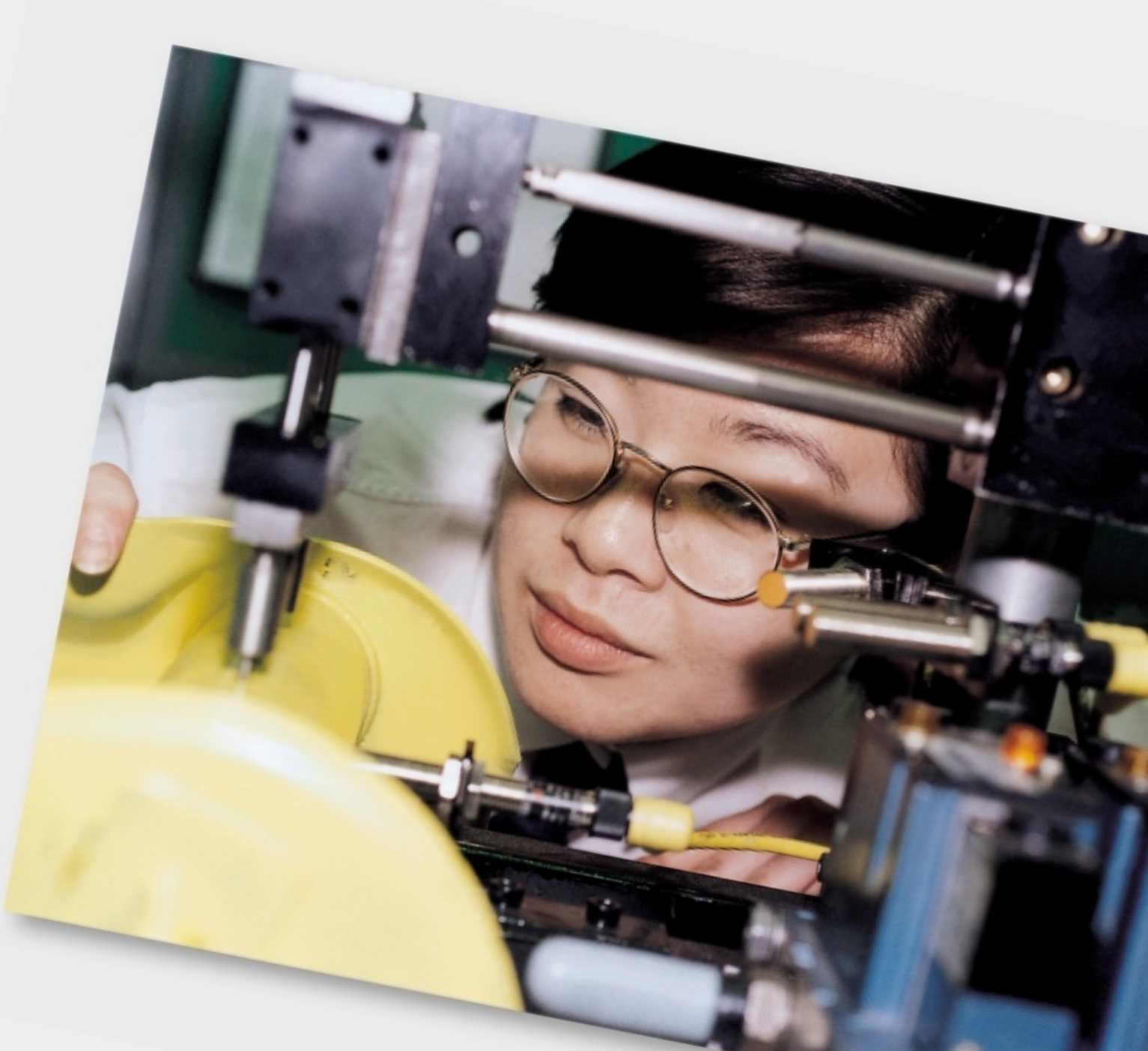




ROYAL  
ACADEMY  
*of*  
ENGINEERING

# Pregraduate Experience of Engineering

REPORT PREPARED BY A WORKING GROUP  
of The Royal Academy of Engineering





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January 2001

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Right across British industry, from space to software, from boiler-making to bioengineering, or from turbines to transport, employers express a common concern: recruiting enough good technical talent. Crucially, not enough of the best young engineering graduates take up vocational first employment.

This study was born out of the feeling within The Royal Academy of Engineering that one particular reason for this shortfall was ignorance: of the joy of creating future products and infrastructure; of likely career satisfaction far exceeding City experience, where well paid jobs can subsequently turn into boring treadmills from which there is no easy escape; of the way that good pregraduation work experience of any duration can significantly improve degree class and employability; and, by far too many students, employers and universities, of best practice arrangements for pregraduate employment. Our starting point was then the conviction that – in the interests of setting a climate conducive to making informed decisions on first employment – improvements to current arrangements were needed.

The consequence is this report on UK pre-university and undergraduate engineering work experience. We have obtained strong evidence that relevant pregraduate experience matters a great deal. Meaningful exposure to the rich and exciting world of vocational engineering really does positively influence job decisions. There are bright spots, amongst them some where Britain leads the world. We noted encouraging progress respecting relevant Dearing recommendations. On the down side, we saw enough to realise that there is a long and ugly tail. We found some clear opportunities for improvements. Considerations include availability, effectiveness and quality management, efficient brokerage and promotion of best practice. If adopted, the remedies proposed will enhance engineering school reputations and bring competitive advantage to employers and the nation alike.

Dr I D Nussey OBE FEng

January 2001



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*Readers looking for a short version of the report are advised to read the summary below and the recommendations in Section 11.*

## Summary

The growing demand from various parties for high quality work experience before graduation was reinforced by the recommendations of the Dearing Committee<sup>1</sup>. The Royal Academy of Engineering has responded by creating a working group to review and assess current initiatives and investigate how any further expansion of such experience might impinge on various 'stakeholders'.

There is widely and increasingly acknowledged evidence that high quality work experience assists considerably in attracting, recruiting and retaining able young people in engineering. The Working Group noted that the four universities involved in the Equipe project were well above average in terms of the proportion of their engineering graduates entering engineering employment.

Work experience may take a variety of forms, with different advantages and costs. It would be unwise to be prescriptive about the form it should take.

The benefits of such experience to students, employers, higher education institutions and the engineering industry as a whole are acknowledged, but there are concerns about the feasibility of further expansion of high quality work experience.

Nevertheless, the scale of the operation to provide work experience for all undergraduates seeking CEng registration does not appear to be insurmountable. The arrangements will need attention, and the quality of the provision will need to be managed.

- Mechanisms to bring together students and potential providers of work experience need to be improved. Whilst some form of central brokerage may be helpful, the system must be sensitive to the needs of a variety of stakeholders, accommodating, creating and celebrating diversity of provision.
- There are financial concerns for students, but these may be less significant than a variety of constraints on employers.
- There are formidable difficulties in overcoming employers' reluctance to commit to taking on work experience students, and providing the necessary personal commitment and support. Where such commitment and support are found the outcomes are very positive. There could be a role for The Academy in promoting such positive messages.
- Although many HEIs already have considerable experience in organising, supervising and accrediting work experience, the spread of 'good practice', and diversity of provision, are issues which need attention.

The attitudes of employers towards work experience may be rather different from those of HEIs, and both of them may be different again from the attitudes of the professional institutions. A more sustainable relationship has to evolve, to the benefit of young people, the professions and the economy alike. Work experience will need its champions amongst engineers if a new relationship is to be forged.

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<sup>1</sup>Higher Education in the Learning Society, Report of National Committee of Inquiry, 1997

## The Background

### 1 Introduction

- 1.1 For many years both those involved in the education of engineers in HEIs and those recruiting them to work in the various branches of the engineering industry have been convinced that work experience enhances the training and performance of engineers. Employers have become more interested in sponsoring those whom they have seen already in the context of a work experience placement well into a degree course. They are much less keen to sponsor unseen and untested undergraduates just setting out on a degree course, long before postgraduation employment is even a vague possibility.
- 1.2 Furthermore, it has been suggested that the drift away from engineering after completion of engineering degree courses may be directly attributable to the lack of any work experience before or during those undergraduate courses, or the quality of that which is provided.
- 1.3 Although the data on first destinations of those completing engineering degrees [see Appendix 1] appears to reveal a more complex picture of this 'drift' away from engineering careers, pregraduate work experience emerges as one of the positive factors, particularly amongst the most able students. Data in Appendix 2 seems to indicate that students who have been through The Academy's Year in Industry scheme are significantly more likely to enter engineering employment on graduation than their equally able counterparts doing similar courses at the same university.
- 1.4 The Dearing Report made two recommendations, subsequently endorsed by the government, regarding undergraduate experience of the world of work, which, whilst expressed in general terms, were particularly important for professional engineers because they reinforced the view about the quality of the experience affecting students' interest in a nationally vital vocation.
- 1.5 The specific recommendations made by Dearing were:
  - recommendation 18: We recommend that all institutions should, over the medium term, identify opportunities to increase the extent to which programmes help students to become familiar with work, and help them reflect on such experienceand
  - recommendation 19: We recommend that the government, with immediate effect, works with representative employer and professional organisations to encourage employers to offer more work experience opportunities for students.
- 1.6 It was thought desirable, two years on from the Dearing Report, to establish a small Working Group of The Academy. Its purpose was to review progress and to assess the contribution that high quality pregraduation work experience might make to achieve the goal of attracting, recruiting and retaining more of the most able students in engineering.
- 1.7 The Academy is concerned with the well-being of all branches of engineering and many of the issues raised and discussed here apply equally to Incorporated and Chartered Engineers alike. This report however is concerned chiefly with those seeking to become Chartered Engineers. We recommend that a subsequent report should examine data regarding Incorporated Engineers as it becomes available.
- 1.8 We also believe that many of the issues discussed here affect both men and women in broadly similar ways, and it would be desirable to instigate better gender-differentiated analysis as a result of this preliminary study. Further consideration should also be given to any differential effects that may be experienced by engineering students from ethnic minorities.

## 2 Defining the Problem

- 2.1 There is a growing volume of literature, though not specific to engineering, suggesting that well organised and well-evaluated work experience brings interrelated benefits to a variety of 'customers', citing the experience of those various customers over the last twenty-five years:
- The students, whose skills, both generic and specific are improved, bringing enhanced prospects of appropriate employment: 'My Year in Industry has placed me in a situation I would never have dreamed of, brimming with confidence, and outperforming all my peers academically.'
  - 'After two years [on a degree course] I was close to concluding that civil engineering was probably not where my future lay. However, year three was in industry..... completed a PhD..... Since then I have spent eleven years on a wide range of projects, publishing my work and lecturing..... Without that formative pregraduation year I would not have had the pleasure of a career in engineering.'
  - 'Good points about my work experience: taking on responsibility, finding out what this actually means and perhaps being allowed to learn by trial and error more than a 'proper' employee could.'
  - A graduate who did not have a work experience placement: 'I have offered to work voluntarily just to get the essential 'work experience'. I would have to emphasise the importance of work experience because without it you cannot even get into the industry!'
  - 'I learnt from the receiving end what bad management was like and I knew I could do better!'
  - HEIs who increase their knowledge and understanding of current activity and developments, gain the opportunity to promote their own research capacity, and enhance the marketability of their students, to mutual advantage.
  - The particular employers, who have specific tasks accomplished, the chance to 'interview' a potential employee over an extended period, and the chance to increase the number of students who know of the company. 'This was the first time we had taken a Year in Industry person, but M has shown himself to be an extremely capable and versatile engineer, with a patent application to his name as a result of his investigative and development work. We hope that M will continue to be involved with the company and the project as he progresses through university.'
  - The sector as a whole, which finds itself recruiting from a wider and more skilled cohort.
- 2.2 The quality of the experience is the vital issue, and an essential part of that quality is the relationship between students and their mentors. Students need to be able to identify with their mentors' concerns and enthusiasms: students may then be attracted and retained within the profession, even if not recruited by a particular firm.
- 2.3 Many of these points are set out in the Report of the first Equipe [Educational Quality in Placements in Engineering] conference held at Loughborough in November 1998: and on the Equipe website [www.lboro.ac.uk/departments/cg/equipe](http://www.lboro.ac.uk/departments/cg/equipe)
- 2.4 *Working Out?: graduates' early experiences of the labour market* [1999] and the later publication, *Moving On* [Nov 1999] make these points, though not with specific regard to engineering. The DTI/Barclays research into First Destinations of the 1998 graduates found that engineers and computer scientists were less likely to lack appropriate 'work readiness' skills than other graduates. Engineering graduates were almost three times more likely to have been sponsored than the whole sample of graduates. At the political level, David Blunkett regularly exhorts the 'universities to provide a minimum period of work experience for each and every student'.
- 2.5 The benefits of work experience are widely and increasingly acknowledged, not only in the UK. France is moving towards making nearly a year of pregraduate experience in the workplace compulsory; other European countries such as the Netherlands are increasing the number of

placements; Japan and other Pacific Rim countries see such experience as a way of counteracting excessively 'academic' learning; and in some institutions in the United States there is a considerable element of 'cooperative education', as it is called. In the UK, however, there is a variety of concerns about moving towards making work experience an obligatory or even more actively promoted part of the undergraduate experience.

2.6 These concerns centre around:

- the scale of the operation
- the crucial importance of employers' willingness and ability to provide appropriate and well managed placements, in which the role of mentors is recognised
- the students' willingness and ability to undertake such placements, not least as the new financial arrangements for them may not be conducive to lengthening their courses
- the ability of HEIs to alter course structures, devise rigorous and appropriate forms of accreditation, provide supportive first level quality control, and to staff such developments
- the need to develop a suitable system to match students and potential employers effectively
- respecting the privacy of HEIs and company information about partnerships for placements, whilst encouraging the sharing of good practice about their implementation. In the longer-term, exclusive bilateral partnership may diminish as the value of more open arrangements is clear to HEIs and companies alike.

### 3 Work Experience and Industry Related Work: A Typology

3.1 Harvey, Geall and Moon<sup>2</sup> suggest three broad categories of work experience, each with its own objectives, strengths, and limitations.

**Undergraduate work experience (and experience relevant to work) as part of a programme of study.**

3.2 In this category are:

- sandwich courses
- some overseas placements; for example, at the University of Surrey the 'with language' courses in Engineering (French, German and Spanish) have been running for several years, and in these the students spend their placement year in a country where the language is native. All of the graduates from these courses have been in great demand by industry, some by international companies in the UK, others by European countries
- work-linked individual or group projects, based within HEIs, using engineers from companies: Sheffield University IT course is an example of this
- workplace visits
- case studies

3.3 It is important to stress that such work experience need not take place away from the HEI, though some of the 'reality' and 'coping skills' will be lost. The emphasis is on the experience being embedded in a programme, with supervision by an HEI and often too by an external agency, such as a professional or regulatory body. The process and the potential outcomes are planned and monitored.

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<sup>2</sup>Work Experience: expanding opportunities for undergraduates, Harvey, Geall, and Moon UCE, Birmingham 1998

- 3.4 In such work experience the objectives are centred on seeing the relevance of academic work in real-life problems and settings, and starting to develop competence to practise. In addition, 'key skills' and personal competencies, such as working as part of a team and time management, are often honed.

**Organised experience relevant to work, but external to the programme of study.**

- 3.5 In this category come:

- an intercalated year
- structured vacation work [eg STEP]
- short courses at home [eg CRAC]
- short courses abroad [eg IASTE]
- work shadowing and mentoring

- 3.6 The distinction here is that the initiative for taking part usually comes from the student. Such programmes, whilst generally similar to those in the first category in terms of objectives and process, are not integrated into a programme of study; the time period tends to be shorter; and there may be little external monitoring.

- 3.7 Such experience may also take place before an undergraduate course commences. The Engineering Education Scheme, the initial programme of the Best schemes overseen by The Academy, provides the opportunity for some 2000 able 16/17 year-olds studying Mathematics to work on real live engineering projects over an extended period, mentored by professional engineers. The Headstart Programme also allows a further 800 Year 12 students to attend briefing courses in the engineering departments of over twenty universities. At the next stage, the national programme of the Year in Industry [whose apparent impact on retention rates in pursuing engineering employment is set out in Appendix 2] provides opportunities for some 750 pre-university students each year, predominantly in engineering and science. Individual companies too provide 'Year Out' or Gap Year opportunities outside such arrangements.

**Ad hoc work experience and activities external to the programme of study**

- 3.8 In this category come:

- traditional, generally unskilled, vacation work
- vacation work arranged at relative's place of work
- an increasing amount of part-time work during term-time
- voluntary work before starting a course, in vacations or during term-time. [CSV/Project Trust]
- Duke of Edinburgh Award.

- 3.9 The objective of such work experience is often to earn money, though interest and commitment may feature, particularly with the voluntary work undertaken.

- 3.10 Students use all three categories to enhance their 'key skills' or employability skills, and for 'making a CV look good'. There is growing recognition amongst employers too that even experience outside 'their' industry may provide the opportunity for students to acquire a range of 'key skills', making them more attractive to those employers. The explicit integration of such skills into engineering courses is being explored through the DfEE funded TRANSEND [Transferable Skills in Engineering and their Dissemination] project: <http://transend.cpe.surrey.ac.uk>

- 3.11 The Academy however is concerned particularly with the quality of such experience and it is important therefore to consider the whole range of categories in terms of strengths and limitations, conflicting demands, and pressures, set out below:

- the perceived and intended objectives of the particular 'experience' and the balance between increased academic/professional knowledge and the development of personal 'key skills'
- ensuring the quality of the experience
- the 'realism' of the experience

- monitoring the progress of an individual student
- the living costs for students going away from an HEI
- the comparative cost to the HEI of various schemes
- the disruption to students and staff programmes of various schemes
- the comparative availability/accessibility of students to various schemes, irrespective of gender, ethnicity and country of origin
- the comparative costs of various modes to companies/organisations
- the long-term sustainability of schemes.

3.12 The HEI-based integrated project might rate *highly* in terms of:

- increasing both academic and professional knowledge
- having control over the quality of the project
- being able to monitor the progress and contribution of the individual student
- lower costs for both the students and the staff
- accessibility and availability to all students

but rate less highly in terms of:

- 'realism'
- certain personal 'key skills'.

3.13 The non-HEI organised, non-integrated experience might rate highly in terms of:

- increasing both academic and professional knowledge
- lower costs for the staff
- 'realism'
- certain personal 'key skills'
- lack of disruption to academic programme

but rate *less* highly in terms of:

- having control over the quality of the project
- being able to monitor the progress and contribution of the individual student
- lower costs for the students
- accessibility and availability to all students.

3.14 Many of these issues have been investigated and discussed in another project funded under the HEQE [Higher Education Quality and Employability] initiative, on the development of Graduate Apprenticeships [[www.dfee.gov.uk/heqe/](http://www.dfee.gov.uk/heqe/)]. Seven NTOs have been involved in this work, including running pilot schemes bringing together HEIs and employers. EMTA, the Steel Industry NTO and the Chemical Manufacturing and Processing NTO are amongst the NTOs participating.

3.15 The [provisional] EMTA Graduate Apprenticeship Model includes three features of this model of particular relevance to The Academy:

- the central importance of the 'work-based component'
- the significance explicitly attached to Key Skills
- the flexibility of the model, allowing approved 'work-based learning' to occur at any stage in the apprenticeship.

## **4 Quantifying the Issue**

4.1 The detailed figures and assumptions on which these conclusions are based are given in Appendix 3. Incomplete and conflicting data makes precision difficult but the Keynesian principle that it is better to be broadly correct rather than precisely wrong has been adhered to.

4.2 The conclusions are:

- In the next three years there might be some 25000 to 35000 students taking CEng courses at any given time.
- Perhaps 7000 to 10000 CEng students might be seeking placements in any given year. [With many IEng students also seeking placements.]
- On average, one in eight/ten of all existing Chartered Engineers would have to oversee a student on pregraduate work experience each year: one CEng might oversee more students, but the day-to-day mentoring might be done by staff other than CEng. It has been suggested that changes in the structures of many organisations, with fewer rungs on career ladders and a matrix approach to project teams, means that there are less obvious opportunities for someone to demonstrate that they have people specifically responsible to them. Being responsible for work experience placement students would therefore be advantageous to the potential CEng graduate.
- If these vital roles of supervision and mentoring are not to be burdensome, appropriate systems of management by exception should be adopted: good practice is set out in Engineering Our Future. Students should be encouraged to take a proactive role in the planning and implementation of their training.
- Given the existing level of placements, and the apparently modest demands on Chartered Engineer involvement, the scale of the operation alone does not appear to be insurmountable. Clearly, the quality of provision and a range of other issues will need attention.

## 5 Brokerage Mechanisms

- 5.1 One of the effects of the Dearing report noted earlier has been to stimulate DfEE funding of a number of projects under the heading Higher Education Development projects: TRANSEND, Graduate Apprenticeships, and Equipe mentioned above are but three. The projects come under some eight headings, one of which is Work Experience, and within that section, three of the nine projects are concerned, at least in part, with creating a brokerage system.
- 5.2 The projects at both Manchester and Newcastle Universities have now created web-based work experience banks [[www.workbank.man.ac.uk](http://www.workbank.man.ac.uk) and [www.experienceworks.ncl.ac.uk](http://www.experienceworks.ncl.ac.uk)]. Both institutions report a significant increase in the number of students seeking placements, and an increased number of employers being willing to enter details on the site, in part they believe because of the 'nifty technology', and in part because of the marketing effort which has been made. [In neither case are the databanks concerned exclusively with engineering.]
- 5.3 Such a national database and search facility may be adequate to ease the allocation of the 7000/10000 placements being sought by the CEng students [drawn from a smaller number of courses recruiting nationally, see Appendix 3] amongst a limited number of high-profile national companies and placement providers. However, neither of these databanks appears to have tackled the issue of existing, and carefully guarded, exclusive bilateral arrangements, in which certain departments create links with certain companies which they will not divulge to other departments within their own HEI, or else companies will take students only from certain departments.
- 5.4 It is clear however that there will be competition for company time and resources between those HEIs seeking placements for potential Chartered students and those seeking placements for potential Incorporated students. They will not be seeking the same placements: the jobs they do should give them the proper perspective on the employment to which they aspire and for which they are being educated.
- 5.5 The recruits to Incorporated courses *may* be drawn from a more local geographical area, often being older, and with some industrial experience already. In turn, they may be seeking placements more

locally too, being unable or less willing to be mobile. Local HEIs may more easily establish a new link on their behalf just because of direct local contacts and the availability of local people. [There is some evidence of this in the work done by another DfEE group, that on Graduate Apprenticeships.] Thus the 'pool' of placements has increased, but it is a pool with restricted access.

- 5.6 The new funding arrangements for students may accentuate this tendency.
- 5.7 Whilst the establishment of such brokerage systems may ease some of the logistical problems of a wider range of students seeking placements, it may raise more sharply a number of other issues, some of which have been aired widely and for a number of years.
- The possibility and desirability of application forms with a standard core; generally acceptable aptitude/competency tests; and the plea from HEIs that all first interviews should be 'on campus' will also have to be discussed if student time expenditure is to be kept within reasonable bounds. At the same time, it is important that students see where and with whom they are going to be working during their placement: feeling 'at home' in both the job placement and its locale are said to be important elements in the success of any placement.
  - The need for, and willingness of, both HEIs and companies to make public the placements sought and offered, arrangements hitherto only suspected by other HEIs and companies.
  - The careful mapping of term dates, the teaching timetable, and various forms of assessment will be necessary to maximise students' chances of finding appropriate placements, with adequate support from staff.
  - Equally important would be attempting to dovetail the academic timetable with the more fluid funding and decision making regime of the various placement partners. Though the motives of SME in taking placement students may be more to do with professional altruism than the larger companies, concerned with their recruitment needs, both may be subject to more rapid and dramatic changes in circumstances than the HEIs.
  - Companies large or small are likely to be interested in 'value for money' from students, not least by having a continuing and developing relationship with the same students over much of their undergraduate career.
  - There is some evidence that acquiring able and comparatively 'cheap labour' is being overtaken in a limited number of cases by an interest in 'free labour', the American-style unpaid 'internships'. (There are, of course, still costs to the employer.)
  - The need to create and perhaps share alternatives to the conventional 'industrial placement', such as simulations and the more extensive use of 'visiting' staff from industry.
  - The increased volume of students on certain courses who will be seeking placements, with greater expectations of what their placement will yield. The need for support from academic staff will be considerable, with increased pressure on some.
  - The pressure will arise from time spent on:
    - preparation, with tutors visiting placements, reducing if not eliminating later problems
    - planning training according to need and purpose
    - appropriate mentoring and monitoring, on the basis of management by exception, and using technologies such as email and video conferencing to minimise travel.
  - The present emphasis on research ratings is perceived as downgrading such support for learning, with funding and supporting placements being dismissed as merely an administrative task.

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## Attitudes, Perspectives and Anxieties

### 6 Introduction

6.1 Employers, HEIs, professional bodies and students view work experience from very different perspectives. These differences have to be acknowledged, and where possible reconciled, so that a more sustainable relationship can evolve, to the benefit of young people, the professions and the economy alike.

6.2 Some of the particular concerns of each are outlined in the following sections: clearly, their attitudes and reactions interact, so the distinctions here are not discrete.

### 7 Company Attitudes to Increasing Work Experience

7.1 A growing number of major companies already use the provision of work experience and other placement schemes as a major source of recruitment, with as many as 100% of sandwich students being recruited by some companies, and 80/90% being usual [IDS Research File 53], because such placements act as lengthy interviews, to the advantage of employer and student alike, and without expecting either side to make a long-term commitment even before the commencement of an undergraduate course.

7.2 Despite these acknowledged benefits, reference has been made to three major and interrelated factors which may influence companies providing placements both in the numbers and of the 'quality' which is being sought. HEIs and companies concur that placements are harder to find for these and other reasons, which should perhaps be discussed in response to the recent White Paper on Science and Innovation.

7.3 These might be categorised broadly as:

- the economic context in which companies are operating: globalisation for example being just one factor in making for increased volatility and uncertainty, two of the elements which make it difficult to make firm plans far ahead, and not only for the placement of students
- the changing structure of organisations, with greater flexibility being sought through the well-publicised processes of down-sizing, de-layering, and devolving decision making to ever smaller cost centres
- the perceived purposes and benefits of placements: are they personal and professional, or essentially hard-edged and economic, aiding the organisations? Are the organisations more concerned about the greater number of Incorporated Engineers, or the smaller number of Chartered Engineers?

7.4 Just as the HEIs are needing greater certainty about the availability of placements [not least because of government policy], so the providing companies and organisations are in an increasingly uncertain world. This can lead to a conflict between the personal predisposition of the Chartered Engineers working in companies and organisations, and the organisational stance of companies in which they work.

7.5 Many of those involved in work experience placement [whether in HEIs, colleges or schools] encounter this tension within the organisations they are trying to involve. Initial contacts with a company, often through personal contacts, may well be favourable, with real enthusiasm being shown. However, once that initial contact has to be formalised, and referred to a Human Resources Department for example, the atmosphere may become less positive, with wider policy and costing issues being raised.

7.6 Many employers recognise this difficulty, which is not peculiar to issues of placement students, affecting the initial career development of many staff. Rightly they believe that unless the whole

organisation is involved and committed, finding placements will be difficult or haphazard, and even if a placement is arranged, the quality of supervision and support may be lacking.

- 7.7 Even when the initial contact is made at the highest level, once the promises to get involved have to be translated into action at a lower level, the raising of contentious internal issues can easily delay or totally disrupt the establishment of a placement. The decentralisation of management, with ever smaller units of accountability has exacerbated this situation.
- 7.8 These tensions between professional and corporate attitudes are compounded if not partly caused by the state of the economy in general; the economic health of a particular sector; and changing structures and resulting uncertainty.
- 7.9 The impact of these pressures and tensions has been confirmed in various conversations, with Igor Wowk, Industrial Placement Coordinator, Department of Engineering, University of Cambridge; June Crabtree of BNFL, speaking in a personal capacity; and Jill Lang, lately of British Energy, and now with People Potential Partnership, also speaking in a personal capacity. Changes in company organisation as causes of difficulty in finding and retaining placements were mentioned frequently at the Equipe/TRANSEND conference in November 1999.
- 7.10 In these circumstances, the likelihood is that, as in the past, the exhortations of the institutions, CIHE, IoD, or the CBI may lead to little change at the operational level. It could be that an essential role for the Fellows of The Royal Academy of Engineering, with a range of contacts with both the professions and the 'employers', would be to reduce these tensions, increasing the rate at which good intentions are converted into good placements for able young people.
- 7.11 'Companies clamour for [our] students, both for placements and postgraduation. The system relies on good structure to each placement, and an effective mentoring system. Also, ongoing assessment by the university of student's progress during the placement [is essential].' This quotation is from a report on course provision in relation to SARTOR 97, commissioned by the Engineering Council.
- 7.12 High quality work experience needs its champions amongst companies and organisations. The Academy and its Fellows should be amongst them.

## **8 HEI Attitudes: Quality and Accreditation**

- 8.1 The positive attitude of many HEIs tutors already involved in work experience is influenced by their belief that work experience has a beneficial effect on the academic performance of students across the range of ability, challenging, engaging and developing most students.
- 8.2 In part such beneficial effects stem from good management of placements, and there is much experience in universities about good practice in running work experience. Individual institutions, such as the Universities of Surrey, Loughborough and many others, have well established regulations that apply to conduct by the HEI itself, the employers involved, and the students being sent out on placement. UCSC is gathering such guidelines together from many HEIs.
- 8.3 Loughborough University is the centre for a consortium of HEIs looking specifically at the issue of the quality of the educational component of work experience in the DfEE funded Equipe project. The report of the first Equipe conference in November 1998 contains admirable guidelines for the proper management of undergraduate placements in engineering.
- 8.4 The Leonardo da Vinci Programme has produced a Good Practice Guide for Managing Placement and Exchange Projects, whilst The Smallpeice Trust has just undertaken a review of its procedures.
- 8.5 One contentious issue within HEIs relates to the recording, assessment and accreditation of placement activities and learning. Again, the concerns are not new, and much work has been done in those HEIs already heavily involved in placements, and in the two projects Equipe and TRANSEND. Another example is the RAPID [Recording Achievement for Professional and

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Individual Development] Progress File project: a web-based interactive system allowing students to track what they have done, what they might need to do in order to get where they think they want to get to, and whether it appears that they have finally got there.

- 8.6 Many institutions have decided to accredit the work and learning of industrial placements separately from the 'academic' component of the courses, with a Diploma in Industrial Studies being awarded, for example. In others, performance during their industrial placement is an integral part of final degree classification: 'integral' and 'separate' can coexist in the same HEI. In maintaining the quality of the experience, it would appear that either can be successful given good management: prescription of format matters less than the quality of management and delivery. QAA may have a role in such matters.
- 8.7 The financial implications for the HEIs of creating or finding placements; supervising the quality of the student experience; and finally evaluating and accrediting that experience must also be considered. The new HEROBC [HE Reach Out to Business and the Community] fund was seen as one potential source of funding for such activities, and institutions are already submitting their bids.
- 8.8 The system under which HEIs receive their income from various sources does not lend itself easily to departments claiming funds specifically for the support of placement activity. Hypothecation is attractive and perhaps desirable, but achieving it will be difficult.
- 8.9 These, and the financial/logistical issues discussed in Section 5, are not however the only concerns of the HEIs. Even 'good' departments have their weaker students: whether they are lacking 'good academic credentials or a personality, or both' there is widespread concern about what will happen to them if placements become compulsory for all. Equally there is concern amongst employers about industry being used, unknowingly, to tutor such students in a range of skills. From an industrial viewpoint such deficiencies should have been dealt with within the HEI, either by not accepting such 'weaker' students in the first place, or by the provision of appropriate courses prior to placement.
- 8.10 Many departments have a significant number of overseas students, and placements may be hard to gain for two reasons.
- Such students may not be able to gain work permits for subsequent employment, and thus they may not be regarded as favourably for some possible placements because they are not potential recruits, a major motivation of many employers in taking placement students.
  - The Schengen Agreement restricts non EU nationals to enter an EU country for only thirty days per year: Professor Peter Lutzeier, of the University of Surrey, reports that 'we face insurmountable problems with placing our overseas students for a work placement in a EU member state'.
- 8.11 However, organisations wishing to develop their business in specific countries may seek to recruit certain overseas students for placement experience and possible future contacts. Today's students may be tomorrow's purchasers.

## **9 Student Finance**

- 9.1 At a recent meeting of the Universities Committee for Sandwich Courses [UCSC] the general feeling that emerged was that the financial pressure on engineering, science and business studies students undertaking paid periods of work experience/pregraduate work experience was not as great as had been expected. Their explanation was that students would be earning for the year, and thus able to pay the portion of the government imposed tuition fee [currently £500] likely to be incurred. This might be disguised by the employer paying them £500 less, or the employer paying the £500 directly to the university without detriment to the student.

- 9.2 However, it could be argued that there could be a negative effect on students' predisposition to undertake or welcome a placement, since they will have to pay NI contributions; pay some tax at standard rate; and often live away from home, in accommodation more expensive than that generally found in HEIs. Thus their net financial position, after these deductions from their placement salary of £10000/£12000, may be unattractive.
- 9.3 However, the main concern in universities was for those students who in the past have undertaken unpaid work experience [mainly in work related to social sciences] but without incurring any fees.
- 9.4 There was however greater concern expressed about the financial and time implications for engineering students undertaking an MEng course, now typically four years, to gain Chartered status, finding themselves committed to a course lasting five years if a year of pregraduate work experience is included. Some representatives feared that applications to their courses had fallen for this reason, with higher education being viewed almost as a painful injection, to be survived, and got over swiftly. However, such views may be particular and partial: there is already limited evidence of the contrary move, with students switching to the longer courses, attracted by the possibility of gaining properly integrated pregraduate work experience.
- 9.5 Furthermore, such concerns have spurred innovative approaches to MEng course design, to ensure that the length remains four years, but includes twelve months of placement, and is accepted by the professional institution concerned. In part this has been achieved by including modules to be completed by supported distance learning during the placement.

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## Conclusions and Recommendations

### 10 Conclusions

- 10.1 There is evidence from various sources that high quality work experience assists considerably in attracting, recruiting and retaining able young people. However, data on a number of issues is fragmented, and greater consistency and coherence of data would assist analysis and action to promote high quality work experience. [Section 1]
- 10.2 Any review of the demands on industry for engineering placements must take account of the total demand, not just one particular group such as CEng. [Sections 1 and 2]
- 10.3 The further expansion of high quality work experience is needed, but cannot be undertaken lightly, and the number of 'stakeholders', with a variety of interests and concerns, requires changes in attitudes as much as systems. [Section 2]  
Note: During the editing of this report, Equipe published *Making Industrial Placements Work for You*. We commend the publication.
- 10.4 Research, and the Working Group's experience, showed the importance of mentoring and personal relationship underpinning good experience of work. [Section 2]
- 10.5 Differing structures for providing high quality 'work experience' will bring varying advantages and costs, suggesting that it would be unwise to be prescriptive about any one form of provision. [Section 3]
- 10.6 Given the existing level of placements, and the apparently modest demands on Chartered Engineer involvement, the scale of the operation alone does not appear to be insurmountable. Clearly, the quality of provision and a range of other issues will need attention. [Section 4]
- 10.7 Whilst some form of central brokerage may be helpful, any system must be sensitive to the needs and concerns of a variety of stakeholders. It must accommodate, create and celebrate diversity of provision. [Section 5]
- 10.8 There are formidable difficulties in overcoming employers' reluctance to commit to taking on 'work experience' students, and providing the necessary personal commitment and support. Where such commitment and support are found the outcomes are very positive. There could be a role for The Academy in promoting such positive messages. [Section 7]
- 10.9 Although some HEIs have considerable experience in running 'work experience', the spread of 'good practice' amongst them and those HEIs with less experience is an issue. HEIs also have concerns about the 'inclusiveness' of provision: they are concerned that all their students should have the opportunity to experience 'work experience'. [Section 8]
- 10.10 The concern about student finances should not be disregarded. It may, however, be less important than the apparent financial constraints on the HEIs, and also potential employers. [Section 9]

### 11 Recommendations

- 11.1 The Academy asserts the value to a variety of 'stakeholders' of pregraduate experience in engineering, and recommends steps to make it more widespread, in order to achieve the goal of greater first destination vocational employment. Quality must not be sacrificed to quantity.

## Principal Recommendations

- a Different forms of work experience each have merits and disadvantages. The experience of schemes such as EES and Year in Industry as well as those managed by HEIs should be promoted. The Academy further urges the importance of 'appropriate realism' in any proposed programme.
- b The brokerage systems already being developed [paragraphs ... to ... ] should be investigated by the Engineering Council with a view to ensuring that the systems could be scaled up to deal with the volume and diversity of placement requirements. This action should be followed by the wider prosecution of 'best practice'.
- c Employers should ensure that every placement is provided with an appropriate mentor and that the practice of mentoring is reviewed and encouraged.
- d The Academy recommends that appropriate government and other agencies promote good quality work experience by ensuring both that financial deterrents to companies participating are removed, and that positive incentives are introduced.
- e It is recommended that the current 'employment tax' surcharge on students undertaking industrial training which is part of a degree should be removed.
- f The financial implications for HEIs of supervising high quality work experience should be reviewed by HEFC, and the financial and fiscal status of students on placement should also be investigated.
- g All relevant parties should, in the interests of consistency and economy, support and assist in the development of appropriate core standardisation of application forms and pre-selection procedure standards for placement students. We recommend that DfEE and/or HEFCE provide appropriate encouragement.
- h The Engineering Council and professional bodies should adapt their HEI accreditation procedures to evaluate the overall quality of the whole process of arranging and carrying out work experience for engineering students.
- i In the interest of minimising bureaucracy and maximising cost-effectiveness, HEIs are encouraged to explore the feasibility of exception management practices to monitor and supervise placements. 'On-site' supervision visits should focus on the extremes of exceptional and weak placements.
- j With others, The Academy should help promote the dissemination of 'good practice' regarding work experience, to benefit students, HEIs and employers alike. Noticing the excellent progress made during the life of the Working Group by Equipe and other projects, The Academy recommends the widest possible dissemination of best practice and offers its help.

## Other Recommendations

- k Noting that, following the Dearing Report, the DfEE and HEFCE launched several welcome initiatives relating to work experience, The Academy recommends that now is the time for the DfEE to increase coherence and effectiveness by reviewing these arrangements, perhaps under the umbrella of the National Centre for Work Experience.
- l More consistent and useful databanks of statistics about flows into engineering employment and the related HEI would make a significant contribution to policy formation relating to skill shortages. The Academy recommends that the Engineering Council, HESA and other interested parties harmonise and enhance their relevant databanks.
- m The Academy, whilst welcoming the various initiatives related to work experience under HEQE, would urge the DfEE to draw together their findings, in order to increase their coherence and impact.



## Appendix 1

### The Movement into Employment of those who have Studied Engineering

It would appear that the drift away from jobs in engineering after graduating from an engineering first degree depends on an interplay between at least five factors:

- the type of engineering studied
- the mode of study
- the 'ability' of the students both on entry to a course and on leaving it
- the HEI attended
- the economic climate in the year of graduation

To explore the relative significance of these elements by some form of multilevel analysis, it would be necessary to work from student level data. It is understood that HESA is unable to release data at that level: however the pivotal database obtained from HESA will allow more flexible interrogation of the data.

The data given below should urge caution in making categorical statements about any single cause of the 'drift away'. The table covers students entering employment directly after graduation; it does not consider those who study for a higher degree and then progress to employment in industry.

**Table 1**

**First Degree Engineering Students Entering Employment by Subject, Mode of Study and Occupation – 1997/8 [this excludes those undertaking research/higher degrees]**

Type of Course	[Total]	Full-time		Sandwich	
		Engineering	Other	Engineering	Other
<b>Subject of Study</b>					
General Engineering	[ 940]	37%	63% [77]	43%	57% [23]
Civil	[1635]	59%	41% [75]	62%	38% [25]
Mechanical	[1800]	62%	38% [75]	75%	25% [25]
Aeronautical	[ 375]	38%	62% [70]	60%	40% [30]
Electrical	[ 375]	55%	45% [83]	66%	33% [17]
Electronic	[1670]	49%	51% [77]	60%	40% [23]
Production	[1230]	36%	64% [61]	44%	56% [39]
Chemical	[ 555]	60%	40% [80]	77%	23% [20]
Grand Total	[9320]	52%	48%	60%	40%

These figures seem to indicate that those who have studied engineering through a sandwich course are more likely to go into engineering employment: 52% from full-time courses compared with the 60% from those with a sandwich course background.

But the 'drift away' is not totally explicable in terms of the mode of study: the type of engineering matters. Comparing Mechanical Engineering with Production Engineering it appears that the Mechanicals are more likely to move into engineering whatever the mode of study. Equally, the Production people who have done a sandwich course still do not move into engineering [44%] at the rate of the Mechanicals [62%] who studied full-time.

This then raises an interesting question of the interaction of demand and supply. To what extent do those with degrees in Production Engineering [or General Engineering] choose not to have jobs in engineering, perhaps being attracted and attractive to other forms of employment, or perhaps they are unable to find

employment as engineers, or no longer wish to work as engineers. It may well be that employers have a priority order of disciplines, with 'mech.eng' and 'elec.eng' generally at a premium, perhaps because employers believe they know what they will get. Graduates from other engineering disciplines may have similar skills and/or knowledge but the 'label' of the degree may conceal both knowledge and skills acquired.

The 'ability' of the graduates may be a factor to take into account when considering this question. Only 14% of home applicants accepted for Production Engineering courses and offering A level as their entry qualification had more than 26 UCAS points, compared with 27% for engineering as a whole, and 40% in the case of Aeronautical Engineering.

It could be that the 'less well qualified' candidates were not able to enter their type/course of choice, but those with spaces available.

**Table 2**

**First Degree Engineering Students Entering Employment by Classification of Degree and Occupation – 1997/8**

Classification	[Total]	Engineering	Other
First Class	[1180]	65	35
2:1	[3370]	57	43
2:2	[3040]	51	49
3	[1170]	44	56
Unclass	[ 550]	47	53

At graduation too the most academically able seem to be more likely to move into employment, but the data does not reveal whether those who did not move into employment had tried but not succeeded, or not tried at all. We do not at present have data to show how degree classification interacts with type of engineering, the mode of study, and the likelihood of a career in engineering.

**Table 3**

**First Degree Engineering Students with A level as the Highest Qualification held on Entry to University now Entering Employment by Classification of Employment – 1997/8**

A level point score	Engineering	Other	Total
01-10	40	60	770
11-15	52	48	575
16-20	53	47	920
21-25	57	43	640
26-30	57	43	1060

In reading Table 3 it is important to note that there may be at least two factors operating here: the ability of the candidates, and their ability to get on to different engineering courses in the first place.

**First Degree Engineering Students Entering Employment, by Institution and Occupation – 1997/8 [this excludes those undertaking research/higher degrees]**

First degree destination figures for particular HEIs appear to indicate that there are a number of elements which may influence the move into engineering employment.

The balance of the types of engineering studied: Table 1 would indicate that an HEI with a high % on Mechanical, Civil or Electronic courses is likely to be an HEI with a high % going into engineering employment.

The mode of Study employed: an HEI with a high % on sandwich courses is likely to be an HEI with a high % going into engineering employment. But doing the 'right' kind of engineering by the 'best' mode may not be adequate compensation for having lower entry grades, and thus gaining entry to the traditionally 'less prestigious' or more recently founded HEI.

The 'ability' of the students recruited: this is the most complex part of the argument, and perhaps a very English issue. Some HEIs will attract and be able to select very able candidates, who, whatever the type of engineering studied, or the mode of study, will be attractive potential employees to a wide range of employers in a wide range of employment.

It has also been suggested that these most academically able students recognise and are attracted by the range of occupations open to them. They might be considered to be committed to 'success', and not necessarily in engineering. They can choose amongst a wide range of employers and employments, and they will not necessarily choose engineering.

In reviewing the figures, the Working Group was struck by the relationship between provision of good vocational experience and the higher proportion of graduates entering engineering occupations. This proportion varied between 23% and 82%, with the percentages averaging 49%. The figures for the universities involved in Equipe averaged 73%.

## Appendix 2

### The Year in Industry

Brian Tripp, Chief Executive, Engineering Development Trust, has made available data that Year in Industry has collected on those students who have now graduated having spent their Year in Industry prior to entering their undergraduate course.

The figures are based on data from 960 students [an estimated response rate of about 50%].

Of these 960 students:

680 went from Year in Industry to engineering courses

68 to computer science and other IT courses

Of the 680:

400 entered employment as engineers  
[85% of those entering employment]

60 entered employment in some other capacity  
[15% of those entering employment]

[The majority of the others took up places on advanced postgraduate courses; about 3% went travelling or were unemployed at the time of the survey.]

By comparison, of UK engineering graduates as a whole,

54% of those entering employment did so as engineers  
46% of those entering employment did so in some other capacity

It would therefore appear that in general the Year in Industry students were significantly more likely to enter engineering employment.

Such a disparity might be explained by differences in the type of engineering being studied, the mode of study, or the ability of the students. However, looking at the pattern for one particular institution, where the pattern of type of engineering being studied, the mode of study, or the ability of the students is likely to be the same for Year in Industry students and other students at the same place will largely eliminate that possibility. At Cambridge University, where the move to engineering employment was below the national average, with 45% going into engineering employment, and 55% into non-engineering employment, we find that 80% of the Year in Industry students went into engineering employment, and 20% into non-engineering employment.

Such figures raise further interesting questions, but it would appear that Year in Industry students are significantly more committed to initial employment as engineers than the generality of engineering students.

## Appendix 3

### Quantifying the Current Situation: the Basis of the Conclusions in Section 4

These figures refer broadly to placements of more than six months and which form an integral part of a higher education course: the other forms of 'work experience' are even less easy to define and quantify.

#### The Flow

The home applicants' admitted to engineering and technology courses in 1998 numbered some 16250 [13960 male, 2336 female] [UCAS Annual Statistical Tables, 1998]. It is perhaps worth noting that the total number admitted to engineering and technology courses in the same year was nearly 24000 [20660 males, 3000 females]: these are figures of the annual flow into courses.

#### On Course

The number of students thought to be on first degree courses in engineering and technology is some 67000, [this is a total across all years] of whom some 18000 are thought to be on some form of sandwich course or courses involving pregraduate professional training [pregraduate work experience] broadly defined. [Malcolm Brewer/David Pollard]

[There are interesting differences between these figures, those of the Engineering Council Digest of Statistics, and the HESA statistics.]

It is not easy to be certain about the number of students on CEng Accredited Courses [see the differences between the UCAS and HESA figures referred to above] but around 12000 to 15000 might be about right.

#### 'Quality'

In terms of academic 'quality' the A level grade distribution amongst all home applicants admitted to engineering was:

16% had at least 26 UCAS points [2650] [27% of those with A quals]  
10% had between 25 and 21 [1650] [16% of those with A quals]  
15% had between 16 and 20 [2500] [25% of those with A quals]

[boundaries set in UCAS Statistical Tables: around 60% of entrants offered A level as their main qualification]

#### On placement

Brewer/Pollard believe there to be some 8500 engineering/technology students out on placement this year but the HESA figure is around 3000: there are apparently considerable differences in the definitions, and have been for many years. Malcolm Brewer believes the HESA definition is too narrow, and is said to omit any 'thin' sandwich students.

**That there is a considerable volume of work experience taking place already is the important point.**

### **Estimates about the short- to medium-term number of students, and the number of Chartered Engineers**

It may be useful and not unreasonable to assume that:

- The total number of people entering engineering and technology courses will remain roughly the same for the next five years.
- By 2003 only one third of them might be on CEng accredited courses, depending on the willingness of those involved in assessing quality of courses to discontinue CEng courses that are said to be doubtful in quality.
- By 2003 all CEng students may be required to spend the equivalent of one year in pregraduate work experience: those seeking placements for these students would be in competition with those seeking placements for IEng students.
- The distinction between 'home' and 'all' students will be ignored, giving a larger figure than might actually take part in any arrangements.
- There are approximately 130000 'active' chartered engineers under the age of 60 [Engineering Council] who might be regarded as those most appropriate to supervise the pregraduate work experience. [The actual total number of Chartered Engineers is about 200000].
- Some 20% of all Chartered Engineers live abroad, clearly reducing the number of potential mentors in this country. However, students and universities are not averse to placements abroad, and this group of CEng living abroad might be seen as an important resource.
- The majority of placements have to be found within the UK: since a proportion of placements will be made abroad, the impact on 'employers' in the UK may be somewhat smaller than suggested.

## Appendix 4

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## Appendix 5

### Terms of Reference of Working Group

The Working Group was asked to:

- Review relevant initiatives begun or significantly enhanced since Dearing reported.
- Seek collaboration with government, the EEF, some leading engineering institutions, educational charities and other bodies with an interest in this matter.
- Make a quantitative and qualitative assessment of the current state of undergraduate work experience, in respect of the needs of the employers and potential employees involved in engineering and related disciplines, where possible making international comparisons.
- Identify opportunities for improvement.
- Make and promote recommendations.

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                         Mr Charles V Betts CB FREng  
                         Professor Patrick J Dowling DL FREng FRS  
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## Appendix 6

### Glossary and Abbreviations

CBI	Confederation of British Industry
<i>Best</i>	The Royal Academy of Engineering's programme of activities to attract and retain more of the most able people for engineering
CEng	Chartered Engineer
CRAC	Career Research and Advice Council
CIHE	Council for Industry and Higher Education
CSV	Community Service Volunteers
DfEE	Department for Education and Employment
EES	Engineering Education Scheme – a <i>Best</i> scheme for sixth formers
Equipe	Educational Quality in Placements in Engineering
EMTA	Engineering and Marine Training Authority
HEI	Higher Education Institution (university or college of higher education)
HEQE	Higher Education Quality and Employability
HEROBC	Higher Education Reach Out to Business and the Community
HESA	Higher Education Statistics Agency
IASTE	International Association for the Exchange of Students for Technical Experience
IoD	Institute of Directors
IEng	Incorporated Engineer
MEng	Master of Engineering
NTO	National Training Organisation
QAA	Quality Assurance Agency for Higher Education
RAPID	Recording Achievement for Professional and Industrial Development
SARTOR	Standards and Routes to Registration, published by Engineering Council
SME	Small- and medium-sized enterprise
STEP	Shell Technology Enterprise Programme
TRANSEND	Transferable Skills in Engineering and their Dissemination
UCSC	Universities Committee for Sandwich Courses
Year in Industry	A <i>Best</i> scheme which places students in companies for a year between school and university

## Appendix 7

### Acknowledgements

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Liz Rhodes – STEP (Shell Technology Enterprise Programme)

Jill Lang – People Potential Partnership

June Crabtree – BNFL

Dr David Pollard – University of Surrey

Equipe project team

Brian Tripp – Engineering Development Trust

Steve Oatey – HESA

Dr Andrew Merchant – University of Birmingham

Those who responded to a request for anecdotal evidence published in the professional journals.



## The Royal Academy of Engineering

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