Learning During the First Three Years of Postgraduate Employment – The LiNEA Project

INTERIM REPORT FOR ENGINEERING

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EXECUTIVE SUMMARY

This interim report is based on data obtained from recently graduated engineers about their learning and development in their first full-time jobs. It covers the first two years of a four-year project, and its main themes have been selected in order to facilitate the next ‘action’ phase of the research. The focus is on the graduate engineers’ learning, and the factors that may affect the speed at which expertise develops. We have identified some areas where adjustments could be made to improve present practices. At this stage, we intend to discuss with our employer partners any changes they might wish to take forward on the basis of the data, and how the research team might assist in the monitoring and evaluation of the effects of such changes.

THE PROJECT

The project is based jointly at the Universities of Brighton and Sussex, and is funded by the Economic and Social Science Research Council’s Teaching and Learning Research Programme. This work is part of a project that is similarly studying accountants and nurses in their first posts. The aims of the whole project are to identify: what is being learned in the workplace, how it is being learned, and the factors affecting the level and direction of learning, as well as the use and extension of prior knowledge and generic skills brought into employment from higher education and other life experiences.

The objectives of the project, which is being run in partnership with three professional engineering institutions and a number of major engineering employers, are to contribute to evidence-based practice in the management and support of newly qualified employees; to further knowledge of learning in practice in the workplace; and to develop understanding of the transition from higher education into employment.

Research Design
The research in relation to engineers has three components.

Part 1. Observation of newly graduated engineers (GEs) at work and interviews with them, their managers and mentors. There are four workplace visits over three years. During this period, an interim report, based on early fieldwork, is produced for employers.

Part 2. An action research component, to be implemented in the 3rd and 4th years of the study, in collaboration with employers, that builds on the findings of the fieldwork. This stage will offer assistance to our partner employers in monitoring and evaluating the effects of any changes they decide to put in place to try to improve the support of newly employed graduate engineers. It will involve visiting a fresh cohort of new graduate engineers who are going through these changes.

Part 3. A study of the transition from higher education into employment, in relation to technical knowledge and generic skills.

Sample, Visits and Interviews
Information for this report comes principally from 38 graduate engineers. Twenty-seven were recruited in the four major engineering companies that are our ‘partner’ employers in the research. Seven others, recruited while at university, work in fields of engineering that include consulting engineers, local authorities and construction companies, in England, Scotland and Wales.
The bulk of the first round of visits were completed between November 2001 and May 2002. This resulted in 34 work-place interviews with trainees, and over 90 interviews with a mix of their managers, mentors, team leaders, directors, and team members. Four university-recruited graduates were telephone interviewed while in their first post, but did not maintain contact.

FINDINGS

Antecedents
Most Graduate Engineers became engineers because of personal interest or family influence, which can have roots at an early age. Higher Education courses were viewed realistically given their time-limited nature, but the value of project work, work placement opportunities, and the transferable skills imparted were recognised as particularly valuable. Graduates expected to learn rather more sector-specific material during their course, although the majority did have some work experience.

Transition
A very wide range of induction practices were in evidence, some more effective than others. Some half of the GEs felt that they knew a significant amount about the industry they had entered, but were still surprised by the nature of their initial work. They did not appreciate the management problems of providing appropriate work, and an excessive concentration on relatively routine tasks was their most common criticism. Five different models of ‘mentoring’ were identified, but the associated roles, responsibilities and functions of mentors were sometimes unclear, and little preparation provided (see page 12).

Work Context
Open-plan offices were almost universal, and were liked by GEs. Such an environment encourages an ‘ask anyone’ culture which most companies seek, and which graduates appreciate. Clear line management and work allocation was recognised by the GEs as an important element in obtaining appropriate experience and levels of responsibility to satisfy the Chartered Engineer requirements, but few graduates appreciated the challenge this could pose for managers. The social environment was important and informal events helped to consolidate the company culture.

Teamwork
The predominant mode of working for GEs was in teams, but this does not necessarily come naturally. Many graduates recognised the relationship skills which needed learning and practising, but were also sensitive to the possible confusion over responsibilities and the problem of holding people to account in a team.

What is Learned
Graduate Engineers appeared relatively less confident in their technical skills than in their more general skills. This counter-intuitive finding could demonstrate a level of maturity in that the graduates already know enough to realise how much there remains to learn in any technical area. Some GEs could articulate an extensive list of what they had learnt since joining their company, clearly a record of what they were aware of learning and remembered consciously. A typical list is included as Appendix 1. Such lists are inevitably too specific to be used to construct a general model, so the main categories of activity used for analysis in this report are based on the interview data obtained in this work, compared with categories identified during work in the 1990s with mid-career professionals.

Satisfactory task performance depends on more than being able to use relevant technical knowledge. Work planning and prioritisation, recording progress, knowing how to contact the right people and report writing to the appropriate format were thought to be equally important. However, awareness,
knowledge and understanding in the industrial context is built up over time, so that it is unrealistic to expect GEs to have a sophisticated understanding so early in their careers.

Personal development for the Graduate Engineer is initially tied closely with becoming Chartered; the importance of the CEng status was widely recognised among the graduates. However, there was some evidence that the early enthusiasm quickly wanes if senior role models are absent. Examples of good practice as regards teamwork included close informal liaison during the working day, regular briefing meetings, good recording systems and flexible sub-task reallocation. However, a number of less satisfactory practices were clearly in evidence in some companies.

The qualities of a ‘Good’ Engineer extend far beyond possessing technical knowledge. Graduate Engineers were aware of this and could articulate the skills and attitudes apparent in the role models they encountered. The GEs’ list included problem-solving abilities, people skills, being logical, being practical, being commercially minded and having a willingness to learn as well as other qualities of value in any profession – such as confidence, self-motivation, vision, etc. GEs generally expressed confidence in their problem-solving skills, but were less confident of their decision-making abilities. The latter will be developed and tested as experience is gained and reflected upon, and ‘judgement’ acquired.

**How it is Learned**

Learning can be a difficult process to describe as we are not always conscious of being engaged in any such process. However, a formal, structured support for learning was recognised as important by all four major companies and examples of good practice included early introduction to the training courses available in-house, encouragement to attend external training events, provision of a confidential counselling service, and early exercises in team working.

Two distinct types of feedback were identified – quick timely feedback on specific task performance and a more considered feedback on general progress judged against company expectations. Both are valuable and point again to the need for mentors to be properly trained. Coaching is a process which appears to be universally happening but is rarely recognised in any formal sense. This forms part of a valuable informal support structure surrounding most graduates, which also included the ‘just ask’ culture, socialising both during and after working hours and sports clubs. Graduate Engineers expressed a clear preference for informal learning processes. A concise list of preferred methods is given in the report (see page 26).

Many of the GEs showed a high level of self-confidence and determination, often clearly linked to a successful academic career. This would indicate a positive predisposition to learning and further self-development. Nevertheless, a graduate still has to be prepared to admit any relative ignorance; this was recognised by most GEs. The local capacity to support graduate learning depends upon clearly identified roles, responsibilities and functions, and a sensitivity to the GEs’ learning needs and how these change over time. These clearly transcend the role of a mentor alone; a learning climate needs to be created and encouraged by senior managers.

**Factors Affecting Learning**

At this stage in the research a tentative two triangle model has been suggested to depict the key factors affecting learning and their inter-relationship (see page 28). The first triangle depicts the factors directly affecting learning, and the second triangle depicts the contextual factors that influence those learning factors. Both confidence in one’s ability to do the work and commitment to the importance of that work are primary factors that appear to affect individual learning.
ACTION RESEARCH

This project includes an action research phase in order to offer assistance to our partner employers in monitoring and evaluating the effects of any changes they decide to put in place to improve the support of newly-employed GEs. The following six areas (see page 31) would appear to be potentially the most profitable to explore, but these are open for discussion and amendment.

Reconsidering Induction Procedures
Which form of induction best suits the organisation? Is there room to modify or extend the current model? Does it need to be more clearly described and promulgated more widely within the company?

Redefining the Role and Functions of ‘Mentors’
Which of the five different modes of mentoring that have been observed are used currently within the company? Is this a deliberate policy? How can mentors be better prepared to carry out their functions?

Experiments with the Nature of Feedback
Are both immediate task performance feedback and longer term normative feedback (i.e. telling graduates about their overall progress against company expectations) in place? Are the managers’ and mentors’ perceptions of feedback in tune with the graduates’ expectations? Is the graduate’s workload influenced by feedback and, if so, how?

Monitoring Training
Are all graduates aware of all available training opportunities? How far is the usage monitored? Are graduates able to indicate weaknesses in a non-threatening environment?

Being Proactive about Learning
Is there a need for some form of ‘priming’ to encourage further learning? Is there sufficient awareness of the alternative modes of learning available? Are the existing company training provisions sufficiently well-publicised?

Improving the Local Capacity to Support Learning
This is a complex area to tackle. Does the company aim to create a ‘learning environment’? Is the company’s policy on graduate recruitment publicised appropriately? Is there a clear company policy on career progression?

It is important to stress the tentative nature of the suggestions proffered above. We look forward to future discussions with all our partners.
THE PROJECT

INTRODUCTION

This study of learning during the first three years of employment of graduate engineers, is part of a four-year project that is also investigating the learning of graduate accountants and newly qualified nurses. The project is based jointly at the Universities of Brighton and Sussex, and is funded by the Economic and Social Science Research Council’s Teaching and Learning Research Programme.

This report is based on data obtained from recently graduated engineers about their learning and development in their first full-time jobs. It covers the first two years of a four-year project and, in places, it also draws on field notes made during visits and information from the graduate engineers’ managers and mentors. The research is focused on the graduate engineers’ learning, and the factors that may affect the speed at which expertise develops. This report’s main themes have been selected in order to facilitate the next ‘action’ phase of the research. So, although we have not set out to criticise current arrangements, inevitably, we have identified some areas where adjustments could be made to improve present practices. At this stage, we intend to discuss with our employer partners any changes they might wish to take forward on the basis of the data, and how the research team might assist in the monitoring and evaluation of the effects of such changes.

Aims and Objectives

The aims of the whole project are to identify: what is being learned in the workplace, how it is being learned, the factors affecting the level and direction of learning, as well as the use and extension of prior knowledge and generic skills brought into employment from higher education and other life experiences.

The objectives of the project, which is being run in partnership with three professional engineering institutions and a number of major engineering employers, are to contribute to evidence-based practice in the management and support of newly qualified employees; to further knowledge of learning in practice in the workplace; and to develop understanding of the transition from higher education into employment.

Research Design

The research design has three parts:

1. Observation of newly graduated engineers at work and interviews with them, their managers and mentors. There are four workplace visits over a three-year period. The same pattern of visits is being undertaken in the accountancy and nursing sectors. During this period, an interim report, based on early fieldwork, is produced for employers.
2. An action research project, to be implemented in the 3rd and 4th years of the study, in collaboration with employers, that builds on the findings of the fieldwork. This stage will offer assistance to our partner employers in monitoring and evaluating the effects of any changes they decide to put in place to try to improve the support of newly employed graduate engineers. It will involve visiting a fresh cohort of new graduate engineers who are going through these changes.
3. A study of the transition from higher education into employment, in relation to technical knowledge and generic skills.
The three professions have been chosen because they play key roles in the UK economy and public services, and they use contrasting approaches to professional formation. Employers of graduate engineers often have systems of organised training support which, especially in major firms, are accredited by corresponding professional institutions. The opportunity to study these systems, and to try out modifications and evaluate them during the lifetime of the research (the action research component) is attractive to both the professional bodies and the employers who are partners in the research.

THEORY AND METHODOLOGY

The critical period of early introduction to professional work has not been previously studied longitudinally, although some one-off surveys have been conducted. Eraut et al.’s (1998) study of mid-career professionals, which included engineers, provides a conceptual and methodological platform for this research. The project’s methodology addresses the problems of accessing information on what people need to know at work. Chief among these problems are:

- Only knowledge acquired in formal educational settings is easily brought to mind, articulated and discussed;
- Tacit, personal knowledge and the skills essential for work performance tend to be taken for granted and omitted from accounts;
- Often the most important workplace tasks and problems require an integrated use of several different kinds of knowledge, and the integration of those components is itself a tacit process.

These constraints affect people's awareness of learning and their ability to recognise and articulate their own personal knowledge and understanding which enables them to think and perform at work. Therefore, the more researchers are able to ground conversations with informants in the actuality of daily working life (tasks, relationships, situational understandings, implicit theories etc), the greater the chance of eliciting information about the full range of what is being learned, how it is learnt, and the factors which affect learning, especially the informal learning of key skills such as team working (Miller, Freeman and Ross 2001).

The framework for analysing the workplace itself can be summarised under four headings:

1. The nature, range and structure of work activities;
2. The distribution of work activities between people, and over time and space;
3. The structures and patterns of social relations in the workplace; and
4. The outcomes of work and learning, their evaluation and feedback, and who carries responsibility for the outcomes.

Our theoretical approach to analysing the factors that affect learning and work performance is briefly described in a later section.

The Sample

Twenty-seven of our total sample of 38 graduate engineers work in the four major engineering companies which are our ‘partner’ employers in the research. In each of these companies data is based on visits to at least four graduate engineer participants. Eighteen other graduates were recruited as they completed their degrees at the University of Brighton. Attempts to recruit other graduates, particularly electrical engineers, from two other universities were not successful.
Sixteen of the 18 were interviewed by telephone. Seven of them were later visited and interviewed at work, five in engineering firms and two working for local authorities. Of the others, five were either not employed or in temporary jobs, and the last four were working when interviewed but did not maintain contact with us afterwards. Including these four workplace interviews means that 38 workplace interviews are used in this report. Our data, therefore, comes mostly from a self-selected group of participant graduate engineers within organisations that have been willing to collaborate when asked to do so. All the participant employers have offered generous access to the researchers and have welcomed the study. The trainees themselves, as well as their managers and mentors have shown a clear readiness to co-operate, to provide various kinds of information, and to discuss a wide-range of issues with us.

Sample Characteristics

The “mode” age of participant graduate engineers is 23 but there are also mature graduates who completed higher degrees or worked before starting their university course. Participants are from both genders, and represent a mixture of ethnic origins. They come from a range of 15 traditional and five ‘new’ universities, are in their first job after graduation, and have one or more degrees of MEng, BEng, BSc, and PhD in one of the main three disciplines; Civil, Electrical, and Mechanical Engineering and their sub-disciplines. They work in different fields of engineering including consulting engineers’ offices, local authorities and construction companies, in England, Scotland, and Wales. The main details of the sample are shown in Table 1 immediately below.

Table 1  Sample characteristics (n = 38)

<table>
<thead>
<tr>
<th>First Engineering Degree (See note below)</th>
<th>MEng</th>
<th>BEng</th>
<th>BSc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Engineering Discipline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical/Electronic/Software</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age Group (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-24</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-32</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Been at work for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 weeks to 3 months</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 to 9 months</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 14 months</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 to 21 months</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Note. Higher degrees: there are five MSc’s, one PhD, and one MBA)

Most of the trainees (34 of 38) graduated in Summer 2001 and then started work as graduate engineers shortly after. Some of those with BEng did a sandwich year industrial placement before graduation whilst some others had some sort of work experience (see Table 5).

Visits, Observations and Interviews

The 16 telephone interviews were conducted in the summer and early autumn of 2001. And the bulk of the first round of visits to the 34 engineers in work were completed between November 2001 and May 2002. The whole point of visiting to observe the graduate engineers at work was that the researchers could note the context in which the graduates worked, and the informal exchanges that helped with task performance.
This would help us to learn something of the work the graduate engineers were doing, before conducting an interview. The interview could then be focussed on real tasks, and on what the graduates had to know and understand in order to do them.

We accompanied trainees to informal and formal meetings, and to training events, both on and off site. This broadened our appreciation of the range of settings in which graduates learnt more about becoming an engineer. Other sources of data have also been available to us. These include trainees’ progress reports and notes, and company training programmes and written documents. We have also attended major engineering recruitment conferences and seminars at professional engineering institutions.

The original research plan, to spend one and a half days observing and talking to those responsible for managing and training the graduate engineer before interviewing the trainee, has been largely adhered to. We had set out to talk with each graduate engineer’s manager and mentor. In practice, roles varied in the different organisations so that we had 92 interviews (83 tape-recorded) in the workplace with managers of various designations, mentors, team leaders, team members, senior engineers and directors.

However, modern patterns of engineering work mean that engineers often spend long periods at their computers, and this meant that the expected dividends of observation were less than expected in some cases. Those who are particularly ‘VDU-bound’, like software engineers, proved to be the hardest to study because of the nature of their work. There was often little that could be observed on a computer screen from a distance that was informative. So we had to adjust our approach. Observation time was reduced, and more emphasis put upon preliminary chats with the graduate engineers in order to find out what they were doing. This could be done at breaks for coffee and/or lunch. However, it was still important to see the more informal sides of the graduate engineers’ working lives. Without this it was impossible to understand the ways in which graduates were able to pick up what they needed to know from their colleagues, without necessarily recognising that any learning had taken place. The subsequent recorded on-site interviews with trainees each lasted between 50 and 90 minutes.

**Interview Content**

The interviews with graduate engineers covered the period from when they began their higher education courses. Topics included views on their degree course and any associated work experience; the change of role from student to employee, including their induction and any subsequent training; the support they received and felt that they needed when they started work; their own work and what they were learning; and the general context in which they worked.

In our discussions with managers, mentors, and with others who had responsibilities towards the graduate engineers, we explored their roles in managing the graduate engineer’s work or guiding their training. We were interested in what qualities and skills were looked for in new recruits, and we wanted to know about the normal patterns of support, induction and training that a company would have in place to help increase the expertise of the newly appointed graduates. We were also interested in the formal and informal systems of appraisal and assessment, how these worked, and how the readiness of the graduates to widen their experience and take on more responsibilities was judged. What criteria did the more experienced senior engineers use to make these judgements?
A Note on Numbers and Quotations

Information for this report relates principally to 38 graduate engineers (34 interviewed face to face at work and still in contact with the project). In various places we give numbers, often in tables, e.g. to show the characteristics of the sample as in Table 1. We feel readers need the clearest indications of differences in experience, or the relative weight of different opinions, and this is often best done by giving numbers, even though the sample size is not great and respondents are self-selected. The sample is not random.

There are several tables and the reader will notice that the total number of graduate engineers in a table is often less than 38 or even less than 34. There are several reasons for this. One important reason is the way the project team has gathered the information. This has been mainly via semi-structured interviews, supplemented by observation, in many different working environments. The interviews with the graduate engineers did not always contain the same questions, because it was important to allow for different experiences, let the interviewees tell their own stories, and to follow up points of interest about learning. A consequence has been that, in places, we have not yet obtained comparable information from everyone. Some gaps have to be filled, and this is being done during the second round of interviews.

A second reason is that not all questions applied to everyone. For example, a few did not have significant work experience before starting full-time work, see Table 5. Finally, although straight questions can be posed, they do not always elicit straight answers. Some respondents may not have had the relevant experience to give an answer; some may not have formed a clear opinion, and other respondents were unclear in the way they stated their opinions. These explanations account for lower numbers in Table 3, where the graduate engineers were asked to evaluate their degree courses, and in Table 4, to evaluate the courses’ relevance to their current job.

We have given a limited number of quotations to illustrate points in the main text, and to help readers to have some feel for the basic interview data we are using. Each quotation carries an identifier code specific to this report and also shows the number of months the graduate engineer had been in work when interviewed. As a further means of keeping the quotations anonymous, we have adopted a convention of alternating between male and female referents. This avoids the clumsy use of ‘him/her’, etc.
FINDINGS

AN INTRODUCTION TO THE FINDINGS

The findings are organised in eight sections. The first three briefly tell the story of how young people make the journey into engineering. The first two of these sections cover the Antecedents to a career in engineering. These include the graduates’ motivations for becoming engineers, their experiences on their degree courses, and the periods of ‘sandwich’ work experience that, to varying extents, prepare them for what to expect. The last section of the three deals with the Transition into full-time work. In this section the importance of having several modes of support readily available during a substantial period of induction comes to the fore. This section closes with an important subsection on Being Mentored, where five different modes of mentoring are described, and an important distinction is made between two kinds of feedback.

The next section deals with the Working Contexts in which graduate engineers find themselves, and the influence of different aspects such as the physical environment, the organisation and allocation of work, and social features that make up a particular working culture. The final subsection on Teamwork recognises its importance. It also identifies significant misapprehensions about teamwork held by some graduate engineers.

The next three sections address learning issues more overtly. The first describes What is Learned by graduate engineers in the early months of their careers. The second unravels How it is Learned, and the part played by coaching and other informal ways in which trainees learn. Once again it brings out the importance of timely and helpful feedback. The third section then steps back to consider the Factors that Affect Learning and, consequently, performance at work. This section draws on the evidence from previous sections to add the project’s theoretical perspective in offering explanations.

ANTECEDENTS

Why Become an Engineer

Most Graduate engineers (35 of 38) decide to become an engineer because of a personal interest or family encouragement, which can have roots as early as five years old. (See Table 2 below)

E67(2.5m): I liked everything mechanical, I was always curious to know how things worked and it seem liked the most natural way for me to go ...yes, because I always liked motorcycles, cars and anything that’s mechanical and that can move so yes ... and I’m always interested to know how things work ...oh yes primary school, I was always designing or making things with Lego, big toys with Lego and moving parts.

Typically they liked to design and build things, with an interest in how things work. Family members, especially fathers, and in one case a brother, can also be a significant influence. A few became interested because of work experience during their schooling. There can be a mixture of influences based on impressions about the role of engineers, the practicality of their work, and their potential for positive contributions to enhancing the living environment. These interests are reflected in the choice of HND courses or A-levels that include Maths, Physics and other scientific subjects. They enjoyed these subjects, being able to demonstrate their strength in the analytical skills.
E48(6m): I chose maths, physics, and geography, because they were the subjects I enjoyed. I’ve always preferred the analytical subjects, rather than English and the Arts which I never fancied, and engineering seemed to incorporate the maths and physics that I was interested in so it was suggested to me that would be a good path to follow. Civil engineering to me seemed to cover the broadest base of topics and variety of work, I think it is more interesting, it’s always what I’ve wanted to do for a long time.

The choice of particular engineering disciplines was, in most cases, made at the time of entering university. One or two, without degrees in engineering disciplines, did not choose the path until after they had graduated. Relatively few seem to have chosen engineering solely as a ‘good career move’.

**Table 2. Graduates’ reasons for becoming engineers (n = 38)**

<table>
<thead>
<tr>
<th>Personal Interest</th>
<th>Family Influence</th>
<th>Other reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>5</td>
<td>1 - shortage of qualified engineers in this country and there are a variety of jobs you can do with an engineering degree.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 - engineering has good career prospects.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 - didn’t initially choose engineering - wanted to do medicine, but bad chemistry grade, so accountancy or engineering remained</td>
</tr>
</tbody>
</table>

At the time we interviewed them, all were happy to be engineers. Only two of 32 who expressed a view felt they were in the wrong job: and one of these two felt s/he was in the wrong firm.

**Experience of the Undergraduate Courses**

Graduates’ opinions of the relevance and coverage of their undergraduate course appeared to be heavily influenced by what they have needed to carry out their jobs so far. The universities can take comfort in the preponderance of favourable views as over a third of the graduate engineers thought their HE courses very good or excellent. This was despite just over a third feeling the content of their degree was, at best, mostly irrelevant. However, there were still suggestions for improvement: more or less of certain undergraduate subjects, or more emphasis on practical applications and final year projects, site visits and more interaction with industry, including lectures by practising engineers.

**Table 3 - How graduate engineers evaluate their undergraduate courses (n = 33)**

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Fair</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>6</td>
<td>15</td>
<td>4*</td>
</tr>
</tbody>
</table>

*One said that the undergraduate course was fair, but the MSc and PhD were both good.*

But in general, there was a realistic appreciation of the fact that undergraduate courses can only provide a broad engineering background and an introduction to basic principles, because they are time-limited. (We will be analysing these views more closely for separate feedback to HE). The graduates recognised they still had to learn a lot that was ‘company specific’ in terms of technical knowledge and skills and internal procedures. They also acknowledged that universities cannot teach the latest processes and practices.
Many thought the final year projects were one of the most valuable parts of their academic course because of the procedures used, the way they had to integrate different aspects of engineering, the need for innovation, and group work. It taught some the need to be self-reliant in finding things out. It let others find out how to seek out and order the equipment they required.

Among our sample of trainees, although an MEng degree was acknowledged to provide some management and leadership skills in addition to its full accreditation by professional institutions, a BEng, with a sandwich year, was thought to provide what an engineer needs to do his or her initial job comfortably despite it only partially satisfying accreditation requirements.

Table 4 - How relevant their undergraduate course was to their current job (n = 31)

<table>
<thead>
<tr>
<th>Very relevant</th>
<th>Fairly relevant</th>
<th>Mostly irrelevant</th>
<th>Not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>6*</td>
<td>11</td>
<td>9</td>
<td>5**</td>
</tr>
</tbody>
</table>

* One said both the MEng and MSc were very relevant
** One said the BEng was not relevant, but the MSc was very relevant.

Only four out of 32 trainees could recall receiving, while at university, any direct information about learning at work.

E59(4m): not as such, not really. There wasn’t any (information about learning at work). I mean you were aware very aware that you need to keep abreast of technology and keep up with things that are still moving on and develop as you go along.

Another four said there were limited hints in some lectures. So, on the face of it, roughly three quarters of the 20 universities our sample of graduates come from were not very successful in helping undergraduates to realise they would have to maintain the discipline of learning when they started work. By now, of course, all the graduate engineers realise the need for continuing to learn at work, and they appreciate its importance for improving and expanding their expertise.

E34 (1m): I learn everyday,.,. and doing a log book for, you know, the IMechE, the normal thing writing what I am doing every day and what I am responsible for but I am also doing a log book for myself with lots of little notes behind it. It is very important, learning on the job is probably the most important thing. You have to be very flexible and you have to be very open and gain as much as you want, it’s kind of a race to gain as much knowledge as you can.

Pre-graduation Work Experience

Strong agreement emerged on the benefits of having previous practical work experience such as an industrial placement or sandwich year during the university course, or a summer job or placement. This enables graduates to get to know the work environment and something of general procedures and expectations before starting postgraduate employment.

Most (n = 34) had had some sort of work experience in engineering and non-engineering fields. They appreciated the importance of such work experience, not just because it provided an early idea about work procedure and strengthened their CVs. It also tested them, explored their choice of field, and enabled them to earn money to support themselves while going through university. In some cases it also helped undergraduates to understand the importance of certain modules, the relevance of certain options, and the significance of some aspects of their degree programme.
In particular, graduates with a BEng or BSc degree who had the chance to do a sandwich year found it very rewarding, especially as it involved doing real practical tasks. When they started work, this helped them to be able to think a problem through, from beginning to end, learning a lot as a by-product. It also gave good opportunities to practise technical and people skills and, in addition, to gain a lot of confidence. Not unexpectedly, the chances of getting a job with an employer are higher if one has worked successfully for them previously.

Table 5 - Trainee engineers’ pre-graduation work experience (n = 34)

<table>
<thead>
<tr>
<th>Nature of the work experience</th>
<th>Doing similar tasks to current job</th>
<th>Doing different tasks to current job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer vacation/other holiday jobs with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same engineering employer</td>
<td>4 (1 sponsored)</td>
<td>0</td>
</tr>
<tr>
<td>Different engineering employer</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Non engineering employer</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Sandwich year or year out organised by University/Trainee with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same engineering employer</td>
<td>4 (2 sponsored)</td>
<td>0</td>
</tr>
<tr>
<td>Different engineering employer</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Non engineering employer</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

TRANSITION

The Transfer from Education to Employment

Trainees strongly believe that having worked for a company during summer holidays, or on an industrial placement, can make the transfer from education to employment much smoother. It can also speed up their learning and progress. When they start their postgraduate employment with the same company they also benefit from knowing the place, the people, and work procedures. Most start work with a bundle of expectations and the chances of them being met seem to be roughly 50:50, as shown in Table 6 below.

Table 6 - Graduates’ expectations of their first job and what they found (n = 28)

<table>
<thead>
<tr>
<th>Similar to expectations</th>
<th>Different from expectations</th>
<th>Had no expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>13</td>
<td>2</td>
</tr>
</tbody>
</table>

Among the 13 who had their expectations met, one graduate was very surprised by the high level of responsibility given at the start, and another was pleased to find that there was more responsibility than expected. But these are exceptions. Returning to the same company could prove novel. One trainee said that he had worked in this place before but, as a graduate, he now saw things differently. Graduates expected to be involved in real tasks and steady work, particularly design work, as early as possible. Others felt disappointed when they started employment at a time when the company’s general workload was low.

E67(2.5m): ... I was a bit disappointed because there wasn’t a lot of work to do ... and you’re not given a lot of responsibility at the beginning, but that’s understandable, it’s a bit slow on the pick up.
Others found the transfer from education to employment meant a lower workload.

E56(3m): I actually found it a bit of a step down, not a step up, a step down in terms of workload. ‘cos obviously I’d just come from doing my exams so used to sort of working, if you’re constantly doing exam stuff. So, coming into a 9 to 5 job where you can just switch off at the end of the day and go home, and not think about anything, is a real, it was really nice actually.

**Induction**

Graduates stressed the importance of induction, when they were introduced into the organisation. But induction procedures varied a great deal from company to company, and did not always meet the needs of these new employees. Some companies, the larger specialists, strongly structured the induction process, providing pre-planned talks, check lists, and courses that introduced the company, the way it was organised, and its products. The process could also include pre-planned courses on the specialist technical areas at the heart of the business. Graduates may have had to travel to another site for some elements of the induction.

This structured approach to induction within the larger, specialist firms, is well thought out and designed to cope with a reasonable number of new employees joining the firm at roughly the same time of year. The process is thorough but, because it needs to be planned in advance, trainees who cannot join with the main cohort may find that they miss out and struggle as a consequence. Our sample includes cases where illness and administrative delay have been the cause.

Problems can also arise when a company has branches in different locations, each with specialist functions. Then induction can be just a one-day visit to the personnel section in another part of the country, where the inputs are general and do not necessarily fit the particular needs of a graduate engineer joining a specialist section of the firm.

E80(20.5m): Yeah, I remember, ‘cos it was a four hour drive to Birmingham. So you leave at six in the morning. Induction was at ten. And it was very broad because it was for all new starters in property, highways and railways, so it was a very broad background information on the history of (the firm) … a lot of their projects … and a health and safety induction which again … wasn’t really appropriate for me. So you wonder if it should be perhaps more tailor made for individual … divisions.

At the other end of the scale, induction may simply be one day on site for an informal introduction to the people, to the layout of the buildings, and to common, low level procedures such as completing travel claims. But a certain pride in such familial informality is not always well based. Key people may be absent on the day, or engaged in meetings. Lack of communication may even lead to a new arrival being a complete surprise to the office. The first day is particularly important!

E70(5m): No manager or senior engineer received me on my first day, that’s partly why I had a bad time of it really, I think. Nobody really sort of sat down and explained things to me. I was just left. I think that was really bad … it was bad, re introduction and I’ve said that to them … the only way I’ve got to know other people is through you know socialising or I’ll help out with QA. So I’ve had to go and pester people, to get to know people that way, so it’s all off my own back really…I didn’t have a desk assigned to me which I thought was very poor … so I … sat at X’s desk which was a complete tip, and introduced to Y and Z ‘cos they were the only two people in at the time … Managers were at a meeting… I wasn’t assigned a desk … so yeah, I was really quite annoyed at that part, ‘cos they knew I’d been coming for a year, and yeah, I’d come in the week before to remind them, … then I just got plonked in a corner after I’d had a quick briefing on some of the projects and got told, ‘Right, read this’.
Induction may not be that significant for graduates who had worked for the same organisation before, but only eight of our sample were in that category. What the others have experienced has had variable success. Some hoped for a better induction to help them to know the workplace and speed up their integration within their team or group of fellow engineers.

Knowing who does what as early as possible is clearly of great benefit. During the first few weeks there is a need to speak to people, to become aware of the available facilities and resources, and find out about various groups and sections of the firm or organisation.

E65(7m)…when I first started, one of the graduates who’d been here for about a year and half introduced me to some people, and told me a few things about just simple things about round the office and staff, things like that. How to do your timesheet, and all the things you need to know in the first few weeks….not officially a mentor, just for the first couple of weeks really. And then I have the sort of DE, SCE with the ICE training….. I came in and I was introduced to X and had a chat with Y and Z about what … my job would be, and what I would do. And then (I) had some meetings with people in from personnel to sort out all my papers and documents, and then I met a few people on the floor, and then I got started with some work.

Several aspects of induction, as we have observed it, deserve comment. Although there is a strong emphasis in induction on ‘socialisation’, helping a new employee to absorb the norms of working in the company, induction is not naturally thought of as a process over time, even when induction activities occupy several days, and apparently isolated activities occur a month or so into the job. Yet common sense tells us that it is impossible to absorb everything one is told as one starts a new job. In part this is because it is difficult for a newcomer to recognise what it is important to remember. Some of our interviewees told us how they felt they had gone past the point where they could be thought of as ‘new’, and were embarrassed because there were now things it was difficult to ask. It is also useful to look through the other end of the telescope. Induction is also the period in which the established staff may get to know the newcomers, their personalities and their strengths and weaknesses. It is not at all clear that the patterns of induction we have seen help established staff as much as they might. It would be helpful to take a fresh look at the induction process, and to start by identifying the needs that it ought to be meeting for everyone involved.

The Early Tasks

For many graduates their first tasks were not what they expected. Unrealistically, a fair number expected to be seriously involved with design at a very early stage, rather than the comparatively routine tasks many found themselves asked to do in their first months. This shows their naivete, but it also shows a failure of communication from the employer’s side. Managers have to juggle varying work-flows as contracts and projects start up, go through established stages, and then close down or are handed over to other sections and teams. Inexperienced graduate engineers do not appreciate this. Nor do they appreciate how managers have to decide the most appropriate composition of project teams. Even in firms with very clear periods of probation, graduate engineers made little reference to the fact that some of their early tasks must be given to see what they are capable of. Evidence thus comes, not solely from what the graduate engineers told us, but also from what they did not say when they told us about the frustrations they had experienced.

In a few cases the resulting level of frustration caused trainees to seriously consider quitting. One told his manager that it was not worth him travelling several hours to and from work in order to do nothing worthwhile during his ‘working’ day.
By the time we interviewed people, these difficulties had been mostly resolved through discussion, but it must be better to avoid such situations in the first place. However, as the table below shows, the main picture is very positive: the majority of graduate engineers felt that they were made to feel at home, catered for as a novice, valued as a member of staff, and made welcome among other engineers and employees.

**Table 7. Feelings about treatment by employer/employees**

<table>
<thead>
<tr>
<th>Feels s/he:</th>
<th>Yes</th>
<th>Not always</th>
</tr>
</thead>
<tbody>
<tr>
<td>was made to feel at home (n = 22)</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>was catered for as a novice (n = 22)</td>
<td>18</td>
<td>4*</td>
</tr>
<tr>
<td>was valued as a member of staff (n = 23)</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>was made welcome among other employees (n = 22)</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>is able to express their views/concerns and feels they are being heard and considered (n = 22)</td>
<td>21</td>
<td>1</td>
</tr>
</tbody>
</table>

* One of these replies was 'No'.

In terms of workload, several trainees found they came from university, where they were constantly working evenings and weekends to complete final year projects and prepare for examinations, into a 9 a.m. to 5 p.m. world where they could switch off after work. It was a bit of a ‘step down’. While at university, they had been able to plan when they would work, and how to spread their workload. That was not possible at work, where the normal working hours, and the deadlines set by team leaders, or other managers, were deciding factors.

**BEING MENTORED**

Historically there have been numerous interpretations of mentorship. And across the organisations that have given us access, the title of mentor covers several different roles and functions. In one organisation practice varied from branch to branch.

At least five modes of mentorship operated in the ten organisations we have visited.

**Mode 1.** a short term arrangement in which a general mentor helped new trainees during their first weeks, rather than months, at work. This general mentor’s function was very close to what other organisations saw a ‘buddy’ as doing, i.e. helping out with the practicalities of fitting into the workplace.

**Mode 2.** a mentor separate from immediate line managers or project leaders whose function was to be a sounding board and stimulus to reflection, advising on possible relationship problems as well as on progressing with one’s CPD, becoming chartered, and establishing a career plan.

**Mode 3.** mentoring that was directly, and exclusively, related to the achievement of chartered status, e.g. with the Institution of Civil Engineers. In this case mentoring is split between a supervising engineer and a delegate engineer. The former may not be available at the same branch or firm, but the latter can usually provide advice on both technical and general developments.

**Mode 4.** a long term, ‘person-centred’, relationship with one mentor, usually in the same work team, who was expected to provide technical guidance, and possibly supervision on the path to chartership, but not necessarily the more general advice and guidance available under Mode 2 above.

**Mode 5.** a ‘decentred’ mentoring in which any of the graduate engineer’s work colleagues could be turned to for help – technical and most other kinds. This was unofficial ‘mentoring’ because it lacked the label, but it was at least semi-official in that it underpinned a deliberate policy of creating a ‘just ask’ culture. This mode may operate alongside any of the other four modes described above.
Smaller companies had to double up on both roles and functions. However, in at least one large company, mentors were not being assigned, or the process was very slow indeed. And in other situations, graduate engineers were not getting the guidance they had been led to expect. Someone had the role, but was not carrying out the functions, perhaps because the functions had not been adequately defined. Considering the five different kinds of mentorship described above, it is not surprising if there is sometimes a confusion about role and function. Without clear guidelines, it is quite possible for someone who is designated a mentor to interpret this as a general mentor function, when their mentee expects support that is closer to the descriptions in 3 or 4 above.

Mentors are important sources of the feedback that graduate engineers rely on to let them know how well they are progressing. The process of supplying feedback is a principal factor in bolstering trainees’ confidence and maintaining their commitment. But feedback must serve at least two needs. A trainee needs relatively quick, on-going feedback on performance that supports the learning of how to tackle particular tasks. But there is also a need for a more ‘normative’ kind of feedback that will tell trainees how well they are doing compared to their employer’s expectations, and in comparison with most other trainees, past and present. We return to the importance of feedback in a later section.

The ‘normative’ kind of feedback usually comes in the form of appraisal, and formal appraisals normally come after set time periods, at the end of a known period of ‘probation’, for example, and every few months thereafter. Modern performance management systems also tend to use appraisal sessions for individual target setting, and the achievement of targets will often relate to obtaining pay rises. At the stage of our first interviews there was too little information to tell us clearly how these systems were working.

THE WORK CONTEXT

Physical Environment and Workplace Culture

All but one of the offices we have visited have been open-plan. So it is just as well that most graduate engineers seem to like working in this kind of environment. The obvious advantages are those of having a desk near to team members, line managers, and senior engineers. There are three basic layouts. They all accommodate the positioning of computers in the corner of the ‘sweep round’ desks that are individual work-stations. In one lay-out, where there is plenty of space, groups of four desks look inward, divided only by low, hessian surfaced space dividers. These give privacy from direct eye contact, but it is not difficult to ask questions of other engineers, to participate in discussion, or to just pass the time together in a coffee break. Getting to know who does what, and the range of available expertise/skills is a relatively easy proposition with such an arrangement.

E47(4m): Through observing and listening you can quite easily work out who’s an expert in geotechnics because you’ll hear someone else saying, ‘Oh go and see this guy.’ … So names bounce around the office, that you remember, or hopefully remember.

In narrower offices the grouped desks look outward so that workers can talk to each other simply by swivelling their chairs. Filing cabinets and higher space dividers usually demarcate divisions between work groups.

The third arrangement takes the form of ‘cubes’ which are formed by external dividers with an opening for an entrance. There may be a separate cube for each person, or a larger cube for a number of people. The latter arrangement is thought to be more useful because it suits teamwork. The head-high barriers between cubes provide a working privacy, but are informal enough to encourage neighbours to liaise with each other, and to discuss things, without the need to formalise appointments, knock on doors, or wonder if that person is busy, on the phone or meeting someone else.
Some graduates, and some older staff who fondly remember having their own offices, feel that the open plan office arrangement can be too noisy, especially when others are using the phone or chatting to colleagues on a subject of no interest to them. It can be distracting when trying to solve a particular problem. However, the advantages of an open-plan office are generally considered to well outweigh any disadvantages.

All these working arrangements are conducive to helping graduate engineers learn from those around them. We have been struck by the way this underpins the recognition of graduate engineers as people who still need to learn, and who need help to do so. The prevalence of an ‘ask anyone’ culture in which people around the office are friendly and usually willing to discuss things, exactly suits the physical office environments in which most graduate engineers work.

E74(9m):  *I mean stuff like that was quite easy to get to know because I could just ask … it is quite a friendly environment so I could just find out from somebody else …*

In nearly all the firms we have visited there is a common understanding that a trainee can ask or contact any person within the firm if the trainee believes that person has the relevant knowledge or expertise. In seeking help or consultation, people can be contacted directly (face to face), or by phone or email.

**Organisation and Allocation of Work**

We have already described some of the unrealistic expectations graduates have about the nature of the work they are likely to start off doing, but all agree that sitting waiting to be assigned a job is boring. They need to keep busy. However, from a manager’s perspective, it is not that simple. The graduates need to work, preferably at something genuinely productive for the firm, but they still need to prove themselves.

E49(12m):  *… It’s been quite variable lately. There have times where I have been very busy, and then jobs come to the end and its been quiet. So, yeah, I mean, if people are busy, there is always other people that could help you and spread the work around a bit …*

Tasks have to be found that need doing, but it will not be a complete disaster if the job takes longer than experienced staff would need, or if eventually, others have to lend a hand. This is why new recruits find themselves designing web sites, up-dating standard 2D engineering drawings by putting the data into computer programmes that will thereafter produce any required sectional drawings, constructing and testing individual components, or working on similarly chosen, discrete, but basically routine tasks. The presently on-going upgrade of technology from analogue to digital systems seems to provide many useful tasks that graduate engineers can be asked to tackle.

A conscientious manager also tries to ensure that a graduate engineer will gradually get enough of a range of different work to cover the requirements of the relevant Chartered Institution. Progress in this regard is monitored against standard documentation. But this is going to be over two years, and does not meet the impatience of an enthusiastic graduate engineer! It is relatively rare in our sample to find a graduate engineer gathering this experience by the once common practice of rotating around the different company divisions. During the first year, a large number of small tasks is the most common pattern.
Remembering that over two thirds of our interviews were within nine months of the graduate engineers starting work, progression in the complexity of tasks they have been asked to do is detectable, but most still did not feel technically challenged at that stage.

E72(8m):… I found that quite a lot of the time I was being bogged down with doing mundane work, just the administration side just the, as you said earlier, spreadsheets, checking the figures and not necessarily always being trusted with the big jobs.

E74(9m):… since I started, yes I have got a lot more of a work load, and first of all … there was three of us working on projects …. eventually I was working on a project just by myself. So yes, so more responsibility and a bit more of a work load as well.

However, during this period, the graduates pick up a feel for the way things are done. They run up against the company protocols, some of which can be complex and are rarely explained in advance — perhaps this is the best way of learning them. They find out how to order and requisition what they need. They find out who to turn to for different kinds of expertise, and some may experience the delays when IT support, which has been outsourced, is required. They are certainly learning.

Trainees might find it easier to bear this period of incremental advancement if they were told more about how their efforts contribute to the firm. Even when they are attached to project teams, the ‘whole scope’ of the project is not always explained.

E72(8m): It depends manager to manager, project to project, sometimes X will just ask you to do something….something specific. You don’t get to see the bigger picture. That was one criticism I had. And then you were left to fend off questions regarding the bigger picture. I never really appreciate it.

The Social Environment

We have already noted how the nature of the physical environment in most engineering companies facilitates interactions between trainees themselves and with other, more senior colleagues. In that sense it helps to create a positive social environment which is important in keeping trainees contented and happy in their work. But other ingredients are needed.

There are obviously more opportunities to mix with other graduate engineers in major firms that have a large organised intake of new recruits, than in workplaces that take one or two graduates, such as a local authority. Working in a team immediately makes a trainee a member of at least one social group, and a new trainee will automatically be introduced to immediate colleagues in the section, but not necessarily to others in the building. So it is helpful to have a number of informal ways in which a wider circle of people can be met. Examples we were told about included:

- Lunch-time talks and discussion groups;
- In-house courses;
- Parties at Christmas and other occasions;
- Going out to the pub or a local restaurant on Fridays;
- Courses or seminars at other firms or institutions;
- Sports and exercise clubs.
E78(14m): … I think the social things at lunchtime, going out to play basketball, and stuff like that. And every Friday we go down to the pub for a meeting, and things like, as a team. … You get to meet people from other floors, as it were, and other departments. And you get to know more. If they weren’t there one week, where were they? And you find out they were in Africa, or something like that. So it’s quite interesting … usually you get the gist of what’s going on. … But where we are, up here because we’re the M&E (mechanical and electrical) department, we get a bit of interaction with the civils working on our projects and, apart from that, we don’t really get to mix with anybody else.

There is employer support for many of these activities because they are believed to promote satisfaction, interest, and work performance. From our standpoint, they also promote opportunities for much informal learning from colleagues. This may not be directly through the talk at such events. As far as we can tell, this is mostly, and appropriately, social rather than work focussed. However, in these gatherings the new graduate engineers can gain some acquaintance with seniors they may later work with in a team, or need to consult at work. They may even pick up indirect indications of whom it would be best to approach for specific expertise, or at least, who could advise them on whom to approach.

TEAM WORK

We found the graduate engineers already predominately working as part of a team: 34 of 35 said they were, one of the 34 saying it was a very ‘loose’ team. But team working does not necessarily come naturally. It involves several skills that have to be learned and practised. So five of the 34 did not feel a part of their team for significant periods, and two of these did not feel part of their teams at all.

People may also work in a variety of types of team at different times, and may be a member of more than one team at the same time, although in engineering, people are unlikely to be simultaneous members of many teams. This contrasts with some areas of nursing where research has found people belonging simultaneously to as many as 14 different teams (Miller, Ross and Freeman, 1999). It is probably within teams that the graduate engineers first have to work against real deadlines. Teams are also an important ingredient of the social environment, as noted above.

Table 8  Team work preferences (n = 32)

<table>
<thead>
<tr>
<th>Preferences</th>
<th>Share the task</th>
<th>Do task on own</th>
<th>Mixture of both (Depends on task)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

The attitudes that graduate engineers start with obviously affect their approach to team work (see Table 8 above). Thirty-two of our sample gave a view on how they would prefer to do an assigned task. Half (16) said that whether they would prefer to work on their own, or work with others, would depend on the nature of the task, the implied workload involved and its complexity. Just under a third (9) would look to share assigned tasks, which is in keeping with modern engineering practice where team working is the norm. But between one fifth and one quarter (7) preferred to tackle tasks on their own.

Those who said they would prefer to share assigned tasks all the time, or share as the task requires, offered reasons along the following lines. One ‘enjoyed (the) interactive environment’.
Another said, it ‘improves inter colleague relationships’, and a third said it gave a ‘chance to communicate’. Communication brings its own advantages, so that other claimed benefits included the sharing – and hence learning - of ideas and techniques new to the graduate engineer. All this would increase the ‘possibility of doing (the) task in (the) right way’.

Other claimed advantages related to making the job easier (‘job may be too large to cope with/complete on my own’, and ‘makes task easier’), and enjoying support (‘you can seek help’, and (you) ‘feel more secure that you're doing the right thing’). These graduate engineers did not necessarily feel that their efforts would go unappreciated in teamwork because when the ‘task is broken down, each person is responsible for their own little bit.’

When graduate engineers prefer to do assigned tasks on their own, they believe it can be quicker and more efficient. Sample quotations include: - ‘(it) takes time to explain (the) task to someone’, and ‘(I) can get on with it myself’. There was also an appreciation of personal opportunities, so that an assigned task, done by one’s self, would be a ‘chance to shine’, that ‘builds your confidence’, even if it presents a ‘personal challenge’ to ‘make (your) own decisions.’

But a third group of comments exposed worries about the ability to handle the interrelationships that teamwork requires. These comments included: ‘arguments occur when you share (there can be) fighting over jobs’ and ‘disagreements take place’. Others worried about, ‘confusion over responsibilities’, and that ‘others don’t fulfil what they were supposed to do or said that they would do’, and it was ‘difficult to pick up other people’s work (because) people work in different ways’.

WHAT IS LEARNED

Technical and General Skills
To lead into what the graduate engineers thought they still had to learn, we asked them which they were more confident in: their technical or their more general skills. We also asked them about their strengths and weaknesses, believing that the latter would reveal areas where more learning was required. Table 9 summarises, in broad terms, the replies to the first question.

Table 9. Relative confidence in technical and general skills when starting work (n = 34)

<table>
<thead>
<tr>
<th>More confident in Technical skills</th>
<th>Equally confident e.g. 50-50</th>
<th>More confident in General skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>

The ‘Technical Skills’ are those that relate directly to being able to do the technical work in the company. Of course the particular technical skills vary according to the company’s business and the type of engineering involved. Under the label of ‘General Skills’ we include all the skills that support being effective at work. These include the generally recognised people skills of communication and team working, and other skills such as report writing and giving presentations. It may seem surprising that these graduates, as they begin their careers, are relatively less confident in their technical skills, but this may be because they have already realised what they still have to learn in terms of company and sector specific engineering skills. They already know enough to realise how much there remains to learn.

This group may be relatively more confident in their people skills, communicating and working in teams, because nearly all of them had significant periods at work, either on a ‘sandwich’ year or in holiday jobs. A few, particularly the few who had been sponsored, had
spent substantial periods working in engineering before taking up their present posts. However, the graduate engineers are less confident about their ability to write reports and give presentations, and their managers also regard these areas as weak, and in need of definite improvement. Writing is generally a challenge. The amount of standard documentation that has to be produced to accompany product development, and the satisfactory completion of contracts, has increased greatly in recent years. Many graduate engineers found this onerous, partly because of the need to become acquainted with associated protocols, but mainly because of the amount of writing that was expected. They had to learn ways of dealing with these aspects of the job by doing it.

Categorising What is Learned
This early in their career, the graduate engineers could not anticipate either the full range of the skill challenges that lie ahead, or all the detailed knowledge and understanding their work requires. So what trainees believed they still needed to learn was quite ‘broad brush’ and lacked useful detail. However, too much detail also presents problems. For example one graduate engineer, knowing of our focus on learning, used quarterly reports and a log record to draw up a spreadsheet summary of what s/he had been doing and learning since joining the firm. From the column describing what s/he said s/he had learnt, it was possible to extract a list with 33 entries. It included such things as:

- How to use a relevant design package.
- How to make careful notes that can be understood at a later date by others and by me.
- The importance of writing information or field notes as soon as possible or on return.
- Value of on site sketching and photographic information.

See Appendix 1 for the full list of 33 entries.

The full list is a fascinating view of the detail of what graduate engineers still have to learn in order to function well. It is obviously a record of what this graduate engineer was aware s/he was learning and consciously remembered. There are probably other things s/he did not include. These may be more elusive because they are less overtly supported by the routines and needs of the job. And it is not easy to remember, because things are not neatly separated.

E48(6m): ... just in the work you do every day, everything that you learn is useful, whether it’s how to practically design something, or a style of report writing, producing documents, communicating with different parties ...I’ve been on specific skills courses.

All entries in this graduate engineer’s list are valid descriptions of what has been learnt. They cover the acquisition of new knowledge, skills and understandings, but such individual, company-based lists are too specific and too detailed to be useful across different fields of engineering. Likewise, the ‘knowledge, skills and understanding’ labels themselves are too broad in their sweep to be useful. So the main categories of activity used for analysis in this report are based on analysis of the interview data obtained in this work, compared with categories identified during work in the 1990s with mid-career professionals (Eraut et al. 1998). The project is currently working with eight main categories. These are: Task performance; Awareness and understanding; Personal development; Teamwork; Role performance; Academic knowledge and skills; Problem-solving and decision-making; and Judgement. These categories feature in the headings that follow in this section of the report.
Task Performance
Satisfactory task performance clearly depends on having learnt, and being able to use, all the relevant technical knowledge and skills for the immediate task, including the understanding of design specifications and standards. But other things are also required. Appropriate work practices need to be adopted, including the prioritisation and planning of work, and keeping a log-record of progress with the task. The trainee needs to have found out who does what, and the people who are sources of relevant help and expertise on this task. So knowing how to contact the right people and communicate effectively with them is basic. Correct task completion brings the need to know, and to be able to use, the appropriate report-writing format and documentation procedures to satisfy quality assurance standards.

Awareness, Knowledge and Understanding
At one remove from the immediate learning necessary for adequate task performance there lie several other areas which demand awareness and understanding. On a macro level, the business of the firm needs to be understood. Large engineering companies usually have important parts of their induction programmes covering this. However, extensive experience, and contact with customers is probably required to develop a sophisticated understanding that will affect bidding for contracts, the way contracts are handled and sub-tasks undertaken. It is too early to expect this from our graduate engineers. When interviewed, they were still getting to know the operational procedures of their companies, and how these were affected by industry codes of practice and legal issues. Much of this knowledge of the firm’s business and products, its procedures, codes of practice and the law, is ‘academic’ or ‘formal’ in the sense that much of it exists in texts that can be read and taught. A wider awareness of implications and a greater understanding of how factors interrelate, however, can only be gained by accumulating and making sense of experience.

Personal Development and Becoming Chartered
Pursuing chartered status is the most visible, and many think the most important, way in which graduate engineers can develop personally.

E50 (6m): *It’s pretty important – that’s what I’m working towards...Because I feel it’s... completing your qualifications, really, although you still continue learning afterwards. But that’s a sign that you really can do the job.*

Progress means engaging in professional training and documenting an appropriate range of work. This means learning the requirements and procedures for achieving chartered engineer status, maintaining a work record, producing quarterly reports and development action plans, and taking part in reviews.

Table 10. The importance of Chartered Engineer status for graduate engineers (n = 35)

<table>
<thead>
<tr>
<th></th>
<th>Very important</th>
<th>Important</th>
<th>Fairly important</th>
<th>Not important</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>6</td>
<td>13</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Twenty-one out of 32 who gave this information are already enrolled, and a further seven were going to be enrolled on a programme. Only four were not. Being enrolled, however, does not mean the graduate engineer is fully convinced of its importance.
A degree of scepticism about the worth of chartered status was evident among graduate engineers in firms of all sizes. Sometimes the graduate engineer was being swayed by knowing of successful senior people in the company who were not chartered. This also seems to link to certain fields of engineering.

E52 (4m): I’d like to get my chartered status, yeah… eventually, but it’s not a priority… …. I think (my) objective … within the company, is just to become somebody that other people can say, ‘I can go to X to get help with this or that.’ So… to become, I don’t know, some kind of expert in what I do. (I’ve) discussed this a lot over the last year…It’s quite important but I believe that the chartered engineer status is just showing that you have continued to learn, and it’s just showing the professional development and the backing of the institute. So, yes, it is important, but the degree you got in the first place is probably more important.

Sometimes the graduate engineer remained to be convinced, despite having been signed up as an undergraduate to a Chartered Institute. In addition, a number of graduates are not keeping up-to-date with the requirements of CEng status, or have no clear arrangement with their mentors.

E69(8m): this is confidential isn’t it…..very little support…X’s not a supportive person … I have quarterly reports which I have to have a meeting with X every quarter and I really, when I go … it’s like getting blood out of a stone to try and get that meeting… X doesn’t really want to have that quarterly meeting with me …

Some were considering the alternative routes to additional qualifications that would bring career advantages through taking a higher degree, or gaining an MBA.

Mentoring in one of our partner firms, while strongly linked to gaining chartered status, was also geared to helping graduate engineers with any difficulties in working relationships (see Mode 2 in the earlier section, Being Mentored). This is significant because personal development also depends heavily on building successful relationships, particularly in teamwork, and we have already noted that some graduate engineers were well aware they needed to acquire a fuller range of team working skills.

Whilst both technical and management skills are important for chartership, some graduates were more interested in the technical side and wanted to be a senior engineer with as little management responsibility as possible, whilst others wanted to follow a managerial route. Such feelings become clearer over time.

E62(5m): I would like to be a team leader or … have control of my own project. …But obviously I need the experience before I get to that stage. … I know that most of my managers and leaders seem to have more paperwork to do, and I’m not ready for that yet. I want to be in the more technical design work.

Another trainee had demonstrated an ability to manage and lead through practice.

E47(4m): management, … I think I am a better person like a team leader than some. I don’t naturally fall into sitting at a desk doing calculations and being that kind of technical. … Leadership side I know I’ve achieved that before, and I’ve had good reports when I’ve done well as leading a team, so…
Teamwork

A few pages back we rehearsed the worries about teamwork that a minority of graduate engineers start out expecting. Some worries focussed on how to handle relationships if disagreements were to arise. Other worries concerned possible confusion of responsibilities, problems of holding people to account in a team, and difficulties arising because people work in different ways. These anticipatory uncertainties point directly to what the minority of graduate engineers needed to learn in their first posts. Experience of teamwork did not figure highly in references to degree courses (although it features in modules that require groups to co-operate to solve problems together) but, as almost every graduate engineer was already working as a team member, practical experience of team working was building rapidly.

Furthermore, references to teamwork that were based on direct experience were predominately positive. Positive features that graduate engineers had noted and were quoted to us included regular, often daily, briefing up-dates when problems could be aired and other team members could either offer a solution, or suggest someone or something to consult. This process was backed up by close informal liaison during the working day, and good systems for recording progress that would allow flexible switching of sub-tasks if someone completed their commission ahead of time.

However, there were instances of less than satisfactory teamwork experiences for trainees. These were associated with working in a looser section grouping, rather than in a team defined by its common output goals. Other unsatisfactory features were insufficient briefing on tasks beforehand, and indifferent coaching to support the graduate engineers while working on their tasks. The latter problem was more likely when there was a nominated mentor, but the mentorship functions were not being fully carried out, perhaps because the functions of a mentor were ill-defined.

Role Performance: Academic Knowledge and Developing the Persona of an Engineer

There is more to being a good engineer than simply having the required technical capabilities, a command of people skills, and being adept at report writing and presentation. Graduate engineers are aware of this, and could name many other qualities, some they themselves still need to acquire or improve, that they believe contribute to being a good engineer. Table 11, below, lists examples of the qualities that were identified.

The general self-confidence of the trainees, alluded to above, meant that most felt they already had a lot of the attributes in the table.

E48(6m): Academically I have always done quite well. So I suppose that is a good starting place. I am very analytical. I am quite patient. I can spend time going over things, doing things. I like the idea of getting out of the office to go on site, … (I) like the idea of working with people as well, … also the fact I’ve been keen for a long time, and quite ambitious … I’ve not done anything and then given up on it. … So, I know if I set out to become Chartered, I know I’ll do it, and I won’t stop half way through. And I think that sort of determination helps as well.

E53(2m): Logic is my main strength. I’m very logical. I can often see…see a solution to a problem, or see a problem with a solution, as a sort of third party… where others often couldn’t.
Table 11. Trainee Engineers’ views on what makes a ‘Good’ Engineer (n = 31)

<table>
<thead>
<tr>
<th>Qualities of a ‘Good’ Engineer</th>
<th>Collated views of Graduate Engineers in their First Year at work</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical skills</strong></td>
<td>Examples: good technical skills; good mathematical skills; capable of fixing software programs; able to put new ideas across with existing technology.</td>
</tr>
<tr>
<td><strong>Analytical and problem solving abilities</strong></td>
<td>Examples: good observational and analytical skills; having a structured and effective approach to problem solving.</td>
</tr>
<tr>
<td><strong>People skills</strong></td>
<td>Examples: being able to work/deal with people; good communication skills; listening skills; patient; good management skills; excellent team working skills; and appreciative of people’s views.</td>
</tr>
<tr>
<td><strong>Other job-focused skills/attributes</strong></td>
<td>Examples: effective time management; good documentation and reporting skills; awareness of financial and commercial aspects; having a curiosity about things; interested in why things work.</td>
</tr>
<tr>
<td><strong>Attitude to learning</strong></td>
<td>Examples: willingness to learn; flexible and open-minded.</td>
</tr>
<tr>
<td><strong>Other qualities – common to any profession</strong></td>
<td>Examples: enjoys the job; self-motivated; hard working; thorough; precise; ambitious; productive worker; constantly improving; positive thinker; able to look at a big picture, but also cope with detail; has vision; able to think ahead.</td>
</tr>
</tbody>
</table>

However, at the heart of the matter is the business of acquiring the **persona** of an engineer, to become a ‘true’ engineer, thinking and acting as experienced, successful engineers do. This is learnt largely by observation, by seeing and analysing, sometimes unconsciously, how others conduct themselves. To find out about this, we asked whether there was anyone the graduate particularly admired.

E73(3m): yeah sure the training director … actually I often, whenever I have any technical problems or questions, I usually approach him. He seems to have an awful lot of technical knowledge, so I do sort of concentrate on speaking to him a lot of the time… He always tends to explain things on graphs, and sort of diagrammatically … Because I have that sort of analytical kind of understanding, I think I can appreciate how he’s actually … trying to explain it.

A second example shows an awareness that to adopt the mantle of an engineer means having a rich mixture of qualities, and being able to balance demands.

E49(12m): So it is like a mixture of so many qualities. Yeah absolutely, X’s got a good engineering background…. X works very hard. X’s good at communicating with people and reassuring them.

To become successful in their career in engineering, graduate engineers have to recognise creditable signs of professional success, and develop the positive qualities, the ‘persona’, that bring this success. It will be interesting to see whether, further on in their working lives, they still emphasise the interpersonal skills. Deciding which aspects of an engineering ‘persona’ to accept is not always a conscious activity. And, as one graduate engineer said, ‘Oh, no – no-one’s perfect!’
Problem-solving and Decision-making

Problem-solving is the very stuff of engineering and graduate engineers are well aware of this. Several claimed that being confident in their own problem-solving abilities was one of their personal strengths. Once work begins in earnest, so the opportunities to learn more about solving problems multiply. One trainee was a member of a team with a large problem.

E49(12m): we have one case where a column from a new extension, … that we were going to found under ground came directly over a great big electricity cable that supplied the whole site, … so we had to come up with some kind of three legged ground beam that would span over the top of It, which was quite a little bit out of the ordinary … S/he also spoke for everyone when explaining how the solving of minor problems was a day to day occurrence. … you are solving problems all the time, its part, it’s just the nature of the work anyway really. … little queries coming in from site by fax actually, … so you find your way around it and send it back …

The last comment sums it up. Frequently, with learning at work, the process is incremental and cumulative but, at this early career stage, it can be overt. One trainee consultant engineer told how s/he liked to be present on site when installations took place so that s/he would know the practical snags that might arise. If, some time later, s/he were to be asked (often over the telephone) about similar problems, s/he would know what to advise.

E78(14m): with the design you can learn about the theory and things like that. It’s like you’re doing design reviews, (and) as I’m going through different sets of drawings with different projects, you start to see different way things are done. And that’s important I think. … and until you’ve got experience on practicalities like on site, you cannot start understanding how things go together … seeing the practicalities of it bring the design and the theory and the management together for me.

Experience in decision-making accrues in a similar manner. Within their first year at work, graduate engineers do not have to make crucial decisions with huge cost implications, but they are immediately plunged into the need for many decisions of different types and at different levels. Deciding the best way to approach tasks, deciding between alternate solutions to problems, and deciding where to seek assistance are obvious examples. Similarly, they are party to, and have chances to observe, decision-making in many different contexts. Even when assigned an individual task, the best approach will usually be discussed, and within teams there are numerous opportunities to hear the decision-making discussions, and sometimes contribute to the decisions. A large element in making good decisions is being able to appreciate all the factors that have a bearing on the decision. Listening to discussions between senior engineers helps, and practical experience reinforces such learning. Instances were related to us in which, for example, restricted access to resources, sometimes ICT hardware or software and sometimes the people with previous experience, affected decisions. Such experience would lay the foundations of the sound judgement required of all engineers.
HOW IT IS LEARNED

Learning can be a difficult process to describe. Sometimes one is very conscious of being engaged in learning; sometimes one only becomes aware of having learned something when, on reflection, one recognises that one is thinking or acting rather differently, and therefore must have learned, but cannot easily attribute that learning to any particular set of activities.

In this section we become more analytical, and present brief descriptions that are based not only on the graduate engineers’ interviews, but also on what managers and others have told us, literature from companies and institutions, and our own observations. However, we need to start with one set of figures. In their present jobs the great majority of graduates feel able to expand their technical knowledge (n = 26), although one of the replies was reserved, ‘a little bit.’ They also feel able to acquire any general work skills they feel they lack (n = 25, where one said, ‘I hope so.’). This points to a broadly positive atmosphere for learning within engineering companies and, in the main, this results from a number of steps taken to provide support for learning.

Formal, Structured Support for Learning

All four of the large firms we are working with provide training programmes that exist independently of the induction programmes we have already mentioned. And not one of the graduate engineers thought that training was unimportant or irrelevant. Over half considered it crucial.

For example, in one company formal training and support exists in several forms. Apart from a ‘Buddy’ arrangement, and a formal induction, there is an important introductory course, designed to familiarise new employees with the technical principles that underlie the firm’s business. One graduate engineer missed it by joining the firm later than the usual cohort, and had to be coached in what it was necessary to know by the team leader. This continued to bother the trainee when interviewed.

A three-year Graduate Development Programme (GDP), with specified modules of training, guides graduate engineers towards their chartered status. The firm’s personnel/training section runs meetings to help graduate engineers make best use of the opportunities. The early modules include exercises designed to foster the people skills, e.g. of team working, by assigning tasks to be carried out in small groups and reported upon to senior engineers. There are also annual conferences to bring together new employees from the firm’s overseas arms.

Within this formal system, and the opportunities it gives for monitoring the progress of the graduate engineers, the personnel section, and some senior engineers, are alert to a range of signals of how well a graduate engineer is settling in, and offer help if required. One important indicator is moving to live nearer the work site. Other signals include: a readiness to seek help; having hands-on skills; and the speed of understanding the firm’s concept of ‘the design cycle.’

Mentors are assigned to help graduate engineers to construct the necessary record of work experience that will help gain chartered status, and to be a confidential ear on other matters, in meetings that should occur within set time periods. And there are other sources of formal support. For technical and software training, the firm’s intranet carries materials for individual use, although not all graduate engineers were aware of this when interviewed. There is also a confidential phone line staff may use to seek advice, counselling, etc. should they suffer adverse circumstances.
In the other three large companies there is similar access to planned programmes of training although it is organised rather differently. Training courses on technical matters specific to the company’s core business are common, but there is variation in the way access to other training courses is decided. All our graduate engineers feel they want a say in the training they receive, and in some companies they can negotiate exactly which courses to attend with their mentor or team leader. In our non-partner organisations, systems for providing formal support vary more widely. Where the graduate engineer works for a large, multi-site company there are official courses, but the associated travel to courses that may not strictly suit the graduate engineer’s specialism can look unappealing. In other cases, special efforts have been made to ensure that the graduate engineer’s training and experience will lead to attaining chartered status.

Feedback and Guidance
As we have just noted, an important part of the system of formal support is played by the graduate engineer’s mentors. But, while they can give guidance, more immediate feedback on work performance should be available from a graduate engineer’s team leader or line manager. However, there are major differences in the frequency with which graduate engineers receive feedback and the way it is provided.

While a sense of progression is closely linked to recognition of learning, it is possible to know that one is learning without knowing that one is making good progress. How does my progress compare with that of other trainees, present and past? Am I meeting the expectations of significant others in my organisation? Making such comparisons depends on getting feedback that extends beyond immediate actions to make general normative judgements about a person’s strengths and weaknesses. Thus it is useful to make a distinction between quick feedback on performance that supports learning how to do particular tasks and a more deliberative kind of feedback on general progress. The former is best given by people present at the time, the latter by someone more senior and experienced who knows you, but has also consulted other people about your progress.

In many instances (13 of 29), graduate engineers claimed to have received very little, sometimes no, feedback. But there are reasons to resist taking this at face value. For example, 28 said they received support, guidance and supervision from a senior engineer, and the one person who said ‘no’ to this question, was in fact sitting next to his/her direct manager, and he/she mentioned that he/she was receiving support, guidance and supervision on other occasions. Now it is difficult to understand guidance in the complete absence of feedback. So, a graduate engineer’s perception of what counts as feedback may well be at odds with their managers’ perception. Managers will often say, ‘Thank you.’ or ‘Well done.’ But this is not necessarily seen as feedback by the graduate engineer. Indeed, one graduate seemed to see feedback as essentially negative! Others have found ways of reading other cues as to how they are doing. The cues include: how much work they are given; the challenge of that work; and who gives them work. Other graduates provoke feedback, e.g. by sending brief progress emails to their team leader. On the employers’ side it seems as if responsibility for giving feedback can sometimes fall between managers, mentors and team leaders. Or it just gets overlooked because of general work pressures.

Coaching and other Informal Support
Coaching is a major process in helping graduate engineers to learn their profession. Yet it stands rather uneasily as a process which is universally expected, but rarely recognised formally. Coaching includes the provision of pre-task briefing, light monitoring while
trainees try their hands, a readiness to answer all questions, a willingness to demonstrate on occasions, and the ability to give pertinent, on-going feedback on how the tasks develop and how well trainees perform.

By now we have mentioned many other of the different forms of informal support that surround a graduate engineer and help them. The ‘Just ask’ culture is a strong element. The way working spaces are organised, and the preponderance of working in teams are others.

Socialisation is also important. It was not only the practical aspects of engineering that had to be learned, but how to operate in the company, and become socialised into the workplace culture. Learning to work in a team was crucial. More than one trainee stressed the importance of understanding the company.

We have also mentioned the deliberately arranged, but still informal, support offered via meetings, clubs and out of office ‘get-togethers’. These are all important contributing sources of learning support although the further along this list one goes, the more indirect the contribution. We realise that the organisations we have visited are conscious of the importance and relevance of these forms of informal support. But in some cases, arrangements have existed long enough for the consciousness of their importance to have dimmed.

Learning Processes

Down the years many lists have been drawn up of learning processes, and some have been exceedingly long. However, in this project our eye has been firmly on what can be confirmed by either observation or cross-checking. On this basis the list we have arrived at is quite short:

- Accumulating and querying experience
- Asking questions
- Listening to advice, and other conversations
- Observing others, or being shown
- Participating in group/team activities
- Practice
- Reading and applying
- Trial and error
- Working it out on your own

The important thing to notice is that this list concentrates on the ingredients of so-called ‘informal’ learning. Among our graduate engineers there was a clear preference for informal learning in the workplace (see Tables 12 and 13 below).

E69(8m): I like the formal learning, but it doesn’t always hit the mark … the informal, like learning from others, that’s quite effective because you don’t really realise you’re learning it … You don’t think of it as a learning type as such, you just pick it up as you go along, which I think is more useful … It’s more relevant to your day to day life.

Table 12. Graduates’ preferences: formal instruction vs. ‘informal’ workplace learning (n = 32)

<table>
<thead>
<tr>
<th>Instruction based, formal learning</th>
<th>Mixture, it depends</th>
<th>Informal, workplace Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>17</td>
<td>12</td>
</tr>
</tbody>
</table>

The trainees had thoughts on what they believed were the most useful methods of learning, but it is too early to say whether their important learning has come about in the ways they imagined.
Table 13. The Graduates’ most useful methods of learning (n = 33)

<table>
<thead>
<tr>
<th>Talking to others</th>
<th>Demonstration, observing</th>
<th>Courses, lectures presentations</th>
<th>Doing the work, trial and error</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>9</td>
<td>6</td>
<td>22</td>
</tr>
</tbody>
</table>

Columns 1 and 2 can be seen as learning from senior engineers (observation, discussion, etc)

Confidence and Personal Learning Skills

Many of our sample of graduate engineers showed high levels of self-confidence and determination. A lot of this had clearly come by virtue of a successful academic career, and the system of appointment in engineering companies tends to favour such candidates for jobs.

E75(12m): *I think the main strength is … my confidence. I have an awareness of what I don’t know, which I think is very, very important in engineering. So, if I don’t know something, I will say, or I will ask … so I think that’s my strength.*

E48(6m): *…my determination definitely … not being afraid to ask for help when I need it … but at the same time you know I can use my own initiative. I can get on with things on my own. I don’t need a great deal of guidance… I haven’t turned down any work that has been offered to me so far. I’ve accepted it all. I’ve realised it will all be a learning experience.*

The point is that the attitudes that accompany high levels of confidence and determination are part of a positive predisposition to learning and self-development. Graduates at this level may be expected to be adept and adaptable learners, able to learn in many ways, and certainly able to learn a great deal by asking questions and listening and observing. Nevertheless, a graduate engineer still needs to be confident enough to show his/her relative ignorance, and ask for help when it is needed, as both the quotations above show.

A Local Capacity for Supporting Learning

The capacity of an organisation for supporting the learning of its graduate engineers depends on several things. Among those who will work with the trainees, some have to have designated roles such as a mentor or team/project leader. These people need to understand the functions that accompany the roles, and be able to carry them out. In particular, they need to have the disposition to provide both kinds of feedback we have identified, and the skills required to do this. Mentors need to be sensitive to a graduate engineer’s learning needs, and how these may change over the first year or two. To back this up, there has to be a sound repertoire of possible responses to the learning needs that are identified. This is not the responsibility of a mentor alone. It has to be facilitated by the company in the way it is willing to support a variety of methods of learning.

These requirements may mean that some, quite senior engineers would deserve some refresher training themselves. A ‘learning climate’ has to be created, and it is good to be able to say that nearly all the firms we have visited do well on this score, having encouraged a ‘happy to help’ style of collegiality, backed up by an obvious expectation that trainees will ‘just ask’. The creation of learning opportunities for trainees calls for some skill on the part of management, and we have already pointed out that this vital contribution goes largely unappreciated by the graduate engineers.
FACTORS AFFECTING LEARNING AND WORK PERFORMANCE

From an employer’s point of view, understanding the factors that affect learning is particularly important, because it suggests ways by which changes might enhance trainees’ learning. At this point in the research, we have developed a two triangle model to depict key factors affecting learning and their inter-relationship. The first triangle (Figure 1) depicts factors directly affecting learning, and the second triangle (Figure 2) depicts contextual factors that influence those learning factors. Both confidence in one’s ability to do the work, and commitment to the importance of that work, have been confirmed as primary factors that affect individual learning.

Figure 1. Factors Affecting Learning

<table>
<thead>
<tr>
<th>Challenge and value of the work</th>
<th>Feedback and support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LEARNING FACTORS</td>
</tr>
<tr>
<td></td>
<td>Confidence and commitment</td>
</tr>
</tbody>
</table>

Confidence depends on the successful completion of challenging work, and that in turn usually depends on informal support from colleagues, either while doing the job or as back up when working independently. Indeed the willingness to attempt challenging tasks on one’s own depends on such confidence. If there is insufficient challenge, or insufficient support to encourage a trainee to seek out or respond to challenge, then confidence declines and with it the motivation to learn.

Commitment is generated both through social inclusion, most strongly felt in teams, and by appreciating the value of the work outcomes for career progress (a problem we have identified for most novice professionals). As argued above, concerns about career progress arise from inadequate feedback of a normative kind; it can be de-motivating and reduce commitment to the organisation. Both commitment to learning and confidence affect the extent to which early career professionals are proactive in taking advantage of the learning opportunities available to them.

Figure 2. Contextual Factors that Influence Learning Factors

<table>
<thead>
<tr>
<th>Allocation and structuring of work</th>
<th>Encounters and relationships with people at work</th>
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<td>CONTEXT</td>
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<td>Individual participation and expectations of a trainee’s performance and progress</td>
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The context triangle above also has apexes related to work, people and individual learners. In this case the best starting point is the allocation and structuring of work. This is central to trainees’ progress, because it affects:

1. the difficulty or challenge of the work, and the extent to which it is individual or collaborative;
2. the opportunities for meeting, observing and working alongside people who have more or different expertise; and
3. opportunities for forming relationships that provide feedback and support.

Over time, trainees are expected to extend their competence by performing similar tasks in a wider range of situations, to deepen their expertise by dealing with situations of increasing size and complexity, and to expand their capability by learning to do new tasks or to take on new roles. To make good progress a significant proportion of their work needs to be sufficiently new to challenge them, without being so daunting as to reduce their confidence.

There are also likely to be competing agendas when tasks are allocated so that, while trainees are more efficient on tasks where they already have enough experience, they also need to be involved in a wider range of tasks in order to extend their experience. Thus managers have to balance the immediate demands of the job against the needs of the trainees as best they can, as well as satisfying the requirements of the professional bodies.

Provided that relationships are reasonably good, there are several factors that help to strengthen them. Teamwork in particular, and appropriate work with colleagues on site where this is appropriate, both allow relationships to develop in different contexts, as do the informal social events we listed earlier.

Working in a team towards completing a project confers the following advantages for learning:

- Trainees are valued for their individual contributions.
- What trainees do is clearly significant both for the final outcome and for continuing good relations with colleagues.
- Trainees have many opportunities for learning, for example by receiving feedback on their work; being initiated into the complexities of projects by good on-the-spot coaching; and benefiting from peripheral participation in activities for which they have not yet acquired the necessary competence.

Completing projects to real, definite deadlines requires a high level of collaboration, and this increases trainees’ commitment to their colleagues and to their work. As a result trainees both see the value of their own work and become valued by senior colleagues, with a consequent increase in confidence and commitment to further learning. They also become aware of the need for the more mundane work they are often assigned as early tasks. The nature of the tasks for which a trainee is given responsibility may provide a proxy indicator of their progress, but there is also a need for clear feedback on the extent to which they are meeting their employer’s expectations.
GRADUATES’ FUTURE PLANS

In our sample of graduate engineers, as we have seen, there were high levels of satisfaction with both their firms and their jobs. Almost all the graduates felt they were in the right job, and that they had made the right choice of company. Very few had considered, or were considering, a move in the immediate future. The majority planned to stay in their present position at least until they became chartered. Few looked further ahead than that. Most wish to get enough experience, to become chartered, and then move to a more senior position somewhere else, or establish their own business. Others need the experience and the CEng status to be able to go abroad and work overseas or in developing countries and aid agencies, to provide expertise where it is most needed.

Few have plans to study for a higher degree in the near future, but a very small number plan to do an MBA. They know there are opportunities for career development, but are only vaguely aware of opportunities for promotion. The exceptions were beginning to consider how they might continue their career: veer towards management, with all its attendant paperwork, or stay with the hands-on, problem-solving engineering they were presently enjoying. A few, from overseas, tended to have plans to return to their homelands after they become chartered.
POSSIBLE AREAS FOR ACTION RESEARCH

Our plans on the project, are to continue to visit the graduate engineers and see how events unfold. And we are also ready to discuss this report with each of our individual partner companies, to explore possible developments in the form of ‘action research’, and agree how the research might assist in monitoring any changes a company might wish to make, and in evaluating the outcomes. To that end we now, tentatively, suggest a number of possibilities. These are intended to stimulate discussion with our partners rather than to stand as definite proposals. Having read and discussed this report, we hope that suggestions will also come from our partner organisations.

Possible Action Research ‘Topics’ – provided to initiate discussion
These suggestions and ideas are open for discussion and amendment.

1. **Reconsidering Induction procedures**
   It is clear that induction procedures vary widely in aims, duration, content and process. Some are just an early and informal introduction to the people, the buildings, and to common procedures. While the larger specialist firms strongly structure the induction process, providing pre-planned talks, check lists, and courses that introduce the company and its products. This process covers many weeks.

   Which form of induction suits your organisation? Is there room to alter it, extend it, add more formal components, review its contents, delete things that are easily picked up or explained by a temporary ‘buddy’? Would it profit perhaps, to include more on: learning at work; the bigger picture; the internal system of protocols and acronyms?

   **Some ingredients of induction we have observed:**
   a) Preparatory documentation sent ahead to the graduate engineer to explain what will happen on arrival on the first day:
      contact arrangements; planned activities for the first day; and where help will be available for setting up the workstation and beginning a first task.

   b) Tours of the place of work, supported by organisation charts so that introductions gain meaning.

   c) Information on the following (provided on paper, via a buddy arrangement or in talks.)
   - facilities and support staff;
   - available learning/training resources;
   - the nature/ range of business of the employer;
   - operational procedures and the company code of practice;
   - who does what and available expertise;
   - resources available, including those intra and internet based;
   - staff lists.

   It can also help a new employee to appreciate where they fit in, if the induction programme includes visits to other branches of the firm.

2. **Redefining the Role and Functions of ‘Mentors’**
   Across the organisations that have given us access, we have been able to describe five different modes of mentoring. We have also pointed out the important distinction between role and function. Mentoring is not a soft option. Amongst many necessary competencies it
requires a sensitivity to learning needs, a disposition to provide feedback, and the skills to provide it. Mentors also need to be able to draw on a repertoire of responses to the needs that are identified.

Assuming that graduates gain from having a mentor, some pertinent questions follow. What should be a mentor’s role in relation to a graduate engineer? How will that role relate to the roles of other colleagues? What are the useful functions of a mentor? How can mentors be best prepared to carry out these functions?

3. **Experiments with the Nature of Feedback.**

The aim of action research in this area would be to help graduate engineers see how well they are doing on a regular basis, with the assumption this will help improve their performance. It is important to maintain the distinction between what we have called ‘ongoing feedback’ on task performance and the ‘normative feedback’ that tells trainees about their progress in the eyes of their managers, and compared to other trainees.

There are instances of graduates claiming not to have received feedback. But there are reasons to suspect that graduates’ perceptions of what counts as feedback may be at odds with their managers’ perceptions. In the absence of clear feedback trainees depend on other signals as to their success on tasks and general progress. Cues can include: how much work they are given; the challenge of that work; whether the tasks come with hard deadlines; and who gives them the work. On the employers’ side it seems as if responsibility for giving feedback can sometimes fall between managers, mentors and team leaders. Or it just gets overlooked because of general work pressures. The action research could be to take soundings from recent graduates and, accordingly, to adjust what happens with the new intake.

4. **Monitoring Training and Matching Training Needs**

Trainee engineers do not always make the best use of the training opportunities available to them. For example, graduates in several companies have access to on-line, or e-based training, usually on the firm’s intranet, but some graduates are apparently unaware of this resource that others in the same company are already using. Other graduates have told us of their weak points, but are not apparently taking advantage of formal or informal learning opportunities to address them. It may be that, in time, appraisal systems will pick this up.

But if that is not likely, then there is a case for organising some monitoring of training. The first level intention would be to give trainees the chance to explain why they were not making appropriate use of training opportunities, and to address any problems that were identified.

The higher level intention is to try to ensure a better match between learning needs and opportunities to learn and practise, but finding out a trainee’s learning needs is not a straightforward business. While graduates appeared willing to admit to weak points in a confidential research interview, they may be less willing to admit their weak points to their managers and team leaders. So an important element will be some way of allowing graduates to indicate weaknesses, and feel safe in doing so. On one level, it could bring dividends to simply extend any existing monitoring of formal training and work-related learning to include more types of informal learning, and the private use of on-line resources.
5. **Being Proactive about Learning at Work**

Very few of the graduates have had any inputs on their degree courses to prepare them for the need to carry on learning at work. Most consciously realise it is unavoidable, but gave it little further thought – until this project came along. This report has identified many components of the learning climate that successful engineering firms create. We believe that some elements can be developed further.

For example, one useful part of a newly employed graduate’s induction could be some priority ‘priming’ for the need to continue learning. ‘Priming’ could take many forms. Some are inputs, in person, on paper, or via web pages. But experience within the wider project, not just in engineering, suggests that it is those employees just a year or so ahead of the new intake who could have the most impact. Raising awareness of alternative modes of learning could also help graduates take greater advantage of the many opportunities for learning around them that companies already provide.

6. **Improving the Local Capacity to Support Learning**

This is a complex area to tackle. As the brief section on this topic indicated earlier, there are several factors to be considered: designated roles; having a disposition for, and the skills to provide more than one kind of feedback; sensitivity to learning needs; the creation of learning opportunities; the generation of a repertoire of responses to any learning needs that are identified; and creating a climate that encourages learning. But elements from among these may be selected for attention. For example, there could be a focus on informal, social support for learning such as promoting any of the following:

- social activities or events such as parties;
- festive occasions;
- going out for lunch or to local pubs;
- supporting sporting events and employees’ hobbies; and
- informal lunch-time talks.

Alternatively a focus on formal training, perhaps centred on support for gaining chartered status, could be appropriate. Areas that may profit from a reassessment could include:

- early arrangements to help trainees understand the chartered institute’s requirements;
- schedules for meetings with the allied supervisors (Designated and Supervising Engineers where appropriate);
- attendance at seminars/courses at Professional Institutions;
- opportunities for trainees to work within their area of interest/expertise;
- broad exposure to the firm’s business, perhaps with rotation between teams/groups;
- opportunities for site visits/site work;
- practice on report writing and presentation skills;
- reconsideration of how feedback is provided.

We close by re-emphasising the tentative nature of the suggestions proffered above. We look forward to future discussions with our partners.
References


Two other papers are available on the project’s web site (www.sussex.ac.uk/usie/linea/timetable.html). These provide an overview of the project’s work in all three sectors of engineering, accountancy and nursing.

Learning in the first professional job: the first year of full time employment after college for Accountants, Engineers and Nurses, AERA Conference Paper, Presented by Michael Eraut on behalf of the project team, Chicago, April 2003.

The LiNEA Project: Learning in Nursing, Engineering and Accountancy; Presentation to the Glasgow SRHE Conference by Stephen Steadman on behalf of the project team, 11th December 2002.
Examples of what one trainee has learned

(Extracted from a full summary provided by the trainee after six months with the company.)

1. Report writing format
2. Importance of QA in general, and the firm’s QA procedure
3. Design of drainage systems
4. Use of design specifications and relevant design standards e.g. pavement, pathways, drainage
5. How to simplify situations
6. Importance of stating assumptions
7. How to summarise and include findings
8. Use of paving materials in car parks
9. How to use a relevant design package
10. How to make careful notes that can be understood at a later date by others and by me
11. The importance of writing information or field notes as soon as possible or on return
12. Value of on site sketching and photographic information
13. Adopt flexible procedures that allow for change
14. How to plan and collect information from various sources
15. Contact and communications with architects, clients, users, and developers
16. Value of contact with organizations
17. Need to chase enquiries and use of persuasive techniques to gain results in some cases
18. Gained greater confidence in verbal enquiries
19. Dealing with tedious and repetitive tasks
20. Familiarity with manufacturers’ literature
21. Familiarity with bill of quantities
22. Purpose and design of some sewage systems and how they work
23. Importance of recording changes-even minor details
24. Experience of comparing tender bids
25. Checking bills for payment
26. Importance of communicating changes and progress
27. Familiarity with the role and purpose of relevant organizations
28. Clearly communicating by drawing, checking drawings, amend/add to drawings
29. Concise design procedure
30. Some understanding of process of applying for planning permission, legal challenge, etc.
31. Experience with legal documents
32. Familiarity with standards of site investigation and contaminated land
33. Identifying inadequacies in information, areas/issues of concern, implications, and suggesting possible solutions.

This document was added to the Education-line database on 12 February