



The Royal Academy
of Engineering

EDT(2) 04-06 (p.2)

ECONOMIC DEVELOPMENT AND TRANSPORT COMMITTEE

Date: 2 March 2006
Time: 2.00 – 5.00
Venue: Committee Room 2, Assembly Offices, Cardiff Bay
Title: The Royal Academy of Engineering

**NATIONAL ASSEMBLY FOR WALES
ECONOMIC DEVELOPMENT AND TRANSPORT COMMITTEE**

Science Policy in Wales

Response from The Royal Academy of Engineering

February 2006

Introduction

- 1.1 The Royal Academy of Engineering is pleased to respond to the invitation from the National Assembly of Wales: Economic Development and Transport Committee to comment on a science policy in Wales which supports the development of a knowledge based economy. The response which follows provides a background to the Academy's activities, comments on the importance of Research and Development to a successful economy and describes the various Academy associated schemes to raise awareness and skills provision.
- 1.2 The information provided below is given with the benefit of having seen the papers submitted to the Committee. Effort has been made to avoid repetition of national statistics already provided and the focus is placed on the many schemes managed or contributed to by the Academy to enhance science awareness, skills provision and HE excellence in Wales.

2. Background

- 2.1 The Royal Academy of Engineering is the United Kingdom's national academy for engineering. Founded in 1976 as The Fellowship of Engineering it was granted its Royal Charter in 1983 and, with the consent of HM The Queen, adopted its present title in 1992. Its activities are overseen by a Council of Fellows chaired by a President elected to a five year term of office. The current President is Lord Broers FREng FRS.
- 2.2 The Academy brings together the UK's most eminent engineers from all disciplines to promote excellence in the science, art and practice of engineering. Election to Fellowship of The Academy is by invitation only – up to 60 Fellows are elected each year by their peer group in recognition of personal achievements of exceptional merit and distinction. An individual distinguished by the title "Fellow of The Royal Academy of Engineering" is entitled to use the designatory letters "FREng".
- 2.3 The Academy has 1372 Fellows (as of 13th February, 2006) but of these only 29 reside in Wales. Many of these are now retired from full-time employment and over two thirds are or were associated with either Cardiff or Swansea university.
- 2.4 The Academy's activities are driven by three strategic priorities:
 - to enhance the UK's engineering capabilities – encouraging, supporting and facilitating the links between academia and industry. Employing targeted programmes we enhance, both at home and abroad, the UK's performance in the application of science, technology transfer and the promotion and exploitation of innovation. (See Appendix 1)
 - to celebrate excellence and inspire the next generation – celebrating engineering excellence and using it to inspire, support and challenge tomorrow's engineering leaders. The Academy's initiatives are focussed on developing excellence and, through creative and collaborative activity, demonstrate to the young the relevance of engineering to society. (See Appendix 2)
 - to lead debate – providing informed, impartial advice. Drawing on the leadership and expertise of the Fellows, The Academy seeks to influence public policy making by providing an input founded on engineering/technological considerations. Such impartial advice serves to enhance the appreciation of the positive role of engineering and its essential contribution to securing economic strength.

3. Science and Engineering base

- 3.1 The existence of a strong science and engineering base is considered to be essential to future economic success. There needs to be a focus on the connection to market to gain and spread the benefits of the discoveries amongst the wider community rather than concentrating on academic endeavours and outputs alone. Further, the route to a successful economy is believed to be one that is not heavily dependent on foreign companies where the focus of

Research and Development (R&D) activities is elsewhere. An economy should be based on indigenous companies supported by their own R&D with homegrown research based on its universities.

- 3.2 To achieve this it is necessary to establish attractive career structures and to encourage industry to become less conservative and more entrepreneurial. Further, basic R&D and professional researchers must be valued and their contribution recognised.
- 3.3 Collaboration between academia and industry must be developed to encourage the commercialisation of research. The existence of strong business links and a willingness and enthusiasm to pioneer the manufacture of innovative products would help inspire the international standing. Future funding would then follow from the resultant trade and economic activity. An example of good practice of support given to emerging technology companies is that of the Hillington Innovation Centre in Scotland opened in November 2000 (<http://www.innovationcentre.org>).
- 3.4 A report on “The Future of Engineering Research” published by the Academy in August 2003 stated : “Engineering research critically contributes to the creation of wealth, health and well-being and underpins innumerable developments that enhance our quality of life. It is therefore vitally important that the UK maintains and improves its capacity to carry out world-class engineering research”. It went on to conclude that the future capability to maintain our reputation in high-quality engineering research was under threat due to a multiplicity of factors. Foremost amongst there were a dwindling supply of skilled graduates, the staffing and funding crisis in HEI engineering departments, the inadequate levels of investment in engineering research – particularly in industry, all within the context of increased global competition. Consequently, the report recommended the need to:
- safeguard the supply of skilled personnel;
 - ensure close coupling of researchers or providers of technology and users;
 - stimulate industry expenditure on research;
 - introduce an integrated national research strategy.
- 3.5 In the Engineering disciplines of the Research Assessment Exercise 2001, universities in Wales recorded only two “5*” (Civil Engineering at Cardiff and Swansea) and four “5” (Computer Science at Cardiff and Swansea, Electrical and Electronic Engineering at Cardiff, Built Environment at Cardiff) rated departments. It was notable that there were no submissions made under either Chemical Engineering or Metallurgy and Materials.
- 3.6 It was surprising to see mention of research funding in Wales from only two Research Councils (Economic and Social; and Natural Environment) amongst the statistics provided to the Committee in paper EDT(2) 12-05 (p3). The Committee should be informed of the grants awarded to institutions in Wales by all the other Research Councils e.g. an inspection of the Engineering and Physical Sciences Research Council website <http://gow.epsrc.ac.uk/GrantsPortfolio.aspx> reveals that £63.7m was allocated to HEIs in Wales: however, this is out of the UK wide “Current Grant Portfolio” of £2,183.9m (as of the 12th February 2006).

4. Enhancing Engineering capabilities and inspiring the next generation

- 4.1 The Academy offers a wide range of schemes across the whole of the UK. These Schemes enable professional engineers, whether in education, academia or industry, to enhance their skills. Academy Fellows are closely involved in all the schemes from the selection of participants to monitoring progress including acting as mentor to the next generation of engineers.
- 4.2 The schemes to enhance excellence in Engineering teaching and research are presented in Appendix 1. These range from professional development awards to Research chairs including a scheme to enable Engineering academics to gain experience in industry to the benefit of their teaching activities. It is worth noting that the number of applications from

Wales for these prestigious positions could be higher. The Academy's Annual report for 2004 – 2005 reveals the following take-up in Wales:

Research Chairs*	1 out of 20	Professor Mawby WDA/University of Swansea
Research Fellowships	0 out of 38	
Visiting Fellowships in Communications	3 out of 25	Cardiff x 1; Glamorgan x 2
Industrial Secondments*	0 out of 15	
Global Research Awards	2 out of 26	Bangor x 1; Cardiff x 1
Visiting Professors in Engineering Design for Sustainable Development*	1 out of 30	Cardiff

*supported by industry

- 4.3 The schemes recognising excellence and inspiring the next generation are outlined in Appendix 2. They include a number of schemes to interest and encourage students to study engineering and to influence teachers. Amongst these is The Royal Academy of Engineering Best Programme, a continuum of high quality curriculum enrichment schemes in science, engineering and technology (SET). The Best Programme works in primary schools to build an enthusiasm for SET subjects, in secondary schools to promote engineering and related SET careers, in universities to support gifted engineering students and beyond university to develop the engineers of tomorrow. Three new activities and other schemes with relevance or specific reference to Wales are described below.

The National Engineering Programme (NEP) and the London Engineering Project (LEP)

- 4.4 An exciting new initiative to attract youngsters into engineering has its origins in discussions between The Academy and the Higher Education Funding Council for England (HEFCE). This culminated in The Academy being successful in its leadership of the National Engineering Programme (NEP): a consortium response to the Government's call to support engineering as a subject of strategic importance in our universities, see Appendix 3. The Academy has received £2.85M from HEFCE to lead the first 2.5 years of the NEP. This will support the opening phases of a pilot project in south London known as the London Engineering Project (LEP). The LEP will deploy over 5 years at a final cost of £4.8M. Subject to funding support, this will lead to similar projects in other inner city areas around England: Tyneside, Merseyside, Manchester, Birmingham, Bristol, Leicester and Nottingham. If successful this model could have further application outside England.
- 4.5 The guiding principle of the NEP (and of its LEP pilot that launched in September 2005) is that attractive, inspiring engineering courses are created in partner universities and that work is done in local primary and secondary schools to find and support the students who have the capacity and interest to take up those courses. Those students will predominantly come from four target groups: women, students from families with no experience of higher education, students from minority ethnic groups under-represented in engineering and adult learners.
- 4.6 For the LEP, attractive Foundation, BEng, MEng and MSc courses are being created in three universities, with external support from two more. A determined effort, matched with careful planning will ensure that those courses are both gender appropriate and culturally relevant to the target groups of students.
- 4.7 These courses, many created in co-operation with local engineering employers, will be promoted in 15 secondary and 35 primary schools in the London Borough of Southwark. Much of the Best Programme will be involved in the delivery of this work benefiting from substantial funding from HEFCE in the process.

- 4.8 Work in schools will be characterised by a two-step approach. First, whole year groups will enjoy access to lively Science, Technology, Engineering and Mathematics (STEM) enrichment activities that are delivered by the LEP and linked to the curriculum taught in the schools. This will be used to identify students with an aptitude for the mathematics and logical thinking required of engineers. Once a capacity for higher education is also identified, these students will benefit from regular and personalised learning support from the LEP as they progress through the school. Support will come in the form of STEM enrichment, periods in university departments, role models, mentoring of students and their parents and e-mentoring.
- 4.9 Success in the LEP will be a significant increase in the numbers of young people from Southwark who go to university. Double success is a good number of those choosing to study an engineering-related course. The LEP pattern will be repeated, modified and enhanced as appropriate, at the other six regions in England in due course.

Shape the Future

- 4.10 Shape the Future is a high-profile campaign, created to help the engineering community in its efforts to raise awareness of engineering and technology as a stimulating career option and as a vital part of Britain today. In addition, a central component of Shape the Future is to raise awareness of the Best Programme and TESS (see 4.14 – 4.16 below).
- 4.11 The campaign launched with nearly 400 guests attending a reception at the Science Museum in London on the 28th November 2005. This was hosted by Lord Browne of Madingley (CEO of BP) and Professor Wendy Hall, (Senior Vice President of the Academy) with a welcoming speech from the minister for Industry, Rt Hon Alun Michael MP.
- 4.12 One of the launch partners of Shape the Future is Airbus, in Broughton, with whom The Academy is working to bring coherence to the promotion of science, technology and engineering and mathematics (STEM) in Wales and England. The Academy is a corporate member of the Technology Alliance Wales and the Shape the Future campaign is supported by SETNET who deliver into local schools through Setpoint Wales.
- 4.13 The Shape the Future campaign is targeted at (but not limited to) Key Stage 2 and 3 students. It aims to start students on a journey towards engineering and technology by engaging them with the engineering world around them: with the everyday objects that they take for granted and the engineering stories behind them, with the significant threats to modern life (climate change, poverty, the ageing population) and the probable solutions to be found in technology.
- 4.14 Having engaged students in the worlds of engineering and technology, Shape the Future aims to make a difference by getting them to do one more thing: to join a Young Engineers Club, to logon to an engineering web site, to have a classroom discussion or debate. By signposting to existing national STEM initiatives, Shape the Future can make its contribution to the ongoing work of bringing consolidation to the many initiatives that are clamouring for the attention of students and their teachers. Shape the Future has six launch partners contributing to the costs of the campaign.

Technology and Engineering in Schools Strategy (TESS)

- 4.15 It is commonly known that there is a multitude (Government estimates suggest 2000) schemes for STEM curriculum enrichment available to schools. Not only is this situation confusing for schools, but the duplication of administrative and delivery functions makes it wasteful. The Academy is coming to the fore to help resolve what has been a persistent problem for many years.
- 4.16 In July 2005, Lord Sainsbury (Science Minister) met with Lord Broers (President of The Royal Academy of Engineering), Sir Alan Wilson (Director General of Higher Education, DfES), John O'Reilly (CEO of the EPSRC), David Hughes (Director General, DTI) and Sir Peter Williams

(Chairman, ETB) to discuss the Government support given to STEM activities in schools. Lord Broers accepted the task of bringing consolidation to the many initiatives in schools connected with engineering and technology. This task is ongoing, with a conclusion due in the spring of 2006. Some background information to the Science Minister's aim of achieving consolidation in engineering and technology initiatives in schools is given in Appendix 4.

- 4.17 When successful, the TESS initiative will change the landscape in which the Best Programme operates. There will be a limited set of coordinated schemes offered to schools: the only schemes to secure Government support. The Best Programme schemes in schools (Young Engineers, Smallpeice courses, EES and Junior EES) will most likely form part of the set and the Best Programme approach to partnership delivery will be adopted. The further adoption of a single delivery network shared by all schemes will be the mechanism by which efficiency gains are made.

Engineering Education Scheme Wales (EESW)

- 4.18 The Engineering Education Scheme (EES) encourages the most able young people to pursue a career in professional engineering by enabling them to work in teams on significant real industrial engineering projects. This is achieved through partnerships between schools/colleges and companies during the October to April period each year. The scheme operates in Wales, England, Scotland and Northern Ireland and, throughout all four regions, between one quarter and one third of participants are female.

Overview

- 4.19 In 2005 there was a slight increase in student numbers in both north and south Wales. Given that there were two major frustrations to recruiting, this was extremely good. The first problem was one of "AS" levels clashing, which inevitably excluded some teams, and a new one which was the recently introduced teachers "working time agreement". This restricts the amount of time that teachers are able to take for out of school activities. As a response we are seeking a solution to the cost of teacher supply cover when staff work with EESW.
- 4.20 The EESW Awards Day in both north and south Wales were a massive success, with Ministers from the Welsh Assembly Government and international speakers providing keynote presentations. In addition to students and parents the events were attended by a notable range of supporters from education and industry. The inclusive seminar programme provided much appreciated opportunities for delegates to keep up to date with developments, and the ever developing trade/careers exhibition ensured that visitors enjoyed a stimulating experience. There are plans to further extend the event in future by collaborating with the recently formed Technology Alliance Wales, TAW.
- 4.21 EESW have been instrumental in getting organisations to work in harmony, forging links for industrial placements, teacher INSET, curriculum and examination development etc. One example was a two day residential conference for teachers and engineers to learn together and evaluate the development of EESW. The outcome provided an action plan that is currently being implemented.
- 4.22 There are two additional issues that are having an impact on EESW's work. The increasing difficulty of booking university accommodation for residential student workshops reduces the opportunity for some young people to get the flavour of an undergraduate experience. Related to this is the new restriction on teachers driving a school minibus if they get a licence endorsement for speeding. In rural areas such transport is essential to the success of the scheme.
- 4.23 Details of achievements are publicised in the EESW magazine 'Talent' circulated to all who have an interest in the scheme.

Schools Involved

- 4.24 A total of 71 secondary schools / colleges are involved in the scheme. Of this, 7 are fee paying, 2 are grant maintained and 62 are comprehensives.

Regions

- 4.25 Coverage in areas of the M4 corridor and the valleys in south Wales, and the A55 corridor in north Wales remains healthy. Coverage in rural areas continues to be difficult, particularly in Powys and Gwynedd. There are few large companies in these areas and schools have massive catchment areas, where difficulties of after school travel have an adverse effect on extra curricular activities such as EESW.

Quality

- 4.26 Feedback from partners in politics, industry and education give EESW confidence that the scheme remains highly successful. Students and their parents are equally enthusiastic about the opportunities provided.
- 4.27 Evaluation is achieved through returns from schools, students, companies and project assessors. We also provide reports to sponsoring organisations. We pride ourselves on the qualitative comments received through an effective communication network.
- 4.28 A two day residential conference was introduced for 20 participating teachers and engineers with a focus on the evaluation of last year's project. The action plan produced is currently being implemented.
- 4.29 In addition a review of EESW activities by an Estyn Inspector using the format of Estyn's Common Inspection Framework was initiated.

Innovations

- 4.30 The website www.eesw.org.uk has been developed to include a comprehensive database, photo catalogue, communication system etc. This is especially effective in providing press releases and media reports. Students are also charged with providing coverage using the 'Media Guidance Directory'. In addition the opportunity to use a secure part of the web site as a project management tool for any individual project will enhance communication between school and company.
- 4.31 The Welsh Assembly Government's emphasis on working together, by partnerships with other initiatives, is supported and includes:
- *Application of Key Skills:* We provide a KS Logbook that students can use to gain a WJEC Level 3 accreditation for work completed on EESW Projects.
 - *F1 Challenge:* with the Welsh Automotive Forum (WAF).
 - *Welsh Assembly Government CAD/CAM Initiative:* EESW Teachers trained in the use of ProDesktop; an industry standard 3D design package. This has had a major impact on the quality of project reports.
 - *EESW PIC Technology Training:* Through funding acquired by EESW, the four regional training centres enabled 80 teachers to use and receive free resources for this technology.
 - *Celebrating Welsh Design & Technology:* EESW is a major contributor to the International D&T Exhibition and Seminars at the NEC.
 - *National Forum:* EESW work with the following on a range of innovations: TAW; Careers Wales; Inpart; WAF; DTIAW; TEP; NAAIDT; WAG; Elwa; WDA; CAT.

Young Engineers

- 4.32 Young Engineers is a national network of after-school and lunchtime engineering clubs in primary and secondary schools. Young Engineers clubs form a focal point for a series of engineering competitions where school pupils tackle complex engineering problems and compete for prizes. These national events include the Young Engineers for Britain competition and the Young Electronic Design Awards.

Overview of the Year 2004/5

- 4.33 Young Engineers had 1,347 active clubs and more than 18,000 members whose activities encompass the whole spectrum of engineering disciplines. Membership is largely from the secondary sector although about 23% of clubs are based in primary schools. Encouragingly 37% of members are girls.
- 4.34 *Challenges and Competitions in 2005/05*
- The **BAA Baggage Challenge** required students to devise a solution that would assist the airport in its baggage handling system. 10 teams qualified for the final with brilliant solutions that were much admired by both the BAA staff and engineers from Alstec.
 - The **BT Robot Challenge**, now in its second year, was held at Ennigun, Ironbridge in Shropshire, with some 22 featherweight (12kg) battle robots competing against each other. Several Young Engineer clubs reached the finals where they competed with great style and professionalism against some quite senior teams.
 - **Operation Storm**, in partnership with the Royal Navy, saw 36 clubs attend the national final at HMS SULTAN in Gosport. The teams built remote control vessels which had to clear a blocked harbour entrance and then retrieve items from the seabed. The day was enhanced by the event being opened to visiting local schools as well as the opportunity to see elements of the Navy's engineering training and take helicopter flights.
 - The **Junior Engineers for Britain K'Nex Challenge** saw record numbers of pupils taking part in the competition; in all, nearly 59,000 pupils took part representing 1,800 primary schools. It was gratifying to note that equal number of boys and girls participated in this competition.
 - The **Young Engineers for Britain Competition** saw an increase from 472 projects in 2003 to 504 in 2004. It was encouraging to see that 30% of students were female.
 - The **Annual Celebration of Engineering** was held at the Old Royal Naval College in Greenwich in July and saw the culmination of all the national competitions. Pupils and students, their teachers, parents and an array of distinguished guests, were privileged to see a tremendous display of innovation, craftsmanship and business acumen before moving on to the prestigious awards dinner.

Communications and information network

- 4.35 Enabled by the Gatsby Charitable Foundation, the recording of student details continues through club registration and re-registration, competitions and challenges. Full time tracking started in September 2005 alongside the introduction of the new database. The database will be linked into a new website allowing automatic download of details as clubs register online.

Scheme Quality

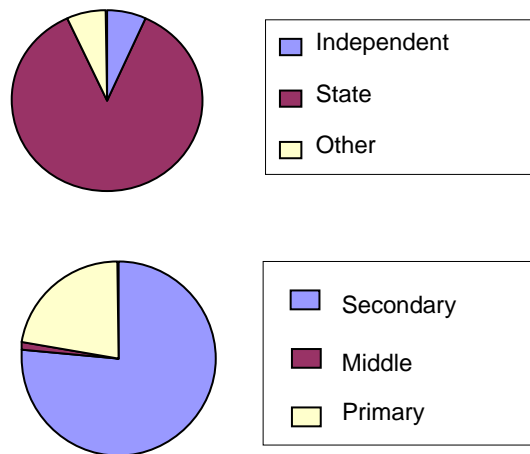
- 4.36 Although not yet subject to a formal TQM process, opinions on quality of organisation, delivery and student work are sought from regional and national judges of all Young Engineer competitions. The general arrangements are felt to be good and the quality of student work has improved year on year at national level. A comprehensive feedback process is followed and individual activities are subject to review regularly to ensure relevance, effectiveness and best value.

Scheme Innovations

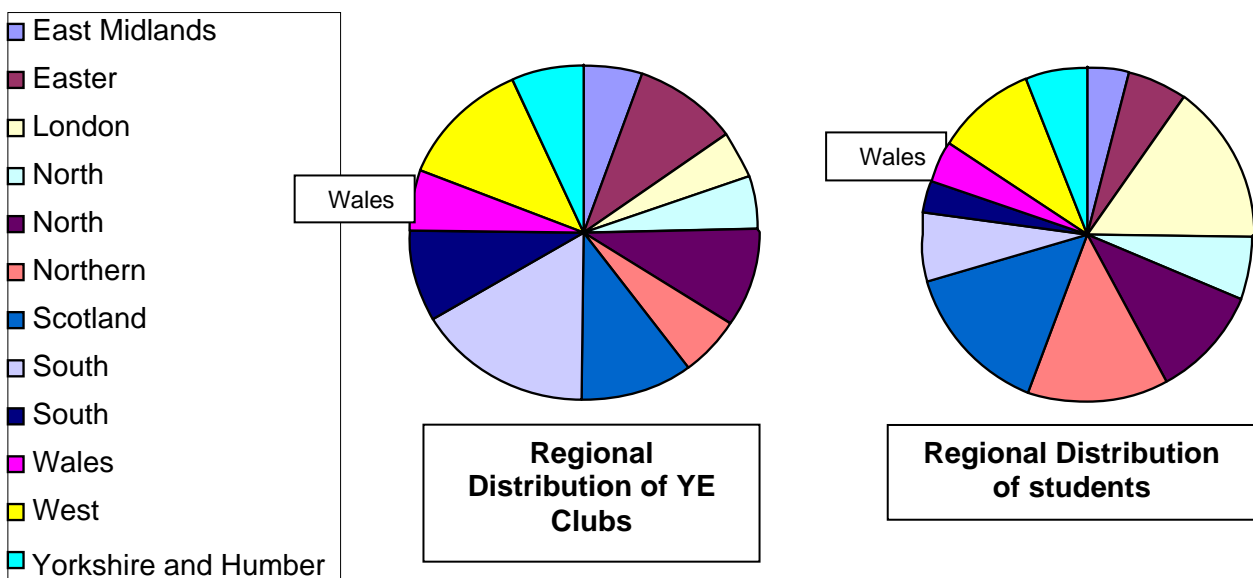
- 4.37 The National Club Awards was updated during the year. It is a scheme that will now be run on an annual basis and will reward those clubs that most closely follow the Young Engineers club ethos and provide the best engineering activities for their members.
- 4.38 The website is also being updated and modernised to provide a range of appealing resources in a members' only area. This will include an activity bank detailing a range of potential projects. The main purpose is to provide a series of options for new club leaders to utilise in the initial few months and more complex projects for established clubs.

Schools Types

4.39 School status of Young Engineers Clubs



Regional Coverage



- 4.40 Young Engineer for Britain and Junior Engineer for Britain regional finals were held in eleven of the twelve identified regions shown above. London entrants were dispersed to the nearest surrounding region. All regional activity is run in conjunction with a local organiser (either from a Setpoint or the Engineering Employers Federation) and seeks the support of local business and industry for provision of the event venue, judges and/or finance.

**THE ROYAL ACADEMY OF ENGINEERING STRATEGIC PRIORITY:
ENHANCING NATIONAL CAPABILITIES**

The Academy encourages and supports links between academic research and industry. Its programmes develop and enhance excellence in engineering teaching and research, and enable engineers to continue their own professional development.

A1 ENHANCING EXCELLENCE IN ENGINEERING TEACHING AND RESEARCH

Industrial Secondment Scheme

- A1.1 This scheme provides a unique opportunity for engineering academics to benefit from a period of industrial experience. Working on identified projects as part of the company 'team,' they contribute their own special expertise to the task, whilst gaining state-of-the-art knowledge which will benefit their teaching activities. The secondments provide academics with the opportunity to develop new case study material, plan new teaching modules and courses, and strengthen the links between their university department and the host organization.

Senior Visiting Fellowships in Communications

- A1.2 Supported by the Vodafone Group Foundation, the scheme provides funding for an engineering department in a British higher education institution to play host for a period between two and four weeks to a senior academic from an overseas centre of excellence. The objective is to promote international relations and networking within the academic community on the broad topic of global and/or mobile communications.

Research Chairs and Senior Research Fellowships

- A1.3 The Academy's schemes to support research chairs and senior research fellowships (SRFs) were established in 1987. Both provide joint funding with industry and other research organisations to support strategic research in UK universities. Appointments are normally for a period of five years. The industrial funding is an important feature of these schemes and it is pleasing to note that every pound funded by the Academy now attracts over four pounds from industry.
- A1.4 Although most appointments are supported by industry, a number have been jointly supported with other organisations. There are two chairs jointly supported under the Engineering and Physical Sciences Research Council's (EPSRC) Innovative Manufacturing Initiative.
- A1.5 The new Leverhulme Trust Senior Research Fellowships provide an opportunity for mid-career engineering academics to be relieved of their teaching and administrative responsibilities to concentrate on full time research for periods between one academic term and a year. The award covers the cost of a replacement member of staff for the period of the fellowship, thus ensuring no loss to the teaching of the next generation of engineers within universities.

Research Fellowships

- A1.6 These Fellowships, which are now funded jointly with EPSRC, are aimed at outstanding researchers from all branches of engineering who are about to finish their PhD or have up to 3 years post-doctoral research experience. The scheme provides funding for five years to encourage the best researchers to remain in the university engineering sector. Those selected as Research Fellows are provided with the opportunity to establish an international track record, and they are assisted by having a greatly reduced teaching and administrative load. The Academy appoints one of its Fellows as a Mentor to offer advice and facilitate industrial contacts and again this is a valuable feature of the scheme. An encouraging aspect of this scheme has been its ability to attract female researchers who account for 20% of all fellows in post.

Global Research Awards

- A1.7 The Global Research Awards Scheme is designed to encourage engineering R&D networking around the world. It allows research engineers to work with leading technology organisations overseas for between 3 and 12 months, and in modules if preferred. The Academy will fund 50% of the total agreed costs of the visit up to a ceiling of £35,000.

The Visiting Professors Schemes

- A1.8 The Academy's original Visiting Professors scheme (in Principles of Engineering Design) helps universities to improve the industrial relevance of their design teaching. The scheme now has 120 visiting professors at more than forty universities. A performance review of the scheme has highlighted its value in improving industry - academia collaboration, and in enhancing creativity amongst students.
- A1.9 A second VP scheme, launched in 1998, has concentrated on developing teaching materials to highlight the role of engineering in addressing sustainable development issues. Although soundly based in technology, this scheme has focussed very much on the role of the engineer as a holistic problem solver, taking account of sociological and economic issues as well as technical ones.
- A1.10 In 2004, a third VP scheme – in Integrated System Design – commenced with the objective of helping universities provide students with an improved understanding of the challenges of designing complex integrated systems. The Academy's vision is that students of all disciplines will be better prepared to work within large system projects, and will have a meaningful understanding of the part that their contribution can make to better overall system design.

ENABLING POSTGRADUATE AND PROFESSIONAL DEVELOPMENT

Engineering Professional Development Awards

- A1.11 The Academy's commitment to enhancing the potential of UK industrial engineers by supporting their professional development continues to be achieved through this scheme. Financial assistance is offered towards the cost of appropriate development programmes linked to an organisation's business plan or strategy.

ExxonMobil Higher Education Support Scheme

- A1.12 This scheme exists to enhance national potential by supporting the delivery of quality learning and training programmes at UK universities. Funds are awarded for projects as diverse as the purchase of state-of-the-art equipment, software packages and even capital building projects. Application is by invitation to universities that have ExxonMobil Teaching Fellows on their staff. (The ExxonMobil Teaching Fellowships – which the Academy also ran – closed in 2004).

International Travel Grants

- A1.13 The International Travel Grant Scheme helps engineering researchers in the United Kingdom make study visits overseas, enabling them to remain at the forefront of new developments and be aware of corresponding activity overseas. The scheme is open to postgraduate students, doctoral and postdoctoral researchers, readers and lecturers involved in research, and chartered engineers in United Kingdom higher education institutions and industry. It is not open to Fellows of The Royal Academy of Engineering.
- A1.14 To be eligible for grants (which will cover up to 50% of approved costs), applicants must be United Kingdom citizens or permanent residents. There are no age restrictions. Recipients of grants are responsible for ensuring that information obtained during visits is appropriately disseminated in the UK to ensure that maximum benefit accrues from their visit.

Sainsbury Management Fellowships in the Life Sciences

- A1.15 These Fellowships support young scientists of high career potential to undertake activities related to their personal development plans. These may include, for example, learning packages, such as an MBA; visits to national and international conferences or industrial sites and foreign language training.

The Panasonic Trust

- A1.16 The Trust's awards scheme provides funding grants to help engineers undertake courses to update and retrain in new developments and technologies. All awardees receive additional financial co-sponsorship from their employer.
- A1.17 The Trust awards Fellowships to assist recent engineering graduates undertake a full-time Masters Degree course in environmental studies or sustainable development.
- A1.18 The Panasonic Trust Project Presentation Prize of £1,000 is awarded to the student who delivers the best final project presentation on a course associated with the Fellowship scheme.

The Sir Angus Paton Bursary

- A1.19 In 1986 the Academy received an endowment from the late Sir Angus Paton FREng FRS to fund an annual bursary to recognise excellence and inspire a suitably qualified engineer to undertake a full-time Masters course related to water engineering.

THE ROYAL ACADEMY OF ENGINEERING STRATEGIC PRIORITY: RECOGNISING EXCELLENCE AND INSPIRING THE NEXT GENERATION

The Academy recognises the importance of supporting engineering leaders and celebrating excellence through award schemes and the election of new Fellows. Tomorrow's generation of engineers is inspired by today's excellent role models and so the Academy has a role to play in the development of excellence at every level.

THE BEST PROGRAMME

A2.1 The Royal Academy of Engineering Best Programme is a continuum of high quality curriculum enrichment schemes in science, engineering and technology (SET). The Best Programme works in primary schools to build an enthusiasm for SET subjects, in secondary schools to promote engineering and related SET careers, in universities to support gifted engineering students and beyond university to develop the engineers of tomorrow.

Young Engineers (Best Programme)

A2.2 Young Engineers is a national network of after-school and lunchtime engineering clubs in primary and secondary schools. Young Engineers clubs form a focal point for a series of engineering competitions where school pupils tackle complex engineering problems and compete for prizes. These national events include the Young Engineers for Britain competition and the Young Electronic Design Awards.

A2.3 The network of Young Engineers clubs numbers some 1250, representing over 25,000 individual club members ranging in age from 7 to 19. In addition, some 60,000 primary school pupils take part in the Junior Engineers for Britain K'Nex Challenge.

Headstart (Best Programme)

A2.4 Headstart is a well-established summer school programme dedicated to encouraging students interested in mathematics or science subjects to consider technology-based careers. It gives Year 12 / S5 students (17 years of age) the opportunity to spend a week at the engineering department of a university to find out what it is like to study for a degree in science and engineering.

A2.5 Students on the residential courses participate in practical problem solving activities, attend lectures and presentations, visit local companies, experience university life as an undergraduate, learn about the challenges and rewards of engineering and meet recent graduates.

Smallpeice Trust Schemes (Best Programme)

A2.6 The Trust's courses enable young people to work with experienced professional engineers either on residential courses at universities or in STEM enrichment activities arranged in schools. A continuum of courses provides training at progressive levels in a variety of specialisms, encompassing a range of projects and management skills, with a gap year programme for pre-university engineering students. A strong interface with industry, education and professional bodies helps to ensure that the courses are properly supported, promoted and developed.

Engineering Education Scheme (Best Programme)

A2.7 The Engineering Education Scheme (EES) encourages the most able young people to pursue a career in professional engineering by enabling them to work in teams on significant real industrial engineering projects. This is achieved through partnerships between schools/colleges and companies during the October to April period each year. The scheme operates in England,

Scotland, Wales and Northern Ireland and, throughout all four regions, between one quarter and one third of participants are female.

- A2.8 The EESE is an access organization for the Duke of Edinburgh Award, meaning that experience gained on the EES schemes can be counted towards the skills section of the Award, and the Scheme will continue to seek its inclusion within the 14-19 framework either as a recommended enrichment scheme or as an accreditable programme of study.

The Year in Industry (Best Programme)

- A2.9 The Year in Industry provides students with challenging, paid, degree-relevant work placements in the gap year before or during their degree course. Participants gain real world experience, add to their skills base and go on to reach their full potential while at university.

Undergraduate Programme (Best Programme)

- A2.10 The Undergraduate Programme encourages university students to retain their interest in engineering as a career through a series of awards and activities. These include business awareness courses, personal development training courses and careers guidance seminars. The programme is open only to students who have participated in one or more of the Best Programme pre-university schemes. All such students are invited to register as they start their accredited BEng or MEng university course.

Engineering Leadership Awards (Best Programme)

- A2.11 This scheme is open to second year MEng undergraduates, all of whom are in the top 20% in their universities. Participants have been assessed to have clear leadership potential and are provided with the funding and opportunities to undertake an accelerated personal development programme. Each Engineering Leadership Awards recipient benefits from a mentor – who will be a Sainsbury Management Fellow – and training and networking events organised by the Academy. They receive funds of £7,500 each to be used over three years to improve foreign language skills, attend work placements (especially overseas), conduct studies of engineering business in specific sectors, and prepare for fast track careers in UK industry.

Executive Engineers Programme (Best Programme)

- A2.12 This programme is designed for highly motivated, entrepreneurial and innovative engineering graduates to enhance and accelerate their professional development to Chartered Engineer status. It provides continuation training for outstandingly able engineering graduates with leadership potential, such as those who have already benefited from the Engineering Leadership Awards programme, and similar company schemes, who aspire to reach senior management and executive positions.

Sainsbury Management Fellowships in Engineering

- A2.13 The award is aimed at high-flying young Chartered Engineers and covers the cost of course fees for MBA courses at selected international business schools.

Headstart for teachers (Best Programme)

- A2.14 2005 saw the Best Programme start to deliver schemes aimed at influencing teachers as well as their students. This additional component to the Best Programme arose from the work that went into the writing of the Academy Strategic Plan 2005-2010 when a commitment to 'influence the influencers' was made.
- A2.15 The Headstart for Teachers scheme was launched as a first step. This has been funded by the Academy using part of the income from a £8M donation made to the Academy in 2005 by the ERA Foundation. £22,000 has been set aside for 2005-2006 with the same for 2006-2007

to enable 100 teachers a year to attend a modified version of the Headstart course that their students would attend.

- A2.16 The aim of the Headstart for Teachers scheme is to expose science teachers to the life of an undergraduate in an engineering department. By attending lectures and workshops, by meeting with engineering undergraduates, by interacting with peers, teachers gain a first hand understanding of the excitement of a life in engineering and a true picture of the nature of engineering. Teachers will be encouraged to pass this on to their students in class. In time, the scheme will reach 500 teachers.
- A2.17 Seven courses for teachers were arranged in 2005. Three were residential and four were one-day courses. Course content was determined from the results of a survey of 300 teachers, identifying their training needs. 95 teachers attended the CPD courses in 2005.
- A2.18 Keys to success in his new area appear to be the clarity of the subject and an ability to fund travel costs or supply-teacher cover. Regular communication with teachers who declare an interest has proven to be vital. Converting expressions of interest to attendance involves a series of second and third contacts with each teacher in the run up to the course. Using part of the Academy funding, Headstart has hired a part-time administrator to undertake the hundreds of contacts and reminders that are needed to recruit teachers to the courses.

Teacher CPD programme

- A2.19 The Academy Strategic Plan was written soon after the Academy submitted its proposals to the Office of Science and Technology for funding under Spending Review 2004. The Academy was successful in its submission, gaining a 35% uplift in its grant-in-aid funding starting April 2006. Part of this uplift is to fund an expansion of the Academy's work in education outreach and this is taken to be in part recognition of the important role the Best Programme has in engineering education.
- A2.20 A new teacher CPD scheme featured in the SR2004 submission. From 2006, the Academy will run one-day CPD events for teachers, demonstrating the links between the science and mathematics curricula taught in schools and the practical applications of that knowledge to be found in engineering design and in product manufacture. In time, the scheme will reach 2500 teachers.
- A2.21 The existing work of GTEP in the area of Teacher CPD is recognised. The new Academy programmes in Teacher CPD are being positioned to compliment the work done by GTEP. Any future collaboration would be welcomed by the Academy.

Headstart summer schools for girls

- A2.22 The Academy has successfully bid for £18,000 joint funding from the OST Science and Society Directorate and HEFCE to support a pilot Headstart summer school for Muslim girls. This all-girl event will be aimed at Muslim girls in south London, to cater for cases where there is a strong family preference for single-sex provision. This is a pilot, held at London South Bank University, and enables Headstart and the EDT (Engineering Development Trust) to take their place as partners in the LEP.
- A2.23 This pilot is particularly useful as entry and exit attitudinal survey will be used to judge the attitudes of female Muslim students to participation in higher education in general and to careers in engineering in particular.

The STEM leaflet

- A2.24 The Academy has joined forces with the BA, SETNET and the Centre for Science Education to produce a leaflet for schools and teachers that explains the benefits of using well thought out, quality assured curriculum enrichment schemes to compliment their teaching.

A2.25 The leaflet is expected only to be a first step in a public expression of these organisations' willingness to work together. The leaflet was launched at the Annual ASE Conference in January 2006.

Engineering diploma in schools

A2.26 In recognition of its work in supporting engineering education in schools, the Academy has been invited by Phil Hope MP (14-19 Minister at the DfES) to contribute to the formulation of the new engineering diploma (one of the raft of new sector specific diplomas arising from the February 2005 14-19 Education and Skills white paper). Matthew Harrison is joining the steering group led by SEMTA. This is seen as a good opportunity to link the Best Programme with vocational engineering education: an enabling step towards a goal of having Best Programme schemes support the formation of engineering technicians, incorporated engineers as well as chartered engineers.

A2.27 In addition, the Academy has been invited to make detailed input to the piloting of the engineering diploma in the London Borough of Southwark.

Academy sponsored elements of the Best Programme

A2.28 In addition to the Teacher CPD scheme, the significant uplift in grant-in-aid funding from the OST has enabled the Academy to fund several new elements of an expanding Best Programme:

- From 2006, there will be a Junior EES scheme running in parallel with the well-established EES scheme for 6th formers. Junior EES will work with teams of year 9 and 10 students on engineering projects connected with industry. As the students are younger, the projects will be less open-ended than those undertaken by the 6th Formers and the time spent will be shorter. However, engaging students with the challenges of industry at a time when they are choosing their options for GCSE study is seen as an important step to recruiting new people into engineering. The Academy is using £35,000 of its grant-in-aid funding to support a pilot of the Junior EES scheme with 10 schools in London. London has been chosen deliberately as the footprint of the 6th Form EES scheme has always been light here. The provision of Academy funding allows the EES to take its place as a partner in the LEP.
- The Academy is using £35,000 of its additional grant-in-aid funding to support the launch of a Junior EES scheme in Scotland. Unlike in England, in Scotland the Junior EES scheme will likely replace the 5th / 6th Form scheme that never sat easily with the Scottish Education system. Negotiations are underway to administer the Scottish Junior EES as either a partnership between the EDT in Scotland or Young Engineers in Scotland. After its launch year, the Academy will be seeking industrial sponsorship for Junior EES in Scotland to take it forward and to grow it to an eventual size of 50 teams per year. This is seen as a realistic target given that the terrain in Scotland has always proved challenging for the EES.
- The Academy is using £24,000 of its additional grant-in-aid funding to support two additional Engineering Leadership Awards in 2006. These will be used to support engineering undergraduates who have a demonstrable commitment to sustainable engineering.
- The Academy is using £10,000 of its additional grant-in-aid funding to launch new strands within the Undergraduate Programme. An internal review will be conducted to identify additional offerings in the Undergraduate Programmes: offerings that appeal to students and support the learning they obtain through their degree curriculum. A short course on sustainable engineering is being considered as one example.

The origins of the National Engineering Programme (NEP) and the London Engineering Project (LEP)

- A3.1 In the summer of 2004, there were a number of high-profile closures of science and engineering departments in universities around the country, the closure of the chemistry department at Exeter being the one that comes most readily to mind. Charles Clarke MP (Secretary of State for Education at the time) responded to this emerging situation by writing to Sir Howard Newby (then CEO of HEFCE) asking HEFCE to consider possible solutions to the problems experienced at Exeter and elsewhere. Sir Howard commissioned a review chaired by Sir Gareth Roberts who reported preliminary findings in late 2004. These findings showed that whilst there wasn't a crisis in our universities, there were problems with certain subjects. One outcome was a list of strategically important and vulnerable subjects. Engineering was prominent in the list of subjects deemed of strategic importance to the health and prosperity of the nation.
- A3.2 Mostly as a result of a long track record with the Best Programme, the Academy was invited to meet with HEFCE to discuss potential means for supporting engineering taught in English universities. It quickly emerged that an approach that sought to strengthen engineering by widening the diversity of students entering university programmes would be appropriate for the following compelling reasons:
- Whilst participation in higher education in its many forms is ever increasing, the numbers of young people electing to study engineering each year has not increased since 1988.
 - Engineering has become proficient in attracting students from certain groups in society. Research suggests that students are commonly influenced in their choice of engineering by close family role models. At a macro level this tends to focus recruitment on certain sections of society and at a micro level on certain families. The fact that absolute numbers of engineering students remain unchanged each year suggests that recruitment from these well-identified sectors of society is now saturated.
 - Perhaps because of this narrow proficiency in recruitment, the engineering undergraduate cohort is very homogeneous. Only 14% of engineering undergraduates are women. Only 2.4% of science, engineering and technology (SET) graduates are Black. Only 6.6% of SET graduates are Asian, most in medicine and not in engineering.
 - Within this context, it is obvious that if more people are going to be attracted into engineering, effort would be better placed in marketing to under-represented groups rather than expecting significant additional numbers to be found from the traditional sectors of society where recruitment seems to be saturated.
- A3.3 This approach was further explored at a National Conference on Widening Participation in Engineering Higher Education, organised by the Academy and held in London in May 2005. This quickly led to the gelling of a programme approach, built around a consortium of 14 founding partners and led by the Academy. The Academy submitted a funding proposal to HEFCE in June 2005 and this was funded in full to the limit of the current Government spending review period.

Background to the Technology and Engineering in Schools Strategy - TESS

- A4.1 Sir Alan Wilson (Director General of Higher Education, DfES) has been leading a comprehensive review of the Government resources applied to STEM in schools. The first phase of the so-called 'STEM Mapping Review' reported with 500 pages detailing the hundreds of initiatives that receive government support each year. The value of this support is understood to be £54M per annum. The second phase of Sir Alan Wilson's review is to make recommendations for a way to consolidate this provision. Both the Science Minister and Sir Alan Wilson have stated a preference for a limited number of national STEM initiatives receiving more focused support from Government.
- A4.2 The Science Minister has stated a preference for:
- a single national delivery network for STEM initiatives in schools. The work on Regional Science Hubs undertaken by Sir Gareth Roberts and funded by the Gatsby Charitable Foundation is likely to play a significant role in this at a regional level. At a sub-regional level, local DfES resources are likely to be the point of contact between individual schools and the National STEM enrichment schemes that enjoy Government support. Mechanisms for the delivery of individual activities in schools have yet to be identified.
 - a partnership model for the Government support of National STEM schemes based on the Best Programme. This is taken as strong endorsement of the Best Programme.
 - the process of consolidation to take place with science and with mathematics initiatives in schools as well as with those for engineering and technology. As the process of consolidation is more advanced for engineering and technology, the methodologies developed under the leadership of Lord Broers are likely to influence consolidation in science and mathematics. To that end, the Science Minister has requested that the Royal Society meet with The Royal Academy of Engineering to discuss the sharing of an approach. These meetings are ongoing.
- A4.3 The work undertaken at the Academy since July 2005 is gathering pace. A first step was to set out the intended scope for Government-supported curriculum-enrichment initiatives in engineering and technology. This can be simply expressed as

The provision of a Key Stage 1 to Key Stage 4+ continuum of curriculum enrichment to all schools regardless of geography or local circumstances.

- A4.4 Being able to deliver to schools regardless of geography is a definition of a National STEM initiative. Being able to deliver regardless of local circumstances is recognition of the additional effort and resource required to engage with schools in more challenging circumstances (inner-city schools in particular). Being a continuum of provision across the UK and the age range with a willingness to apply the additional resources to work in inner-cities is also a descriptor of a fully-functioning Best Programme.
- A4.5 A second step towards consolidation in engineering and technology support to schools was an analysis of the various forms this can take. Three classes of activity have been identified:
- The formation and training of new teachers.
 - Teacher continuing professional development.
 - Curriculum-enrichment in schools.

A4.6 The first element is excluded from the work underway at the Academy as it falls squarely under the control of the Teacher Development Agency. Although teacher CPD is important (and new Academy initiatives in this regard are discussed later in this report) curriculum-enrichment in schools has become the main focus.

A4.7 Curriculum enrichment activities in schools have been mapped as having three mutually overlapping themes:

- The raising of aspirations for careers in engineering and technology (the Shape the Future Campaign described later in this report is an important element of this)
- Information and careers advice
- The delivery of curriculum-enrichment activities in schools.

A4.8 A third step towards consolidation in engineering and technology initiatives in schools, which is ongoing, is to identify a list of candidate members to a Best+ Programme selected on the basis of:

- Being able to deliver nationally.
- Being able to deliver in all types of school, those well-resourced and those under challenging circumstances (including those in inner-cities).
- Being able to sign up to an aligned set of priorities, aims and objectives.
- Being able to operate under a single quality and impact assessment scheme.

A National Stem Board would be set up to govern the Best+ Programme.

Submitted by:
Mr Philip Greenish CBE
Chief Executive
The Royal Academy of Engineering

Prepared by:
Mr B G Doble
Head of Engineering Policy