



House of Commons

Innovation, Universities, Science
and Skills Committee

Engineering: turning ideas into reality

Fourth Report of Session 2008–09

Volume I

Report, together with formal minutes

*Ordered by the House of Commons
to be printed 18 March 2009*

HC 50-I
**[Incorporating HC 470-i-iii, 640-i-iii, 599-i-iii,
1064-i, 1202-i, 1194-i, Session 2007-08]**
Published on 27 March 2009
by authority of the House of Commons
London: The Stationery Office Limited
£0.00

The Innovation, Universities, Science & Skills Committee

The Innovation, Universities, Science & Skills Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Department for Innovation, Universities and Skills.

Current membership

Mr Phil Willis (*Liberal Democrat, Harrogate and Knaresborough*)(Chairman)
Dr Roberta Blackman-Woods (*Labour, City of Durham*)
Mr Tim Boswell (*Conservative, Daventry*)
Mr Ian Cawsey (*Labour, Brigg & Goole*)
Mrs Nadine Dorries (*Conservative, Mid Bedfordshire*)
Dr Ian Gibson (*Labour, Norwich North*)
Dr Evan Harris (*Liberal Democrat, Oxford West & Abingdon*)
Dr Brian Iddon (*Labour, Bolton South East*)
Mr Gordon Marsden (*Labour, Blackpool South*)
Dr Bob Spink (*UK Independence Party, Castle Point*)
Ian Stewart (*Labour, Eccles*)
Graham Stringer (*Labour, Manchester, Blackley*)
Dr Desmond Turner (*Labour, Brighton Kemptown*)
Mr Rob Wilson (*Conservative, Reading East*)

Powers

The Committee is one of the departmental Select Committees, the powers of which are set out in House of Commons Standing Orders, principally in SO No.152. These are available on the Internet via www.parliament.uk

Publications

The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at www.parliament.uk/ius

A list of reports from the Committee in this Parliament is included at the back of this volume.

Committee staff

The current staff of the Committee are: Sarah Davies (Clerk); Glenn McKee (Second Clerk); Dr Christopher Tyler (Committee Specialist); Dr Joanna Dally (Committee Specialist); Ana Ferreira (Senior Committee Assistant); Camilla Brace (Committee Assistant); Anna Browning (Committee Assistant); Jim Hudson (Committee Support Assistant); and Becky Jones (Media Officer).

Contacts

All correspondence should be addressed to the Clerk of the Innovation, Universities, Science & Skills Committee, Committee Office, 7 Millbank, London SW1P 3JA. The telephone number for general inquiries is: 020 7219 2793; the Committee's e-mail address is: iuscomm@parliament.uk.

© "Photo images on front cover and lower back cover supplied by University of Cambridge Institute for Manufacturing ; photo image on upper back cover supplied by UKAEA Culham Science Centre"

Summary

The Secretary of State for Business, Enterprise and Regulatory Reform, Lord Mandelson recently said: “If you really want to change the world—choose a career in engineering. And I mean real engineering, not financial engineering.” His comment encapsulates the spirit of our Report. In the current economic climate, engineering has come under the spotlight because it is a critical component of our national economy and of society in general.

We have found engineering to be one of the UK’s great strengths and were pleased to discover that UK engineering and engineers are highly regarded internationally, more than they are at home. We are convinced that the strength of the UK’s engineering base means that the UK can play a major part in solving global problems such as climate change, food and water supply, energy security and economic instability.

Engineering cuts across every aspect of the work of DIUS—skills, higher education and innovation—as well as other departments. It encompasses research and development, design, production, distribution and services. We decided to take a case study approach, exploring key themes through the lenses of nuclear engineering, plastic electronics engineering, geo-engineering and engineering in Government.

Nuclear engineering: The Government's recent enthusiasm for nuclear power has raised important questions about the UK's capacity to deliver a new generation of nuclear power stations. We discovered that there are significant skills shortages, which could affect plans to bring new plants online by 2020. We argue that there should be a master roadmap for all major engineering projects, including nuclear new build.

Plastic electronics: This case study highlighted the potential opportunity afforded to the UK through the support of emerging, innovative industries. Hailed as a disruptive technology, the UK research base in this area of plastic electronics is world-class. We are concerned, however, that the UK is likely to miss out on the economic return associated with translating the findings of research into commercialised technologies, and call for a serious revision of the structures used to support the growth of fledgling industries.

Geo-engineering: The global nature of many engineering challenges was highlighted during our discussion of geo-engineering research. During this case study we considered the implications of a new engineering discipline for UK policy-making. It became clear that, if the Government is to be an informed actor in the development of any future international policy relating to geo-engineering, it is essential that the views of the science, engineering and social science communities be seen as complementary sources of expertise, and their advice actively sought and considered.

Engineering in Government: Our final case study went further and demonstrated that engineering advice and scientific advice offer different things, and that this should be recognised in the policy process. Government, in key policy areas of several departments, does not have sufficient in-house engineering expertise to act as an intelligent customer and engineering advice is frequently not sought early enough during policy formulation. We were shocked to discover that engineering advice had been lacking in the formulation of policies as important and diverse as eco-towns, renewable energy and large IT projects.

We suggest that there should be a greater level of engineering expertise in the generalist civil service as well as more engineering policy specialists. As a starting point, the

Government should at least know what expertise it has in the civil service. It should also recruit more people into the Science and Engineering Fast Stream, distribute them more widely and provide real opportunities in career progression while retaining specialist skills. And it should also strengthen links between the public and private sector through secondments.

We argue that there is a need for better trans-departmental management of engineering policy. To help achieve this, we have suggested a reorganisation of the high level advisory structures in Government. The GCSA should be renamed the Government Chief Scientific and Engineering Adviser (GCSEA). This person would be the head of profession for science, engineering and social science and should have a more senior role in the Government with direct access to the Prime Minister. The GCSEA would head up the Government Office for Science and Engineering, which should be placed in the Cabinet Office. Beneath the GCSEA should be a Government Chief Engineer, a Government Chief Scientist and a Government Chief Social Scientist. Additionally, departments should either have a Departmental Chief Engineering Adviser (DCEA), or a Departmental Chief Scientific Adviser (DCSA), and in some cases they should have both.

Our overall conclusions link our case studies together and are relevant to the engineering sector as a whole. As stated above, we argue that there is a need for better trans-departmental management of engineering policy. The Government should adopt a practice of formulating and following roadmaps for each major engineering programme with co-ordination between each of them. And the Government should be more strategic in its support for emerging industries and policy areas. To achieve these goals, the Government would benefit from having senior officials with appropriate skills and experience tasked to oversee engineering roadmaps and strategic plans. These officials should also manage engineering advice in a civil service with more specialised engineering expertise throughout.

The recent economic crisis has presented the Government with a once-in-a-generation opportunity to restructure the economy by building on the existing substantial strengths of UK engineering. Our report suggests how that could be achieved.

Conclusions and recommendations

The profession

1. The engineering community's approach to this inquiry has been coherent and co-ordinated, with the institutions working together to communicate a common message with and through the Royal Academy of Engineering. The Academy must take forward and formalise its leadership role, so that the engineering community can communicate—and co-ordinate—more effectively. (Paragraph 10)

Nuclear engineering: skills

2. The Generic Design Assessment (GDA) process is important and requires highly skilled inspectors. The Government should make available sufficient resources to the Health and Safety Executive and the Environment Agency so that they can recruit enough staff to complete the GDA process in a timely fashion and to the high standards required. A clear timetable should be published by the end of 2009. (Paragraph 33)
3. We note the Government's optimism that delivering new nuclear power stations within ten years is possible. However, we are not convinced that the skills shortage in nuclear engineering can be bridged quite as easily as some have suggested. In particular, the General Design Assessment, which kick-starts the whole process, is already running slower than expected, and the remaining workforce is ageing. The Government must continue its investment in engineering and nuclear engineering skills and produce a clear skills plan by the end of 2009 (see Paragraph 33), to ensure its nuclear new build ambitions can be met. (Paragraph 41)
4. We welcome the formation of the National Skills Academy for Nuclear: employer-led training is the best way to ensure that industry gets the skills it requires. However, we also believe that there should be greater clarity from industry and Government about which institutions do what in terms of skills provision. (Paragraph 47)
5. The design of fourth generation nuclear reactors will go ahead with or without UK participation, and it is likely that the UK will want to start building fourth generation power stations in the future. The UK should avoid positioning itself so that it has little expertise in the very nuclear systems it needs in the future. In a post-oil economy, nuclear power will be a major player in the energy market and the UK should grasp enthusiastically the opportunity to take a lead role in the international nuclear industry. (Paragraph 50)
6. The Government should consider which research programmes—including the Generation IV programme, EURATOM, and IAEA and OECD research programmes—are required to support its nuclear activities. We strongly recommend that the Government commission the National Nuclear Laboratory to conduct a cost-benefit analysis on what international R&D offers the UK in relation to maintaining UK nuclear engineering capability and ensuring future UK energy policy is supported. (Paragraph 52)
7. We support the formation of the Office for Nuclear Development, but remain concerned about the lack of a clear and detailed plan for delivering the next generation of nuclear power stations. There should be a master roadmap for all major engineering projects, including nuclear new build. The Office for Nuclear

Development should take ownership of the roadmap for nuclear. The roadmap should include consideration of: what skills are required over time and what will be needed to deliver the skills capacity ahead of time; other general engineering programmes and nuclear engineering programmes, both national and international; potential bottlenecks in the supply chain; and who is responsible for the delivery of each part of the roadmap. There should be six-monthly progress reports against the roadmap. The roadmap should be in place by the end of 2009. (Paragraph 57)

Plastic electronics engineering: innovation and commercialisation

8. The UK is well placed to capitalise on the economic potential of the growing plastic electronics industry. However, we are concerned that without a clear understanding of how best to build on and market the UK's strengths in this sector this opportunity might not be fully realised. We urge BERR to engage with the Technology Strategy Board, UK Trade and Investment, UK Displays and Lighting Knowledge Transfer Network and the plastic electronics community to develop a technology roadmap. In constructing this roadmap it is essential that stakeholders across the sector be consulted, from spin-out companies to multinationals. (Paragraph 72)
9. We welcome the support for plastic electronics research and development provided by EPSRC and the Technology Strategy Board, and believe sustained support by these organisations is vital to the growth of the industry. (Paragraph 80)
10. We do not believe that the Technology Strategy Board's grant schemes and the Managed Programme proposed by UKDL KTN and the former-DTI are mutually exclusive forms of support. UKDL KTN champions the needs of the plastic electronic community, and as such we urge BERR and the Technology Strategy Board to engage with it, and to reconsider the deployment of a Managed Programme in this area. (Paragraph 89)
11. The future success of the UK plastic electronics industry not only lies in its ability to lever public and private finance, but also in the co-ordination of funding sources. We recommend that BERR, the Technology Strategy Board and UKDL KTN take immediate steps to increase the understanding of technological risk in the private sector, and to review the funding landscape. (Paragraph 95)
12. PETeC's location is a function of the fact that it was established as a regional initiative. It is an open question whether PETeC would have been sited elsewhere had it been founded as a national resource, something that it undeniably is. However, we do not see further discussion on this issue as constructive or worthwhile, and wish to see a line drawn under the debate. (Paragraph 100)
13. We are sympathetic to PETeC's need to generate income in order both to assure its future survival and to allow it to participate in UK grant competitions. The Technology Strategy Board and OneNorthEast should review whether the requirement for self-sustainability within five years is realistic. (Paragraph 104)
14. We urge PETeC to continue developing its relationships with other Research Centres, and to liaise with these Centres to ensure national capability in facilitating R&D across the spectrum of plastic electronic technologies. (Paragraph 106)
15. The plastic electronics industry is likely to grow substantially over the next few years. Although the UK's research base puts it in a unique position to capitalise on this growth, we must not be complacent as countries such as Germany and the USA are becoming increasingly competitive. We recommend that the Research Centres supporting UK plastic electronics R&D engage with the academic research base to

ensure state-of-the-art facilities are accessible to the academic community. (Paragraph 112)

16. The UK academic research base should be applauded for its strong record in ‘spinning out’ start-up companies. Focused support, however, is needed to ensure these businesses grow into world-class enterprises. We recommend that the Technology Strategy Board, BERR and UKTI consult with UK business, from start-ups to multinationals, to identify how best to support the growth of innovative businesses in emerging industries. (Paragraph 120)
17. We encourage the Technology Strategy Board to engage with multinational companies across Europe to determine whether pan-European consortia could be established to progress the development of emerging industries with the potential for high economic returns. (Paragraph 128)
18. The manufacture of plastic electronics devices is not destined to occur outside of the UK. However, we are extremely concerned that without urgent action by the Government this will be the reality. As in our previous recommendation (Paragraph 72), we urge the Government to engage with the plastic electronics community, and to articulate a strategic vision for the development of this innovative industry. (Paragraph 130)
19. Support for innovative businesses as they transition from being primarily R&D focused to launching pilot manufacturing lines is imperative. We recommend that the Government consider whether there is merit in establishing an open access fabrication facility for the manufacture of Plastics Electronic devices by UK SMEs. (Paragraph 133)
20. The economic opportunities provided by this growing industry do not only lie in the manufacture of devices, but also in the development of enabling technologies. It is imperative that any national strategy for this industry must embrace the materials supply chain, particularly as this sector holds huge potential for UK industry participation. (Paragraph 138)
21. Public procurement has the potential to be a valuable tool in driving innovation. We welcome the Government’s efforts to develop innovative procurement mechanisms, and recommend it supports pilot projects in the area of plastic electronics in order to stimulate product development and manufacture. (Paragraph 148)
22. The Small Business Research Initiative (SBRI) is potentially a valuable source of funding for innovative companies in the UK. Our concern is that unless this support mechanism is re-launched in a format accessible to SMEs developing future technologies, UK companies will refocus their business models to engage with the lucrative procurement opportunities offered by the US under its Small Business Innovation Research programme. We ask that DIUS keep us updated on progress made in rolling-out the revised SBRI. (Paragraph 155)

Geo-engineering: a new policy area

23. At this stage, we do not consider a narrow definition of geo-engineering technologies to be helpful. Technologies to reduce solar insolation and to increase carbon sequestration should both be considered as geo-engineering options. (Paragraph 182)
24. Like the Minister of State for Science and Innovation, we believe that Government should give the full range of policy options for managing climate change due

consideration, and we share the view of the Tyndall Centre that geo-engineering technologies should be evaluated as part of a portfolio of responses to climate change, alongside mainstream mitigation and adaptation efforts. (Paragraph 185)

25. Given the need for urgent action in addressing the challenge of climate change, we can see no reason for not considering geo-engineering technologies as a 'plan B'. Quite the opposite, the decision not to consider any initiative other than 'plan A' could be considered negligent particularly, for example, if 'plan A' fails to act as planned or climate sensitivity is greater than expected. (Paragraph 187)
26. We find the divergent views of DECC and DIUS, as outlined by Lord Drayson and Joan Ruddock, as to the future potential of geo-engineering research to be confusing, and urge the Government to establish a clear view on the matter. (Paragraph 190)
27. Further, we conclude that it would not be appropriate or sensible for opinion-leaders or the public to see any policy on the potential use of geo-engineering schemes as implying a lack of ongoing commitment to the development of conventional emission mitigation strategies or adaptation responses. We urge the Government to be proactive in communication efforts to dispel any incorrect perceptions. (Paragraph 191)
28. In order 'to sort the wheat from the chaff' and identify those geo-engineering options it may be feasible to deploy safely in the future, it is essential that a detailed assessment of individual technologies be conducted. This assessment must consider the costs and benefits of geo-engineering options including their full life-cycle environmental impact and whether they are reversible. We welcome the efforts of the Royal Society to review the geo-engineering sector, and urge it to engage with the Royal Academy of Engineering and the Science and Engineering Academies of other nations in this regard. (Paragraph 197)
29. Support for detailed modelling studies will be essential for the development of future geo-engineering options, and to the construction of a credible cost-benefit analysis of technological feasibility. We urge the Research Councils to support research in this area. (Paragraph 203)
30. The Tyndall Centre for Climate Change is well-placed to co-ordinate geo-engineering research, and we would welcome the conduct of geo-engineering-related work as an additional work-stream. Further, we recommend that the Government engage with organisations including the Tyndall Centre, Hadley Centre, Research Councils UK and the Carbon Trust to develop a publicly-funded programme of geo-engineering research. Research grants should be awarded on the basis of excellence after a process of competitive peer review. (Paragraph 217)
31. Before deploying any technology with the capacity to geo-engineer the climate, it is essential that a rational debate on the ethics of geo-engineering be conducted. We urge the Department for Energy and Climate Change to lead this debate, and to consult on the full-range of geo-engineering options with representatives of the science, social science, and engineering communities and implementing agencies e.g. national Governments, international bodies or private sector organisations. (Paragraph 226)
32. It is essential that the Government support socio-economic research with regard to geo-engineering technologies in order that the UK can engage in informed, international discussions to develop a framework for any future legislation relating to technological deployment by nation states or industry. (Paragraph 229)

Engineering in Government

33. We conclude that engineering advice and scientific advice offer different things to the policy formulation process and that the benefits of both should be recognised. Further, it should not be assumed that a scientific adviser can offer competent engineering advice or even know when it is needed. (Paragraph 248)
34. We conclude that the Government, in several policy areas of several departments, does not have sufficient in-house engineering expertise to act as an intelligent customer. (Paragraph 257)
35. The Guidelines on Scientific Analysis in Policy Making should explicitly include engineering advice. We are pleased that Professor Beddington has already agreed to review these guidelines, and suggest that the research and engineering community be consulted on the content of the guidelines. (Paragraph 260)
36. Engineering advice should be sought early in policy formulation and before policy is agreed, not just in project delivery. We recommend that the Secretary of State for Innovation, Universities and Skills and the Minister for Science and Innovation act as champions in cabinet for the early engagement of engineers in policy making. Further, this issue should also be central to discussions in the Science and Innovation Cabinet Sub-Committee. (Paragraph 265)
37. For engineering advice, the Government should consider the Royal Academy of Engineering as its first port of call. The Academy can then bring together the relevant experts, including representation from the relevant professional institutions, to provide impartial, expert and timely input to policy formulation. (Paragraph 272)
38. The Government should set up a Working Group with the Royal Society, the Royal Academy of Engineering, the British Academy and the Academy of Medical Sciences to explore how and whether the relationship between Government and the Academies could be formalised so as to improve policy making. We reiterate the 2006 Science and Technology Committee recommendation that strong consideration should be given to the US model. (Paragraph 273)
39. We reiterate the 2006 Science and Technology Committee's previous recommendation that: "the Government implement the 2002 recommendation of the Cross-Cutting Review of Science and Research to maintain records on specialist staff in order to identify their qualities and experience". (Paragraph 281)
40. The Government could promote the importance of professional accreditation in engineering by insisting that staff and consultants in technical roles are chartered. Additionally, the Government should keep proper records of the professional qualifications of its staff so as to improve its human resources information and continuing professional development. (Paragraph 284)
41. The Government claims that the Science and Engineering Fast Stream is highly valued, yet only four departments recruit from it. We ask the Government to explain why this situation has arisen and what steps it plans to take to ensure that all Departments recruit from the Science and Engineering Fast Stream. (Paragraph 287)
42. There should be more trained and experienced engineers in the civil service at all levels. One way of helping to achieve this would be to expand and adapt the Science and Engineering Fast Stream (SEFS) so that more scientists and engineers are recruited, more departments recruit from this cohort and SEFS recruits have the option to pursue careers as policy specialists. We also recommend that the

Government prioritise training in the civil service to improve the ability of generalist civil servants to identify issues where engineering advice will be critical to the viability of a policy. (Paragraph 291)

43. The Government should seek ways to improve the career flexibility between industry and the public sector. Both sides would benefit: engineers from the private sector would improve their understanding of Government, and civil servants would improve their understanding of industry; additionally, the public sector would benefit from using the skills of engineers who have managed major projects in the private sector. (Paragraph 295)
44. We share our predecessor Committee's concern that the Treasury does not have scientific or engineering advice at the highest level. The Treasury should appoint both a Chief Scientific Adviser and a Chief Engineering Adviser. (Paragraph 299)
45. The Government could easily support its claim to recognise the importance of engineering and engineers by appointing Chief Engineering Advisers, at a minimum in positions where existing Chief Scientific Advisers act as Chief Engineering Advisers. (Paragraph 305)
46. The Government has argued on several occasions that 'science' includes engineering, and therefore there is no need for a Chief Engineer. But it also argues that 'science' includes social science and statistics, yet there is a Chief Social Scientist and a National Statistician. The Government's position is illogical. (Paragraph 306)
47. Some departments should have Departmental Chief Engineering Advisers (DCEAs), some Departmental Chief Scientific Advisers (DCSAs), and some should have both. The Government Chief Scientific Adviser should liaise with Departments to determine which arrangement is most appropriate. (Paragraph 307)
48. The role of the GCSA should be altered. We suggest that the GCSA should be renamed the Government Chief Scientific and Engineering Adviser (GCSEA). This person would be the head of profession for science, engineering, social science and statistics and should have a more senior role in the Government with direct access to the Prime Minister. The GCSEA would head up the Government Office for Science and Engineering, which should be placed in the Cabinet Office. Beneath the GCSEA should be a Government Chief Engineer, a Government Chief Scientist and a Government Chief Social Scientist. We recommend that the Government implement these changes as a priority. (Paragraph 313)

Overview and general conclusions

49. We were greatly impressed by the high quality and wide-ranging work to give young people experience of engineering. We are supportive of all efforts to make young people aware of the rewarding and challenging nature of a career in engineering. While we would not advocate that geo-engineering be championed as a research field above any other, we believe that it might have the 'X-factor' when it comes to alerting young people to global engineering challenges and we welcome its inclusion in engineering events. We are concerned, however, that engineering is not always promoted as a worthwhile, challenging and exciting career option, and advocate that it feature more prominently in the provision of careers advice at schools. (Paragraph 323)
50. The key to solving sector-specific shortages of engineers will ultimately lie in the UK's ability to train the next generation of generalist engineers, who will then

specialise after university. Plastics electronics is one example of an industry that would benefit from the introduction of post-graduate programmes that offered generalist engineers specialised training. We recommend that EPSRC engage with industry to assess the potential for establishing a range of conversion courses according to need across the engineering sector to upskill generalist engineers. (Paragraph 331)

51. We believe there to be value in incorporating management skills in post-graduate masters and doctoral programmes. We recommend that HEFCE, EPSRC, the Royal Academy of Engineering and the professional institutions co-ordinate to advise on best-practice in the delivery of this training by higher and further education institutes. (Paragraph 336)
52. We support the Government's efforts to promote diversity in engineering. Its financial support for STEMNET and the Science and Engineering Ambassadors programme, WISE, the Computer Club for Girls, and the work of the Royal Academy of Engineering and the Engineering Development Trust is welcome and should continue. (Paragraph 344)
53. We are concerned that evidence is lacking on the factors that affect the career choices of women and other under-represented groups. We recommend that DIUS commission research to examine these factors. This evidence should then be used as a platform from which to develop and target widening participation initiatives. (Paragraph 345)
54. We suggest that the engineering institutions, Engineering Council UK and the Government (see Paragraph 284, Chapter 5) should do a better job of promoting Chartered Engineer status (CEng), Incorporated Engineer status (IEng) and Engineering Technician status (EngTech). In the same way the general public respects academic qualifications such as PhDs, Masters and Honours Degrees, or professional qualifications in law and medicine, so should it be possible to inform the public about the professional status of CEng, IEng and EngTech. (Paragraph 357)
55. There is a need for better trans-departmental management of engineering policy. The Government should adopt a practice of formulating and following roadmaps for each major engineering programme, including skills provision (see Chapter 2) with co-ordination between each of them. The Government should also be more strategic in its support for emerging industries and policy areas (see Chapters 3 and 4). Finally, Government would benefit from having senior officials tasked to oversee engineering roadmaps and strategic plans, and to manage engineering advice in a Civil Service with more residual and specialised engineering expertise. There should be two people responsible for this challenging body of work: a Government Chief Scientific and Engineering Adviser and a Government Chief Engineer (see Chapter 5). (Paragraph 360)
56. We are convinced that the considerable strength of the UK's engineering base makes it both this nation's responsibility and in its economic interest to play a major part, through our engineering base, in solving global problems such as climate change, food and water supply, energy security and economic instability. The recent economic crisis has presented the Government with a once-in-generation opportunity to restructure the economy by building on the existing substantial strengths of UK engineering. (Paragraph 362)