Review of the Supply of Scientists and Engineers

A Summary of the Responses to the June 2001 Consultation Paper

Sir Gareth Roberts' Review

November 2001

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FOREWORD

In June this year, as part of my review of the supply of scientists and engineers, a consultation paper was published in order to give universities, businesses and other interested parties an early opportunity to comment on the key issues for the Review. As well as receiving many written responses to the consultation paper my review team and I undertook a series of meetings with those with an interest in the issue. In addition, we embarked on a number of international visits to countries such as Canada, Sweden, Finland, Germany and The Netherlands in order to draw upon their experiences in addressing these issues.

I would like to take this opportunity to thank those who contributed views and ideas to the Review and reassure all those involved that we are taking into consideration all of the comments received.

This summary of the responses to the consultation paper and of our meetings with universities, businesses and other organisations serves to highlight the recurring themes in the responses and discussions. It is not intended as an exhaustive list of every comment made. All of the responses received have helped in identifying the key areas for the policy recommendations of the Review.

I have written to the Chancellor of the Exchequer and the Secretaries of State at the Department of Trade and Industry and at the Department for Education and Skills to set out the main areas in which I am likely to be making recommendations. This letter is attached at Annex B. Policy recommendations for these areas are currently being developed, and my team and I will continue to consult with the interested parties up to our final report to the Government early next year. Any further comments or proposals on the areas for recommendations would naturally be welcomed; contact details are at Annex C of this paper.

Gareth Roberts

Professor Sir Gareth Roberts FRS
November 2001

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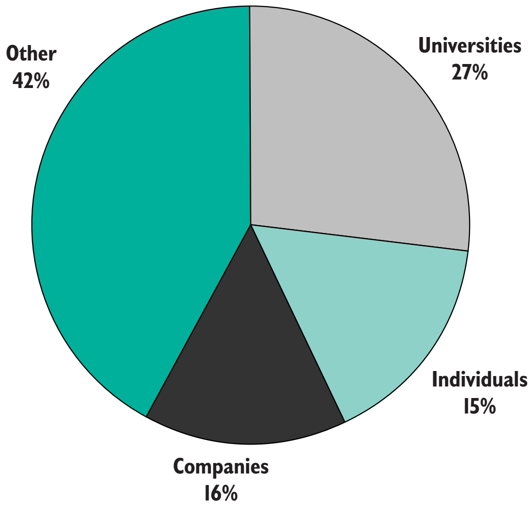
1 OVERVIEW OF THE RESPONSES

1.1 Approximately 1500 copies of the consultation document were distributed and the document was also made available on the Internet. In particular, responses were sought from science and engineering businesses, Higher Education Institutes (HEIs) and other organisations with an interest in innovation and the science and engineering base of the UK.

1.2 The Review received around 150 written responses; the breakdown of the responses received is shown in the chart below. The majority of responses came from universities, followed by companies and individuals. The category entitled 'Other' includes responses from Professional and Learned Societies, Research & Technology Organisations, Regional Development Agencies, and National Training Organisations. The review team also had discussions with a significant number of organisations and individuals interested in the Review. Issues raised in these discussions are also reflected in this summary.

Source of written responses to the key issues consultation paper



1.3 The consultation paper was well received by the vast majority of respondents, who agreed with the hypothesis that there is a problem with the supply of scientists and engineers that needs addressing. Most responses differentiated between a shortage of scientists and engineers in general and a shortage of good quality scientists and engineers. One such response said, *"[Our company] welcomes the paper's emphasis on top level scientists and engineers and its recognition of the issue of shortage of quality graduates rather than total numbers of engineers and scientists."* However, there appear to be specific areas where shortages in overall supply are more acute, such as chemical and electrical engineering. One company said, *"[Our company] has had significant difficulty recruiting electrical engineers (particularly heavy electrical). This is seen as a national shortage area. Other areas where difficulties have been encountered are in recruiting materials/structural analysis engineers."*

1 OVERVIEW OF THE RESPONSES

1.4 It was also suggested that the situation regarding the supply of scientists and engineers in Scotland was somewhat different to the rest of the UK. It was felt that the greater participation rates in Higher Education (HE) and Further Education (FE) in Scotland had been beneficial to the supply of scientists and engineers there.

1.5 A few respondents raised some specific concerns about the scope of the Review. One concern was that the Review should place more overt emphasis on the mismatches between supply and demand at a regional level. Others argued that more attention should be given to professional development and industry-based training. Another concern was that the Review should encompass all levels of scientists and engineers and not just top level researchers, although many respondents argued the problem really lies in the shortage of top level scientists and engineers.

1.6 In addition to providing individually tailored responses, many consultees enclosed or drew the Review's attention to existing studies of relevance, such as the recent Institute of Physics report on undergraduate physics, work by The Wellcome Trust on career issues in UK academic research, analysis by the Council for Science and Technology, and the Institution of Civil Engineers' study on the recruitment and retention of academic staff in engineering faculties.

1.7 The consultation paper sought comments on a number of key issues set out in Section 4 of the document. These related to: the education system; skills needs and communication mechanisms between bodies involved in the skills dialogue; roles and responsibilities of stakeholders; recruitment and retention of researchers; substitutes for scientists and engineers and international dimensions.

1.8 Responses to the consultation paper fell into three broad areas:

i. The education supply chain, including issues relating to

- schools;
- undergraduate university education (and taught postgraduate courses); and
- postgraduate research, and university careers;

ii. The marketplace for scientists and engineers; and

iii. Other issues affecting the supply of, and demand for, scientists and engineers.

These are covered in more detail in the following sections.

2 THE EDUCATION SUPPLY CHAIN

SCHOOLS

Summary:

Comments on education at school fell into four main areas:

- teachers;
- teaching;
- the curriculum; and
- careers advice.

Many respondents thought that despite the financial incentives that have been introduced to encourage entry to the teaching profession, there needed to be further incentives to stimulate able and enthusiastic individuals to become science, mathematics or design and technology teachers, so as to compete with the attraction of other fields of employment. Other comments relating to incentives for science and mathematics teachers, and indeed teachers in general, included the importance and benefits of Continuing Professional Development (CPD). Respondents commented that CPD could upgrade and modernise the skills of existing science and mathematics teachers while generally improving teacher morale. Another point mentioned frequently was that the number of newly qualified physics and mathematics teachers entering the profession was insufficient to offset the number of teachers retiring. It was widely believed that this could develop into a serious deficit of these teachers in the near future.

Comments on science and mathematics teaching in schools frequently referred to what was perceived as a deterioration in the teaching environment for science. It was suggested that this was a result of a generally low level of capital investment in school laboratories. Some respondents, despite reports from OFSTED (Office for Standards in Education) which indicate to the contrary, felt that there had been a decline in the standard of science and mathematics teaching in schools and suggested that this had contributed to a weakening, reported by a number of consultees, in the scientific and mathematical skills of new entrants to universities.

Most respondents who commented on the curriculum felt that science teaching should improve its relevance in order to interest pupils better. Respondents also suggested that the perception of many school pupils that mathematics and science subjects are ‘hard’ was having an adverse effect on the number of pupils taking these subjects at A-level. Many respondents perceived the Health and Safety obligations on science experimentation to be too restrictive.

Comments made on careers advice in schools on balance suggested that it needed to promote objectively the benefits of studying science, engineering and mathematics to children at school, and currently did not always achieve this.

2 THE EDUCATION SUPPLY CHAIN

Teachers

2.1 Many respondents expressed concern at the shortages in science and mathematics teachers in schools and suggested that science teachers' pay acted as a particular disincentive for good science, engineering or mathematics graduates to enter the profession, given the other opportunities available to them. It was felt that there should be greater financial incentives to encourage well-qualified science and engineering graduates to enter and stay in the teaching profession – though the full effect of recent initiatives in this respect has yet to work though.

2.2 Several respondents thought that improved opportunities for the CPD of teachers were very important and that the involvement of businesses and universities with schools should be encouraged further to enable this. Respondents were pleased about initiatives on this front, such as The National Centre of Excellence for Science Teaching, which is being established during Science Year[1] and which will provide a focus for the CPD of science, mathematics and design and technology teachers. Respondents suggested that CPD could improve the retention of teachers by raising morale and that through spending time in either industry or academia teachers would update their knowledge and skills which they could then employ in the classroom.

2.3 A number of universities and companies commented that those science and mathematics teachers who are not graduates of the discipline they teach (for example, biological science graduates teaching physics) could be less enthusiastic about the subject they were teaching and this might be a negative factor affecting the supply of pupils going on to study these subjects at a higher level. One respondent felt, *"The quality of science teaching is vital to awakening interests early in the educational process. I personally do not believe that teaching of science by non-scientists will result in the transmission of the 'enthusiasm' and 'spark' to the students."*

2.4 Several universities and other respondents expressed concern that a significant proportion of science and mathematics teachers in schools, especially physics teachers, were near to retirement age. It was felt that there were insufficient science and mathematics graduates entering teaching to replace the large numbers of science teachers approaching retirement age in the near future. One university said, *"The position on physics teachers in particular is very serious."*

[1] Education and Skills Secretary Estelle Morris officially launched Science Year on 7 September 2001. Science Year is a 12 month campaign working towards improving the profile and perception of science, enhancing science teaching and learning, involving communities in science and strengthening and demonstrating links between schools, higher education and industry. Science Year will also complement the science strand of the Key Stage 3 Strategy – a new programme which will start to roll out during the course of the year to support and strengthen the teaching of science for 11-14 year olds and so raise standards. Science Year is intended to have sustainable long-term effects on science teaching and achievement.

Teaching

2.5 Some universities and individuals, despite the increased investment in school science laboratories in the last two years, still felt that a generally low level of capital investment in school laboratories over the years had led to the deterioration in the teaching environment for science. Responses mentioned the continuing need to maintain the facilities and resources in school laboratories at a good standard. Some respondents believed that lower student : staff ratios would help to provide better science education, particularly in the context of practical work.

2.6 Some universities felt that the teaching of science in schools was traditionally too 'fact based' and that learning through memorisation of facts or 'parrot fashion' was unpopular with pupils. A few companies agreed with this comment. One response said, *"the taught curricula in the sciences in secondary school have changed little in style over the past 30 or more years; to pupils these courses appear as a "knowledge grind" in an age where the style of approach in nearly all other subject areas in schools has altered to give much less emphasis to the memorisation and recall of factual information"*[2]. However, there was also opposition to any 'dumbing-down' of science or mathematics.

2.7 The importance of making children aware of the relevance of science drew comment from a number of respondents. It was felt that teaching methods that introduced the relevance of science and highlighted its practical applications would improve the level of participation in science education by enthusing pupils' interest in these subjects. One respondent commented, *"the school curriculum hardly connects at all with the "big public issues" ... much is being done through the creation of Science Centres ... [but] they can be no substitute for a more continuous and systematic engagement with the major ideas of science, how these have been and are applied and their relevance to the continuing progress of our economy and society"*.

2.8 Although key stage GCSE and A-level pass rates have risen over the years, several respondents thought that the quality of mathematics and science teaching in schools had declined. It was also suggested that this was the source of a general decline in the mathematics skills of students and the need for remedial maths classes to be provided at university.

[2] In this context it should be noted that in September 2000 the science curriculum was revised to give greater emphasis to scientific enquiry.

2 THE EDUCATION SUPPLY CHAIN

The curriculum

2.9 A number of respondents perceived that the school curriculum, and in particular the 'Double Award' in science, did not adequately prepare pupils for studying these subjects at A-level. (This has been recognised by The Qualifications and Curriculum Authority and revisions introduced to try and address this.)

2.10 Some universities and companies thought that mathematics and science were perceived to be 'hard' subjects at school which led to fewer pupils taking these subjects at A-level. One respondent commented, *"Mathematics and science are perceived by many students (and parents) to be 'difficult' subjects, which takes on an added significance in an age when grades and A-level points are perceived to be more important than the profile of study."* There was also concern that this perception led to some schools discouraging or preventing too many 'hard' subjects being chosen by students at A-level in order to protect their position in the school league tables.

2.11 The previous point related to the view that the absolute number of pupils taking A-levels in mathematics and sciences was declining. This was shown to be the case in the subjects of physics and mathematics where the number of students entering A-level examinations declined between 1985 and 2000 (Source: *Statistics of Physics in UK Higher Education*, October 2001, Institute of Physics).

2.12 Business participation schemes in schools were commended by several respondents. It was said that individual organisations and schemes such as the Industrial Trust and Young Foresight provided important interaction between businesses and schools and acted to involve local businesses in school teaching. However, many respondents expressed concern that there was not enough coordination between schemes.

2.13 A few respondents perceived Health and Safety regulations as restricting schools from undertaking some types of experiments in the classroom. Although practical work is designed to be an integral part of the new science curriculum, respondents felt that in some cases experimental work, potentially an exciting part of science, is being hampered.

Careers advice

2.14 Many responses, particularly those from companies, said that careers advice in schools needed improving because it did not always give adequate advice about the subjects needed for particular degree course entry. However, a few individuals and universities thought that parents and teachers were more influential when it came to students making career decisions, and that in general careers advice was good.

UNDERGRADUATE UNIVERSITY EDUCATION (AND TAUGHT POSTGRADUATE COURSES)

Summary:

Comments on undergraduate university education and taught postgraduate courses fell into three main areas:

- the quantity and quality of students;
- student motivation towards studying science and engineering; and
- course structure and content.

Responses relating to the quantity and quality of science and engineering students focused on the perceived decline in the quality of science and engineering students entering university, as well as a decline in the quality of those graduating in science, engineering and technology (SET) subjects. It was felt that the declining number of applicants to SET courses had led to some universities relaxing entrance requirements, which had consequences for the quality of students. Respondents also thought that increased numbers of overseas students were being accepted onto SET courses, in part as a result of the declining number of UK applicants.

Those responses commenting on student motivation towards studying science and engineering mainly speculated on the significance of student debt in choice of course. Many respondents felt it important to ensure that the increasing move to four year courses in engineering and science did not put off students concerned about the increased financial burden that a four year course might place upon them.

Another issue frequently mentioned was the need to improve the resources available in university laboratories. Respondents said that the lack of modern facilities in laboratories often created an unattractive study environment for students. The quality of laboratories, coupled with other factors (such as what were seen as relatively high student : staff ratios) led to some respondents calling for greater funding of SET subjects. Responses also mentioned the importance of strengthening careers advice at university and, in particular, making the opportunities available to science and engineering students more visible and appealing.

Comments regarding undergraduate course content and structure concentrated on the potential benefits of enabling more students to undertake work placements, as identified previously in the Dearing report. It was said that work experience made graduates more attractive to industry and that businesses often found work placements an effective recruitment mechanism.

2 THE EDUCATION SUPPLY CHAIN

The quantity and quality of students

2.15 Some universities felt that the quality of students entering science and engineering degree courses from school had declined, as well as the quality of science and engineering undergraduates emerging from them. One university said, *"we believe there is a particularly strong decline in the proportion of the most able school leavers entering core science and engineering"*. Another respondent stated, *"In my experience as a university professor of nearly 20 years, the standard of entrants to the universities has fallen over the past 10 years. Also, as an external examiner … I believe I have seen the quality of graduates fall."*

2.16 Those universities and companies that felt that the quality of science and engineering graduates had declined suggested that this was because some universities had lowered the entrance requirements to SET courses in order to fill places and that the current system of university funding had exacerbated the situation. One respondent said, *"certainly, in response to declining applications more marginally qualified entrants are being admitted by many institutions"*.

2.17 Some responses conflicted with the view that the quality of entrants to university SET courses were declining, at least in terms of engineering courses. In contrast it was felt that entry requirements for engineering courses were too stringent and have consequently had an adverse affect on the number of entrants to these courses. One university thought, *"We note in particular that the entry requirements for engineering courses are now too stringent: the requirements of SARTOR[3] are making a problem for engineering education throughout the system."* In addition, it was felt that the flow of students onto SET courses was being limited because the accreditation bodies were not forward looking or flexible enough to allow universities to design courses that would be attractive to a greater number of students.

2.18 Several universities commented that an increasing number of overseas undergraduate students were being accepted onto SET courses in UK universities. This was in part due to the declining number of UK applicants for SET courses, but also reflected the extra income universities receive from overseas students. It also reflected the Government's aim of attracting overseas students.

[3] Standards and Routes to Registration (SARTOR) defines the criteria and main pathways to registration for the whole engineering profession. Candidates who wish to become registered with the Engineering Council must first become members of an engineering institution recognised by the Engineering Council (which is shortly to be replaced by the new Engineering and Technology Board). In order to do this, they must provide evidence of, among other requirements, a satisfactory education base, preferably by means of an accredited course. In 1997 some important changes were made to SARTOR in relation to the educational base. These included: the introduction of entry standards into criteria for accreditation of MEng, BEng (Hons) and IEng degree courses in order to ensure a cohort of sufficient intellectual capability to support a high standard of course content; four years academic study for Chartered Engineers instead of three as the educational base; and three years academic study for Incorporated Engineers instead of two as the educational base.

2.19 Some responses suggested that conversion courses are a good source of science, engineering and technology students. One respondent stated that conversion courses are of particular importance in supplying Information Technologists, *"For the past 30 years, universities have provided a source of highly trained computing personnel through conversion MSc courses, where good graduates in other disciplines are given a year of intense computing education."* Several universities were concerned that the future of these types of courses might be in jeopardy, *"There is also a concern that the recently established QAA[4] qualifications framework may result in the MSc title having to be discontinued for these courses. These factors could have a significant effect on the output from this source."* Some respondents thought that there should be more opportunities for students to study science foundation courses to enable students from non-science and engineering backgrounds to study these subjects at university. One university respondent felt that, *"In some areas, R&D is increasingly interdisciplinary … This provides the opportunity to convert top graduates from universities outside science and engineering to contribute to the R&D effort."*

Student motivation towards studying science and engineering

2.20 Many universities mentioned the significance of student debt to students when choosing a degree course. Concern was expressed that the growing number of four year engineering and science courses might discourage some students, concerned about the future burden of student debt, from embarking on these courses (as opposed to three year alternatives in other subjects)[5].

2.21 Despite the recent investment in UK science infrastructure by the Government and The Wellcome Trust, some respondents argued that the resources and facilities in SET departments in UK universities needed to be improved further. One response said, *"Infrastructure problems have become ubiquitous in British universities. Poor equipment levels apply both in research and teaching laboratories."*

2.22 Many respondents felt that careers advice in universities should be strengthened because it did not always present the full range of career options available to science and engineering graduates. However, one or two respondents thought that careers advice given by universities was good[6].

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[4] Quality Assurance Agency for Higher Education

[5] A review of student funding was announced by the Government in October 2001, with the aim of increasing participation in HE.

[6] Sir Martin Harris' HE Career Service Report has made a number of recommendations to improve performance in this area.

2.23 Several respondents suggested that funding for science and engineering needed to be increased. It was felt that the high and increasing costs of SET teaching at universities, in part due to the laboratory/practical work on top of lectures and tutorials, should lead to an upward revision of the premia[7] for these subjects. It was also felt that higher premia would enable lower student : staff ratios in SET subjects, making the study of these subjects more attractive to undergraduates. One respondent said, *"Currently, nearly every science and engineering department in our UK universities is under severe financial pressure as a consequence of the long-term decline in the unit of teaching resource without a compensating increase in student numbers."*

Course structure and content

2.24 Some companies argued that work placements should be made available to more undergraduates because students who had work experience were particularly attractive to employers. One response said, *"Appropriate work placement experiences have been found to accelerate maturity of outlook in students and to improve understanding of practicalities and financial constraints."* However, other respondents expressed concern that not enough businesses were willing to offer placements to students. It was also noted as a caveat, that work placements must be well organised and monitored, as some students had been put off a career in R&D as a result of their work placement experience. A number of other responses said that some companies found work placements an effective way of recruiting future graduates.

2.25 A few universities suggested that all engineering undergraduate courses should be four years in length, i.e. the MEng degree, with Chartered Engineer status, in order to bring them into line with similar courses in other countries and create consistency in the standard of engineering graduates. The implications of this for student debt levels have already been mentioned.

2.26 Concern was expressed also about the need for greater relevance in undergraduate science and engineering degree courses in order to engage students. However, this was set against the desire to maintain or increase academic rigour.

[7] The system of giving funding for different subjects taught at university.

POSTGRADUATE RESEARCH AND UNIVERSITY CAREERS

Summary

Comments on postgraduate research and university careers fell into three main areas:

- the quantity of PhD students and disincentives to postgraduate study;
- the quality and skills of PhD graduates; and
- disincentives to university careers (including contract researching).

Comments on the quantity of PhD students concentrated on the lack of suitable UK applicants for PhD courses and the increasing number of overseas PhD students. This issue was thought to be particularly acute in the field of computer science. Responses mentioned the benefits of extending maintenance awards to European Union (EU) PhD students who might supplement the supply of good quality UK PhD graduates and applicants for postdoctoral research positions. There were concerns, however, that many overseas PhD students studying in the UK often return to their country of origin after completing their research. Respondents repeatedly mentioned that, despite the recent significant rises, the relatively low level of the PhD stipend acts as a major disincentive to embarking on a PhD, both because of unfavourable comparisons with remuneration available elsewhere, and also because of the overhang of undergraduate debt.

Among the comments regarding the quality and skills of PhD graduates, it was noted by employers that UK PhD graduates were often less mature and experienced than their counterparts from other countries where the PhD was longer. It was also suggested that the shorter length of the PhD in the UK put pressure on students to complete their research. It was thought that this often led to some students undertaking 'safe' projects that were not necessarily as 'innovative' as they might have been had students had more time to complete their research. Most respondents agreed that PhD graduates should possess 'soft' generic skills (such as business awareness and entrepreneurship) as well as specific technical and scientific knowledge.

Respondents commenting on university careers frequently said that the relatively low level of academic salaries and the insecurity of fixed term contract work acted as major disincentives to embarking on a career in HE. Respondents also said that salary differentials in shortage subjects should be more widely introduced to improve the incentives to remain in academia. The lack of a visible career structure and adequate career development was also cited as an issue making the recruitment and retention of researchers more difficult. Other factors mentioned included the burden of large amounts of administrative work falling on academic staff (e.g. in applying for research grants) and the lack of suitable role models for students among academic staff.

2 THE EDUCATION SUPPLY CHAIN

The quantity of PhD students and disincentives to postgraduate study

2.27 Many respondents, particularly from universities, believed that there is a lack of sufficiently able UK applicants for PhD courses, as well as for postdoctoral research positions. This had led to increasing numbers of PhD students from overseas. One response commented, *"We are increasingly dependent on overseas postgraduate students to carry out research in UK universities. This is partly because of the shortage of good UK candidates and partly because of other, better-paid, opportunities for them."*

2.28 The majority of respondents, particularly universities, thought that the PhD stipend is too low and compares unfavourably with the remuneration from other potential employment. One university said, *"PhD stipends in science and engineering need to increase so that postgraduate study becomes attractive when compared with the salaries paid in other professions."* Many respondents indicated that the low PhD stipend, in combination with the burden of student debt, acted as a major disincentive to many students considering undertaking a PhD. One university said, *"There is a large disincentive to postgraduate study (particularly to PhD level) due to the way that the student loans (to cover living costs) and student fees systems are organised - saddling the graduate with a large debt."* Another respondent argued, *"Student debt and academic pay are major inhibiting factors for UK nationals to enter research"*. Another response said, *"Students in debt from their undergraduate studies are less willing to take on the low income involved in postgraduate ... coupled with low salaries."*

2.29 Some universities said that Research Council funding for EU PhD students should be extended to offer maintenance funding as well as covering study fees; equal to UK students. They felt that this would encourage more good quality EU students to undertake their PhDs in the UK. In addition a few companies said that CASE Awards (Cooperative Awards for Science and Engineering) should be available to EU students. One respondent felt that this would *"raise the general quality of postgraduates and would also provide important diversity."*

2.30 However, a number of universities were concerned that many overseas PhD graduates and postdoctoral researchers return to their country of origin after completing their research. The concern was that this would mean a loss of some of the best human resources from our universities. One respondent said, *"Many departments have a high level of overseas PhD students who in the majority of cases return home after graduation."* Another respondent felt, *"This predominance of overseas students is a concern for the future. If the majority of overseas students return home, we are exporting our expertise to our future cost."*

2.31 A number of individuals mentioned concerns about what they saw as the very low number of computer science graduates entering postgraduate research. Many computer science graduates are attracted to working in industry by the relatively high level of remuneration available to them. One response said, *"pay is a serious problem for the Computer Science HE sector, with many new graduates earning more than their senior lecturers."*

The quality and skills of PhD graduates

2.32 Several companies and a few universities thought that those graduating with PhDs abroad tended to be of better quality and more mature than their counterparts in the UK. This was felt to be the case because both undergraduate and PhD courses in the UK are shorter and, it was argued, more narrowly focused than those in Europe or the US. Such respondents tended to support the creation of the New Route PhD that is based on the best American models. This new qualification has been developed by several UK universities in collaboration with HEFCE (Higher Education Funding Council for England). It combines a specific research project with a coherent programme of formal courses and professional skills development, as an alternative to the traditional PhD, and is aimed particularly at the overseas market.

2.33 Many universities and other respondents felt that the pressure on students to complete their PhD in three years was likely to lead to them undertaking 'safe projects'. Some respondents went further to say that the length of the PhD should be greater than four years, *"With regard to PhD training, pressures to complete the research within four years have led to the inevitable consequence that students are only given 'safe' projects. This diminishes risk but stifles innovation."*

2.34 Many respondents felt that the length of the PhD should be extended to allow for more depth of research or a greater component of taught courses during the PhD. Several companies and universities thought that PhD students focused too much on one specific area, and that they should obtain a more broad based grounding in their studies and more transferable skills relevant for work in industry or academia.

2.35 It was mentioned positively by some respondents that several universities and other bodies, such as The Wellcome Trust, had introduced or were piloting four year PhDs.

2.36 Most responses agreed that the skills PhD graduates should possess included both 'hard' and 'soft' types of skills. It was felt important by most that doctoral graduates should have a thorough grounding in the fundamentals of their scientific discipline and possess core technical skills. Some of the 'soft' skills mentioned included: communication and organisational skills, business acumen, problem solving aptitude and the ability to work in a team. It was thought that more generic skills were needed to work in Small or Medium sized Enterprises (SMEs) as well as the ability to 'hit the ground running'. Larger companies tended to be more willing to offer training programmes to improve (post)graduates' 'softer' skills. Nevertheless, such skills were regarded as important by business. One respondent said, *"[There] ... is the distinct need for graduates to have a wider range of transferable skills and inter-personal skills."* One company said, *"We ... need an increasing proportion of our recruits to have good interpersonal and marketing skills, to have an entrepreneurial attitude and to have ambitions to lead and to achieve. For whatever reason, industry does not see enough applicants with these personal qualities"*.

2.37 The demand for postgraduates possessing entrepreneurial skills was mentioned by some respondents, including providers and funders of postgraduate training. For example, one Research Council said, *"[The council] expects a PhD training to provide a sound training in employment related transferable skills including entrepreneurial skills."* A number of universities mentioned that they were attempting to develop the entrepreneurial skills of students[8]. Entrepreneurship is also being given more attention in schools. For example, Sir Howard Davies has been commissioned by the Government to review how young people's understanding of enterprise is formed within the school and further education systems.

2.38 Respondents also commented, on the whole favourably, on the concept of doctoral training accounts, introduced by the EPSRC (The Engineering and Physical Science Research Council) as a means of giving universities more freedom over the duration and amount of funding for EPSRC postgraduate students.

Disincentives to university careers (including contract researching)

2.39 Several universities said that they faced a shortage of suitable UK applicants for academic positions and have therefore had to recruit more from overseas. One university commented, *"This University has recently appointed several high quality staff from overseas in subjects where there were no suitable UK candidates."*

2.40 Many universities and other respondents argued that academic salaries for researchers were poor, despite the additional government funding that has been specifically targeted for academic and non-academic pay in HE. One response said, *"Starting salaries for academic staff – particularly researchers – are often derisory."*

[8] Universities' efforts to develop student entrepreneurial skills are supported by initiatives such as the Science Enterprise Centres, in which science, engineering and technology undergraduate and postgraduate students are taught entrepreneurial skills.

2.41 Several respondents argued that the system of academic salaries needs a complete overhaul and the variance in academic salaries, that currently exists on an ad-hoc basis, should be formalised. One university said, *"Salary incentives to reward the highest quality academics in science and engineering departments in universities are also needed."* Another respondent felt that, *"Only a radical rethink of academic scales and salaries will assure a healthy supply of new academics."*

2.42 Many universities and companies said that a significant number of good quality scientists and engineers leave research in the UK to work abroad because of the better salaries available, particularly in North America, as well as the opportunity to engage in research without the distraction of teaching.

2.43 Many universities and PhD students said that the short term contracts often given to postdoctoral researchers at universities act as a serious disincentive to many graduates pursuing a career in university research. It was felt that the short term contracts created an insecure career path for researchers, who could spend much of their career in the unenviable position of continuously moving from one short term contract to another with little recognisable career structure or development ahead of them. One response said, *"The prospects for academic researchers are poor. For someone who wishes to continue to do research this usually means a succession of short term contracts."*

2.44 According to a number of universities, recruitment of university staff is made more difficult by the high cost of housing relative to salaries in some areas. One university said, *"Recruitment of science R&D workers is increasingly being affected by the expense of housing relative to the salary that can be earned."* It was also thought that short term contracts in academic research made it more difficult to obtain a mortgage.

2.45 One or two universities thought that university staff were overburdened due to the large amounts of paperwork and time involved in assessments, such as the Research Assessment Exercise (RAE) and gaining accreditations.

2.46 A number of respondents felt that academic staff often weren't good role models for students considering a career in academia, in part because of the work pressures they faced. Several PhD students agreed that university staff appeared over-worked, stressed and underpaid.

2.47 Many respondents expressed concern about the age profile of the science and engineering academic staff in universities. One respondent said, *"Analysis of data from the Higher Education Statistics Agency (HESA) shows that the 'demographic timebomb' is becoming a growing problem. It is particularly acute in departments of physics, chemistry, mathematics and engineering ...".*

3 THE MARKETPLACE FOR SCIENTISTS AND ENGINEERS

Summary

Comments on the marketplace for scientists and engineers fell into three broad areas:

- the recruitment and retention of scientists and engineers;
- the communication framework between HE and business; and
- the demand for scientists and engineers.

Responses that commented on issues relating to the recruitment and retention of scientists and engineers focused on the negative effect on supply of the often relatively low salaries available to PhD graduates in business R&D (compared to other sectors of employment, such as financial services). The frequent use of short term fixed contracts by employers in R&D was also cited as a major disincentive for researchers to remain in R&D. Respondents thought that the career path for researchers was often uncertain, it was perceived as necessary to move into management or marketing roles in order to achieve greater responsibility and this made the recruitment and retention of scientists and engineers in R&D more difficult.

Comments regarding the communication framework concentrated mainly on the need to strengthen and formalise the currently ad-hoc communication mechanisms between HE and industry. Although the flexibility of existing informal arrangements was valued, it was suggested that more coherent communication mechanisms were required. Some responses also suggested that there needed to be a national forum to aid the process of communication between the various stakeholders. The need to bridge the gap between university research and corporate development drew comment from many respondents. Some felt that the Fraunhofer Institutes in Germany provided a good model for closer working and communication.

Comments relating to the demand for scientists and engineers focused on the strong competition in demand for scientists and engineers from other sectors and professions, where the financial rewards and responsibilities for employees are often greater. It was felt that the relatively weak demand from industry for R&D might have had a negative effect on the supply of researchers, both studying SET courses and choosing to stay in R&D. The introduction of R&D tax credits could improve the demand for corporate R&D and therefore have positive effects on the supply of good quality scientists and engineers.

3 THE MARKETPLACE FOR SCIENTISTS AND ENGINEERS

The recruitment and retention of scientists and engineers

3.1 Many universities and companies said that they had problems in recruiting scientists and engineers for their R&D operations. One response said, *"the recruitment of postgraduate students, particularly in engineering and science disciplines, is becoming increasingly difficult."* Many companies specifically mentioned that they had problems recruiting good quality researchers to their R&D activities and that this often led to recruiting a significant number of employees from overseas. One company said, *"we are finding it increasingly difficult to recruit … Suitably qualified applicants are now turning to finance, administration, IT … and other such occupations"*.

3.2 Almost all individuals and most universities thought that salaries in business R&D were too low, which hindered the recruitment and retention of scientists and engineers in R&D. It was suggested that many scientists and engineers were lost to R&D by pursuing better paid professions and that while money is rarely the primary factor involved in making a positive choice to work in R&D, it may nevertheless have a significant influence.

3.3 Many PhD students felt that business undervalues PhDs: starting salaries for PhD holders in business R&D were seen as relatively poor and often business offers salaries to PhDs at levels equal to or only slightly above those for a first degree graduate.

3.4 The majority of respondents felt that the prevalence of short term contracts in corporate, as well as academic research, was a major issue affecting the recruitment and retention of scientists and engineers. The lack of job security in R&D was a major disincentive to many PhD graduates and made the career unattractive to women in particular.

3.5 The Fraunhofer Institutes in Germany drew comments from several respondents, who applauded the fact that they offered stable employment to most of the scientists and engineers they employed. It was thought that the Fraunhofer Institutes were a good example of how R&D partnerships between universities and businesses could provide better career opportunities for scientists and engineers.

3.6 Several universities and other respondents felt that the career structure for scientists and engineers in R&D is unsatisfactory. There is the perception that in order to achieve greater responsibility and financial rewards researchers in industry have to move into other roles such as management or marketing. One respondent said, *"The career path to success is often seen as going into management rather than staying in science."* Some companies said that they were addressing this situation by offering a 'dual' career path, which presented the researcher with the choice of either a managerial or technical career but which in theory allowed for freedom of movement between the two.

3.7 Several individuals said that industry did not always effectively utilise researchers' skills. One individual said that, *"A great many leading scientists and engineers are employed in semi-technical fields ... Many elements of such roles can be undertaken by less technically able staff."*

The communication framework between HE and business

3.8 Almost all respondents agreed that there needed to be greater communication and collaboration between HE and industry to enable appropriately skilled graduates to be supplied to industry. Both groups felt that the existing communication mechanisms were too ad-hoc and that relationships have tended only to be built on small scale networks. A few respondents felt that the large number of bodies currently involved in the communication process was a hindrance. Several universities felt that a forum where stakeholders could air their views and come to a coherent view should be created.

3.9 Some universities and companies thought that non-scientific employers should be involved in the skills dialogue between universities and R&D employers of scientists and engineers, if only to aid the understanding of any potential strategy to improve the supply of substitutes for scientists and engineers in non-scientific areas of employment. Companies also thought that trade associations and professional societies, as well as National Training Organizations, should have a part in the dialogue.

3.10 Many universities and companies thought that the planning horizons of HE and industry were different. The planning horizon of industry was perceived as generally much more short term than that of HE. Some companies said that the rapidly changing needs of business made it difficult to coordinate their skill requirements with HE.

3.11 A few respondents felt that universities were unfairly perceived to be unresponsive to the skills requests from industry. One respondent said, *"There seems to be a tendency in some quarters to promote the view that universities are unresponsive to industrial needs and that they are not providing people with the right skills."* Some companies argued that universities were, in fact, unresponsive to the skills requests of business. One response said, *"members working in academe report that they believe universities are far too slow to respond to the needs of industry in terms of new degrees and new types of business skills. Within universities, the departmental funding structures make switching of funding to new types of degree problematic and far too slow."* The requirement for time-consuming external validation of courses (e.g. SARTOR for MEng courses) was also cited as a factor inhibiting the response of universities.

3 THE MARKETPLACE FOR SCIENTISTS AND ENGINEERS

3.12 Some universities and companies acknowledged that a considerable time lag exists between businesses communicating their needs to them and universities producing the required graduates. One university said, *"It is accepted that the time lag in producing graduates of a new discipline or a mixed one can take from inception to output at least four years. However much can be done to adapt more readily to changing circumstances through the adoption of more flexible modular course structures."* A number of universities said that they were providing more modular SET courses with this in mind.

3.13 On the other hand, some responses thought that universities were at times too reactive to demands from industry and that a balance had to be found. One company thought *"In the past, universities have sometimes been slow to respond but have on other occasions over-reacted to signals from one company or industry, potentially creating new imbalances in supply and demand."*

3.14 Some universities thought that businesses, particularly SMEs, were not always able to assess their skills and recruitment needs effectively. One university said, *"Individual companies, and in particular SMEs, are preoccupied by short-term needs and will rarely have a clear view of their skills requirements in the long-term, or strategies to address these. There needs to be a much more cohesive and systematic approach to supporting businesses in their long-term planning, and to making the interface between business and the HE sector operate more effectively."* Another university said, *"In our experience businesses can only estimate their longer-term needs in broad-brush terms. More detailed forward planning is rather unreliable."*

3.15 A number of universities mentioned that businesses did not have a common view of their recruitment needs and there was diversity of skills requirements depending on the size and nature of businesses. Some companies said that they had established links and collaborated with other companies with similar skills needs, but that there needed to be a specific forum to encourage this type of behaviour.

3.16 According to some universities, CASE awards (research studentships with significant industrial involvement) were beneficial in that they could lead to greater dialogue between universities and business, as well as acting as a recruitment mechanism for companies. One university said, *"Increasing interdependency of the bodies concerned may be a way of ensuring continuing and, indeed, greater dialogue between HE and business. An example of this is seen in CASE awards where experience suggests the industrial sponsor is closely involved in the development of the student as well as the project."*

3.17 The TCS (formerly the Teaching Companies Scheme) was also mentioned as an effective intermediary between HE and business and for attempting to deal with the issue of innovation itself. One respondent said, *"our view is that the Teaching Company Scheme (TCS) is even more relevant as the projects are jointly devised as in the CASE awards but deal with a real problem of innovation in a company ... with the TCS the great majority of the work takes [place] in a commercial organisation. The value is that more members of their staff are exposed to new technology and the innovative process."*

3.18 Several respondents thought that the gap between university research and corporate development needed to be bridged and that it was essential to 'plug' the gap between research and development. It was thought that the Fraunhofer Institutes in Germany provided a good model of how research partnerships between universities and business could be successful and could create substantial channels for communication between the two types of organisation.

The demand for scientists and engineers

3.19 A few companies felt that strong competition for science and engineering graduates from non-science and engineering sectors had reduced the supply to R&D. One company said, *"the demand for bright, numerate people has grown. We compete with banks, management consultancies, the civil service and many other sectors for the same people."* It was felt that other sectors would be attractive to science and engineering graduates because they often offered higher remuneration but also more initial responsibility to new entrants.

3.20 It was also sometimes mentioned that the relatively low demand from business for R&D had an adverse effect on the supply and retention of researchers. Some companies admitted that R&D is sometimes seen as a drain on their profits and is not valued as highly as it should be. One respondent argued, *"The problem may not be one of supply, but one of culture: a failure to understand and commit to the link between innovation and business performance."*

3.21 However, a number of respondents felt that the introduction of R&D tax credits would increase the level of demand for R&D from companies and consequently improve the demand for scientists and engineers to work in R&D. It was thought that this might eventually have a positive effect on the quality, as well as the quantity, of individuals entering these professions.

3.22 Many companies and universities said that corporate research was increasingly being out-sourced to universities, while companies concentrated on 'development'. Several companies said that this had reduced their demand for PhD graduates as the development side of R&D could be carried out by first degree science and engineering graduates.

4 OTHER ISSUES AFFECTING THE SUPPLY OF, AND DEMAND FOR, SCIENTISTS AND ENGINEERS

Summary

Comments on other issues affecting the supply of, and demand for, scientists and engineers fell into four main areas:

- public perception;
- the participation of women;
- mobility and work permits; and
- substitutes for scientists and engineers.

Responses relating to the public perception of science and engineering agreed that this was poor and the social status of scientists and engineers was weak. Most responses suggested that greater effort should be put into improving the nation's perception of science and engineering, and of careers in these areas.

Those responses that commented on the participation of women in science and engineering and R&D believed that the scarcity of women employed in these fields was a problem which needed to be addressed. It was felt that more role models for women in science and engineering and more relevant curricula and courses, as well as greater career security, could help to address the gender imbalance in R&D.

Responses that mentioned mobility said that international mobility among scientists and engineers is important (particularly among scientists and engineers in the EU). The majority of responses that mentioned the work permit system said that it allowed for easy access of overseas scientists and engineers into the UK. It was, however, apparent that not all respondents were aware of the recent changes to the work permit system announced in Budget 2000.

Comments on substitutes for scientists and engineers on the whole recognised that an improvement in the numerical and quantitative skills of non-science and engineering graduates would help in meeting employer demands for these skills in non-R&D sectors of the economy.

Public perception

4.1 Many respondents agreed that the image and public perception of science and engineering was poor. This was cited as a major obstacle to improving the supply of scientists and engineers in general. One respondent said, *"A conversion to a science friendly society (which we do not have in UK unlike USA) would have a major impact on the whole science education chain."* Another respondent said, *"The long-term solution to recruitment in engineering subjects (especially) is a better public image, with recognition of professionals as on a par with other sectors, e.g. Law, Medicine. The media have a role in this, which is difficult to utilise, but we must strive to reach the levels of emphasis, respect and enthusiasm found in other countries."*

4 OTHER ISSUES AFFECTING THE SUPPLY OF, AND DEMAND FOR, SCIENTISTS AND ENGINEERS

4.2 Similarly, many individuals, companies and universities felt that the social status of scientists and engineers in the UK was poor. Some individuals said that they had chosen not to pursue a career in science and engineering because they felt the low status given to scientists and engineers would eventually limit their career progression.

4.3 Some individuals and universities thought that the status of computer science in general was better than that of other sciences, and that it is perceived as a worthy career. It was felt that this might stem from the higher salaries available to graduates of computer science in industry and also to more positive media coverage of the IT sector in general.

The participation of women

4.4 The majority of responses noted that there was a gender imbalance among scientists and engineers and in R&D that needed to be addressed. One university thought, *"good role models that attract female students are needed"*. Some respondents felt that the gender imbalance could be attributed, in part, to the short term contracts that are ubiquitous in research and the consequent lack of career security. One response said, *"Action is therefore needed to create a career structure that provides adequate security from an earlier age in order to attract more women into academic research."* Other respondents were concerned that the style of science and technology teaching in schools, as well as the public perception of scientists and engineers, acted to put off women.

Mobility and work permits

4.5 Some respondents thought that work permit issues were important since the international mobility of scientists and engineers was strong, while some thought that mobility within the EU deserved further support.

4.6 Most universities and companies said that in general they hadn't experienced any difficulties in acquiring work permits for their overseas recruits. However, a few companies said that they had experienced some problems in obtaining work permits for potential employees from the Middle or Far East. A few companies mentioned other obstacles facing recruitment from overseas, including relocation and security clearance costs.

4.7 Among companies mentioning issues relating to the work permit system it appeared that a number were not fully aware of the changes to the system announced in Budget 2000.

Substitutes for scientists and engineers

4.8 Several respondents agreed that increasing the numerical skills of non-science and engineering graduates would help provide a sufficient supply of suitable graduates to industries such as finance and accounting. One respondent said, *"improving numerical and IT skills for young people … is very welcome. With more numerate pupils, a wider range of university courses could develop numerical skills. This could lead eventually, to fewer engineering and scientific graduates being required by other industries."*

4.9 Some universities and companies felt that weaker competition in demand from non-R&D fields would not necessarily lead to an improved supply of researchers to R&D. Universities thought that working in R&D must be made more attractive in order to motivate scientists and engineers to work in R&D rather than in other fields. One respondent said *"Taking steps to make careers in science more attractive is a better approach to recruiting and retaining young people."*

ANNEX A: LIST OF CONSULTEES

ABB Ltd
Advantage West Midlands
Aleksander, Nicholas
Alstom UK Ltd
ARM Holdings plc
ASE (The Association for Science Education)
ASE Ltd
The Association of Clinical Biochemists
Association of Consulting Engineers
Association of Researchers in Medicine and Science
Association of University Teachers
Atmel Ltd
Avecia Pharmaceuticals

BA (British Association for the advancement of science)
Balfour Beatty plc
BBSRC (The Biotechnology & Biological sciences research council)
Becker Industrial Coatings Ltd
BEL Ltd
Beta Technology Ltd
BG Group plc
Bodycote Ltd
Bombardier Aerospace
Boyd, Lesley A (Dr)
BP plc
The British Computer Society
British Geological Society
British Nuclear Fuels plc
BTL Group
Business Link

CAA SRG
Caterpillar Peter Lee Ltd
CeNeS Ltd
CIA (Chemical Industries Association Ltd)
CIWEM (Chartered Institute of Water and Environmental Management)
Ciba Speciality Chemicals plc
CITB (Construction Industry Training Board)
CLRC (The Council for the Central Laboratory of the Research Councils)
CBI (Confederation of British Industry)
Cobb, Maurette (Dr)
Conference of Professors and Heads of Computing
The Construction Industry Council
Corus Group plc
Council for Science and Technology

DATA (The Design and Technology Association)
Deans of Science Committee
Department of Zoology, University of Cambridge
Diabetes Trials Unit, University of Oxford
Ditchfield, Robert (Dr)
Domnick Hunter Ltd
Duckworth Group Ltd
Dupont Teijin Films UK Ltd

EDS
Education and Training Team (Lewisham)
EEESTA (East of England Engineering, Science and Technology Association)
EEF (Engineering Employers Federation)
EEF South
Electronics Scotland Ltd
Elementis Chronium
EMTA (National Training Organisation for Engineering Manufacture)
The Engineering Council
Engineering Professors Council
Engineering Training Council (Northern Ireland)
Entec Ltd
Environment Agency
EPSRC (The Engineering and Physical Science Research Council)
ERBI Ltd
e-skills NTO Ltd
ESRC (Economic and Social Research Council)

Farthing, Richard
Filtronic plc
Food and Drink NTO
The Forum for the Future
The Foundation for Science and Technology

Glasgow Caledonian University
Glass NTO

ANNEX A: LIST OF CONSULTEES

GlaxoSmithKline plc
GMC (General Medical Council)
Goddard, Sean
Greenwich University
Grey Matter Ltd
GSM Group Ltd

Heriot-Watt University
HETAS Ltd
Hills, Sir Graham (Prof.)
Horner, R Malcolm W (Prof.)
Hoskyns, Chris

IBM UK Ltd
ICI plc
IEE (Institution of Electrical Engineers)
Imperial College
Inbis
Independent Television Commission
Indigo Photonics plc
Institute of Biology
Institute of Corrosion
Institute of Environmental Sciences
The Institute of Food Research
Institute of Food Science & Technology
Institute of Physics
Institution of Civil Engineers
Institution of Mechanical Engineers
International Career Alternatives for Scientists
IPMS Ltd (Institution of Professionals, Managers and Specialists)

Jaguar Ltd
Johnson Matthey plc
John Innes Centre
Jones, Bill

Keighly Laboratories Ltd
Kirker, Tim

Learning and Skills Council
Lee, Mark (Prof.)
Leeds Metropolitan University
Lewis, D J
Lewis, R H (Dr)

Madison Filter
Manley, Susan E (Dr)
Marconi plc
Mason, Helen E (Dr)
McQuaid, Jim
Medical Research Council
Microphiltrex
Muir, Norman
Murray, Charles

National Assembly for Wales
National Postgraduate Committee
NERC (The Natural Environment Research Council)
New, Anthony
Newton, Chris (Dr)
Nissan UK Ltd

Office of Science & Technology
One North East
Oxford Brookes University
The Oxford Institute
The Oxford Trust

P&S (Birmingham) Ltd
Pace Micro Technology plc
Philips Electronics UK Ltd
Pilkington plc
Portsmouth University
Potts, Brian
Powergen plc
PPARC (The Particle Physics and Astronomy Research Council)

QCA (Qualifications and Curriculum Authority)
QinetiQ
Queens University, Belfast

Rabbets, Tim
RAS
RCGSP (Research Councils' Graduate Schools Programme)
Reading University
Rees Laboratories
Richardson, Neville (Prof.)
Ricoh (UK) Ltd
Robert Gordon University
Rolls Royce plc
Royal Academy of Engineering
Royal Aeronautical Society
Royal Astronomical Society
Royal Holloway, University of London
Royal Society
The Royal Society of Chemistry

ANNEX A: LIST OF CONSULTEES

Royal Society of Edinburgh

Save British Science Society
Salter, David C
Science Year
Science Recruitment Group Ltd
Science Technology and Mathematics Council
The Scottish Council for Development and Industry
SCONTO (Scottish Council of National Training Organisations)
Scottish Enterprise
Scottish Power plc
SEEDA (South East England Development Agency)
SETNET (Science Engineering Technology Mathematics Network)
Skillsnet South West
Small Business Network
Smart South West
Smith & Nephew Group Research Centre
Sofedit UK Ltd
Software Business Network
Southwest of England Regional Development Agency
SpaceLink Learning Foundation
Stelram Engineering Ltd
STEP Solutions

TDR Ltd
TTA (Teacher Training Agency)
Thales Research Ltd
Tripp, Brian

UK Computing Research Committee
UKLSC (UK Life Sciences Committee)
UMIST (University of Manchester Institute of Science and Technology)
Unilever plc
UUK (Universities UK)
University College London
University of Bath
University of Birmingham
University of Bradford
University of Cambridge
University of Cardiff
University of Central Lancashire
University of Coventry
University of Dundee
University of Edinburgh
University of Glasgow
University of Huddersfield
University of Hull
University of Leeds
University of Leicester
University of Loughborough
University of Manchester
University of Newcastle
University of North London
University of Nottingham
University of Oxford
University of Paisley
University of Plymouth
University of Sheffield
University of Southampton
University of Strathclyde
University of Sunderland
University of Surrey
University of Ulster
University of Wales
University of Warwick

Vodafone plc
Vosperthornycroft UK Ltd

Ward, Geoffrey
The Wellcome Trust Ltd
WISE (Women into Science and Engineering)
West Yorkshire Education Business Services Ltd

Yorkshire Forward

A number of other consultees preferred for their comments to remain anonymous.

ANNEX B: LETTER TO THE CHANCELLOR OF THE EXCHEQUER

PRODUCTIVITY, R&D AND THE SUPPLY OF SCIENTISTS & ENGINEERS

At the time of the March 2001 Budget you – and Stephen Byers and David Blunkett in their previous roles – asked me to undertake a review of the supply of scientists and engineers in the UK. The aim of this review is to enhance the supply of scientists and engineers and, through this, to raise the UK's R&D, innovation and productivity performance.

Now that we have passed the halfway point in the Review, and as you prepare for the Pre-Budget Report, I wanted to provide you with an update of progress on the Review.

The first significant step in our work was the publication of a consultation paper in June. This paper sought the views of business, universities and other interested parties on the key issues for the Review. I have been pleased with the quality of the responses to the consultation paper, and with results of the programme of discussions and evidence gathering that my team and I have carried out alongside the formal consultation process.

From these responses and discussions, and the volume of evidence being gathered by my team, the structure of the supply and employment of scientists and engineers in the UK – and their importance to R&D, innovation and productivity – is becoming clearer.

First, however, it is important to stress that the UK has a justifiable strong scientific and technical reputation. For example, between 1995 and 1997, the UK produced more scientific articles per head of the population than the US, Germany, France or Japan.

Furthermore, although there is in my view further scope for improving the interaction between business and academia, there are countless good examples of businesses successfully collaborating with or commercialising the fruits of our academic research.

The measures that you and your Ministerial colleagues have already announced – the Science Research Investment Fund and the Higher Education Innovation Fund to name but two – will contribute to continuing the UK's strong scientific tradition. However, many of these measures have focused on encouraging research and promoting its commercialisation. Through work on this Review, it is clear that action is needed to complement this by securing a strong future supply of scientists and engineers themselves.

In particular, the work on the Review has indicated that only through coherent, structured action throughout the supply chain for scientists and engineers, coupled with action by employers to improve the attractiveness of jobs in science and engineering, can the UK's future R&D and innovation performance be raised to match the world's best. Alongside boosting R&D, innovation and productivity directly, I also hope that my proposals will help in meeting the target of 50 per cent participation in higher education.

ANNEX B: LETTER TO THE CHANCELLOR OF THE EXCHEQUER

As we approach the final report, my team and I will be developing further our proposals for addressing the issues identified in a coherent and structured way. These proposals will cover a number of areas, but, to highlight a few, it is clear that action is needed to:

- address issues in the recruitment and retention of design and technology, maths and science teachers, and in the quality of laboratories and other factors influencing practical work in schools; and to encourage participation (particularly by women) in science and engineering study through appropriate course design and careers advice;
- examine any financial barriers to the uptake of science and engineering study at undergraduate level; and to address the quality of the learning experience, including undergraduate teaching laboratories, in science and engineering;
- address the funding and training available to postgraduate students and contract researchers; and to address issues in the recruitment and retention of academic staff through, for example, considering their remuneration in the context of the overall forces of demand and supply; and
- examine the opportunities for scientists and engineers working in R&D in industry; to improve the perception of careers in science and engineering; and to address the coherence of the communication between employers and universities.

I hope that you find this progress summary useful. I should add that the UK is not alone in facing these issues. Many of the UK's major competitors also face a number of these problems, and in the Review we are looking to draw on successful and innovative solutions already in operation in other countries.

Finally, I hope that through the analysis and proposals set out in my final report we will be able to build further on the UK's scientific prowess and keep the UK at the forefront of scientific and technological progress, and thereby contribute to raising the UK's R&D, innovation and productivity performance.

I am copying this letter to the Secretaries of State for Trade and Industry and for Education and Skills.

[complimentary close]

Professor Sir Gareth Roberts

ANNEX C: CONTACT DETAILS

If you would like to contribute to the Review (for example, by commenting on the likely areas of recommendations set out in the letter to the Chancellor of the Exchequer), please email or post responses to:

email: roberts.review@hm-treasury.gov.uk

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Allington Towers
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Telephone enquiries: please call 020 7270 1383

Further copies of this paper can be obtained from the 2001 Pre Budget Report section on the HM Treasury website:

http://www.hm-treasury.gov.uk

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