent Stern report, which some of you will have seen, that means we need an 80 per cent decrease in human emissions by 2050. Now, 50 per cent and 60 per cent have been mentioned but it is likely to be much greater than that, and the question is how quickly it can be done. . That is a fantastic challenge, absolutely fantastic. Taking longer or over-shooting the limits of the concentration of carbon dioxide means that the risks are raised. We are aiming at 2 degrees warming, no more, by 2050 and even if we hit that (which will be really tough) there are still big risks involved. Yet I do not see the international agreements, policies, action plans, mobilisations, putting us all into an action mode that the urgency of the situation seems to indicate. Failing to react soon enough has seen the collapse of previous civilizations, and

the analysis of what happens is that a moral paralysis descends. In this context the G8 outcomes were not very promising.

I think part of the hesitancy (and this is me thinking positively of being able to articulate what it is we need to do, whether it is at the G8 or in our UK policy documents) is that governments are very bogged down in economic and political analyses, what is needed is probably the engineering equivalent of the Stern report which explains scientifically and dis-passionately how that sort of reduction in carbon dioxide emissions might be achieved. We do not have an 'energy reduction industry' as such but we probably could do such a report.

Energy : an ethical approach (1)

A couple of quick case studies to look at what an ethical approach to energy and waste might do. This is thinking about applied ethics, because if the ethics are not applied then they are not worth the paper they are written on. Many people say that sets of ethics are mostly just common sense, but in fact writing them down and calling them ethical principles is a really good way of getting people to use them to help think through complex decision-making processes. I hope very much that guidelines to using the RAEng ethical standards will be made available. I have used energy and waste because, two White Papers have recently come out.

If we are taking an ethical approach to energy these are the sorts of questions that probably we have to ask: what problem do we have? It is not unknown for people to resolve the wrong problem. Are we asking the right questions in the right language to be able to unpack the problem and to understand what we need to do? Do we really understand who will be affected by the answers? The evidence in unsustainable development is that we have breezed through a couple of hundred years of development without really being conscious of the things we were doing – not badness but just unthinking - and ethical standards as a framework can make you think much more positively about how to avoid negative impacts. Can we do better by collaborating? A lot of people will do things without talking around and seeing how they can offer help to others and get help from others to get a better outcome. Have we made the ethics and the values behind our conclusions explicit?

If you remember the previous slide, it did not treat energy as a sector, and that is because the White Paper is predominantly concerned with the supply of fuels. In this room above all, people should know that it is not an energy policy we need, the total energy in the universe is always the same. What we are interested in is energy carriers, the things that make energy available to us in useful form – ambient energy; sunlight, moving air, water, or as a fuel. The word 'fuel' comes from the Latin meaning fireplace, and those of us who are

old enough will remember that until the 1970s we didn't have an energy policy in the UK we had a fuel policy. Green leaves are of course carriers of energy as well.

Energy : an ethical approach (2)

Misuse of the word 'energy' makes it more difficult to understand the problem. We have to ask the right questions and therefore come to the right solutions, and here is a fairly quick look to see that the problem we have is to hold the growth of global temperatures well under 2 degrees between now and 2050 – really, really tough – and at the very least halve carbon dioxide emissions and probably a great deal more, and to do it in a way that is fair and just to people, of course.

Are we asking the right questions? I do not think we are. Like not wanting to own a carpet but wanting the services that a carpet provides, maybe we do not want to own 'a fuel' or 'an energy', we don't want to buy it, we don't want to consume it. You can't consume energy, it is everywhere. What we need are the services of heat, power and light in order to make our lives work, and this is exactly the phraseology that Gordon Brown himself used in that same speech when he was talking to European environment and energy Ministers, that we want the services we get from energy and not energy *per se*. The minute you pose the question 'How do you get secure, affordable supplies of low carbon heat, power and light in London, in the North of Scotland, in Bangladesh?' then you start to get a different set of answers in each place. We are handicapped from being able to have that discussion because we are always talking about large generation and arguing whether it is windmills or nuclear fuels. We are asking the wrong question.

The services might be very different in different geographical areas. I might end up having most of my needs met by fossil fuels, you might have your needs met mostly by renewables, but until we ask the right question in the right geographical context, then we are not going to be able to be much more efficient in the way that we use the energy we use (and we should be able to gain at least a third of the energy that we need in the future by efficiency) nor will we be able to deliver what people need where they are.

One of the things about the White Paper was that it does do an impact appraisal of the policy, but it is only an economic impact. There is no mention of social or broader environmental goals. Chris Patten and indeed Friends of the Earth have been very critical of the energy White Paper, saying that it is too cautious and out of step with the urgency of the problem.

With waste, again the same questions apply, and we come to a similar set of answers; but we also have to look at that second point which is how we provide secure, affordable supplies of low carbon goods and services. Because this is the second Industrial

Revolution, in energy, but especially here, in the way we produce the goods and services that we all need, in a way that radically uses less materials. However the waste strategy is about waste that has already been created and we have a rising waste stream. If you recycle on top very often you are adding more energy and more raw materials to the equation, so unless a waste strategy is operating in a *falling* waste stream it is adding to the problem. It is not helping at all. Again that is because the wrong questions have been posed. We want something that will be a resource management strategy so that we can squeeze the waste out of all that we do.

It is probably not worth recycling paper for example; the best way, thermodynamically, to use a tree in our economy is to use it in high-grade use like papers and books, then use it as packaging, then at a lower grade, as animal bedding, and finally recapture the energy either by composting or by burning it very efficiently. There are advertisements telling us to recycle bottles because it is much better for the environment to recycle bottles than it is to put them into landfill; but that is the wrong question. We should not be recycling bottles, we should not be disposing of bottles, we should be re-using them. It is much, much better for the environment to re-use bottles and it is even better for the environment if we have our own containers and we take them wherever possible to have them refilled.

Squeeze waste out of the system: the new Industrial Revolution

Squeezing waste out of the system is the new Industrial Revolution. We are obscenely and unethically wasteful in the way we process raw materials, and at the moment unless there is some big change in the way we decide how successful is our economy, profligacy and ignoring the negative environmental and social consequences of our choices will remain built into the system. But there is change coming, there will be a different way of measuring whether our economy is successful. As a Treasury spokesman said to a friend of mine, "I can't argue at the moment except in the existing economic paradigm", but there will be a shift to a new paradigm where we judge how successful we are in terms of human welfare and in terms of low energy and raw material use. Unless we take the opportunity fast to get what has been described as at least a 10-fold improvement in the way we put resources, and indeed energy, through our economy then we will be beaten to it. China is well on the case for this, and one of the biggest shames about these White Papers is that they are not going to trigger the kinds of investments, industrial changes, new business and innovation that will help us take a lead.

Keeping the lights on: the ethics of transition

I have put in here again Chris Patten's quote because it was published only yesterday and it sums things up very well. For you, implementing your ethical policy is of paramount importance. It has to be a living document, it has to be backed by support for practising engineers from the institutions to enable them to make those everyday decisions in a way that is more likely to contribute to sustainable development than not. With your knowledge and your insights into the application of the physical laws that govern the universe, it would be unethical for you to do anything but help others acquire and apply the same principles. You talk about people being seriously misled, that it is an ethical principle of an engineer not to allow others to be seriously misled. I think that people are being seriously misled right now because they do not have the very basic knowledge and information they need so no wonder we are going about our business in a way that persistently flouts the laws of nature.

Evidence says we have about 10 years to get the right investment in the right place, the right technologies, the right education, to shift us off our highly unsustainable path in order to avoid what we are told by climate scientists will be pretty serious outcomes. If you read the White Papers you would think we have centuries. So I think it is very important you will be policing the application of your ethical principles, and rather than waiting for the first villain to breach them you will start now to recognise and reward those who are really applying them to the best service of society, remembering the top ethical challenge that we face. Unsustainable development is an ethical challenge, but it is hugely practical and the solutions are hugely practical, and engineering has so much to tell us – not just from the scientific principles but for the enormous amount of innovation in how we can meet the needs justly and fairly around the world with humongously less energy and raw materials being used. Perhaps you could come up with a prize or something so that you are highlighting those amongst your colleagues who do the best service for society as we wrestle with the toughest and most urgent moral and practical dilemma we have.

Thank you for listening

Thank you very much for listening; a quote updated for the twenty first century:

*"I sell here, sir, what all the world desires to have – affordable, **efficient, low-carbon POWER.**"*

Matthew Bolton quoted by Samuel Johnston, 1774 with a 21st century amendment

and congratulations on producing your ethical principles. I hope very much you will put them to work quite quickly, as I have suggested. Thank you very much.

Ethics in Engineering – Whose Responsibility?

**John Armitt CBE FREng FICE
Chief Executive
Network Rail**

Good evening ladies and gentlemen; follow that, as they say, and I shall follow it in a somewhat different style. I was asked if I would talk this evening in terms of my practical background and experience in engineering, and the sort of ethical issues that I have dealt with or come across during the last 30 or 40 years. In talking about those I hope I shall imply and influence how that may go forward and whether it will change very much, and what the role of engineers will be in the future in terms of the sorts of issues which Sara has just been describing.

I would like to start by going back and reflecting simply on the fact that we beat ourselves up all the time as engineers, or somebody else comes along and beats us up which is possibly what has just happened! I always start with the fact that engineers and scientists can go to bed at night feeling pretty proud about what they have done and the influences they have brought to bear on society over endless generations, probably about 2,500 years of them.

There is an enormous amount of good which engineers have developed during that period, which has led to the quality of, and the welfare in life that we experience today. It is engineers who provided the world with clean water; it is engineers who provided the world with sewage treatment; it is engineers who provided the world with every aspect of transport that we use; it is engineers working with bio-medics who provided so much of the medical advances which we use and take for granted today; it is engineers who have delivered the world of communications that we live in today and which we use all the time; it is engineers of course who created the Industrial Revolution and yes, the Industrial Revolution – topically as it happens – initially utilised child labour, and I would suggest to people who criticise China at the moment that perhaps they think about that and the demands that they place on China to be like us, when 150 years ago we were just like China.

There were negative aspects in our moral values today about the Industrial Revolution. We changed society utterly with the Industrial Revolution. We moved from an agricultural environment to an industrial and city environment, the move from closely-knit communities to dispersed communities. Those were some of the negatives to set alongside what frankly were in my belief vastly greater positives.

We have spent the last 5,000 years developing weapons of one sort or another, and engineers and scientists have led the way in those always. They did it largely because somebody was paying them to do it, and they do it today because somebody is paying them to do it, and today we have the weapons of mass destruction. We can be critical or not of the engineers who have generated the systems which have enabled those weapons of mass destruction to be developed. The same goes for drugs; massive good has come from drugs, but clearly dependency and other issues are a downside for some people. As we have just been reminded out of all of this development we have finished up with global warning. Do we have to be pessimistic about that or do we have to be optimistic in the opportunities generated in how we deal with that, and our ability to deal with that as engineers going forward?

How often over that period as engineers have we reflected on any of the things I have been talking about, good or bad, and the consequences? We have done them because people's imagination, people's desire to develop, people's desire and natural inclination to use their brains, has created opportunity. They have looked at a challenge and said 'I can deal with that challenge', and they have gone ahead and found a way of dealing with that challenge; one very often which nobody else could see but which they could see, but they probably did not reflect too much on the consequences.

Did they ever reflect on their ability to refuse to engage in something which they could see would be highly detrimental to somebody or other? Clearly many of the scientist and engineers in the early forties and fifties did not when developing the atom bomb and everything that went with that, but there was a lot of good potentially which came out of that work as well as the threat that we created for ourselves at the same time. I would argue that over all those periods there is no doubt whatsoever that the good has outweighed the bad, even if we can do some calculations today which tell us that in 10 or 20 years' time it is all going to be rather difficult.

During this period and more so recently we have seen, particularly in the West, a decline in the moral compass which is provided to us in how we make our decisions through traditional faith. You can argue that is not the case in other parts of the world, but I would say that in the West it is certainly the case that there has been a decline in that. However I think it has been offset by a far more valuable thing which is an increase in our awareness of actions. A greater debate, the opportunity for people to provide alternative points of view, the Freedom of Information Act and everything that comes with that, is providing us with an opportunity to argue through some of these moral and ethical issues in, I would suggest, a far better way than simply relying on the tradition of a religious faith.

At the same time as that has been going on we have seen the decline in power as executed in the past through the Empires and the colonies, but we have replaced it with a series of other influential and powerful mechanisms, for example aid in all its forms, the World Bank, export credits and such-like. Much good has been done through those mechanisms, even if at the end of the day we have to write off the aid, but why did we do it? Frankly I would argue that we did it because it salved our conscience, but it also provided trade opportunities and without export credits there were not the trade opportunities and without aid there were not the trade opportunities. You only had to look at the decisions made around those loans to recognise that in fact it was a two-edged sword in political terms, which was 'Yes, we will lend you the money but the money will be spent back in good old Blighty or the USA', so we solve our own political problems because we generate jobs at the same time – so, I would argue, a quiet, market-orientated and fairly brutal view taken, and not one which is done necessarily for ethical reasons.

Where have engineers been in all this? Engineers have gone along. They have gone along with what is necessary, as Sara intimated, through their employers, and they have gone along with it because it paid their own wages and enabled them to live the lives they wanted to lead. We relied on other people to point out the weaknesses. Our job was there to provide what was required, our job was there to do it in the most economic means that we could find, but fundamentally our job was to support the status quo. Others would come along and argue against what we were seeking to do, and by and large we have seen off the opposition. I don't think any of us can remember too many things in the last 50 years which have not happened as a consequence of opposition to them. The power of governments, the power of if you like the ruling engineering elite working with government usually achieves what government and engineers can see is a solution to a problem.

We have worked with the grain, which is my experience on more than one occasion. We have gone along with the local fees, we have gone along with the local culture, we have gone along with the dictatorship; remember we were falling over ourselves only 20 years ago to support and work with Saddam Hussein. It suited our political desire or position at the time in the Middle East, and certainly it suited us from an industry point of view. It created jobs here, it created jobs over there, so at the end of the day you could say it was all for the greater good. Dictatorships can be ignored because dictatorships one could argue are political leadership of a type in that country, and if through that dictatorship you are seeing more hospitals being built then what is wrong with going along with that dictator to provide those hospitals, because without him there may be no hospitals at all. Therefore without that local political culture you do not get development so is it our job to say that it is wrong?

Engineers have to make those decisions all the time if they are to work in these countries, and I don't think that will change very much in the next 20 or 30 years.

In my time in John Laing I was involved extensively in international activities, particularly in the Middle East and the Far East. In the Far East we managed to walk quite happily down the street with one foot in hospitals and one foot in defence. We dealt with the same politicians, and we knew that if we did not deal properly with one then we were unlikely to get work with the other, so you compromise and you go along with it, and if you don't there is no work for you but there might be work for France. As an engineer you have to decide what to do; are you going to have no work for the UK and let the French win it?

In Saudi Arabia I walked away once; I walked away because of the scale of the fees which I was being required to pay in order to be paid. I didn't walk away because I disagreed with having to pay the fees but because I couldn't afford it, and as I said to my Chairman at the time 'If we stay we will just bleed to death, so we might as well get out now and suffer the heat and the indignation'. It was not so much the indignation from the Saudis, they got over that pretty quickly as you might imagine, and we were back negotiating after a few months, but the indignation of the Foreign Office over here, 'How could you upset the Saudis like that?'

When I arrived at Costain the company was already into the Newbury by-pass, which probably represented concern about civil engineering on a major scale in a way which we had not seen in this country before. The ancient forests I assumed would be pretty large; what I learned was the ancient forests, or ancient woodland to give it its correct title, simply means it has been there a long time and not that the trees are big. As far as the local people who lived in Newbury were concerned they couldn't wait for the by-pass. They were fed up with having lorries coming through the middle of Newbury all the time churning out fumes, and not being able to cross the road, danger to children, etc. For a few villagers living around Newbury the by-pass was not welcome because it went within a quarter of a mile of their back door, and therefore we got what we would all do – I accept I would be the same in those situations – 'Can't you move it over to the other village because I don't want it past my village?'

At Costain we carried on because in my opinion at the time, and I guess it is probably not that much different although it might be modified a bit today, it was not our job as engineers to make the decision about the democratic process. If the democratic process through the endless planning permission which is required in these situations finally says 'We are going to have Terminal 5, we are going to have the Newbury by-pass', the best thing

engineers can then do is build it as efficiently, effectively and sustainably as they possibly can. It is certainly not our job to walk away from it.

At Costain we were also building for the animal testing companies, the animal testing labs. That became a bit more difficult when the bombs were put under the cars of the directors. Did we stay or did we walk away? We actually stayed, and we stayed quietly. We were not going to be threatened and bombed out of the work which we had decided we would do for those companies. Would we make the same decision today? Would any construction company work for those companies today? It would certainly cause a very big debate today as to whether a company wanted to work in that area or not, but if you have a Government which says 'We want these things to continue' then you have to make a choice, because not only will you be standing against the protester but also against the Government, and for anybody working in industry that is always a choice but not always an easy choice to make.

When we developed the Channel Tunnel rail link, to have a Channel Tunnel rail link as far as Treasury was concerned required that it cost as little as possible, and so when we got to Barking and we had to take the railway between the backs of the houses at the bottoms of the gardens, and probably about 30 feet below the garden, the cheapest way to do it was to do it in open cut. We then went in front of the politicians in the Select Committee, and the Select Committee decided that because it would be better for the environment in the long term, because it would be better for the people whose houses backed on to it particularly during construction, 'Please put the whole thing in tunnel'. It added £50 million to the cost of the project. Frankly I think it was the right decision to make in the long term, but as an engineer developing the link my primary objective was to keep the cost down and to keep Treasury on-side in order to ensure that we got a link. I was quite happy for the politicians to decide, which was more difficult for Treasury to ignore than it would be for Treasury to ignore me, in terms of 'Do we have a tunnel or don't we have a tunnel?'.

The recent years on the railway have generated a whole set of different challenges. One which John Uff has been closely aware of and involved in is the whole issue of ALARP, or As Low As Reasonably Practical, when it comes to assessing risk and what you do about risk. What do you do about the value of life? What should the value of life be? How do you get people to understand that there is a value on the life of their grandmother or of their child, or most expensively their 23-year-old graduate? But you have to make these real decisions, you have to decide what you are going to do. You can't have absolute safety, because if you sought it you would have a level of cost which would be unsustainable, and you would not

build at all. You have to accept that there are these difficult decisions, and then you simply have to make professional judgments around them.

The value of life at the moment for us is £1.5 million. As engineers in the company when they get to the cost of something, valuing a life, to mitigate the risk they will expend money to the tune of £1,5 million, 'Fine, we will spend the money, we will mitigate the risk'. If it costs £2 million what do we do? Do we say 'You can't have it' or do we make a judgment? That is a challenge which people face all the time; in fact we have just agreed with the Rail Regulator as it happens that we will think about gross dis-proportionality when making that decision, so if it is going to cost £5 million almost certainly we won't do it, but we can see that we would have a bit of a job explaining to the *Daily Mail* that we had not spent £1.9 million. It is as simple as that in some ways, but you have to make that judgment and that is where engineers can add real value.

We have come in for a lot of stick recently on the GSMR project, which is designed to make the railway safer and will provide radio communication between signallers and drivers across the whole of the network, something which today does not exist and where it does is not totally effective. In order to do that you have to put up lots of masts. That generates two things: one, an immediate concern in those who live within half a mile of the mast that there will be an effect from radiation, and particularly if it is anywhere near a school, and that they will be affected. You deal with that by saying 'We will only essentially transmit up and down the railway and we will pass by the opportunity, which is presented to us all the time, to invite third parties into the use of the mast to use it for other communication systems which would then transmit in all directions at the same time'. We are then criticised of course for not having exploited the commercial opportunity which was available to us by putting up the masts.

Engineers I have to say are also quite good at positioning the mast where it says on the drawing, so if the masts have to be at two-kilometre centres they go on the drawing at two-kilometre centres and before you know where you are somebody is digging the foundation at two-kilometre centres. The fact that the foundation is in the churchyard and the 150 foot mast will be rather higher than the church spire – well, that is where it says. There is an education still to be done with engineers, to say 'You might have moved it a bit to the left, and then we wouldn't have the village rioting in the streets'. What have we done about that? We have given latitude and told them they can spend more money by reducing the height of the masts. But clearly we do not want them to reduce the height of the masts, which then means you have more of them, as a single solution. People will be required to make a value judgment, or call it an ethical judgment if you like, as to how they deal with that.

Going forward there are a whole host of these sorts of decisions which engineers will have to be involved in and face up to. I read one recently, and tonight I can't remember which way round it was, but there was going to be water pumped I think from the Red Sea to the Dead Sea because the Dead Sea is dropping because of the irrigation requirements. Of course there is an alternative as Sara would say which is to use less water, and then we don't have to pump so much from one Sea to the other.

Nuclear alternative energy has been mentioned already this evening. I personally believe that we have no choice but to go nuclear. I do not feel guilty about that, I feel it is a necessary part of providing the levels of energy which the world will require before the lights go out in 20 years' time if we don't do something about it. At the same time we clearly need to look at what alternatives we have, but what we must not do as engineers is lead politicians into believing that there are other solutions which at the end of the day will not provide the energy which is required in the quantities that it is required. That would be dishonest. That would be unethical.

Genetic modification, whether it is to crops or to animals or whether it is to human beings? Personally I believe it should continue. I believe as engineers, as scientists, we have a role to continuously explore and expand the limits of our knowledge. You will never get people to stand still, you will never close down people's thinking, particularly the brightest people, and so you should allow them to think. Let's see what can come out of that thinking, let's see what can be generated and then decide how to use it. That is not a decision for engineers alone, that is a decision for society. Engineers are there to provide the opportunity and the break-throughs. It is a very complicated process, and it has been complicated just recently as we suddenly realise that we can have or not have genetic crops. We think we can't have genetic crops, but as has already been pointed out this evening if we want bio-fuels we might need even more genetic crops because we will not have the land to provide the food that we need by conventional means, so we will have to make a choice, 'Do we want bio-fuels or do we want to keep the land for crops?'. If we want both we will probably have to require a different sort of crop, which will probably be a genetically-modified one. The important thing is that the engineer is providing the opportunity of making those decisions, it is not I would argue the engineer's responsibility to make those decisions by himself in isolation from the rest of society.

Society needs information. It needs information which is accurate, it needs information which is honest, and we can do that. We can provide both sides of the story, but at the same time if we want to be listened to and respected then I would argue we should have a view as well. We can't just simply say 'Here are your apples and here are your pears, and it is up to you Mr Politician to decide which one you want', and The Royal Academy of

Engineering along with the other institutions at the moment are very deliberately sitting down to try and point to the very thing which Sara was referring to, which is 'What are the energy options which are the best energy options?'. What do we as engineers say to Government, 'These are the best energy options for you to adopt as a policy going forward'? That I think is engineers acting in a sensible and responsible manner, but we must have a view and that is going to be very difficult. Could you get the engineering institutions and The Royal Academy to come to some agreed positions which will mean that some people's position will not be recommended? Will they be willing to remain members of an institution which is promoting nuclear power if they are a windmill fan?

Engineers have to face up to that. They have to be mature and accept that they will not always get their own way, because if we simply turn off and walk away from some of these issues I would argue that is a bigger moral and ethical failing by us than ever, just sitting there and refusing to be involved. We have to be involved. I don't think you will turn engineers into politicians overnight, but we have to be prepared to stand up and very forcibly advise politicians as to what we think is right and wrong, what is the power that we can give them in terms of engineering and science, so that they, taking into account the views of the whole of society, can then with our support come to conclusions, right or wrong. Those will depend on real politik, and real politik at the end of the day will be 'Have I got enough food to eat, am I living a life of reasonable welfare, can I see that the quality of my life is improving to what I believe is a standard which stands itself alongside what I can see happening over the fence, and I can see it all the time now because of modern communications?'.

The guy in the Chinese hut with his television aerial knows exactly the way the Americans live and he thinks 'I would like some of that; it looks a bit better than standing beside an ox trudging up and down the field all day'. That is what is happening in China, and as engineers we have to work with that. We have to support them in their ambition and we have to work with them to come to the right conclusions, and it is because it is very difficult that we do not get what we would ideally like from the G8. We should not be disappointed by that; we have made some progress and we should keep pressing on to arrive at what ideally at the end of the day are conclusions about which we can say 'Yes, we think that will get us where we expect to be in about 50 years' time'. Personally I do not think you will do it by having absolute targets. At the end of the day it is free trade, it is the free market, it is the free-thinking individual which will decide the world we live in, not one which is driven by Government-inspired targets and political principles.

Thank you very much.

Question & Answer Session

Professor Shannon (Institution of Mechanical Engineers): I would like to congratulate both of our speakers this evening for highlighting a number of the ethical issues which engineers face, but it seems to me that the engineering profession is being reactive rather than proactive when it comes to putting ethics into practice. Would you agree or disagree with that?

Sara Parkin: Your question was do we think you should be proactive rather than just reactive, or are you?

Professor Shannon: It seems to me that the profession is reactive when it comes to when it comes to applying ethics rather than proactive.

Sara Parkin: Yes, I would agree with that. [*Laughter*]

John Uff: Should we be more proactive? John, do you have a view?

John Armitt: I think probably everything I have said implied that I think we are largely reactive, and that we reflect where society is at that particular point in time. What we do is create new opportunities all the time, and then if you don't like that opportunity sooner or later you might decide there are some disadvantages to it, or you might choose to use it in an entirely different way, and I guess the whole nuclear issue is a typical example of that and how we have used nuclear energy. We have used it in the medical world in a thoroughly good way, but on the other hand people would seize the opportunity to use it in a negative way.

Should we be more proactive? Yes, we should be more proactive in seeking solutions, and in my new job already with the EPSRC there is no shortage of people coming forward with proposals of things they want to research – 450 a month – so there is proactivity out there. Who should direct that proactivity? Should it be Government? Should it be ourselves? Frankly at the end of the day it probably needs to be both because it is Government's money very often which is being spent to pursue these issues, so you would expect Government to want to have some say in how it is being spent. In a sense it is saying that if politicians are going in a particular direction that direction is likely to be society's, because they follow rather than lead by and large, then the result is that engineers will be in that same game.

Sara Parkin: I would agree, and reflect on the fact that a lot of organisations now are producing value statements and ethical principles which is a reflection of what you said, that we do not have the same shared sense of values that we had when there was a much more religious society. I think this is quite important. If you look at what young people are worried about and what they care about, a lot of them want this shared sense of purpose, a lot of them want to feel that there is a common set of values, a sort of glue that holds us all together. That for me is the strongest argument why you should be very proactive about the way you use your ethical principles, not just for engineers but because they are grounded in a lot of common sense and a lot of people welcome that notion that we are sharing things that we can all agree with. That moral compass that you can provide is going to become increasingly important.

John Uff: If I could just add to this, it seemed to me following on what John said, and indeed what Sara said, that one of the great traditions of engineering is the sharing of knowledge; someone comes up with an invention, they give a paper, the idea is spread and other things develop from it. We do not find people in the financial futures market doing that sort of thing when they have a good idea, do we? We should be proud of what we've got.

Sarah Bell (University College, London): John mentioned that in the last 50 years of development the engineering elite together with Government have seen off opposition to major projects and instances of development. I was just wondering whether you think that makes it right?

John Armitt: No, no. I was not saying it was necessarily right, I was just stating it as if you like a fact of real life that engineers in a sense have collaborated with Government. Usually there are engineers collaborating clearly with those who are opposed to what is going on, because they require technical and scientific evidence to put to Government and Government is working with its engineers. I was simply making the point that when you combine the power of engineers together with the power of politics, then in most cases it becomes very difficult for opposition in isolation to deal with that. The opposition is more likely generally to seep into the consciousness of society over a period of time, which is what I think is happening now, and the reaction to Stern has demonstrated that, then it seeps into the political consciousness and then you get change.

Rev Dr John Strain (University of Surrey): I am slightly puzzled as to quite how I might regard this ethics initiative in engineering. On the one hand I am very struck by

John Armitt's explanation of the very real concern he has had for ethics over many years, and I am left with a sense that there is not a lot that is new about all this. Engineers as you rightly say have always been decent honest people spelling out the implications of engineering. On the other hand I was struck by the fact that this whole discourse of ethics is new today. We are no longer asked to be just good parents we are asked to be ethical parents, would you believe, we have to be ethical consumers. I am not saying whether it is good or bad but just pointing to the fact that because of the globe, because of real issues about sustainability, I am wondering whether this whole ethics discourse changes things a little bit. John, what is it for you? Is it basically 'Just carry on as before and be good and decent and spell out the implications of what we do?', or is this something really important that we need to see as a new initiative?

John Armitt: That is a brilliant question, and it is one that has gone round in my mind. In fact what I said this evening was to a certain degree not what I thought I was going to say two weeks ago, so as I have worked these things through in my head my position has been over here or over there and has floated around.

Let me ask a question in response, perhaps not to yourself but maybe to The Academy: why does The Academy think it is necessary to have the Statement of Ethical Principles for engineers? Is it because in fact The Academy, like Network Rail and like ICI, recognises that it has to produce a corporate responsibility statement every year and if it does not it will be criticised, and therefore do we as an Academy think we need to set these things down, which frankly are common sense and are the way that engineers ought to behave anyway if they have had anything like a sensible upbringing within the engineering profession? Some of the things I have to say which are in the ethical principles are good engineering, and we shouldn't really have to write it down and tell somebody 'This is what you have to do to be a good engineer', because it is essentially common sense.

If you look at risk assessment, are we safer because of risk assessment than we were before? We used to do our risk assessments, we just used not to spend an hour sitting in the office writing it down before it went out on to the site to be given to a foreman, who probably couldn't understand what the engineer was on about in his written statement and would probably have understood it a lot better if the engineer had gone out and stood with him, looked at the problem and discussed how they were going to do it, rather than being stuck in the office writing it down in a format which then could not be understood.

But we are in a world of protection. We are in a world of 'Let me produce the piece of paper post the event to show that I was acting properly'. Are we seeking as The Royal Academy and other engineering institutions simply to be able to put a tick in the box which

says 'We have got a set of ethical principles, and the fact that old Bloggs over there didn't act in accordance with them means we are going to kick him out of the institution. We are okay, society, because we have our set of ethical principles and old Bloggs didn't comply with them'? It is a bit Sarbanes-Oxley; Sarbanes-Oxley is not going to stop people in America who are intent on fraud carrying out fraud. I am not sure that a set of ethical principles will essentially change the way that good engineers carry on doing their work, and I believe the vast majority of engineers are good engineers.

John Uff: Sara, would you like to add to that?

Sara Parkin: Yes, I would like to add to that because you asked whether it meant continuing as before or whether there is something new here. I think there is definitely something new, and the newness is that there is a breakdown in trust of those that were in leadership positions, so when the politicians and the engineers got together and decided that 'Things will be like this and we will see off the opposition' there is a sort of trust in the moral principles that were applied by the leadership. We are in a world now where we really do not trust leaders quite the way we used to, whether it is in the corporate sector or in our local Council or in the Government. The reason for that is because of communications now, and we can see when people behave in an untrustworthy way.

What is different now is not just that we can assume behind the scenes there are lots of trustworthy people working to a shared moral compass, but what we want is to see very explicitly stated what those ethical principles are which are at work, what are the values which are behind the decision that has been made. That is Number One and we need to see that because we have lost trust in the gentlemen's agreement or all the ways that honour was assumed to be taking place behind closed doors.

The other thing that is different is the size and the complexity of the challenges that we face. Fifty years ago it was quite easy to isolate an issue and deal with it completely in isolation from everything else, so when decisions were made then you didn't have to think about the impact elsewhere. Bio-fuels is a very good example; John talked about how we will have to make a decision about using GM crops because we will require a trade-off between land for food and land for fuel, but there is another candidate for access to the land and that is the natural environment itself because it is under such pressure at the moment. There is not enough biological mass out there to mop up what is happening, so it is not whether we use it for food for the growing population or for bio-fuels because we want to use that instead of fossil fuels, but we are going to have to give more land back to the natural environment in order to provide the ecological resilience that we need to support life. It is

those sorts of things, the bigger scale, complexly inter-related, and vital that we are able to discuss those with a very transparent set of values and ethics on how we are doing it.

John Uff: This is such an interesting question I hope you don't mind if I add my small contribution. You are quite right to ask the question. Ethics was kick-started in the US 20 years ago by the destruction of the space shuttle Challenger. It was followed by a number of other very interesting cases, such as the San Francisco Bay area transport system which summarily sacked the man who pointed out that the brakes were defective a few weeks before the train crashed. That kick-started the whole idea and it has taken off. It is big business in the United States, and the idea that we can be immune from it is something that we could not entertain.

To come up to date it is absolutely right that there are some very big issues that involve engineers, and one could ask the simple question when we hear people talking about these big issues – nuclear power, sustainable wind power and so on – do we trust experts who appear on television and tell us what we ought to be thinking about these great issues? Look at the Code of Ethics which says that engineers should actively promote public awareness and understanding of the impact and benefits of engineering achievements, and be objective and truthful in any statement made in their professional capacity. I hope all those who are about to appear on television and tell us their opinions will just read that before they do so, and think. That is enough from me.

Terry Mulroy (Institution of Civil Engineers): I would like to congratulate The Royal Academy on producing its ethical principles, which I am pleased to see draws very heavily on the Civil's Code of Conduct and guidance. Many of you will have seen the article in the Sunday paper about the Saudi defence contracts; it was hinted in there that a 5 per cent back-hander might be acceptable but 25 per cent wasn't. Sara and John, do you believe there are any absolutes in engineering ethics?

John Armitt: You have crossed the boundary there from engineering ethics into business ethics.

Sara Parkin: Yes, I agree.

John Armitt: That is fundamentally a business decision. The person making it in the business may have an engineering background but when he is faced with that decision I don't think he makes it based on his engineering knowledge, it is a pure business judgment for that particular opportunity - how that arrangement will be viewed at home in his own country, which is different according to which country you come from, and how it will be

viewed in Saudi Arabia. Everybody knows that for the last 25 or 30 years Saudi Arabia and elsewhere in the Middle East a 'commission' was normally part of the business, usually quite small percentages, and most people took the view that it was up to that host country to decide whether that is how it wishes to procure its work. We want to work there and we want to be involved in the opportunities, very often technical opportunities because these are countries which were very often doing things that were not happening in their own countries and they would go along with that.

Today the views around that are different from 20 years ago, and you can see in the reaction from the people in Saudi Arabia to the recent discussions around the whole British Aerospace issue that the Saudis are not going to sit there and say quite happily that this money went in any particular direction. However what they will not say, and I have not seen anything yet, is that they felt it was wrong that an element of the money was paid in a support services way. I don't think it has very much to do with engineering ethics other than, as I said earlier on, to the degree that as an engineer, an individual, you can make a choice whether you want to be involved or not in that particular activity.

John Uff: Can I just close that out by saying there is a very good website of Transparency International which you probably know about, which covers this in great depth. I happen to know the person who organises the construction arm in this country, and he has told me of the relative ease or difficulty he has had with various institutions and organisations in getting them to sign up to his code of non-corruption. Some institutions have signed up more readily than others, but you will get it all from the website.

Dr Heather Fotheringham (University of Leeds): John touched upon this issue, although he did not particularly articulate it in quite the way I am going to: one might see one of the prime duties of engineers is to fulfil the needs of their clients, and if the client is in business often their prime aim is to make money, and pursuing money might often not ensue in the most ethical course of action. Do we see any way of resolving this kind of tension in how engineers should conduct themselves ethically?

John Uff: John, you did deal with that, so would you like to enlarge?

John Armitt: And also just touch on John's last comment. I go back to what I said earlier on about China. We cannot sit here and assume that the current mores, values and views that we have about how life should be lived in the UK is automatically that which should be followed by other countries. John used the word 'corruption' but many people would not accept that it was corruption by the standards and values of that particular society in which you are doing business.

There was a very good discussion recently on Radio 4 about women, I think in Bangladesh, who are now working in the garment manufacturing industry in Bangladesh, and the debate was whether it was correct that they should be doing this for 5p an hour or whatever the very, very low wage was, which was exploitation, etc. and whether Marks & Spencer should stop buying clothes there and so on. There was what I thought a very valuable set of arguments put from the opposite point of view, which said that for these women the opportunity to go to that factory was an act of freedom for them, because otherwise they were stuck in the village within the confines of society as it has been for the last 500 years, dominated by men, there simply to look after children, simply there to cook. They were prisoners within that society. The 5p an hour in the factory which was producing clothes was giving them freedom to get away from that way of life, they were getting three square meals a day in the factory, and for Bangladesh it is the first step to Bangladesh being able to stand on its own two feet. That is where South Korea was 20 years ago, and South Korea now produces high-tech equipment but it started off in the low-tech industry, and Bangladesh is going through the same process.

All the time we have to ask ourselves what the end objective is; we can't just say that because this is where we are today in the West that is where we expect others to be in five years' time. They are entitled to spend their time getting through these issues in their own development, whether it is a physical development or whether it is a value of life or more ethical values within their society. They are just as entitled to take their time getting through them as we have taken, because it has taken us a jolly long time to get to where we are today.

Sara Parkin: I would like to comment on this because this was one thing that exercised us in the Engineer for the 21st Century initiative, this difficulty if the engineer was there to serve the client and there was clearly an ethical issue. I think it is very important, and that is why the professional standards and ethics are very useful in that relationship with the client, and also those questions, the opening-up of what it is the client wants, and whether there are ways of being able to provide what the client wants that meet far better either the ethical standards or other criteria, like protecting the environment and so on. It is opening it up and asking the questions and having the debate that is really important.

I do agree with John about different cultures, and there are different cultures, but we also need to have that discussion about what are the values behind those different cultures. There are universal values, and taking your example of the women in the factory there are a lot of women, not just in this country but in Bangladesh, who might have a different view about the paths they would like to follow for their emancipation, because what is for sure is they cannot follow the same path as the last 150 years that we have done. It has to be

something completely different. So there is a real danger in, as it were, translating the way we were 150 years ago and saying that is the way that countries that are currently poor have to go too. There is a real danger that we will be very wrong-footed if we do that.

Professor Stephan Jeffris (Environmental Geotechnics Ltd): Perhaps we have reached the stage of the evening where I may be forgiven a slightly facetious, though absolutely serious, suggestion. We are this evening here to launch the Statement of Ethical Principles, the SEP. Have we forgotten the SEP 20 years ago, about two decades ago? In Douglas Adams' *Hitchhiker's Guide to the Galaxy* the SEP was the "somebody else's problem" screen. The SEP could hide a mountain by making it somebody else's problem, and I am a little worried that if we are going to sit in a reactive mode we have put up an SEP that will hide engineers from any complaint about our ethical principles. This is not a 'somebody else's problem' screen. We have to use it, and we are losing the proactive/reactive balance.

If I could just cite an example of that, Sara said 'Wouldn't it be nice to have an engineering equivalent of the Stern report?' – heck, wouldn't it have been nice to have had an engineering report and not had to have engineering translated to Government by an economist? It only matters to Government if it is translated to money. We have lost the plot. We need the engineering in there, and we have lost the connection to Government, so let this not be the Douglas Adams' SEP.

John Uff: I will take that as a comment rather than a question! Thank you very much for it.

Rowland Morgan (University of Bristol): I think you will agree that most of today's political problems have engineering solutions, so why are we governed by people in Westminster and Whitehall who are technically illiterate – and what's more, they are proud of it? How can we persuade more engineers to become involved in the national affairs of this country, and particularly get in to the House of Commons and the House of Lords?

John Uff: That is a question, I think – Sara?

Sara Parkin: It is a very important point and one I was trying to make, that there are clearly some fundamental illiteracies in the politicians who have been writing certainly the White Papers I have been reading. As far as sustainability is concerned we spend a lot of time doing capacity-building with boardrooms, with civil servants and with

others, so they get some understanding of the issues in a way that they can usefully use as they pursue their political careers.

There is a big education campaign to be had, because even engineers themselves forget the basic fundamental principles that underline their profession. There is something the institutions can do, not just for their own members and not just for the way engineers are educated in universities, but they can also provide attractive ways of bringing up to speed people like me and others who really have a need to understand the fundamental science and engineering challenges in the way the world works, and how we have to manage our future in the way we use energy and raw materials. I have beaten up engineers about this for a very, very long time; you could as a profession make this a big campaign, that everybody should have sufficient science and engineering literacy to understand the way energy and material is transformed through an economy.

John Uff: Isn't it curious how a fundamental principle of our society is that everyone is deemed to know the law? Why shouldn't they be deemed to know the second law of thermodynamics as well? *[Laughter]*

Sara Parkin: I quite agree!

John Armitt: The question in a sense was answered by Sara's point about Shakespeare and the second law of thermodynamics. Politics is about understanding people, and Shakespeare understood people. The second law of thermodynamics has got nothing to do with people, and that is why one is attractive and the other is not. That is the challenge which we face as engineers; one is dry, one is about human emotion. Politics is about human emotion, people are emotional and that is why they vote for one politician or another and therefore that is what the politician offers. The engineer doesn't offer that, so the challenge is enormous for us as to how as engineers we get in there and influence, but we will not get voted into Parliament on the second law of thermodynamics.

Sara Parkin: All nine members of Central Committee in China are engineers.

John Armitt: But they weren't voted in!

John Uff: Thank you very much indeed, I think I am now the only thing that stands between you and your drinks. I would like to make a couple of points: we started by looking at all the supporters of this event, and we were reminded that some of this document is based on what the ICE Code says, quite right; it is in fact based on all the other institutions as well, and the point is that all those Codes are different. I have come across cases in which it has been claimed that someone was in breach of the Code of one institution but not in breach of the Code of another institution of which that particular institution the engineer

happened to be a member. We can't have that, and that is one of the great achievements of this Statement of Ethical Principles, that it covers all engineers so there will be no more nonsense about whether you comply with one Code but not with another.

We have had some fascinating illustrations of ethical dilemmas which we ought to be thinking about, thinking up solutions. I will leave you with one ethical dilemma that I came across in a project somewhere in the Indian sub-continent for provision of a bridge with power lines. A decision was made that the power lines had to be extended a very great distance into a very remote community for the purpose, as it was perceived at the time, of bringing television to this remote community so that, if I can put it delicately, there was something to do after dark other than procreation. Of course, that in itself immediately raises the opposite ethical problem, in that you are opening to people who know nothing of it a world that is going to create the tensions, the wishes, the desires to have that which is quite unobtainable, and where the right solution in that dilemma might lie I would not like to guess, but it is certainly something that we should think about and talk about.

There have been lots more ethical dilemmas thrown up. John Armitt gave us the classic one about when you are asked to pay too much for a project do you simply walk away, the effect of that being that you, colloquially, leave it to the French? There are many other dilemmas that we all know about and we should be talking about them. We should be addressing them and we now have a common basis on which we can address them, think about the meaning to be given to these provisions of the SEP. It is my hope that as this evolves we will be able to say in practice what these provisions mean, what does it require of an engineer to say that he must be objective and truthful in any statement made in his professional capacity. We know that can't always be true, but let us hope that the SEP gives us serious guidance on how engineers should conduct themselves in these great debates that are to come.