The Royal Academy of Engineering

Educating Engineers for the 21st Century

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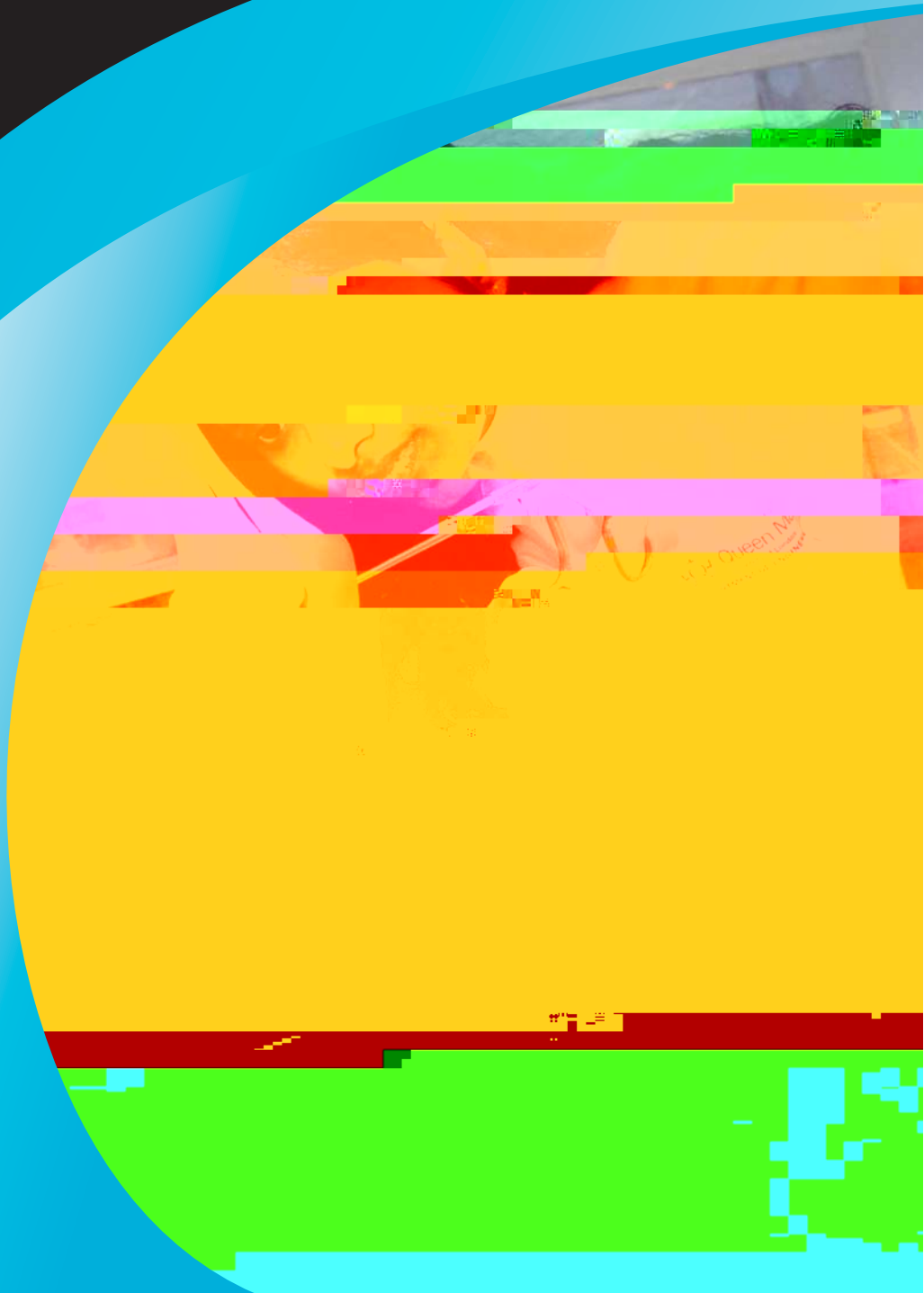

Amongst the greatest challenges we face in the world today are those of delivering growing, secure and affordable supplies of clean water and of energy, to meet the needs and expectations of an expanding population, whilst reducing our CO_2 emissions and the human contribution to climate change. The implementation of innovative engineering solutions is fundamental to addressing these challenges, whilst also offering exceptional opportunities for economic growth to the nations which are able to deliver them.

Yet at this time when our need for engineering talent is huge, and when our young people are increasingly interested in how they can help to save the planet, we are failing to persuade them that engineering careers are exciting, well-paid and worthwhile. The report concludes that we will face an increasing shortage of graduate engineers in the UK unless action is taken.

The main focus of the working party's review has been the quality and relevance of engineering undergraduate education in the UK. In particular, its fitness for purpose in this age of the 'Knowledge Economy', now that developed countries must rely increasingly on intellectual capital for their competitiveness.

Encouragingly industry and academia are in close agreement on the key issues and what needs to be done. The university respondents would welcome closer collaboration with companies to ensure that our graduates can apply their knowledge effectively in real engineering situations and the opportunity to develop and implement new courses and approaches. It is essential that we provide the right conditions in university engineering departments for such university/industry partnerships, as well as new approaches to learning and teaching, to flourish.

I would like to thank the members of the working party for their thoughtful, constructive and challenging inputs to this work:

Professor Graham J Davies FREng — Head of School of Engineering, University of Birmingham
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The working party would not have been able to undertake the study without the excellent support of The Royal Academy of Engineering team:

Dr Robert W Ditchfield: Director, Education Affairs
EurIng Ian J Bowbrick: Manager, Postgraduate and Professional Development
David M Foxley: Manager, Engineering Design Education

Many other people have made valuable contributions. These include the staff of companies listed in Appendix 3 who answered our questions and returned the questionnaire, senior academics from the universities listed in Appendix 5 who responded to the consultation, participants in the meeting at the Royal Society of Arts, held to launch the results of the Industry Study and the Academy's Visiting Professors of Design, who, at their annual conference in September 2006 provided excellent, action-oriented inputs. The working party members would like to thank all of those who have been involved.

Professor Julia E King CBE FREng
Vice Chancellor
Aston University

Chair of the Educating Engineers for the 21st Century Working Party

June 2007

Overview

No factor is more critical in underpinning the continuing health and vitality of any national economy than a strong supply of graduate engineers equipped with the understanding, attitudes and abilities necessary to apply their skills in business and other environments.

Today, business environments increasingly require engineers who can design and deliver to customers not merely isolated products but complete solutions involving complex integrated systems. Increasingly they also demand the ability to work in globally dispersed teams across different time zones and cultures.

The traditional disciplinary boundaries inherited from the 19th century are now being transgressed by new industries and disciplines, such as medical engineering and nanotechnology, which also involve the application of more recent engineering developments, most obviously the information and communication technologies. Meanwhile new products and services that would be impossible without the knowledge and skills of engineers - for instance the internet and mobile telephones - have become pervasive in our everyday life, especially for young people.

Engineering businesses now seek engineers with abilities and attributes in two broad areas - technical understanding and enabling skills. The first of these comprises: a sound knowledge of disciplinary fundamentals; a strong grasp of mathematics; creativity and innovation; together with the ability to apply theory in practice. The second is the set of abilities that enable engineers to work effectively in a business environment: communication skills; team-working skills; and business awareness of the implications of engineering decisions and investments.

It is this combination of understanding and skills that underpins the role that

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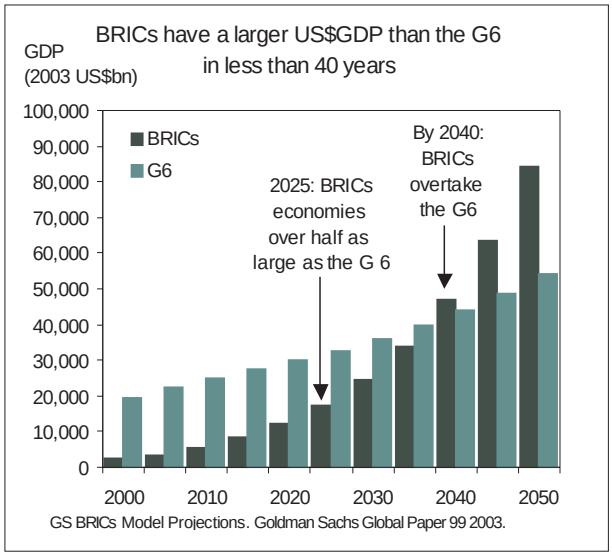
Right now in the UK even the basic output of engineers is effectively stagnating. Between 1994-2004 the number of students embarking on engineering degrees in UK universities remained static at 24,500 each year even though total university admissions rose by 40% over the same period. Further, after completing their studies less than half of UK engineering graduates subsequently choose to enter the profession [1].

International developments make the implications of this situation even more disquieting. Mature economies, such as that of the UK, must now compete with those of rapidly developing countries such as the BRIC nations - Brazil, Russia, India and China. On current projections the combined GDPs of the BRIC nations are set to overhaul those of the G6 countries (US, UK, Germany, Japan, France and Italy) by the year 2040 [2]. Furthermore the BRIC nations are producing record numbers of graduate engineers. In China and India alone, the most conservative estimates suggest that around half a million engineers now graduate each year [3].



Consequently countries like the UK face the double challenge: producing increased numbers of a new type of engineer. The long term implications of a failure to confront this situation are self-evident. Ultimately the UK could slide into insignificance as an internationally competitive industrial nation.

Action is needed to counter and reverse these trends. But such action must be based on reliable, in-depth information on several key issues. These include: the current state of undergraduate engineering education in terms of its quality, content and funding needs; future industry requirements; accreditation procedures; and the extent to which the school system is ensuring a healthy 'pipeline' of engineering undergraduates.

For these reasons The Royal Academy of Engineering set up a working group specifically to address the issue of Educating Engineers for the 21st Century, chaired by Professor Julia King. The group commissioned extensive research within both UK industry and the universities; altogether over 400 companies and nearly 80 university engineering departments have been involved. The

membership of the Educating Engineering for the 21st Century Working Group is listed in the Chair's Foreword on page 3; the terms of reference appear in Appendix 1.

This report is a summary of the findings of that research and the resulting actions proposed by The Royal Academy of Engineering. The major findings of the research are that:

Research Process

This report has been produced on the basis of extensive consultation with industry, the universities and recent engineering graduates. It represents the most comprehensive recent survey of attitudes, expectations and experiences amongst the key customers, providers and recipients of engineering education in the UK.

The Industry Study

The first step in the consultation process was an industry study carried out on behalf of the Academy by Henley Management College during 2005. The study began with 21 in-depth interviews with senior personnel in major companies in the manufacturing, energy and process sectors, civil engineering, IT and the utilities. It was followed by a further 13 interviews with SMEs, seven of which were high-tech spin-outs from UK university engineering departments. In addition three focus groups were conducted with recent engineering graduates. The companies involved are listed in Appendix 3.

The information gained was used to formulate a detailed questionnaire that was distributed to over 8,000 further engineering companies. The questionnaire sought to obtain information in four main areas:

- € changes in the industry;
- € current and future skills requirements;
- € the comparative quality of UK and international engineering graduates;
- € consequential requirements for changes in engineering degree courses.

Altogether 444 replies to the questionnaire were received, a response rate of 5.4%; more than double the usual rate for such exercises. Moreover 53% of the companies responding were SMEs. This response rate is strong evidence of the importance attached to the issue within industry. The Academy working party's Commentary and the full report on the industry responses are available for download from the Academy's website at www.raeng.org.uk/henleyreport

The research indicated that industry expects that the supply of high calibre engineering graduates will steadily diminish over the next ten years with serious and direct repercussions for productivity, creativity and hence profitability. Current shortages of graduate recruits in Civil, Electrical, Electronic Engineering and Systems Engineering were all highlighted. Companies identified Information and Communications Technology and Materials as key areas for increased graduate recruitment to support future growth.

Companies are concerned about the type of graduate engineer they want to

About the Engineering Subject Centre

Background

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The prominence of creativity and innovation endorses the conclusion of the Cox Review on the importance of creative skills in improving the UK's competitiveness in the face of the challenge from emerging economies [5].

Although business skills come last in the ranking of industry requirements, industry is nevertheless quite specific about the nature of such skills it wants graduate engineers to possess. These are general commercial awareness - defined as an understanding of how businesses work and the importance of the customer - combined with a basic understanding of project management.

Significantly the research found little difference between the requirements for graduate engineering skills of major companies and SMEs. The only difference of note is that SMEs have a distinct preference for graduates with some experience of the commercial world, whereas major companies with their own graduate training schemes tend to recruit directly from universities. Less than half the SMEs that responded to the survey operate graduate training schemes of their own, whereas almost 90% of the large companies reported having such schemes in place.

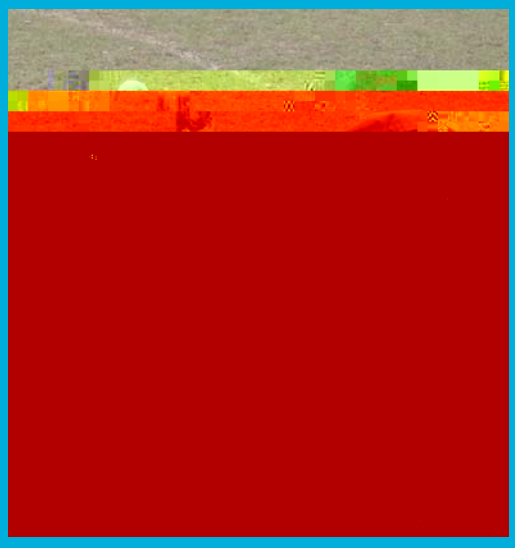
Measures to support the introduction of structured graduate training schemes within the SME sector could, therefore, prove of great value. This is an area in which public sector bodies such as the RDAs or professional bodies such as the engineering institutions could become involved. It is also an area in which larger companies could usefully provide support to the SME community, possibly as part of their supply chain development policies.

Real industrial experience, however, remains a primary factor in the recruitment policies of the great majority of companies and is highly influential in determining the selection of job applicants for interview. The need to ensure that students gain practical experience of real industrial environments during their studies is therefore extremely important. This perception is shared by students themselves, since the graduate focus groups expressed concern

The CDIO Initiative

A new vision

"We have adopted CDIO as the engineering context of our education"



duties but there is strong perception of inadequate incentives and rewards for teaching compared with research. Despite the fact that most universities have a formal commitment to recognising teaching expertise in their appointment and promotion processes, many of those involved feel that research activities and even administrative expertise are given undue weight.

UK universities are also anxious about the moves currently taking place at a European level to achieve 'Bologna compliance', effectively the harmonisation of the required standards for engineering degree courses, but primarily

through an approach based on course length. Specifically they want to ensure that the current UK four-year MEng degree course structure is recognised as fulfilling all the relevant requirements through its delivery of a compact syllabus in an integrated manner and that there is no need to adopt the five-year format used elsewhere in Europe. A major fear is that failure to defend the integrity of the existing UK degree structure might devalue UK degrees in the eyes of potential overseas students, whereas increasing the length of degrees to 5 years could discourage UK students from studying engineering.

Nevertheless the overall picture also contained some positive elements. Nearly three fifths of the academic respondents, for instance, were implementing elements of the CDIO (Conceive, Design, Implement, Operate) approach to learning and teaching which puts an emphasis on articulating and solving problems as a lead in to developing the important but more abstract analytical skills, a highly appropriate approach for engineers [7]. Around three quarters also expressed support for the introduction of new types of engineering course, such as biotechnology or nanotechnology. In addition just over half reported they had had contact with at least one or other of the HEFCE-funded Engineering Subject Centre (engSC) or the UK Centre for Materials Education.

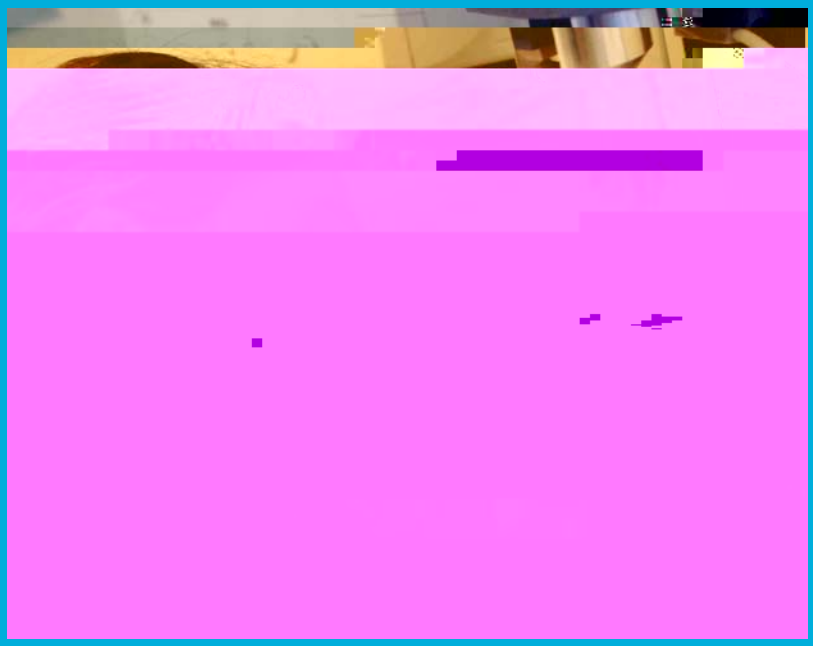
Overwhelming enthusiasm was expressed for greater industrial involvement in the education process, something already implemented through initiatives such as the Academy's Visiting Professors scheme. One useful way in which greater involvement could be effected would be through increased participation by practising engineers in the accreditation process for degree courses, a measure that would help ensure that course content is developed in sympathy with the real requirements of industry. This would be particularly valuable in the case of newer courses, such as Systems Engineering or Bioengineering, of a multi-disciplinary nature that do not obviously fall under the remit of a single engineering institution.

The information gathered from these studies subsequently informed much of the discussion at the conference of the Academy's Visiting Professors schemes in Engineering Design, Sustainable Development and Integrated Systems Design held at Churchill College, Cambridge, on 12-13 September 2006. The confubsequently ioan atvifunthe cirussi(e thof trs sche on ur)11.2wifuighlc[(sk)-nhe oi

4 Engineering courses must develop in line with the real and constantly evolving requirements of industry. Regulation and maintenance of standards should encourage and enable change rather than inhibit.

- To ensure that UK engineering education is world-class, academic staff need the time and resources to implement new approaches to engineering learning and teaching, an example of which is the Conceive, Design, Implement and Operate (CDIO) framework.
- There is a need to embed multidisciplinary approaches based on systems thinking, with strong industry links, within all engineering courses.
- New courses which appeal to a wider range of students, and particularly women undergraduates, such as Bioengineering and Medical Engineering, should be encouraged. But engineering must avoid the 'forensic science' trap of training graduates in fashionable subjects for jobs which do not exist. We must ensure that all new courses retain a strong core engineering content, both in terms of depth and quality, such that graduates can be employed in a wide range of professional engineering roles.

Medical Engineering at Queen Mary



5 The prestige of and resource for teaching in research-active engineering departments have been compromised by a disproportionate emphasis on the research output as a consequence of the Research Assessment Exercise.

€ Teaching must be seen as central to academic career prospects and be

7 Universities must continue to teach 'core engineering' and not dilute course content with peripheral subject matter.

€ Industry's top priorities for engineering graduate skills are practical application, theoretical understanding, creativity and innovation.

- € Accreditation panels should include current industry practitioners who can provide advice on how course content should be shaped to produce graduates with the knowledge, skills and aptitudes that industry genuinely requires. The Accreditation process offers one route for industry to comment on what will be needed for the future and thereby stimulate new thinking and course improvements.

9 To fill the "pipeline", more must be done to ensure that school students, parents and teachers perceive engineering as an exciting and worthwhile subject that offers stimulating and well-paid careers.

- € Industry itself, and indeed government, must get involved in this process, especially in the critical task of ensuring that teachers and parents - by far the most crucial opinion formers for school students - become convinced of the benefits of engineering as a career choice. Key messages are the value of engineering to society (energy, climate change, care of the elderly etc), the excitement of the technological challenges, and the good career prospects and salaries accessible through the study of engineering.
- € Current initiatives to encourage school students to study mathematics and the physical sciences and to increase the number of science teachers are strongly welcomed.
- € Similar encouragement should also be given for universities and companies to collaborate with other interested parties along the lines laid out in the Teaching Engineering in Schools Strategy (TESS) as envisaged in the National Engineering Programme (NEP).

Recommendations

Reshaping undergraduate engineering education in the UK to meet the demands of the 21st century will require input from the Government, the engineering profession, industry and academia. The major recommended actions are as follows:

To Government

€ To increase university funding to cover the true cost of providing world-class teaching in engineering from the present factor of 1.7 to at least 2.5, and optimally three, times the basic unit of resource.

€ To place teaching quality alongside research excellence in the assessment of the funding requirements for universities

€ To enable overseas engineering students to work in the UK for a period of 5 years after graduation, enabling them to contribute to a high technology-based economy in the UK, and to pay off their loans

€ To ensure that the Bologna process is managed so that UK degrees are preserved in their current form through the replacement of the European Credit Transfer System (ECTS) by an output competences approach in the new European Qualifications Framework.

€ To increase the funding for engineering education initiatives which

To the Engineering Institutions

€ To help raise the profile and status of university teaching in engineering, for example through high profile awards for excellence and innovation in engineering teaching and learning.

€ To make the accreditation process a strategic tool for ensuring continued relevance of courses to the real needs of the economy. The accreditation process should encourage course development and innovation, taking greater account of the professional competencies and fitness for purpose of the graduates whilst being less prescriptive on specialist technical content.

€ To establish processes which support the creation, development and accreditation of multidisciplinary degrees.

€ To engage actively with the Government's STEM programme.

€ To be proactive in strengthening the university/industry interface through cooperation, liaison and promotion of activities, such as Formula Student.

To Industry

€ To establish active, long-term relationships with university engineering departments in the area of education (as many companies have now done in research), including membership of Advisory Boards, providing Visiting Professors and Industrial Tutors, offering project topics and facilities and student placements. Companies should also recognise the secondary benefit from such engagement, for example in the development of younger staff.

€ To engage actively with the Government's STEM programme.

€ To work with the Institutions in degree accreditation, in particular releasing active members of staff to serve on the Accreditation Boards and Panels.

To the Academy

€ To enlarge and expand the Visiting Professors Schemes in Engineering Design - to disseminate current industrial best practice, to address the Innovation and Creativity agenda, and to embed integrated systems design principles into all degree courses.

€ To work with companies and universities to develop new links and opportunities for exchange of personnel, eg by the introduction of a Visiting Lecturer scheme and secondments for academics to spend time with companies developing new teaching materials.

€ To continue to take the lead, through TESS, Shape the Future and the Best programme, in coordinating activity to 'fill the pipeline'.

€ To make greater use of the younger people in the Best Programme and other Academy schemes to provide feedback to university departments.

References

1. Engineering UK 2005, etb Research Report, November 2005.

2. Goldman Sachs Global Economics Paper No 99 Dreaming with the BRICS: The Path to 2050, October 2003.

3. Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with India and China, Duke University Master of Engineering Program Paper, December 2005.

4. Leitch Review of Skills: Prosperity for all in the global economy-world class skills, HMSO, December 2006

5. Cox Review of Creativity in Business: Building on the UK's Strengths, HMSO, November 2005.

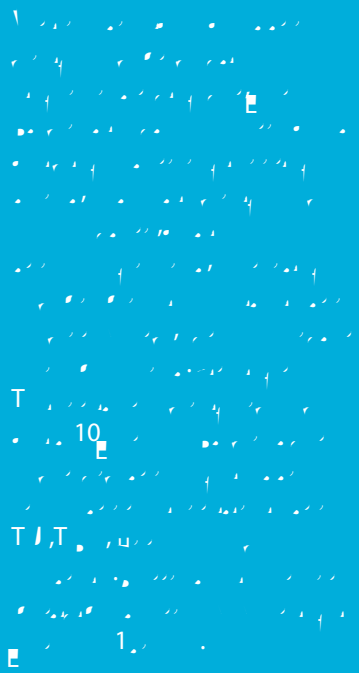
6. The Engineer of 2020, National Academy of Engineering, Washington DC, 2004.

7. See www.cdio.org

8. The Science, Technology, Engineering and Mathematics (STEM) Programme Report, DfES, October 2006.

9. Science and innovation investment framework 2004-2014, HMSO, July 2004

Formula Student at Birmingham



Appendix 1:
Educating Engineers for the 21st Century Terms of Reference

€ To draft an Academy policy statement on the changes required in the engineering education curriculum for the formation of the professional engineers required in the 21st Century.

€ To take account of the following aspects in the study:

The need to ensure that the UK can strengthen its position as a centre for world class high value added engineering.

The Business and Industry Requirements with particular reference to the requirements and preferences of International Business following the Bologna Declaration.

The nature and length of engineering degree courses with particular reference to the impact of the Bologna Declaration and the changes occurring in pre-university education.

The process of Regulation and Accreditation.

The most effective ways to recruit high calibre students.

Overseas developments and best practice.

€ To complete and present the study to The Standing Committee for Education and Training.

Appendix 2: Educating Engineers for the 21st Century: The Industry View

Conclusions from the Industry Study

The Academy's Working Party and Fellows on the Standing Committee for Education and Training have identified the following major conclusions from the study of industry views.

1 **Over the next ten years there will be a worsening shortage of high calibre UK engineering graduates going into industry. This shortage will impact the productivity and creativity of UK-based businesses unless it can be addressed.**

In several areas, companies in the survey report difficulties today in recruiting graduate engineers. Many comment that it is difficult to get 'enough of the best'. But they expect graduate engineers to make up an increasing proportion of the workforce over the next ten years. The latter point is encouraging in the light of the aim, stated in the White Paper on Innovation [9], to raise UK R&D spending from 1.9% to 2.5% of GDP by 2014. Nevertheless companies are concerned about the 'pipeline' of suitably motivated and qualified young people in schools equipped to progress to engineering degrees.

2 **Shortages of suitable engineering graduates and skill gaps are impacting the performance of UK businesses**.

Over one-third of companies responding indicate that shortages and skill deficiencies are impeding new product development and business growth, as well as increasing recruitment costs. Specific gaps exist in problem solving and application of theory to real problems, breadth and ability in maths.

3 **University courses need to provide more experience in applying theoretical understanding to real problems.**

Whilst industry is generally satisfied with the engineers it recruits, there are concerns about the ability of graduates to apply their knowledge to real industrial problems. This has become more acute in recent years and is identified as one of the skill shortages impacting business growth.

The graduate focus groups also expressed concern about limited and 'unrealistic' project work in their degree courses. Project work was nevertheless identified as the most important element of their education in terms of their subsequent experience in industry.

Over the past ten years the unit of resource for teaching an engineering undergraduate has fallen by a factor of two to three. This has led to a reduction in expensive practical and project work and an increased reliance on computer-based models in place of real experiments. At the same time

academic staff members have been focussed on increasing their research outputs to improve performance in the Research Assessment Exercise, leaving teaching as a 'poor relation' in terms of competition for staff time and commitment in our leading universities.

4 The quality of the best UK graduates is as good as their peers in Europe, despite our shorter degree courses.

Companies expressed concern over the additional costs/debts associated with the four year MEng, compared with a BEng. There was no evidence of a strong desire to move to five years in line with other parts of Europe.

It is important that we achieve 'Bologna compliance' within the four-year MEng structure for UK engineering degrees to ensure that both our students and courses remain highly marketable in other parts of Europe. UK universities will need government support to ensure that further negotiations allow for this outcome, while HEFCE will need to recognise the additional cost of new elements which may be required to achieve compliance.

5 UK engineering degree courses must: recognise the changing requirements of industry; attract and maintain motivation of students; ensure UK degrees continue to be recognised in Europe.

In terms of priorities for future graduate skills, respondents present a very consistent picture. Practical application, theoretical understanding and creativity and innovation are seen as the top priorities. Whilst broader technological understanding is also important, it should not come at the expense of understanding the fundamentals.

Key business skills are envisaged primarily as commercial awareness or sensitivity - an understanding of how businesses work and the importance of the customer - combined with a basic understanding of project management.

The perspective of the graduates in the focus groups mirrored the business respondents and emphasised what motivates students to study engineering: a good all round degree course offering a wide range of career options, a strong sense of wanting to make a difference, contributing to society and being able to see the results of their creativity.

Closer collaboration between industry and universities in the area of undergraduate education is a key requirement going forward.

6 Industrial experience is a major factor in recruitment of new graduates.

A large majority of companies report using industrial experience, whether before or during university as an important discriminator in selecting job applicants for interview.

Appendix 3: Companies involved in the Industry Study

The following companies were interviewed for this study:

ABB
Arup
Atkins
BOC Edwards
BP plc
BT Group (2 interviews)
Cadogan Consultants
Cold Drawn Products
Cultech Limited
DSTL
Filtronic plc
Ford Motor Company Ltd
Foster Wheeler Energy
Grimley Smith Associates
IBM
Lightweight Medical Limited
National Grid Transco
Nortel
Renishaw plc
Roll-Royce plc
Shell UK

1 Over the next ten years there will be a worsening shortage of high calibre UK engineering graduates going into industry.

The majority (87%) agreed with this. While some universities (27%) aspire to increase both quality and quantity within the current funding environment the majority (68%) are aiming to maintain the same numbers and entry standards. It is anticipated that the number of graduates entering industry will remain at current levels.

2 There is a need for more inspiring engineering degree courses.

The majority (80%) are in agreement that this is a key aspiration. It is generally considered that all universities should continually strive to improve their courses in terms of technical content, pedagogy, transferable skills, professional responsibility, management and project work as well as motivation and inspiration. Most believe that they are doing this within the constraints of the current accreditation process. However, there is a requirement for more degree programmes which cross nineteenth century institutional boundaries.

3 There is a need for engineering degree courses with closer industrial engagement.

There is widespread agreement (89%) that industry should supply more feedback on the quality and education of graduates and provide high quality project and case study material. Academics see themselves as responsible for designing courses to suit a wide range of aspirations in professional engineering whilst taking into account both intrinsic educational value and the views of potential employers. It must be stressed that many courses already have a large industrial content.

4 University courses need to provide more experience in applying theoretical understanding to real applications and the open-ended problems faced by industry.

There was again overwhelming agreement (91%) from respondents. While noting the need to build on theoretical knowledge ('the basics'), the requirement for 'real applications' and 'open ended' project and practical work are also well recognised. Given additional resources the majority of respondents would use them to refurbish, better equip and expand practical and laboratory facilities. This would also mean engaging increased numbers of technical support staff and developing more industry based case studies.

5 The current stance on Bologna is that the quality of the best UK students is as good as their peers in Europe despite our shorter degrees.

There was general agreement with this proposition, which was also endorsed by the industry survey. But it is difficult to make any direct comparison due to the lack of any formal benchmarking system.

6 It is important that 'Bologna compliance' is achieved within the four-year MEng degree structure for UK Engineering.

At departmental level there is surprisingly little activity in this area, though 52% claim to be doing something amongst whom most are 'awaiting advice from the university and/or the Engineering (degree) Accreditation Boards'. Very few (25%) are finding the Universities UK advice (Europe Note E/05/12) useful or easy to follow.

More significantly it is clear that few intend to take any positive action to conform to the Bologna process until they receive specific directions from either their university (through QAA, UUK or HEFCE) or from the engineering institutions licensed by EC^{UK} to accredit engineering degrees. Currently all Engineering degrees are accredited in accordance with UKSPEC and the EC^{UK}/QAA Engineering Degree Benchmark Statements in order to gain professional recognition. It is, therefore, a matter of paramount importance to issue detailed advice on how to present these requirements in such away as to be 'Bologna compliant'. Currently no UK body has been specifically tasked, or made accountable, for ensuring that this is done.

7 Are BEng degree courses being structured to comply with the first cycle requirements?

Again most consider themselves already compliant but the formalities have yet to be completed.

8 Are degree standards being structured to comply with the EC^{UK}/QAA Engineering Benchmark Statements?

The great majority of respondents (86%) have actively complied with this as it is now required by the Accreditation Boards. All relevant degree courses are accredited by the appropriate Engineering Accreditation Boards.

9 The Report identifies a hierarchy of Skills and Attributes (in decreasing order): Practical Application; Theoretical Understanding; Creativity and Innovation; Teamworking; Technical Breadth and Business.

There is general agreement about the required skills and attributes, but not about the ranking. While a clear majority (68%) agreed without demur, the remainder (particularly in the Russell Group) consider that theoretical understanding is paramount.

It is generally considered that the course content specified in UK-SPEC is well aligned with these recommendations. Most respondents also point out that their courses and curriculum are constantly evolving.

10 The Report confirms the future requirement for Technical Specialists, but also identifies future demand for Multidisciplinary Systems Engineers who will fulfil the role of Integrators.

This elucidated a mixed response due for the most part to different perceptions of 'systems engineering'. But there is widespread agreement on the need to develop engineering graduates with the multidisciplinary approach required for successful systems integration.

Universities teaching general engineering courses consider that they are already achieving this, principally through embedding system theory and

Anglia Ruskin University
Aston University
Bath University
Birmingham University
Bournemouth University
Bradford University
Bristol University
Brunel University
Cambridge University
Cardiff University
Coventry University
City University
Cranfield University
De Montfort University
East London University
Edinburgh University
Exeter University
Glamorgan University
Glasgow University
Heriot Watt University
Huddersfield University
Imperial College
King's College London
Lancaster University
Leeds University
Leicester University
Liverpool University
London South Bank University
Loughborough University
Manchester University
Manchester Metropolitan University
Napier University
Newcastle University
Northumbria University
Nottingham University
Oxford University
Queen Mary, University of London
Queen's University, Belfast
Reading University
Sheffield University
Sheffield Hallam University
Southampton University
Staffordshire University
Strathclyde University
Surrey University
Ulster University
University College London
University of Wales, Bangor
Institution of Civil Engineers
Institution of Mechanical Engineers
Institution of Structural Engineers
New Engineering Foundation