NOTTINGHAM TRENT UNIVERSITY

Working with engineering employers to develop transferable higher level skills in work-based learners

EdD Module 1

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"Employers believe that colleges develop the technical knowledge and skills and they [the employers] develop the "soft" skills. Often, the trouble is, the employers do not provide training in "soft" skills."Malcolm Carr-West, Academic Advisor, Engineering Subject Centre, Higher Education Academy, in interview, Loughborough University campus, 13 November 2009.

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Abstract

The purpose of this research is to provide recommendations and strategies for the enhancement of engineering higher education work-based learners' "transferable" skills in academic and work-based contexts.

Historically, the engineering profession has focused on applied technical knowledge as the essential criterion for admission to and progression within the profession. However, there is significant research evidence that transferable skills such as problem solving, critical thinking and self-management are equally essential for effectiveness in the workplace.

Two major questions will be explored: firstly, what are employers' perceptions of their employees' transferable skills development, and secondly, can strategies and training interventions be developed to improve trainees' capabilities?

The aim of the research is to link employers' understanding of the deficit in transferable skills and the development of approaches to address this.

Research on the first question will generate market intelligence on skills development within the engineering workforce at higher education level, a specific area where gaps in knowledge exist.

Research into the second question will contribute developed, trialled and evaluated case studies, activities and exercises specifically designed to improve trainees' reflective and problem-solving skills, as a handsome fit to any identified shortfalls.

An overview of the general area of research

A historical perspective on the engineering profession

A profession can be defined as a body of technical knowledge which is held and developed, the practice of its use and application for the common good and a form of self-regulation of the processes inherent in the application (synthesised from Schein 1973, Schön 1983, Goodlad 1984). Professionalism could be said to develop through the conflict between technical knowledge and practice (Stronach et al 2002, quoted in Hodkinson 2004).

Engineering fits the definition of a profession: universities and other research institutions develop the body of technical knowledge, which is in some part detached from actual practice, where knowledge has been subsumed and embedded into codes of practice and standard procedures; self-regulation is the province of the engineering Institutions and the Engineering Council. The achievement of Chartered Engineer status through an Institution is pivotal in terms of progression, promotion and status for a professional engineer.

The origins of the status of the engineering profession lie in the early 1800s with Thomas Telford, variably and unreliably quoted defining engineering as “shaping the forces and materials in nature for the benefit of man.” Telford led the formation of the Institution of Civil Engineers, which provided the self-regulation and defined the parameters of knowledge, practice and the regulatory codes of conduct for the profession. Each of the Institutions now in existence has a Royal Charter and the power to confer the status of Chartered Engineer upon members, generally determined by an examination of their knowledge and experience in interview.

In the literature review (Document 2), it is proposed to explore the historic power and influence of the engineering Institutions (Engineering Council 2009a) in contrast with Max Weber's historical perspectives on the sociology of politics and government (Mommsen 1974) and in contrast with the current and future drivers from the political agenda.

In 1980, the Government-commissioned Finniston Report "Engineering our Future" identified "soft" skills (listed as generic thinking, business, interpersonal and problem-solving skills, hereafter referred to as "transferable" skills) as specific deficiencies in entrants to the profession and in practising engineers (Finniston 1984). Up to this point, the Institutions had only required evidence of the application of technical knowledge for admission to Chartered membership.

The Finniston Report led directly to the formation of the Engineering Council in 1983 as an overarching body to the Institutions. In 1985, the SARTOR regulations defined the Standards And Routes TO Registration as a Chartered Engineer and made them common across all Institutions (Engineering Council 2009a).

The academic and experiential requirements for achievement of Chartered status remained wholly in the domain of technical knowledge and led to the creation of BEng and MEng programmes which specifically met these criteria (it is only in the 21st century that DEng programmes have been developed). A requirement to evidence transferable skills was added to the professional interview component. In the personal experience of the researcher, a diary of training activities undertaken was considered adequate for this purpose and given no consideration in the actual interview.

In 2003, SARTOR was replaced by the Standard for Professional Engineering Competence, hereafter referred to as UK-SPEC and subsequently revised in 2008 (Engineering Council 2008a). The minimum academic standard for new entrants to the profession to achieve

Chartered status was revised to MEng. For the first time, the evidencing of effective interpersonal skills was included in the requirements. As a direct consequence, most universities incorporated an element of "employability" skills into their undergraduate programmes (Engineering Council 2008b); this later became a Quality Assurance Agency requirement (QAA 2008a). From a trawl of Midlands universities' websites, it is generally post-1992 universities, where programme specifications are more closely aligned to professional practice, which have embraced these developments: there are several exemplars of good practice (Derby University 2009, Coventry University Add+Vantage Scheme 2009) although none carry academic credit.

It is worth noting that since 2008 there have been three grades of Institution membership which show a progression between practice and technical knowledge in terms of the definition of professional status:

- Engineering Technician (EngTech, added 2008) – involved in routine operations following defined codes and procedures (HE qualification not required)
- Incorporated Engineer (IEng, added 2003) –able to check the validity of routine work and able to apply existing codes and procedures to non-routine situations (HNC/D, BSc or post-2008 BEng)
- Chartered Engineer (CEng) – capable and experienced to apply underlying technical knowledge to check the validity of non-routine solutions and to situations where the codes and procedures do not apply (pre-2008 BEng or MEng). (Engineering Council 2008a)

This change reflects the increasing influence of technology in the workplace (Kim 2002): once, a Chartered Engineer required facility with technical knowledge to frame a problem, perform design calculations and evaluate the solution. Now, generally, an Engineering Technician operates computer software to perform calculations, guided by an Incorporated

Engineer, so only non-standard cases require the input of a Chartered Engineer. This is illustrated through the increasing levels of qualification required; the requirements for transferable skills only apply to CEng and IEng and are the same in each case.

Having explored the structure of the engineering profession and its development, governmental influences, the other main external driver on entry to and development within the profession, will be considered.

The Government skills context

The Leitch Review, a Government-commissioned report on the skills situation in the UK (Leitch 2006) made recommendations for closing the skills gap between the UK and competing OECD countries. “Skills” are inconsistently defined in the document, although a large proportion of the content refers to practical workplace skills below HE level. The phrase “economically valuable skills” entered the general canon of terminology (Leitch 2006 p2). There is considerable commentary within the report on “higher level skills” as being those skills developed through study at HE level, however, nowhere in the document are such skills specifically defined. The report did not address the absence of consultation between government and industry (Keep 2005), which appears to be continuing (Engineering Council 2009b), or the ineffective role played by some Sector Skills Councils in engaging with employers (Payne 2008, UKCES 2008).

The EMUA referred to the Leitch view of higher-level skills as “the knowledge an employee needs to do an immediate job of work for an employer, disregarding the analytical skills and deeper more generic knowledge that it has in the past been uniquely the function of higher education to provide.” (Sastry and Bekhradnia para 11)

In relation to higher education, the Leitch review recommended increasing employers' financial commitment to workforce development and increasing the employer voice in the development of demand-led programmes.

There is an argument that demand for undergraduate programmes is currently student-led and that serving the interests of students and employers would create conflicts of interest (Sastry and Bekhradnia 2007). This is subject to increasing criticism (Arlett 2007). The New Engineering Foundation discovered that "the majority of universities are either not involved or are somewhat limited in their work-based learning activity" (Medhat 2007a p82).

The political agenda on skills has developed, with significant studies undertaken into higher level skills demand (Kewin, Casey and Smith 2008, CFE 2009). These identified shortages of science, technology, engineering and maths (STEM) graduates with the capacity to work effectively in the engineering industry (DIUS 2008).

Employer issues - identifying and explaining skills requirements, supporting students and involvement in collaborative programme design with higher education institutions - have all been identified (CBI 2008), although not specifically in terms of transferable skills.

The government's policy for investment in post-compulsory education appears to be firmly grounded in human capital theory (Coffield 1999, initially propounded by Schultz 1961, 1971, and Becker 1964, quoted in Sweetland 1996). This approach is flawed in that it presupposes investment in the technology and infrastructure to support developments in education (Olaniyan and Okimakinde 2008) and neglects the effects of "diploma creep" (Ferguson 1998), where the value of education qualifications is diminished by the increasing proportion of people achieving them. The government permits itself, through investment in education, to transfer some of the blame for poor economic performance onto educators and the trainees themselves (Coffield 1999).

Employer engagement with higher education

It is worth quoting paragraph 2.27 of the Leitch report in full:

> "The previous system was focused on asking employers to collectively articulate their future skills needs and then trying to plan to meet these needs. Too often, collective articulation of future skills needs has been an ineffective and inefficient mechanism. As a result, too much provision has been supply driven, based on trying to predict and provide. Consequently, employers were reluctant to contribute toward training costs because they did not have confidence in the quality of training on offer and felt frustrated by the lack of influence over qualifications. At the same time, they felt let down by poor levels of literacy and numeracy resulting from a failing school system."

The phrase "employer engagement" is a much-used and ill-defined term, which often allows for any involvement from industry to be categorised as such, regardless of its depth or value (Bolden and Petrov 2008, Kelly 2007). The reality of working with engineering employers from the researcher's own experience is that in the main their desire is to devote the minimum of their own resource to developing and implementing a programme of learning for their employees; they are generally prepared to participate in the delivery, although not the assessment (Bolden and Petrov 2008, fdf 2008a, Kelly 2007).

The LiNEA project (Maillardet et al 2004) followed a group of graduate engineers through the first three years of employment in their progress towards Chartered Engineer status. The interview findings showed that their perceived teamwork and problem-solving abilities had improved in the three years. This was mostly achieved through mentoring and informal learning; the graduates' general perception of their universities' approaches to preparing them for learning in the workplace was poor – only four out of 32 could recall any such activity (Maillardet et al 2004, p8). The engineers' own perceptions of the "persona of an engineer" (ibid p22) and their professional identity showed a strong recognition of the need for transferable skills for self-development within the profession.

In terms of "strengthening the skills pipeline" (Department for Business, Innovation and Skills 2009 p9) through partnerships, increased flexibility and improved progression opportunities, "transferable" skills of problem solving, team working and communication have finally reached policy level, although without strategy for their development (CBI 2009).

The Confederation of British Industries' opinion of the universities' perceived role, with a strong bias towards research and generation of new knowledge, contrasts with their findings on the requirements of industry, which relate to education relevant to employment (CBI 2008 p16).

Higher education in further education

In none of the above documents is there more than passing consideration of the work of Further Education colleges in delivering higher education (Medhat 2007a, Moreland 2005). The majority of engineering learners in universities study full time and since UK-SPEC in 2003 have been involved in the development of "employability" skills (HEA 2005, Hind and Moss 2005). The majority of engineering learners in further education study their higher education qualifications part-time (Kumar 2007). Many of these have entered the profession as apprentices, progressing to higher education at approximately the same age as full-time undergraduates after undertaking work-based and work-related study on a block- or day-release basis (fdf 2008b). Employer responsiveness and successful long-term employer-college partnerships have been integral to progression between programmes (CBI 2008, Kumar 2007, Medhat 2007a).

Universities have been identified as having the lion's share of the higher education work-related market in the UK, however, many of the engineering programmes in question are foundation degrees which are delivered by franchise arrangements through further education colleges (fdf 2008a, Edmond, Hillier and Price 2007). There are a variety of flexible learning modes in place, with block release, blended learning, distance learning and delivery through the workplace already in operation (Stewart and McKee 2009, Blundell 2007, Benefer 2007, Engineering Council 2007, Medhat 2007b, Chadha 2006, Davies and Berrow 1998, Ferguson 1998).

There is evidence of conflict between government regulation and employer needs in the FE sector (Avis 2009). Cultural differences between HE and FE institutions (Turner 2009) and the challenges of working with multiple funding sources and quality systems will be further explored in the literature review.

Transferable skills

The key areas where the literature identifies underdeveloped skills are as follows (summary in Markes 2006, updated to incorporate BIS 2009, CBI 2009, CBI 2008, DFES 2008, QAA 2008b and Leitch 2006):

- critical thinking skills: information literacy, analysis, synthesis and evaluation of concepts
- problem solving skills: definition of the problem and its limitations, development of arguments and evaluation of potential solutions

- business skills: business and customer awareness, technical and commercial management
- personal self-management skills: critical reflection, motivation, confidence, independence, initiative, planning and organisation
- interpersonal skills: oral and written communication and effective team working

A definition of “transferable” skills for the purpose of the research will be made from the above, as part of the literature review.

While this proposed research hopes to provide some means to address particular shortfalls in these skills, care must be taken to avoid equating the hyperreality (Stanford 2009, King 1998) of a defined set of competences with the skillset of an actual person (Marcuse 1964). NVQ-style competency frameworks and education based around them have been heavily criticised in higher education, specifically for not developing these transferable skills (Sastry and Bekhradnia 2007, Winter 1992). The personal characteristics of average entrants to the engineering profession, in terms of introversion, lack of assertiveness and poor verbal communication abilities (Harrisberger 1984) also require consideration.

The nature of learning

The development of transferable skills in a workplace context requires exploration of epistemology: the acquisition of knowledge and skills. There are various categories into which forms of knowledge can be placed – codified, cultural, personal, propositional and tacit – although the transferable skills under discussion tend to cross boundaries (Eraut 2001). Piaget’s essentially constructivist model of assimilation followed by accommodation (Atherton 2009, Tinkler 1993) supports the idea of learning in the workplace being both active and authentic. The work of Vygotsky introduced cultural and linguistic influences (Burke et al 2009): the identity, culture and unique language of the engineering profession all need to be considered here (Gee 2000, Walker 2001). The concept of tacit knowledge, the "know-how" communicated by non-explicit means (Polanyi 1967, quoted in Schön 1983) is fundamental here in terms of "transferable" skills. The work of Kolb on experiential learning (Kolb 1984, 2001) explores the development of knowledge, and particularly tacit knowledge, through experience. Concrete experience and subsequent reflection develops generally applicable concepts which permit experimentation and observation, contributing to further experience.

There is significant evidence of the advantages of experiential learning - acquiring knowledge of the world - over "mediated" learning (Laurillard 1993) - acquiring knowledge of *descriptions of* the world (Case 2008, Biggs 1999a, b, Marshall 1999, Taylor 1997).

Honey and Mumford (1986, quoted in Houghton 2004) identified a number of specific learning styles which reflect students' preferred methods of acquiring and retaining learning. Acknowledging the variety of ways in which students acquire, process, comprehend and retain knowledge, the implications for traditional pedagogy (the science and practice of teaching and developing knowledge and skills) and the conventional higher education didactic lecturing approach are apparent. It is possible to identify specific teaching strategies to address the range of learning styles (Felder and Silverman 1988, Houghton 2004).

The scope and variety of research on learning styles is extensive and disjointed, with much overlap and conflict between approaches (Coffield 2004a, 2004b). The approach in education management, particularly prevalent in schools, to address individuals' preferred learning styles as the sole approach to developing learning, has been widely criticised (summarised in Coffield 2004 a and b). A focus on learning styles has an immediate but not sustained impact on academic progress in most research examples (Curry 1990). To quote Shipman and Shipman (1985, p52, in Curry 1990):

> "In a complex changing society with diverse environmental demands, students need the opportunity to become sensitive to and proficient in multiple alternative strategies."

One should view Kolb's theory not as individual elements appropriate to individual learners, as with the prevalent learning styles approach, but as a continuous cycle of acquisition and assimilation of knowledge. This in itself could be described as a spiral, with learners achieving higher levels with each turn (Cowan 1998). This illustrates how learned knowledge and skills can become tacit in operation and "routinised"; most transferable skills processes require routinisation to be accessible and effective (Eraut 2004).

The Higher Education Academy (2006a) provides a useful exploration of the types of activity which could be used specifically to develop transferable skills. For the work-based learner, activities such as summarising a report or considering a case study will be more easily transferable to the workplace; others, such as team and group working on a particular task, would need to be integrated into the academic element of the programme on release from employment.

"Employability" activities are predominantly aimed at the non-employed undergraduate (Chadha 2007, Hind and Moss 2005, Houghton 2004, Boud 2001), as is the CDIO curriculum concept (Crawley 2001, McCartan 2008), intended to redesign the traditional didactic approach to engineering education around a model of <u>C</u>onceiving, <u>D</u>esigning, <u>I</u>mplementing and <u>O</u>perating to develop transferable skills alongside technical knowledge.

Designing appropriate activities to promote learning and encouraging student self-managed learning form the basis of constructive alignment (Biggs 1999a, 1999b, 2003, Houghton 2004) wherein the student's critical faculties develop to the point where they construct their own concepts and meanings aligned to the learning objectives - and assessment tasks, since all students tend to focus on these (Ramsden 1992). This is the essence of "deep learning" (understanding and retention through critical analysis and linking concepts) (Houghton 2004), although encouraging self-managed construction of concepts through activity can be a challenge with technical knowledge-heavy subjects (Case 2008). Self-management of learning and the deep learning process itself require well-developed transferable skills in critical thinking and personal self-management.

Constructive alignment in higher education teaching, although uncommon (HEA 2005), should be easy to relate to higher taxonomic learning (Bloom's taxonomy, Bloom 1956, Krathwohl 2002), since such learner-centred methods are integral to teaching in schools and further education colleges at lower levels. The approaches suggested by the literature are equally appropriate to part-time employed learners and full-time undergraduates. Biggs and Collis (1982, quoted in Moon 2000) call this "transformative learning": integrating ideas and developing new structures of knowledge for wider application to new situations.

The bulk of higher education for employed engineering students is accomplished through some form of release from employment (Kumar 2007, Medhat 2007a) for development of technical knowledge and skills in an academic context. Modular programmes, popular for this form of delivery, have been shown to encourage deep learning, through students forging their own connections in an environment of continuous feedback (Morrison 1996).

The research will explore the development of transferable skills both in the workplace and in the release phase and intervention strategies will be integrated into the most appropriate environment to maximise their effect, in consultation with employers.

The Engineering Council UK-SPEC provides a list of transferable skills to be developed (Engineering Council 2008a), which will be used in discussions with employers, since these are required to achieve Incorporated or Chartered Engineer status (see Appendix 2).

The development of deep learning can be promoted through problem solving, at increasing levels of complexity as students develop their critical faculties (Burke et al 2009, Case 2008, Portwood 2007, Houghton 2004, Biggs 1999a). Development of the transferable skills of critical analysis and synthesis can then act as a vehicle to accelerate acquisition and application of new technical knowledge (Moon 2000).

The problem-solving process should be accompanied by continuous cyclical reflection and evaluation to assess the progress of the evolving solution against the criteria and constraints at every stage. This is fundamental in combining previous experience with general expertise and transferring that experience to a new context.

Through developing critically reflective problem-solving abilities in students, their overall level of transferable skills, and hence, in theory, their workplace effectiveness, will be enhanced.

The initial starting-point in considering reflection is the work of Schön (1983, 1987), who considered the epistemology of practice for a professional as reflection-in-action. This highlights the contrast between higher education teaching in engineering, which focuses on fundamental scientific knowledge above its application in practice, with the professional context, where practice skills are valued above fundamental technical knowledge.

The Finniston Report identified that education for the engineering profession was ignoring the evaluative dimension which enables the engineer to answer the “what” and “why” questions. Schön quotes a personal communication with the Dean of an American engineering school: “We know how to teach people to build ships, but not how to figure out which ships to build” (Schön 1987 p11).

Schön refers to the “artistry” of professional practice (Schön 1987 p22): professional practice and its demand to continuously adapt to changing circumstances is more akin to an art than the clearly-defined parameters and strictures of a science.

Schön’s work has, however, attracted significant criticism:

- the conclusions on professional development concerned mentoring those already partially expert in their field, and did not explore the applicability of reflection-in-action to developing non-experts (Moon 2000)
- it ignored the ethical, social and political dimensions of reflective practice (Eraut 1994, 2004)
- the arguments are developed through good/bad dichotomies, where most writers regard reflective abilities as a continuum (Eraut 2004, Smyth 1991, quoted in Day 1993)
- the conclusions were reached with little or no empirical research (Moon 2000)
- the concept of reflection-in-action neglects the element of confrontation or challenge in order to initiate change (Morrison 1996).

This last aspect, of critical reflection, which can be defined as empowerment for emancipation (Moon 2000), can be traced through the work of Habermas (1972) who regarded reflectivity as a means for social emancipation utilising description, examination, development and evaluation. Reflection, encouraged initially by distancing oneself from the situation, can develop into a “tacit competence” (Van Manen 1991, quoted in Moon 2000) from which transferable skills and deep learning are enhanced (Brockbank and McGill 1998, Morrison 1996, Eraut 1994).

The proposed research

Questions

1. What are transferable skills?
2. What transferable skills do employers require in a practising graduate engineer?
3. How do employers, government agencies and institutions believe these skills are being developed at present in work-based learners?
4. How could the development of transferable skills in engineering work-based learners in higher education be enhanced, and is this better accomplished in an academic setting or the workplace?

Literature review

The skills literature is continuously developing; several of the major policy documents (and responses thereto) referenced above were published in the last two months of 2009. Document 2 will provide a summary of the literature available at its completion date; as the policy agenda and assessment of its impact continue, relevant updates will be provided in subsequent documents.

A number of areas of enquiry, such as the historical development of the structure and regulation of the engineering profession, have been highlighted above and these will be explored within the literature review. It is also proposed to develop a definition of "transferable" skills, building on and updating the work of Markes (2006), which can be applied to subsequent research (Question 1 above).

There is very little literature other than from the LiNEA project (Maillardet et al 2004) readily available in the UK on the development of transferable skills within the engineering profession, in comparison to the volume identifying shortages and inadequacies (which will contribute to Question 2). There is, however, considerable research already done on work-based skills development in the health professions and some of this will be applicable to the development of interventions for engineers. At one time, the concept of reflective learning in the workplace was considered the "Holy Grail" of nursing education (Moon 2000 p55). In terms of "employability" skills for non-employed engineering undergraduates, most of the research literature in the UK resides within documents commissioned by the Higher Education Academy Engineering Subject Centre on undergraduate teaching and learning in general (HEA 2008, 2006a, 2006b, 2005, 2004); beyond that, much of the remaining literature is Australian (Billett 2004, Gibb 2004, Biggs 2003, 1999a, 1999b, Ferguson 1998).

Research rationale

The research will be in two parts: a study of the engineering profession's perception of the development of transferable skills in the workplace and the development and trialling of interventions to develop such skills in work-based learners.

<u>Part 1</u>: The first of these studies will be in two phases, forming what might be termed a cruciform study:

A stratified survey through the engineering profession is proposed, questioning the development of transferable skills in new entrants to part-time higher education, recent graduates, their immediate managers and senior managers, plus sector skills council, awarding body and government representatives. Sampling will be purposive, selecting a small sample of employers representative of the industry as a whole, with the intention of identifying trends between levels of management and influence rather than within them. This will be Document 3, developing answers to Questions 2 and 3.

The guiding hypothesis is that at entry to the programme and at distant remove from the workplace, the belief that transferable skills are actually being developed by engineering learners will be greatest; the real skills development deficit will be identified by the recent graduates and their immediate managers. All participants will complete an initial quantitative questionnaire and then be interviewed, with a set series of questions based around the Engineering Council requirements for Incorporated and Chartered status (Engineering Council 2008a, see Appendix 2) and the opportunity to extend these with further exploration (Denscombe 2003, Silverman 2000).

The results from the stratified survey will inform a further survey of engineering employers, obtaining qualitative and quantitative data on transferable skills development through a questionnaire, based around the Engineering Council requirements (Engineering Council 2008a). Using some of the same questions as in the previous study, it is hoped to correlate a large data set at one level within the profession with the stratified research to add credibility and transferability to both studies' output. It is hoped that the unfolding research will yield outcomes which can be induced to represent the national picture. This will comprise Document 4, in further answer to Questions 2 and 3.

The researcher has a number of personal contacts within the engineering profession, sector skills councils and similar bodies; it is hoped that a list of appropriate employers can be established over a wider general and geographical area than the initial survey to eliminate the potential for localised influences. It is hoped that contacts within the Higher Education

Academy, the Engineering Employers' Federation and the New Engineering Foundation will be able to provide appropriate contact lists. There exists the possibility for further quantitative research via follow-up telephone interviews, should unexpected lines of enquiry or trends present themselves (Silverman 2000).

<u>Part 2</u>: The findings from the employer surveys will inform the initial direction of the second phase of the research, in terms of the specific gaps in transferable skills and modes and locations available for development interactions. This will address question 4 and become Document 5.

An initial pilot study is proposed. A quantitative and qualitative questionnaire-based before-and-after study, triangulated with observation of performance and participant interviews, will be carried out with a small group of undergraduate learners undertaking two problem-solving activities in a team environment – one an ethical issue requiring equitable resolution and the other a technical problem under severe time pressure. Questioning will explore the students' perception of their transferable skills development through the activities; quantitative questions will provide numerical data on a Likert scale with opportunities to reflect in writing on the activities which can be correlated with observation notes (Punch 2000, Silverman 2000, Wellington 2000). The outcomes of this will contribute to Document 5 and Question 4. Questions will be developed using self-evaluation criteria for employability skills developed by the Higher Education Academy (HEA 2004, included as Appendix 3).

It is proposed to develop materials for case studies and learning activities, similar to those employed in the pilot study, and trial their use with work-based learners in parallel with full-time students on the same qualification. The findings of the pilot study, particularly in respect of the effectiveness of the data-capture methods, will be used to develop an approach to gathering consistent data from all participants. Again, qualitative and quantitative questions in conjunction with observation of performance will be used, at least initially.

A larger sample and greater time frame will permit consideration of phenomenography: exploring participants' perceptions of their experiences (Andretta 2007, Marton 1981). Carrying out the study with both work-based and full-time learners will enable examination of differences in perception and rate of development which may occur between the two and of any barriers to progress experienced by either group. It will be difficult to illustrate professional progression within the limited time frame; however, development of "deep" learning skills will be measurable through improved performance in the learners' technical qualification.

It is proposed to develop a series of small developmental interventions – case studies, exercises or problem-solving activities – which can be trialled with the students in question. The findings of the feedback from each trial will inform the design and operation of the next in an action research approach (Denscombe 2000, Punch 2000). Although action research has its limitations (Ebbutt 1985), particularly since the research is located wholly within the professional practice of a single practitioner (Kelly 1985), through thorough critical reflection on the part of the researcher and the participants, the validity of the eventual outcomes will hopefully prove effective in terms of their wider applicability and efficacy.

Limitations

Even restricting the study to higher education linked to employment in the engineering profession, the scope of the field of study is vast. Given that most work-based engineering higher education delivery takes place in colleges of further education (although often on programmes franchised from universities), it is proposed to limit the scope of the enquiry to the work of FE colleges at undergraduate HE level.

Power relations between researcher and participants in the pilot study and action research phases will require careful consideration: there will be a tendency for students to give “right” answers if they are not wholly comfortable with criticality.

Educating participants to be reflective, in conjunction with approaches designed to develop their transferable skills, may merely highlight the value of reflectivity in the self-development of transferable skills. For this reason an action research approach has been selected.

Ethical considerations

All research activities will be carried out in conjunction with the BERA ethical guidelines (BERA 2010), information which will be shared with all potential participants at every stage. All research data gathered will be confidential to the researcher, and will be anonymised for publication; participants in interviews will be asked to identify any aspects of their responses which might compromise their anonymity and will be able to remove these responses from the data if desired. Debriefings for interview participants will be offered.

Transcripts of all interviews will be made available to the interviewee for comment if specific quotations are to be used to support conclusions. The context in which such quotations would be used will also be shared. It is not intended that raw data, recordings of interviews or transcripts would be released at any stage of the process and consent would be obtained if that is to be the case.

This research is for personal purposes and no aspect of the data collected will be shared with any employer. The professional status of the reviewer may create difficulties with employers whose provision is located in competing colleges, since this may suggest a potential conflict of interests. It will be necessary to highlight explicitly the private nature of the research: representatives of the Higher Education Academy, of which the researcher is a Fellow, have suggested that the New Engineering Foundation may be prepared to “badge” the research to underpin its impartiality. Obviously, any such service will not jeopardise intellectual property rights.

Any developmental interventions with students which fall without the regular curriculum will be explained to the students in advance. Any such activities proposed will not be allowed to jeopardise their main programme of learning and will only be undertaken with the full cognisance and consent of both student and employer.

Justification

As stated above, there is a considerable disparity between the number of publications available which identify transferable skills needs in the UK engineering profession and those which report on projects to address these needs. The LiNEA project yielded considerable insight into qualified engineers’ perceptions of their professional development post-graduation and some work has been done in this field in Australia; the conclusions therefrom will form part of the literature review and inform the action research phase. Similarly, considerable attention has been paid to processes to develop these skills in full-time undergraduates and the success of such approaches will be examined for adaptation to work-based delivery. To date, however, there is no published research specifically examining development of higher level transferable skills in work-based engineering undergraduates.

In the current climate of the ongoing skills agenda, this research is believed to offer a unique contribution to the pantheon of documentation relating to skills development.

Personal and professional outcomes

This research is aimed at improving the personal self-management and reflective skills in engineering learners through and alongside their employment. My own personal experience of progression to Chartered Engineer status was that no significance was placed on such skills at undergraduate or employed level, nor did I experience any specific work-related personal development. My personal experience within further education, interacting with employers and higher level trainees has been that the learners' transferable skills are generally poor and their employers are either unwilling or unable to affect this. It is therefore the intention of the research to explore this further and hopefully develop a methodology for developing these skills through employment which will evidence benefits to both employers and employees.

At the same time, I myself am embarking upon a reflective journey of self-development in undertaking the Professional Doctorate and I shall therefore be considering the impact of my research on my own personal journey to improve my "soft" skills.

The work of Kolb and others suggests modes of learning through which skills can become tacit, in much the way that a musician develops muscle-memory and playing skills to the point where playing ceases to be a conscious process. Donald Schön's concept of reflection-in-action is accompanied in his book "Educating the Reflective Practitioner" with an analogy of a jazz improvisation session, where each musician is continuously adapting their playing to suit that of those around them. As a musician myself, and one who is regularly involved in similar sessions, the analogy strikes a chord and will hopefully provide a motif for future writings on the theme.

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EdD Module 2

Jon Melville

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“Employers believe that colleges develop the technical knowledge and skills and they [the employers] develop the “soft” skills. Often, the trouble is, the employers do not provide training in “soft” skills.”Malcolm Carr-West, Academic Advisor, Engineering Subject Centre, Higher Education Academy, in interview, Loughborough University campus, 13 November 2009.

Working with engineering employers to develop transferable higher level skills in work-based learners

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Abstract

The engineering profession has well-documented issues with the readiness of graduates for the workplace in terms of their non-technical skills: communication, team working, problem solving, business awareness and self-management. Endeavours to address this are generally termed the "employability agenda." However, the profession also has similar issues with employees in Higher Education through work-related learning, despite employers' professed involvement in the design of the programmes they follow.

The skillset in question, formerly "soft skills" and now more commonly "transferable skills," is subject to numerous different definitions, all of which relate to subjective measurement of workplace performance. As a consequence, development of these skills is generally marginalised by both academics and employers – there is no formal body of technical knowledge, no curriculum and no objective measure. This is particularly true for the subset of transferable skills which relates to self-management and self-development, which is therefore not immediately measurable through workplace performance, but would be reflected in longer-term career success.

Three studies will be undertaken to explore the situation in more detail: an exploration of the success of a collaborative employer / college HE programme in achieving its objectives; an evaluation of the development of in-college strategies for transferable skills development integrated into the curriculum; and an evaluation of a skills-based curriculum approach where technical knowledge development is a secondary outcome.

It is hoped that, through combining the findings of these three studies, recommendations can be made to improve the development of transferable skills in work-related HE programmes.

Introduction

Section 1: Professional context

Engineering is one of the oldest occupations, dealing as it does with the development of practical solutions to problems for the use and benefit of mankind. As a "profession," it origins lie in the charismatic leadership of the key driving figures behind the Industrial Revolution in the UK. The transition from artisan-craftsmen to mass-production workforce achieved, the profession declined in status and has become more subject to governmental control (Engineering Council 2009a).

As the Government of the UK has focused increasingly on education and the development of skills for the perceived needs and demands of the engineering workplace (DIUS 2008; BIS 2009a, b), much of professional education, once driven by the engineering institutions, has become more task-focused and less forward-thinking or self-developmental than the over-arching aims of education, particularly higher education. This skills agenda is driving UK professional higher education into demand-led activities (BIS 2009b).

Further Education colleges, responsible for the bulk of the Higher Education delivery to part-time, employed learners in many vocational areas, including engineering, are in a unique position. These colleges are generally highly focused on working with industry and the employer base, with extensive experience of apprenticeships and workforce development and they generally possess the ability to provide professionally-experienced staff and the flexible delivery demanded by engineering employers (Hodkinson and James 2003; Medhat 2007a; Smith and Betts 2003). However colleges, although less hamstrung by time-consuming internal bureaucracy than many universities, are nevertheless subject to a rigorous, rule-driven externally-imposed audit culture of Government control (Avis 2009).

From the personal experience of the researcher, supported by the relevant literature, the current position for the engineering learner in the workplace is a strange one: their higher education experience will be at QCF level 4/5, either Higher National or Foundation Degree, designed in conjunction with their employer to meet specific skills needs for their current and immediate future employment. On completion of this programme of study, however, progression to QCF level 6 (Bachelor's level) is rare; graduate engineer positions within their company will, in the main, be filled by recruitment from universities producing graduates with minimal experience of engineering employment (HEA 2006a; RAE 2010) but who, apparently, possess additional skills which make them more suitable for these positions, despite the apparent lack of involvement of engineering employers in the design or delivery of the undergraduate programmes of study (Medhat 2007a; HEA 2008).

The purpose of this entire study is to explore ways in which these additional skills perceived in graduate engineers can be developed in work-related part-time HE learners as part of their structured learning to improve their prospects for progression within employment.

Section 2: Knowledge, learning and transferable skills development

The “employability” agenda is a government-driven focus on improving current workplace performance and the ability to enter employment (Little 2010) which ignores the self-developmental aspect of improving the prospects of those already in work, the work-based learners who are the focus of this study.

Much of the literature on education refers to knowledge, skills and attitudes / aptitudes as separate entities. Eraut’s contention (1994) that these are respectively propositional, procedural and personal forms of knowledge aligns better with discussions on transferable skills – procedural knowledge encompasses those skills required for effective performance in employment and personal knowledge those skills for self-development into future employment opportunities. The literature on transferable skills is confused in respect of definition and terminology and the various studies available are not compatible with each other (Markes 2006).

There are various taxonomies of learning, all of which comprise stratifications of increasing autonomy, independence, synthesis of concepts and criticality – key aspects of self-development.

The cyclic nature of learning has long been recognised, in the classroom (Piaget 1972; Vygotsky 1962; 1978) and in communities of practice such as workplaces (Lave and Wenger 1991), where Kolb’s experiential learning cycle (Kolb 1984) is useful to represent the learning process. Adding elements of challenge and reflection creates transformational learning (Mezirow 1991).

The work of Donald Schön (1983; 1987) on reflection-in-action refers to the adaptability of the professional through tacit knowledge as “artistry.” With additional criticality to the reflection (Hyslop-Margison and

Armstrong 2004), the cycle of learning can be viewed as a spiral (Cowan 1998) of increasing achievement.

If self-development skills are to be advanced alongside propositional knowledge, an approach focusing more strongly on student activities is required. Constructive alignment (Biggs 1999a) and problem-based learning (Boudet et al 1985; Case 2008; Houghton 2004; Poitras and Poitras 2011) led to a holistic approach in the CDIO initiative - conceive, design, implement, operate (Crawley 2001; McCartan et al 2008), where students are involved in entire, real-world projects, often collaboratively between disciplines. This promotes higher taxonomic and deep learning (Dewey 1933; Moon 2000), aiming to achieve double-loop learning (Argyris 1977) where the reflective learner not only takes corrective action but reflects on their own presuppositions.

There are many conflicts and challenges in promoting and fostering self-development skills in higher education in general: technical research and propositional knowledge are held in higher regard (Chadha 2006; Coffield et al 2004a; Portwood 2007; RAE 2007); there is no theoretical knowledge base (Bennett at al 1999), established curriculum (de la Harpe and Rodloff 2000) or pedagogic standards (Billett 2004) for such skills; there is little professional esteem or value attached (Biggs 1999b; Drummond et al 1998; HEA 2005; 2006a); it is difficult to measure these skills with traditional academic rigour (Alpay and Walsh 2008; Begum and Newman 2009).

However, a holistic approach to self-development involving realistic and relevant activities (Burke et al 2009) aids the development of professional identity (Moreland 2005), the ability to meet challenges of increasing complexity, difficulty and unfamiliarity (Billett 2011) and a critical approach (Dochy, Laurijssen et al 2011; Senge 1990).

It therefore would appear that the reasons problem-based learning, although of great benefit to employability and self–development, is not more prevalent in engineering higher education are twofold: a lack of esteem for skills development within higher education institutions and a lack of coherent research evidence of the disconnection between the skills demanded by industry and the development of those skills through education in both the classroom and the engineering workplace.

Section 3: The proposed research

Three studies are proposed: A case study into a collaborative employer/college HE project, over several years with a small cohort of learners; an action research project into interventions and activities to develop transferable skills; and a case study into the introduction and implementation of project-based learning within a college environment.

The main challenge relates to the positivist engineering approach to tangible, objective, quantitative research of an inductive, reductionist nature. The skills being appraised are by nature subjective; research will be constructivist, qualitative and deductive, with no empirical standard to align with: a paradigm shift for engineering research.

Measurement of skills development will be from two sources: firstly, employer perception of learners' skills as demonstrated in the workplace, a valid measure since employers themselves have extensively criticised similar programmes and their learners for not developing or demonstrating these skills; secondly, students' own perceptions of their skills and abilities, which can be demonstrated through other studies (Little 2010) to be a valid proxy for actual skills in these areas.

An initial exploration of the potential methodological issues has been made:

- whether the proposed case study possesses sufficient transferability and validity within the wider engineering context
- the challenge of managing quantitative data on qualitative subject matter
- the reliance on context for validity with action research in this area
- drawing conclusions from learners' own perceptions of their skills development
- whether a phenomenographic approach to exploring learners' perceptions will triangulate with quantitative achievement data
- the challenges of discourse analysis through interviews with developing engineers
- whether the perceived power of employers and researcher/participant will influence learners' expressed views

These will be explored in more detail in the individual research studies.

Section 1: Professional Context

"Would you exchange a walk-on part in the war with a lead role in a cage?" Roger Waters (Pink Floyd), *Wish You Were Here*, EMI, 1974

1.1 The engineering profession

Many definitions of a profession contain three consistent elements: a body of technical knowledge, a form of practice for the use and application of this knowledge for the common good and a form of self-regulation of those practices (Etzioni 1969; Goode 1969; Goodlad 1984; Schein 1973; Schön 1983).

The counter-argument, that professionalisation can be used as a means to obtain status, market closure and a monopoly on competence (Evetts 2006) may well have been the case at the profession's inception and it was certainly true that initially the profession of engineering was embodied by the Institution of Civil Engineers, but with the lack of protection of the designation (Evetts and Jefferies 2005; Engineering Council 2009b), engineering now has little power to construct its own discourse of professionalism (Evetts 2006).

Thomas Telford founded the first professional engineering institution, the Institution of Civil Engineers, in 1818. It moved into two adjoining premises on Great George Street in London (donated by George Stephenson and Sir Joseph Whitworth respectively) which provided a venue for a technical library and meeting facilities. Shortly thereafter, the institution was awarded its Royal Charter and the ability to confer the status of Chartered Engineer upon its members. Initially, this was achieved through election by ones peers upon presentation of a paper at Great George Street. The institutions were able in this way to influence the education of future engineers and thus the universities' engineering curriculum through the definition of admission requirements.

In 1847, the Institution of Mechanical Engineers was founded by Robert and George Stephenson and Sir Joseph Whitworth, in a move away from Telford's original definition of "Civil Engineer", widely and unreliably quoted as "shaping the forces and materials in nature for the benefit of man" (Engineering Council 2009a). The focus of civil engineering became more closely aligned to the construction of major static works such as bridges and canals, while mechanical engineering as a discipline was formed in response to the developing sub-branch of engineering concerning itself with transportation machinery and manufacturing equipment.

By the time the Joint Council of Engineering Institutions was formed in 1964, there were 16 Institutions able to confer the status of Chartered Engineer and the requirements for admission varied widely (Engineering Council 2009a; Jordan and Richardson 1984). The profession had passed through Max Weber's three stages of domination – from the charismatic leadership of the early engineers, through the creation of routines based on tradition (as the membership grew and control passed from those original charismatic founders) to bureaucracy and loss of autonomy (Lortie 1969; Mommsen 1974; Owen 1994; Scott 1969). The status of Chartered Engineer was thoroughly devalued by this (Taylor 1997). In the UK, unlike mainland Europe, the title of engineer is not protected as those of doctors, dentists and solicitors are (Engineering Council 2009b; Evetts and Jefferies 2005). Anyone can call themselves an engineer – witness the proliferation of plumbers dubbing themselves "heating engineers" and motor mechanics self-determining as "automotive engineers." The image of engineering is thus forever associated with mass manufacture labour and domestic maintenance operations: "…we seem ashamed to refer to trades people…" (Engineering Council 2009b: 101) and in fact car mechanic Kevin Webster of Coronation Street was identified as the nation's most well-known "engineer" (Engineering Council 2009b).

The Callaghan government of the late 1970s commissioned Sir Monty Finniston to investigate the decline of the engineering profession and his report, presented to the Thatcher administration in 1980 (Finniston 1980), provided much ammunition to wrest control of the engineering profession from the institutions (Jordan and Richardson 1984), since Finniston suggested the institutions' bureaucracy and lack of strategic direction was hampering innovation and development. Although the Institutions and Joint Council resisted the changes (Jordan and Richardson 1984), in 1983 the Engineering Council was formed as an overarching regulatory body for the Institutions (Engineering Council 2009a). In 1985, the Engineering Council introduced the SARTOR (Standards and Routes to Registration) regulations to make the requirements for Chartered Engineer status common across the Institutions (Engineering Council 2009a). This was replaced by the Standard for Professional Engineering Competence, hereafter UK-SPEC, in 2003, further revised in 2008 (Engineering Council 2008a).

The Finniston Report had highlighted a lack of "soft skills" – generic thinking, business, interpersonal and problem-solving skills – in entrants to the profession (Finniston 1984). There was also identification that entrants to the engineering profession are more likely to lack skills such as oral communication, assertiveness and leadership than is the case for other professions (Harrisberger 1984).

It is noteworthy that at this time the designation of "soft skills" used by Finniston covered mainly the non-technical skills for functioning in the job and any skills for developing oneself beyond the current role would be incidental. The terminology has developed into "transferable skills" but in many cases this still covers both job-function and self-development skills (see more detailed exploration in Section 2).

Prior to the SARTOR regulations, the requirements for admission as a Chartered Engineer had been solely based upon academic qualifications and professional experience, without consideration of personal effectiveness or self-development. SARTOR, and subsequently UK-SPEC, led to a clearer definition of the content of a degree programme considered suitable for progression to Chartered status (Engineering Council 2008b), which in turn led to BEng and MEng qualifications (QAA 2008a) and UK-SPEC added a requirement for the demonstration of "soft skills" in professional engineering practice, comprising only job-function skills.

Actual admission requirements to the Institutions still vary beyond the requirement for an accredited degree and minimum professional experience – the Institution of Civil Engineers require a diary of professional development activities and a professional interview (ICE 2011), while the Institution of Structural Engineers require applicants to complete a detailed design project under examination conditions in seven hours (IStructE 2011). While both Institutions require candidates to diarise their self-development, neither gave any consideration to this at the admission stage, in the direct experience of the researcher. There is still no effort on the part of the Institutions or the Engineering Council to address the shortages in transferable skills through formal processes (Engineering Council 2009b).

With the increasing mechanisation and mass-production processes of the late 19th and 20th centuries came a loss of craft skills. An engineering craftsman who might once have fabricated an entire artefact would now be making only a component to pass down an assembly line (Braverman 1974). Braverman shows the consequence of this is deprofessionalisation, through loss of pride in the end product, and deskilling, since individuals possess a narrower range of skills than previously. He uses the example of watchmakers, each a skilled craftsman taking pride in the creation of high quality individual instruments. Forming these into a collective initially to share resources eventually results in each craftsman only making a part of the whole; they are no longer responsible for an artefact, merely a part thereof, and any sense of self-worth in the creation of an object of quality and value is lost.

Such processes of “scientific management” were also applied to professional engineering, with codes of practice and subdivision of operations into routine procedures taking away the autonomy of the professional engineer (Marcuse 1964; Schein 1973; Toren 1969). Most engineering companies now have standard procedures manuals for most activities, including design, which dissociate the process from one of innovation.

The Institutions’ response to these changes has been to introduce lower classifications of Institution membership, partly to reflect the issue that fewer engineers gain sufficient breadth and depth of experience to achieve Chartered status and partly to address a declining and ageing membership (Evetts and Jefferies 2005). This also reflects the changing demands of the technological workplace, with much of the mundane work of the engineer having been replaced by software (Kim 2002).

One can now become an Engineering Technician (EngTech) on completion of an apprenticeship, without Higher Education qualifications. This is intended for the growing number of technicians (Medhat 2007a) responsible for solely routine codified activities.

Achievement of Incorporated Engineer (IEng) status requires a Higher National or BSc degree and experience of non-routine activities or the supervision of technicians, while Chartered Engineer (CEng) status requires a BEng, MEng or MSc degree and significant professional experience in dealing with non-routine operations or managing whole projects (Engineering Council 2008a); the QAA Subject Benchmark around which all academic undergraduate programmes must be designed has now been modified to align with the UK-SPEC requirements (QAA 2010b).

The engineering profession has now separated the practices of design and craft (manufacture in this context) at every level, with a corresponding loss of technical interest in the craft workforce (Braverman 1974). Engineers such as Telford, Stephenson and Whitworth, and their more modern counterparts such as Sir Frank Whittle, who were able to design and manufacture their concepts with equal facility, no longer suit corporate structures and programmes of education reflect this (Engineering Council 2008b; fdf 2008b).

The status of engineering as a profession has thus declined, and with it the influence and impact of the engineering institutions. The next section will explore the influence and intervention of the UK Government in engineering as a profession and in the education, training and development of prospective and career engineers. It is noteworthy that following the chronology above, the decline of the institutions outlined above through the latter part of the 20th century and early 21st appears to mirror the increase in governmental control and influence over the same period.

1.2 Government policy and skills demand

Following significant industrial unrest in the late 1960s and early 1970s, UK Government policy on education made a radical shift from the starting point of Prime Minister James Callaghan's 1976 address at Ruskin College. Callaghan stated, with little attempt to justify, that raising the level of education of the average man was the route to future prosperity (Callaghan 1976). This signposted future Government intervention in curriculum and educational standards, the imposition of monitoring and benchmarking at national policy level and a focus on minimum standards of literacy, combined with a drive to increase take-up of STEM (science, technology, engineering and mathematics) subjects, which were in decline at that point. This has led to the micro-managed performative (Austin 1962) audit culture with continual surveillance which is the educational landscape of today, at least in schools and further education (Avis 2009), yet the Government policy agenda 35 years on is still driving improvements in literacy (and now numeracy) and uptake of STEM qualifications, seemingly having not succeeded in the intervening years (BIS 2009b).

A focus on education as a route to prosperity is a single strand of human capital theory (Becker 1964; Schultz 1961; Schultz, 1971; Sweetland 1996), where human capital can be defined as

> "... the acquired and useful abilities of all the inhabitants or members of the society. The acquisition of such talents, by the maintenance of the acquirer during his education, study, or apprenticeship, always costs a real expense, which is a capital fixed and realized, as it were, in his person. Those talents, as they make a part of his fortune, so do they likewise that of the society to which he belongs. The improved dexterity of a workman may be considered in the same light as a machine or instrument of trade which facilitates and abridges labor, and which, though it costs a certain expense, repays that expense with a profit." (Smith, Adam 1776).

The concept of human capital is not dissimilar to Marx's concept of labour power (Braverman 1974; Owen 1994) – the mental and physical capacities exercised in productive activity - although in educational terms one can possess human capital without labour power through being qualified, experienced and underemployed.

A focus on developing human capital provides a short-term boost to economic productivity in most cases (Olaniyan and Okemakinde 2008), which makes it suitable for a government with a four-year term of office to generate success stories. An economic downturn can also thus be blamed on poor educational standards rather than ineffective government economic policies. Coffield (1999) uses the term "credential inflation" for the devaluation of once highly-regarded qualifications as more people attain them; it is also termed "diploma creep" (Ferguson 1998); the question whether improved qualifications represent genuine improvements in knowledge and abilities is frequently raised and a number of jobs in the UK workforce now require graduate status where previously they did not (Paton 2010).

Linking educational attainment with economic prosperity can neglect the necessary infrastructure to generate growth. Japan, with 70% graduates in the workforce, has a strong culture of supporting innovation and backing initiative; similar approaches in Nigeria, for example, have led to no improvements in economic prosperity and a highly-qualified but largely unemployed workforce through lack of investment in the infrastructure for knowledge and innovation development (Olaniyan and Okemakinde 2008). A similar situation is appearing in the UK (de Grunwald 2010; Paton 2010; Williams 2010). There are four parties involved in increasing economic prosperity through education: government, employers, whose demand for skills is always immediate; the universities, often seen to be focusing on knowledge for its own sake, certainly by de Grunwald and the CBI (CBI 2008a); and students, seeking to improve their future prospects, nowadays through their own investment (de Grunwald 2010).

With the Government removing tuition funding from most HE programmes and the consequent rises in student contributions, the average student is likely to focus more closely on their employability prospects and the quality of their higher education. Only approximately 35% of all employers who engage in training and developing their workforce measure the effectiveness of such training (Elliott, Dawson and Edwards 2009).

Human capital is only one aspect of the individual in the workplace: identity capital, an individual's qualifications and contributions to their self-esteem; and social capital, their interpersonal networks and relationships, are also significant in the effective employee (Jamieson et al 2009). Focusing education and development solely on human capital and ignoring wider abilities could be dangerous: "The flaw with the choice between expert skills and intellectual values is that creative entrepreneurs and critical citizens are not different people" (Scott P 2010: 2). Within the Bourdieusian "habitus" of the workplace - the predispositions, skills and knowledge of the workforce within the "field" of their workplace relations (Bourdieu 1984; 1986) - vocational education can transform identity and develop of a sense of "calling" in a professional context (Colley et al 2003).

It is noteworthy that as Government education policy for higher education evolved, through the White Paper "Higher Education: meeting the challenge" of 1987, the 1988 Education Act and "Higher Education: a new framework" in 1991 (Assiter 1995), it is only with the Dearing review of 1997 (Dearing 1997) that the value of transferable skills (both job-function and self-development) in the employment market was recognised, although the main policy thrust remained firmly rooted in human capital development.

"The powerhouses of the new global economy are innovation and ideas, creativity, skills and knowledge. These are now the tools for success and prosperity as much as natural resources and physical labour power were in the past century.” (David Blunkett, Minister for Education, quoted in Wolf 2002: xi). Such a statement reflects the Government’s extrapolation of employment trends away from manual labour and toward graduate occupations beyond what might be considered reasonable (Wolf 2002; CBI 2008; 2009; 2011).

The current policy agenda on education and skills is based upon the Leitch Report (Leitch 2006), which introduced the term “economically valuable skills” (ibid: 2) into the canon and highlighted a weak skills base holding back productivity in comparison with the UK’s global competitors. Although conflicts in structure and responsiveness between education (particularly higher education) and industry are recognised as barriers to imposing a demand-led system (Medhat 2007a), the much-repeated “demand for higher level skills” is not accompanied by a definition of those skills.

Sastry and Bekhradnia (2007) suggest the higher level skills referred to in Leitch are those required for immediate functionality in the workplace, without recognising the additional breadth and depth provided by higher education for future progression and self-development. However, their argument that employer demand should not be a factor in higher education, since universities are already responding to student choice, is flawed, as evidenced by the number of unemployed graduates with popular degrees where no employer demand exists (Paton 2010). There is little mention made in the Leitch report of the work of Further Education colleges in delivering part-time higher education to employed learners, this only appears in case study examples.

In none of the literature on engineering education is there a definitive distinction made between the two aspects of transferable skills – skills for effective function in the current role and skills for developing the self into future roles (Bolden and Petrov 2003). In terms of the literature, therefore, both aspects of transferable skills need to be considered together: it would be difficult to disaggregate them as so many different studies across various disciplines apply overlapping categorisations and groupings (CFE 2009; Markes 2006); however, the research element of the study will focus on the latter aspect.

Any discussion on higher level skills requires a single working definition, and the QAA definition, while unwieldy, appears to cover all aspects:

> "Higher level skills are those which go beyond acquiring basic knowledge and understanding and being able to apply that understanding to straightforward situations. They include analysis and synthesis of a range of knowledge, which may be acquired using research skills; critical reflection on different and potentially conflicting sources of knowledge; problem-solving by identifying a range of possible solutions, evaluating these and choosing the solution most appropriate to the situation; developing complex arguments; reaching sound judgements and communicating these effectively" (QAA 2008b para 57).

It is noteworthy, as suggested above, that here both aspects of transferable skills have been considered homogeneously, although again the focus is on immediately applicable skills.

Regrettably, although the Leitch Report and subsequent studies and documents (see below) have reported on consultation with employers, their organisations and Sector Skills Councils, the contribution of all of these has been notably absent from the policy-forming agenda (Keep 2005; Payne 2008), certainly within engineering.

Engagement of higher education providers with industry is never an easy marriage. Issues of different agendas and different timescales to respond to demand have historically been sticking points for employers (Medhat 2007a), and many universities have long been wary of work-based learning:

> "… scepticism as to the academic rigour that can be achieved, a tacit support for the dichotomy between workplace and academic learning and a reluctance to be drawn into the necessary engagement with industry" (Medhat 2007a: 21).

Various studies and policies have come into being post-Leitch to explore the apparent demand for higher-level skills, both generally and within specific disciplines. A Government-commissioned study by the CFE found it impossible to correlate any of the studies undertaken pre-Leitch, since the definitions of higher-level skills differed so greatly. The CFE used level 4+ accredited provision as their defining criterion and found that, although 92% of all employers surveyed were engaged in training or education, only 33% did so at higher level, with 27% reporting regular demand for this. Major barriers to training were found to be the inflexibility of providers in terms of programme lead times and delivery patterns (CFE 2009; Kewin et al 2008; QAA 2010a). These findings correlate well with the DIUS' own policy document, "Higher Education at Work," which found 80% of employers found level 4+ qualifications a good proxy for higher level skills, although again this document neither defines nor classifies such skills. Issues highlighted were the proportion of graduate managers in the UK (49% compared to 74% in the US) and, in transferable skills terms, a shortage of STEM graduates with the capacity for effective working (DIUS 2008). This latter phrase apparently emerged from employer consultations and implies a bundle of transferable skills for immediate workplace effectiveness, with no consideration of self-development beyond maintaining competence and reactivity to change (UKCES 2008; 2009).

DIUS became the Department for Business, Innovation and Skills (BIS) in 2009 and published three policy documents of note: "Higher Ambitions" addressed the future of higher education in a self-congratulatory manner, but added the phrase "strengthening the skills pipeline" (BIS 2009a: 9) to the vocabulary of the policy-makers. "Skills for Growth" (BIS 2009b) outlined the national skills strategy, repeatedly linking higher education to increasing prosperity and wealth generation without justification or promise of a supporting infrastructure. Proposals for higher apprenticeships and university technical colleges were made, seemingly not considering the functions already performed by FE colleges in the HE marketplace.

The third BIS document reviewed skills demands in the UK construction industry, identified in government labour market analyses as having the greatest skills gap between supply and demand. This study highlighted the lack of pathways for progression between apprentice and graduate engineer, which is true of the wider engineering profession, and also the unwillingness of employers to pay for training in straitened times, when ironically there is greater capacity to release staff from employment (BIS 2009c).

From the industry side, the various Government policy documents can be read approximately in parallel with the annual review papers published by the Confederation of British Industry. "Stepping Higher" (CBI 2008a) identified communication difficulties between industry and higher education providers in articulating skills needs in a way that could be addressed and a lack of flexibility on the part of universities. 60% of employers surveyed engage in training for current roles, but only 22% train for predicted future skills demand. Holmes (2000) challenges the whole assumption that skills can be identified in this manner, that such an approach may fail to identify skills which later become "key" and questioned the transferability of such skills between workplaces and job roles. The CBI responded to the STEM agenda by identifying the drain on graduates from STEM employment into better-salaried positions, for example in banking, which suggests that the skills developed through higher education are at least partially transferable between professions.

Government policy documents have focused on skills and knowledge, neglecting personal qualities which may have significant impact on the development of transferable skills (Carter 1985) – certainly this would apply to the self-development skills. There has also been little attempt, since the Finniston Report, to address the disparity between academic objectives and their professional application (Carter 1985), what Argyris and Schön (1974) would term theories espoused and theories-in-use; in an engineering context, most published research progresses knowledge of processes, materials and techniques, while professional practice relies more on the application of existing knowledge, often using codes of practice and standards. Eraut (1994) classifies these two as propositional knowledge and procedural knowledge, the latter being more common in workplace practices (Portwood 2007).

Cheetham and Chivers (1996) proposed a model for professional competence assessment which covers theoretical, procedural and practical knowledge, tacit, task and management skills, personal and ethical behaviours and also what they defined as “meta-competencies” – transferable skills for professional effectiveness, self development and progression.

“Stronger Together” (CBI 2009) highlighted the gap between the skills possessed by graduates entering industry and the skills required for industry, specifically in terms of transferable skills. This echoes an extensive study for the Council for Industry and Higher Education (Archer and Davison 2008), which ranked a range of higher-level skills in terms of both importance to employers and their satisfaction with their graduate intake. This is summarised in the table below:

Graduate skills	communications	teamwork	integrity	academic ability	good degree
Importance	1^{st} 86%	2^{nd} 85%	3^{rd} 83%	4^{th} 81%	15^{th} 60%
Satisfaction	16th	7th	9th	5th	3rd

(Archer and Davison 2008)

It is noteworthy that both the CBI and the CIHE appear to regard attainment of a “good degree” as a skill, but none of the above skills is explicitly developmental.

“Employability” skills, as the transferable skills of non-employed students are often referred to, are fundamental to the CBI and Universities UK report “Future Fit” (CBI/UUK 2009). Here, at last, employability skills are actually defined:

> “A set of attributes, skills and knowledge that all labour market participants should possess to ensure they have the capability of being effective in the workplace – to the benefit of themselves, their employer and the wider economy” (CBI/UUK 2009: 8).

The above definition fits most closely with the first of the two aspects of transferable skills, immediate workplace effectiveness. The report identified that employability skills such as self management, team working, business awareness and problem solving are more important to 78% of survey respondents than academic attainment; a number of university programmes successfully delivering employability programmes to undergraduates were also explored. A lack of transferable skills in the graduate entry population is echoed by the Royal Academy of Engineering (RAE 2007; 2010), with recommendations for students to undertake compulsory sandwich placements and work experience as part of full-time degree study. This has to be countered with the increasing cost of higher education: an additional year of study, for which the university requires fees even if the work experience is unpaid, can only extend the graduate debt burden and the majority of undergraduates in vocational disciplines such as engineering and construction are now rejecting optional sandwich elements (Attwood 2010b).

In “Skills for Sustainable Growth” (BIS 2010) the skills agenda passes imperceptibly to a government of a different hue; the focus remains on improving general levels of literacy and numeracy, although educational HE provision is driven (at least in funding terms) by employers’ perceived needs and vocational higher education delivered through the further education sector (BIS 2010: 7). The intention to link curriculum directly to professional standards is articulated and reflected in revisions to QAA Subject Benchmarks to align with CEng criteria (QAA 2010b).

The disconnection between undergraduate preparation for employment and the skills demands of the workplace were explored at length in the LiNEA project (Maillardet, Ali and Steadman 2003), which found the majority of the engineering graduates surveyed (a cohort of 32 engineers as part of the wider study) had little confidence in their technical knowledge, which after three years they had found to be largely irrelevant, and inadequate preparation for the expectations and demands of the workplace. There appears to be little evidence that the policy agenda is aiming to change that in a tangible fashion.

Although its main focus is pre-HE vocational learners, the Wolf Report of 2011 highlighted employers' concerns that many entrants to the workforce are over-qualified for their role in academic terms yet still possess inadequate skills for effective function in the workplace in terms of basic literacy and numeracy and a fundamental understanding of the requirements of employment and the workplace (Wolf 2011).

A statistical summary of the position at May 2011 can be expressed as follows (CBI 2011):

- 64% of engineering employers require increased "employability" skills in their HE intake
- 60% of all engineering positions are at graduate level
- 58% of engineering employers foresee an increase in demand for higher level (graduate) skills
- 66% of engineering employers are not confident of filling vacancies

The CBI lists the following as employability skills, with the percentage of employers dissatisfied with their intake graduates' skill level in brackets:

- Self management (25%)
- Team working (20%)
- Business and customer awareness (44%)
- Problem solving (19%)

- The CBI also includes literacy, numeracy and IT skills in its definition

The UK government controls the education and skills agenda and the focus is moving, particularly with higher education, towards provision led by perceived employer demand. While the need for "employability" skills is recognised, it remains the case that the government considers this only in terms of full-time undergraduates and their gaining employment, rather than development of such skills in the existing workforce (with the exception of basic literacy and numeracy skills). However, there exists a significant national cohort of part-time HE learners, potentially in need of such skills. According to HESA statistics, there were approximately 8,000 HNC/D and FD graduates in engineering in 2009/10. The next section will explore what is available to them and the involvement and expectations of the various parties engaged in their education.

1.3 Work-based learning

Work-based learning, or learning derived from employment, concerns the knowledge, skills and attitudes for successful performance of a role and future self-development (HEA 2006a), thus encompassing both aspects of transferable skills outlined previously. The Qualifications and Curriculum Authority define work-based learning as:

> "Planned activities that use the context of work to develop knowledge, skills and understanding useful in work, including learning through the experience of work, learning about work and work practices, and learning the skills for work" (QCA 2003: 4).

This definition, which will be used hereafter for "work-based learning," covers both activities within the workplace and work-related activities undertaken elsewhere.

There are basically two types of engineering HE part-time learner. Firstly, the former Advanced Apprentice (someone who has followed an Advanced Apprenticeship framework of qualifications at level 3 under an appropriate employment and funding contract), who will often progress to a Higher National or Foundation Degree qualification while still within their official period of training, and secondly, the direct entrant who has gained employment following A-levels or equivalent study. As a general rule, neither of these will progress to a full QCA level 6 qualification: engineering employers tend to recruit graduates directly from university for those roles (BIS 2009c). The common argument for this is that employers value the practical content of Higher Nationals for operatives at technician level but would prefer to recruit graduates for breadth of knowledge and analytical skills (Little and Connor 2004). There is strong evidence that employers are not actually realising their expectations in this regard (CBI 2008; 2009; CBI/UUK 2009; RAE 2007; 2010) and the Little and Connor study presented limited evidence to support what they found to be a widely-held opinion.

It could be argued that the progression of engineering technicians to higher education is an example of qualification inflation, or “diploma creep”, since the bulk of technician roles do not require higher-level skills, knowledge or abilities. While less than 2% of level 3 apprentices progress to Higher Education nationally according to the Skills Funding Agency, the proportion in engineering is much higher (approximately 40% in the personal experience of the researcher). There exists no coherent data on this, possibly since the designations of “technician” and “engineer” have been vague up to and in some cases beyond the clarification brought by UK_SPEC (Engineering Council 2008a). It is now commonplace in the engineering industry to term someone in a clearly defined role requiring a level 3 qualification as a technician and to define an engineer as someone with some degree of autonomy and an expectation of troubleshooting or problem-solving in their role, requiring a Higher Education qualification. Even this does not extend to the power generation industry, where all technical staff qualified to below Bachelors level are automatically designated technicians.

Higher Nationals (level 4 certificate, level 5 diploma) are national-standard qualifications, with a core curriculum and multiple option pathways to enable tailoring of qualifications to specific employer skills needs. Being outside the control of universities, they could be considered to lack rigour (and personal experience of university engineering lecturers and managers would support this), whereas in fact their structure of criterion-based assessment means the volume of curriculum knowledge and application which must be assessed and achieved is actually far greater than the traditional 40% pass-mark of university examinations (Edexcel 2010). It is, however, true that the published Edexcel specifications place even less emphasis on transferable or “employability” skills than most university undergraduate programmes (Edexcel 2010). Foundation degrees are designed with guaranteed progression to a level 6 qualification with the objective of achieving full QCF level 5 credits (usually 240) with the same release time from employment as for a level 4 HN Certificate, through work-based learning and assessment of project or problem solving activities based in the workplace (fdf 2008a; Reeve et al 2007).

From the personal experience of the researcher, it is strange that many part-time programmes of education are designed in partnership between the employer and educational institution but employer feedback suggests they do not meet the employers' needs in this regard (CBI 2008; 2009; CBI/UUK 2009), however, they prefer to employ inexperienced graduates at considerable cost in terms of in-house training and mentoring, even though the studies highlighted above suggest that such graduates are ill-equipped for the workplace (Maillardet, Ali and Steadman 2003; RAE 2007; 2010).

The concept of an education partnership with an employer tends to mean different things to either party. It is highly uncommon for engineering employers to provide valuable input into the design or development of new programmes or to their assessment or review (Medhat 2007a), however, in studies employers have generally suggested their perceived level of involvement is quite high (Kumar 2007). On the other hand, employers and their representative groups readily criticise higher education providers, particularly universities, for unnecessary bureaucracy (or the requirements of external inspection and audit) and prioritising academic calendars and workloads over flexibility to customers' needs (Bolden and Petrov 2008). This is particularly the case in the engineering and construction industries (CBI 2008a).

It is noteworthy that less than 35% of employers across engineering and technology sectors make an effort to measure the return on investment in the training and development they undertake at any level (Elliott, Dawson and Edwards 2009; Phillips 2002), preferring instead to prioritise the reputation and track record of the institution over a detailed examination of content and programme suitability in selection of staff development interventions (Gibbs 2010).

Medhat's findings in a major study of work-based learning in engineering higher education can be summed up thus: "The majority of universities are either not involved or are somewhat limited in their WBL activity" (Medhat 2007a: 82).

Exclusively work-based learning, as opposed to studying qualifications part-time on release from employment with some linkage to the workplace, in this context involves accreditation of the learning, self-development and function of the employee against equivalent criteria to the learning and application of the full-time HE student, through some form of credit-transfer method. There exist modules and placements which carry academic credit as part of many other programmes which have a partial work-based element. Given the CBI's suggestion based on the diagram below, that industry (in general) is seeking graduates with a bias to the top left and that research-focused universities' focus is on the bottom right, this accreditation presents a challenge in syllabus and assessment design (Boud and Solomon 2001).

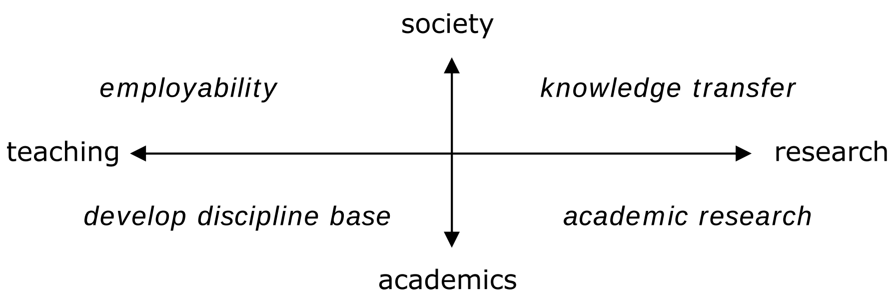

Figure 1 (CBI 2008: 16)

There now exist a number of credit-transfer models in use for the accreditation of workplace knowledge and learning in engineering, some of which are successful (Blundell 2007; Roodhouse 2010), although most of the success stories are at Masters level or above (Edmunds 2007; Engineering Council 2007). The findings of a selection of engineering schemes based wholly in the workplace (Burke et al 2009) suggests the quality is good but that the programmes lack breadth and/or depth due to time constraints and that employer involvement in assessment of candidate performance is limited to provision of evidence for accreditation of prior experiential learning (APEL).

There are also some successful schemes to integrate employability skills into the engineering curriculum (Coventry University Add+Vantage Scheme 2009, Derby University 2009). It is noteworthy that both of these, and other institutions offering similar programmes, are post-1992 institutions where the vocational aspects of higher education will have been more highly regarded in the past; these institutions are also located in heavily industrialised regions and have strong links with specific local engineering industrial partners (Jaguar Land Rover in the case of Coventry University and Rolls-Royce at Derby University).

The issue of propositional knowledge (the traditional focus of higher education) and procedural knowledge (the most common form of knowledge use in the workplace) will be discussed in more detail later in this document, however, a number of significant contrasts between the two (Eraut 2004; 2008) seem to lead to the "cultural disparities and the diversities of expectations between stakeholders" (Benefer 2007: 211):

- a programme of academic study requires the assessment of individual performance, yet the majority of workplace activity is accomplished collaboratively, and often the skillset within the "community of practice" (Wenger 1998) is far greater in terms of both propositional, and procedural knowledge and of experience than could be expected of any one individual.
- a programme of academic study is designed at the outset, with specific requirements for progression between levels through prerequisites, while the changing nature of business leaves numerous enterprises incomplete due to changing commercial demands (Benefer 2007).

- academic institutions focus on curriculum, which is absent in the workplace, and on pedagogy (the science and art of teaching), which is a far more informal matter in an ongoing working situation (Billett 2004; Maillardet, Ali and Steadman 2003).
- There are also concerns raised by employers relating to the lack of industrial experience among academics in relation to the theory / practice balance (HEA 2008).

Foundation degrees have been introduced to bridge these gaps, although to date experience of their design has been led by the universities, with limited participation from industry (Braham and Pickering 2007; Edmond et al 2007; fdf 2008a, b; Kumar 2007; Medhat 2007b).

Part-time higher education provision for those in employment can be seen to be not wholly satisfactory for employers or academic institutions. It tends to be peripheral to the main curriculum offer of most universities but central to the higher education function of many further education colleges. The next section will explore the particular challenges faced by FE colleges and their learners.

1.4 Higher Education in Further Education

A significant proportion of part-time higher education in engineering delivered to employed trainees is accomplished through colleges of further education, either through Higher Nationals or foundation degrees via a franchise or accreditation agreement with a higher education institution (fdf 2008a, b). Candidates tend to be older, have less in the way of study skills and higher-level skills on entry and the time pressure on them is greater, with employment and possibly family demands on their study time (Callender and Feldman 2009; Turner et al 2009). They tend to be first-generation HE students (Attwood 2010a). This changing student entry profile is now becoming apparent in university entrants (Corrigan et al 1995).

Part-time students lack peer-group support in the same way as full-time students (Arlett 2007; Callender and Feldman 2009). There is also less financial support available to part-time HE students (Arlett 2007; Attwood 2010a). Their programmes of study are likely to be more focused on employment objectives and skills to meet immediate workplace demand, so peripheral skills development, such as those transferable skills necessary for self-development, is generally not incorporated in their curriculum (this was mentioned earlier). Given that most higher education institutions refer to such skills as "employability skills," particularly in engineering, following terminology used by the institutions, it can thus be justified that anyone already in employment has less need of these, whereas in many cases the reverse is true (Callender and Feldman 2009; HECSU 2010). In order to provide the "competitive edge" in industry, employability components such as self-management are fundamental to creating self-developing, flexible learners in the workplace (Moreland 2005; Scott K 2010; Schein 1993).

The academic environment in FE is different to that of a university: income is lower per student and groups are generally kept smaller to facilitate more support. There is no tradition of scholarly activity outside the direct teaching and learning function (Turner et al 2009).

The Government's demand-led agenda for FE and the performative micromanagement culture of continual targets, audit and surveillance has driven FE colleges to meet industry's needs (Kelly 2007) but at the expense of the social agenda at the heart of many colleges' original missions (Avis 2009; Hodkinson and James 2003). Limited funding has led to a focus on large employers at the expense of small and medium enterprises (SMEs), a key employment group with significant skills demand: "… the grumblings of big employers and the CBI, to make FE more business and industry friendly – often at the expense of SMEs – suggest that the sector is far from well served by a balanced policy environment" (Gleeson 2005: 240). The audit culture and highly structured, rule-driven nature of responding to government targets and contingent funding is at odds with the flexibility required for higher education. This has led to a culture of "underground working," with FE teaching staff performing additional duties and circumventing systems for the benefit of the students' learning (Gleeson 2005). A study in FE by Hodkinson and Hodkinson (2004) identified the cynicism bred by the regulated, audit-driven culture, the lack of autonomy felt by teaching staff and the "strategic compliance and resistance" (Hodkinson and Hodkinson 2004: 171) adopted to overcome them. A wider study (Hodkinson et al 2005) summed this up as "… strongly held professional values and practices come into conflict with new expectations or requirements from College Managers" (Hodkinson et al 2005: 3). Despite continual measurement and target-contingent funding and inspection objectives, many teaching staff in FE institutions apply this culture of "underground working" to ensure the students' experience is of genuine benefit to their personal objectives (Hodkinson et al 2005).

Fuller et al (2003: 46) argue that "... externally imposed performance measures are resulting in structural change which destroys the conditions necessary for experienced staff to pass on their tacit skills and knowledge to their less-experienced peers." There exists a conflict between the concept of a "learning organisation" undergoing continual change in the belief that this leads to continuous improvement and the process by which tacit knowledge (Polanyi 1967) are made explicit and passed on to peers. There will be further discussion on tacit knowledge in section 2.

As the Government skills agenda drives Higher Education more into the realm of responding to employers' needs and demands, FE colleges are ideally placed to lead on this, since they lack the focus on Bachelor's degrees and research and have strong vocational links with the employment sector already (Smith and Betts 2003). The majority of teaching staff have come to engineering education in FE from industry, rather than via a solely academic route, and this anchors propositional knowledge in practical application and lends vocational aspects of the subject an authenticity which is essential for effective learning (Burke et al 2009).

The engineering profession was once the powerhouse of UK innovation and managed its own skills and knowledge development through the institutions. The UK government is now driving and controlling the skills agenda in a supposedly demand-led fashion, although the determination of that demand and the scope of consultation with industry has been questioned by the CBI among others, as has the quality of candidates entering the workforce(CBI 2008; 2009; Kelly 2007; RAE 2007). The UK engineering industry is utilising work-based learning, often through beleaguered further education colleges, to develop its existing workforce. The main focus of such development is skills and knowledge required for immediate functionality in role; there is also an apparent need to develop individuals for future progression and to improve their true employability. The next section will explore the acquisition and development of knowledge and skills in various environments.

Section 2: Knowledge, Learning and Transferable Skills Development

"Tell me, and I will forget.

Show me, and I may remember.

Involve me, and I will understand." Confucius, 450 BCE.

2.1 The nature of knowledge

It is common in educational literature to separate knowledge, skills and aptitudes / attitudes and treat them independently (Case 2008; Eraut 2001; Houghton 2004). Transferable skills, as defined in Government education and skills policy and the associated literature, conflate those skills required for the effective performance of a current employment role and the skills required for self-development for longer-term career progression (Alpay & Walsh 2008; Archer & Davison 2008; Bailey 1995; Bennett et al 1999; Bolden & Petrov 2008; CBI/UUK 2009; Engineering Council 2008b; Gibb 2004; HEA 2005; Hind & Moss 2005; Markes 2006; RAE 2007). The former category is often referred to as "employability skills," particularly in connection with those in learning prior to entering the workforce, while the latter has no consistent terminology relating to it. For the purposes of this study, these will be referred to hereafter as "self-development skills."

A brief consideration of the aspects of professional performance which fall under the transferable skills heading – communication, problem solving, team work, leadership for example – illustrate that each aspect contains elements of knowledge, skills and attitudes. Thus in considering transferable skills, it is preferable to use the contention of Michael Eraut among others that all three elements are forms of knowledge (Eraut 1994; 2001; 2004).

Eraut (1994) classifies knowledge into three forms:

- Propositional knowledge - facts and academic "know-what," generally relating to *a priori* rationalism and factual information known in advance
- Procedural knowledge – skills, processes and "know-how," relating more to *a posteriori* empiricism and real-time experience and performance; this relates most closely to the concept of employability skills
- Personal knowledge – attitudes, dispositions and "know-self;" this relates most closely to self-development skills

Propositional knowledge is that upon which most educational processes, especially those in the classroom, focus while procedural knowledge is often of more value in the workplace (Portwood 2007).

Polanyi's definition of tacit knowledge is also important here (Polanyi 1967), where through experience or repetition, intermediate reasoning is removed. Tacit knowledge in the professional workplace is that implicit knowledge of what to do and how to do it which comes through experience and immersion in the community of practice (Mutch 2003; Wenger 1998).

While Eraut (1994) argues that routinisation makes the explicit tacit and is a positive efficiency measure leaving more capacity for the non-routine, Wenger contends that this would only be the case if the routines are self-derived, and that imposed routinisation "… removed from the execution of the procedure the need to assume responsibility for its meaning" (Wenger 1998: 39). Tacit knowledge can therefore be regarded as having made the transition from explicit to implicit through the involvement of the individual, and must be separated from mechanistic imposed routine activities.

Portwood (2007) defines work-based learning in terms of making the tacit explicit, particularly when it can then be used to provide propositional knowledge for academic assessment in a credit-transfer or work-based situation (Blundell 2007; Boud and Solomon 2001; Roodhouse 2010).

It is evident that tacit knowledge is both desirable for speed and efficiency and undesirable if it then removes the capacity for independent thought; making the tacit explicit re-enables responsible reflection on the value of routine actions.

The next section will explore conceptions of knowledge acquisition.

2.2 Learning taxonomies

A number of authors have attempted to stratify the learning process, starting with Bloom's Taxonomy (Bloom 1956) and subsequent revisions (Anderson and Krathwohl 2001; Krathwohl 2002). Bloom classified the learning processes of remembering, understanding, applying, analysing, synthesising, evaluating and creating as demonstrating progressively higher levels of learning; this suggests a shift from propositional knowledge, through procedural knowledge to personal knowledge and self-development. The higher strata of analysis, synthesis and evaluation/creativity are core to higher education pedagogy (Houghton 2004; Case 2008). Moon (2000) suggests that transition between strata is achieved by a Piagetian process of assimilation and accommodation (Piaget 1972).

Bateson (1973) classified learning in terms of experience, the ability to make rules and contexts and the ability to reflect upon one's learning; this appears to align more closely with the activities undertaken in the workplace and with the work of Biggs and Collis (Biggs, 1999a, b; Biggs 2003; Biggs and Collis 1982) in terms of the Structure of Learning Outcomes (SOLO) taxonomy, which leads from familiar to unfamiliar contexts in terms of applied knowledge, eventually developing one's own contextual links. Again, from propositional knowledge to self-development.

Biggs' taxonomy reflects more what goes on in the typical workplace within a "community of practice" (Lave and Wenger 1991), and the concept of self-management of learning is integral to the pedagogical concept of constructive alignment (Biggs 1999a; Biggs 2003; Houghton 2004) in which the student takes responsibility for their own learning and the teacher creates an environment and activities which facilitate the student achieving the learning outcomes.

Constructive alignment is embraced by the CDIO (conceive, design, implement, operate) approach being developed and operated in a small number of engineering institutions (Crawley 2001; McCartan et al 2008) which can be directly linked to the graduate employability curriculum, although with little evidence of its efficacy at this stage (Dacre Pool and Sewell 2007). This is a project-based approach to a holistic engineering curriculum, with the expectation that students self-develop propositional and procedural knowledge and synthesise their own links to solve complex problems in unfamiliar contexts.

There is a distinct "step" in most learning taxonomies between memorising and applying knowledge in familiar contexts and linking concepts in unfamiliar contexts. These can be categorised as surface and deep learning respectively (Biggs 1999b; Entwistle and Tait 1990; Marshall, Summers and Woolnough 1999; Moon 2000; Ramsden 1992). This step requires the application of self-development skills.

Surface learners rely on signposts in activities, repetition of tasks and memorisation of facts without making their own associations between elements of knowledge. They exhibit single-loop learning (Argyris 1977), taking corrective action on encountering problems. In terms of transferable skills, a surface learning perspective would illustrate the positivist viewpoint of "employability" skills being discrete independent realities (Holmes 1995).

Deep learners recognise the difference between information and knowledge (Dewey 1933), seek the significance of knowledge, the relationships between key elements of knowledge and between theory and practice. They exhibit double-loop learning (Argyris 1977), not only taking corrective action but reflecting on the assumptions and presuppositions which have led to the problem encountered. This is obviously a more advantageous form of learning for higher education and long-term learning and essential for distance learners and those undertaking development remotely (Richardson 2000). However, "… while tutors commend 'deep learning' but at the same time spoon-feed their students, the world of work claims that it is crying out for creative, 'rule-bending' and original graduates who can think for themselves." (Coffield et al 2004a: 59)

It can be argued that a higher level of learning still, profound learning, can be attained (West-Burnham 2006), where "shallow learning is playing the notes; deep learning creates the melody; profound learning enables the great performance," West-Burnham (2006: 2).

Deep learning characteristics need to be developed and nurtured in higher education students if they are to become confident self-managed learners (Case 2008; Houghton 2004; Laurillard 1979; Tinkler 1993). The next section explores how this can be achieved.

2.3 Theories of learning

The cognitive-constructivist theory of Piaget (1972) suggests that the individual's knowledge is modified by new information through a process of assimilation (trying to fit this new knowledge into the existing world-view) and accommodation (adapting the worldview to incorporate new knowledge with the old; this process is an accepted model for learning which fits well with the learning taxonomies (Moon 2000; Tinkler 1993), however, it does little to recognise social and environmental influences on learning (Atherton 2009).

The social constructivism of Vygotsky (1962; 1978) places the learner in a "zone of proximal development," which can be both situational and chronological, in the presence of a "more knowledgeable other." Basically, this is the model of learning from which apprenticeships have developed (Wenger 1998), learning through valid activities in a realistic environment (Burke et al 2009).

A learning environment of this type containing both learners and more knowledgeable others (who are, of course, themselves learners) can be regarded as a community of practice (Lave & Wenger 1991; Wenger 1998) within which learners undertake "legitimate peripheral participation" – they participate in activities of increasing complexity, demand and responsibility within the community; again, this is a learning model appropriate for traditional apprenticeship-type learning and procedural knowledge in the engineering workplace (Atherton 2009; Brown, Collins & Duguid 1989; Hargreaves and Gijbels 2011).

Lave and Wenger's social theory of learning encompasses aspects of identity, power relations, social structure and cohesion as well as practical experience. For work-based learners, all these have significance, not least that of identity (Lindsay et al 2008), since such learners automatically carry dual identities as students and (say) engineering technicians, while trying to evolve into the identity of an engineer. Learning within communities of practice relies much more heavily on negotiation of new meanings and identities and alignment to the power structure and culture through experience – self-development skills.

This idea of a "cognitive apprenticeship" (Poitras & Poitras 2011) is rooted in problem-based learning: students undertake solution of problems without prior teaching or experience, clarifying the problem, planning, implementing and evaluating their solutions, applying analytical skills, creativity and lateral thinking (Case 2008; Holmes 1995; Houghton 2004; Laurillard 1979; 1993; Tinkler 1993). The learning environment must replicate the real in key areas for validity; Laurillard (1993) cautions against "mediated learning" through simulation alone, where instead of gaining knowledge of the world through the workplace, the learner gains only knowledge of *descriptions* of the world in the classroom.

Learning can be considered in terms of knowledge and skills gained and applied, but also in terms of the transformation of identity (Mezirow 1991; Segers and de Greef 2011). Critical thinking (the development of a new perspective through analysing a problem or situation (Garrison 1991)) and critical reflection (self-examination and reintegration of a modified identity and worldview following a disorienting dilemma (Mezirow 1991)) form the cornerstones of Mezirow's transformational learning, although the concept itself appears to neglect the role of intuition – which Schön (1987) would call "artistry" – and comes into immediate conflict with the current managerial climate of conformity and control (Segers and de Greef 2011). Resilience in such a climate is also an aspect of self-management.

Many studies have recognised that learning can be cyclical. At the forefront of this is the work of Kolb (Kolb 1984; Kolb, Boyzatis & Mainemelis 2001; Segers & van der Haar 2011) on learning through experience.

The figure below is based on Kolb (1984) and illustrates the four stages of experiential learning (developing knowledge through direct experience). Most learners have a preference – a point in the cycle where learning is maximised for them through the nature of the experience. It can readily be seen that the accommodation and assimilation categories are diametrically opposed and refer back to the work of Piaget, and similarly the converging and diverging aspects reflect the dichotomy between deductive and inductive reasoning. Deductive reasoning can be considered to be the extension of theory through experimental evidence; inductive reasoning is the generalisation of theory from empirical evidence.

This work was extended specifically aimed at engineering students by Felder and Silverman (1988), using the Honey and Mumford learning styles index (1986); the four terms activist, theorist, pragmatist and reflector suggest four forms of learning activity to be incorporated into any experience:

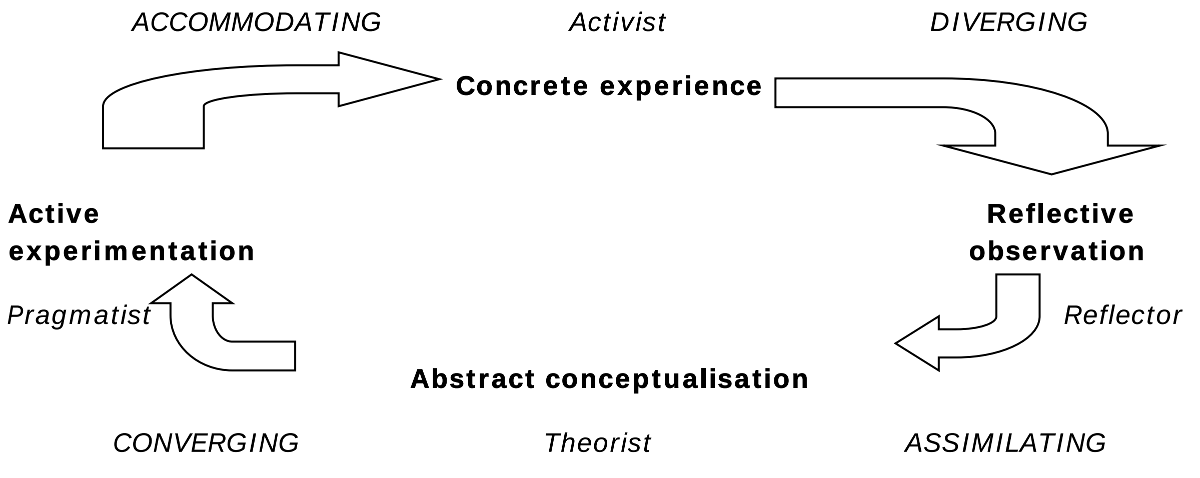

Figure 2, based on Kolb (1984), and Segers & van der Haar (2011: 56)

Focusing on a student’s preferred learning style can maximise learning in the short term and in a limited scope (Curry 1990). What evidence there is on the efficacy of learning styles does not stand comparative analysis, since so many of the various studies (summarised in Coffield et al 2004a) use differing definitions or metrics (Coffield et al 2004a, b).

> "In a complex changing society with diverse environmental demands, students need the opportunity to become sensitive to and proficient in multiple alternative strategies." Shipman & Shipman 1985.

It is self-evident that a focus on a specific learning style is not appropriate for the variety of challenges the modern workplace presents. All engineers will at some point in their working life be required to assimilate information presented in a variety of forms and apply the resulting self-developed knowledge effectively.

The concept of a learning cycle is the foundation of excellent performance in sport, music and similar activities (Ericsson & Lehman 1996; van de Wiel, van den Bossche & Koopmans 2011), and can be considered as a learning spiral (Cowan 1998), attaining progressively higher levels. The concept of expansive learning propounded by Engeström (Dochy, Engeström et al 2011; Engeström 2004) focuses on questioning, modelling, testing and implementing, then evaluating the results through reflection. This is closer to engineering problem-based learning than Kolb's model and considers reflection as a key aspect of self-development.

2.4 Reflection

Reflective thinking is "active, persistent and careful consideration of any belief or supposed form of knowledge … a conscious and voluntary effort to establish belief upon a firm basis of evidence and rationality." (Dewey 1933: 33)

The initial starting-point in considering reflection is the work of Schön (1983; 1987; Van den Bossche and Beausaert 2011), who considered professional practice as reflection-in-action, as distinct from *a posteriori* reflection-on-action, both of which appear in this context to be self-development skills. Schön highlighted the contrast between higher education teaching in engineering, which focuses on propositional knowledge, with the professional context, where procedural knowledge is valued above fundamental technical knowledge.

The Finniston Report identified that education for the engineering profession was ignoring the evaluative dimension: Schön quotes a personal communication with the Dean of an American engineering school: "We know how to teach people to build ships, but not how to figure out which ships to build" (Schön 1987: 11).

Schön refers to the "artistry" of professional practice (Schön 1987: 22): professional practice and its demand to continuously adapt to changing circumstances is more akin to an art than the clearly-defined parameters and strictures of a science. Here the professional exhibits tacit knowledge at a high level, which needs to be made explicit for others to perform at the same level; again, the requirement for self-development and personal knowledge.

Schön's work has, however, attracted significant criticism:

- the conclusions on professional development concerned mentoring those already partially expert in their field, and did not explore the applicability of reflection-in-action to developing non-experts (Moon 2000)

- it ignored the ethical, social and political dimensions of reflective practice (Eraut 1994; 2004)
- the arguments are developed through good/bad dichotomies, where most writers regard reflective abilities as a continuum (Day 1993; Eraut 2004; Smyth 1991)
- the conclusions were reached with little or no empirical research (Moon 2000)
- the concept of reflection-in-action neglects the element of confrontation or challenge in order to initiate change (Morrison 1996).

Critical reflection on action can be defined as empowerment for emancipation (Habermas 1972; Moon 2000). Reflection, encouraged initially by distancing oneself from the situation, can develop into a "tacit competence" (Van Maanen 1991; Moon 2000) from which transferable skills and deep learning are enhanced (Brockbank and McGill 1998; Eraut 1994; Morrison 1996).

Critical reflection on the assumptions and presuppositions inherent in a situation is at the heart of transformative learning (Mezirow 1991; Segers and de Greef 2011); it is the essential component to transform single-loop learning into double-loop learning (Argyris 1977) and the reflective integration of theory into practice is fundamental to problem-based learning (Boud et al 1985; Graham and Rhodes 2007).

The next section explores the specific literature on transferable skills development in engineering.

2.5 Transferable skills

A wide variety of studies have been undertaken into transferable skills under one definition or another for various purposes. In figure 3 below are tabulated the skills surveyed in a series of studies selected on the basis that they involved UK engineering students at higher education level. It is readily apparent that no consistent definitions for transferable, employability or slef-development skills are extant and the findings of these studies are incompatible: "… the theoretical justifications for the ensuing lists and characterisations of skills demonstrate an alarming circularity and lack of depth" (Bennett et al 1999: 75).

	Team/ group work *(employability)*	Communication *(employability)*	Problem solving *(self-development and employability)*	Project planning, task management *(employability)*	Personal awareness, self development & management *(self-development)*	Leadership *(self-development and employability)*	Business awareness *(employability)*
Alpay & Walsh 2008	√	√		√	√		
Archer & Davison 2008	√	√					
Bailey 1995	√	√	√	√	√		
Bennett et al 1999			√		√	√	
Bolden & Petrov 2008					√	√	√
Carter 1985		√	√	√	√		
CBI/UUK 2009	√	√	√		√		√
Drummond 1998	√	√	√		√	√	
Engineering Council 2008b	√	√	√			√	
Gibb 2004	√		√		√		√
Gravells 2010		√	√		√		
HEA 2004, 2005	√	√	√	√	√	√	
Hind & Moss 2005	√	√	√		√	√	
Markes 2006		√	√				
RAE 2007	√				√		
Stiwne & Jungert 2010	√	√	√		√		
Winter 1992		√			√		√
Totals	11	13	12	4	14	6	4

Figure 3

Markes (2006) undertook a comparison of the various studies then available, extended above to incorporate later information. It was found that terminology was confused between employers and academics within individual studies, as well as between them.

Although the skills studied differ, the majority of the studies found little development work on transferable skills at higher education level; the following reasons are suggested for this:

- There is no recognisable theoretical base (Bennett et al 1999) upon which to develop a curriculum appropriate for practice of a profession such as engineering (de la Harpe and Rodloff 2000) which can be aligned with pedagogic standards (Billett 2004).
- The priorities of higher education institutions in terms of research, propositional knowledge and funding are not aligned with the needs of industry (RAE 2007): "… almost all attributes and skills which graduates were asked about are required to a greater extent in employment than they are developed during [engineering] education" (Chadha 2006: 23).
- The status of teaching propositional knowledge is generally held in higher regard than skills development in higher education, both of which are considered inferior to disciplinary research in most higher education institutions (Biggs 1999b; Drummond et al 1998; HEA 2005; 2006a); this has a consequent impact on an academic's self-image in respect of skills development (Eraut 1994).
- The perception of skills does not align with conventional academic rigour (Alpay and Walsh 2008) and is difficult to generate hard, constructivist data from (Begum and Newman 2009); engineers traditionally have poor communication skills (Hassall et al 2005) and the best measure of transferable skills development appears to be self-expressed confidence in their application (Little 2010).

Some early attempts to introduce a transferable skills curriculum into higher education programmes met with criticism for applying performance criteria and reductionist approaches akin to NVQs (Winter 1992). Applying a professional context and developing procedural and personal knowledge rather than propositional knowledge (Eraut 1994), while meeting the needs of the engineering industry in terms of fostering independent thought and team working (QAA 2010a), risk exposing a lack of professional experience in some career academics (Pan et al 2010).

Using work-relevant contexts and activities and developing student self-managed learning integrated with the development of theoretical knowledge is the underpinning principle of constructive alignment (Biggs 1999a), detailed in section 2.2 above. "Our ability to contextualise skills is as important as the skills themselves" (Chadha 2006: 19).

Such contextualisation can be supported by relevant case studies (Glover and Boyle 2000; Riebe et al 2010), interactive exercises (Burke et al 2009) and integrated developmental IT activities (Davies and Berrow 1998; Ehiyarazan and Barraclough 2009; Stewart and McKee 2009), although excessive reliance on IT simulations tends to encourage surface learning at the expense of transferable skills (HEA 2006a; NUS 2010). Increasing levels of difficulty and responsibility enhance skills development (Biggs 1988; Billett 2011; Sanguinetti et al 2004).

The CDIO (conceive, design, implement, operate) approach (Crawley 2001; McCartan et al 2008) integrates the three forms of knowledge; it also fosters critical thinking (Hyslop-Margison and Armstrong 2004) and impacts directly on learner confidence (Harding 2000).

The above studies focused exclusively on UK students and the other texts cited on Anglophone students. Care needs to be taken when working with students from other cultures where education is traditionally passive propositional knowledge transference, as they tend to disengage from problem-based learning and await the "right" answers; such paradigms need to be challenged beforehand for effective participation (Folley 2010; Petty 2006).

Increasing students' self-development skills and capabilities for the active development of propositional knowledge and employability skills develops professional identity (Moreland 2005) and moves the student through Schein's range of career anchors: autonomy, security, technical competence, management competence, entrepreneurial activity, service, challenge and lifestyle (Schein 1993, relates to Maslow's hierarchy of needs, Maslow 1943). Such a holistic approach can lead to holistic understanding of professional practice (Dochy, Laurijssen et al 2011; Senge 1990).

It could be argued that a learning process involving inductive reasoning – from observation to theory – rather than deductive reasoning – confirmation of espoused theory through experiment – would be of more benefit to engineering part-time HE learners both in terms of employability skills and skills for self-development in the workplace. Problem-based learning and the CDIO approach are examples of this. However, it could also be argued that there are two reasons why these processes are less evident than could be expected within engineering higher education: a lack of conventional academic "rigour" and link to discipline research results in low esteem within many higher education institutions and a lack of coherence between the diverse studies undertaken into transferable skills leads to a confused picture of these skills and their development. This would at least in part confirm the findings in Section 1 of the disconnection between the needs of industry and both governmental education drivers and engineering higher education provision in universities and colleges.

Section 3: Research

“The greater part of what is taught in schools and universities … does not seem to be the proper preparation for that of business.” Adam Smith, *Wealth of Nations*, 1776.

3.1 Research questions

Two main issues emerge from the review of the literature surrounding transferable skills and employed learners above.

Firstly, employers are expressing both the extent to which they are involved in the design of work-related programmes (Medhat 2007b) and the extent to which they are dissatisfied with the skill levels resulting from those programmes, particularly in terms of transferable skills (Leitch 2006; BIS 2009a, b; RAE 2010; CBI 2011).

Secondly, the learners themselves appear not to be confident that their transferable skills are being appropriately developed by their higher education programmes (Maillardet, Ali and Steadman 2003) and the students’ own confidence in their ability to apply such skills is a strong indication of their actual ability (Little 2010). There is strong evidence that this relates to the status of personal and procedural knowledge (self-development skills and employability skills respectively) in comparison with propositional knowledge in higher education institutions and to the lack of a coherent discipline base for their development (Biggs 1999b; Drummond et al 1998; Eraut 1994; HEA 2005; 2006a; RAE 2007).

Research question 1 : *How can employers and higher education institutions work together to ensure work-related learners have the transferable skills required for career development?*

The engineering industry is broad and diverse, with employers varying in size from handful numbers of staff to some of the largest employers in the country, across many sectors – mechanical, manufacturing, civil, structural, power, electrical etc. This diversity has led to previous large-scale studies undertaken by official bodies being broad in scope but not necessarily compatible with each other. A case study (Yin 2009) into one employer/college relationship will illustrate and further explore the issues.

The employer and college co-deliver a programme to cohorts of approximately ten learners per year, the programme being a mix of a higher education qualification and role-specific practical skills training delivered by both college and employer.

In the experience of the researcher, there has been a shift in recent years for employers to demand increasingly bespoke programmes for their trainees, particularly in terms of timing of attendance and blended learning elements; at the case study college over 40% of all engineering HE learners are on block-release and blended learning bespoke programmes. Since this appears to be a growth area, it would be appropriate material for a case study, since it will be reflective of a key aspect of college/employer partnership.

The research question focuses on skills for career development; it is intended to focus on self-development skills above employability skills, however, these are intrinsically linked in previous studies which inform the research and much of the literature, and most engineering employers struggle to distinguish between them.

The research will evaluate the level of input into the original HE programme by both the employer and the college, subsequent modifications to the programme content and delivery in the light of emerging issues, and whether the eventual output of qualified trainees meets the corporate need which led to the establishment of the programme. This will be done through questionnaires and interviews.

Research question 2 : *How can transferable skills be more effectively developed in higher education learners?*

This area of study will focus mainly on part-time employed learners on HNC/D programmes, exploring interventions and activities which are intended to develop specific transferable skills, and learning approaches designed to develop the overall student into the role of a self-developing professional engineer. The two distinct approaches to be evaluated here will be separate pieces of research. As with the first question above, it will not be straightforward to consider self-development skills in isolation, due to the way previous studies have been constructed and engineering employers' perception of such skills, however, it is intended to focus on, and draw conclusions relating to, self-development skills where they can be disaggregated.

The first will be an action research project (Ebbutt 1985; Hopkins 1985; McNiff 1988) developing resources and small-scale approaches to developing transferable skills with employed college students. While the bulk of the data capture resulting from each successive intervention will be from questionnaires and interviews, there is also statistical achievement data available for modules which can be incorporated into any judgements made on the effectiveness of the approaches.

Action research, where each successive intervention is designed incorporating feedback from its predecessor, is generally considered a rapid method of developing effective resources for purposes such as this (Wellington 2000), through a process of critical reflection.

The second will be an in-depth observational case study (Cohen and Manion 2011, Yin 2008) of a more fundamental change in approach to teaching and learning in higher education intended to develop the individual, and to evaluate the transferable skills development resulting from this. It is intended for this to be a linear study of a project with small groups of students, as a pilot to a more substantial change in approach if successful. As such, it will mainly involve interviews with the stakeholders in the project. This type of research is most appropriate for evaluating pilot projects of this nature to provide constructive feedback into subsequent developments through critical reflection. Since only part of a cohort of learners will undertake the project, their progress and achievement can be compared against those following a more traditional route to validate judgements made and inform recommendations.

3.2 The proposed research

Engineers are by nature positivists. They deal in objective realities and engineering research is experimental in nature to establish and measure empirical quantities. Such research is undertaken inductively, developing hypotheses from observation and generalising from the specific (Cohen and Manion 2011; Wellington 2000). The variables encountered in most engineering research are tangible and objective: tests and experiments produce repeatable results, since all variables are quantitative and can thus be controlled. This is very much a reductionist philosophy to develop new laws and principles on the basis of observed evidence and test their applicability in wider contexts.

Any dictionary definition of "skill" will refer to an aptitude or ability demonstrated through performance, often related to a measure of the quality of that performance or its output. Engineering skills are generally physical in nature and relate to the performance of a task or activity to a required standard. For example, most mechanical engineering students are taught a range of manufacturing skills, including turning, the reduction of diameter or change of shape of a piece of material when processed on a lathe. This skill is easily defined: can the individual set up the machine appropriately and operate it to turn a piece of material down to a lesser diameter, cut a screw thread into it or give it a knurled surface? The quality of this performance is also easy to measure: tolerances can be applied to the finished product, such that if, for example, the final diameter is within ±0.01mm of that required, the resulting component will be sufficiently accurate to be suitable for the purpose intended.

The very nature of transferable skills, and particularly those relating to self-development, is subjective. The literature differs substantially as to what they are and how they can be measured. There is no empirical standard which can be applied here, so a solely positivist approach common to engineering research is inappropriate. This is undoubtedly a contributing factor to the low esteem placed on developing these skills by higher education and employers alike, particularly within engineering.

Although it is intended to focus the research on self-development skills, due to the breadth and diversity of skills considered in previous literature on this subject, a working definition of "transferable skills" is required and will be taken, as a skillset, from the Confederation of British Industry (CBI 2008b):

Seven key employability skills:

1. Self management (readiness to accept responsibility, flexibility, time management, readiness to improve own performance)
2. Teamworking (respecting others, co-operating, negotiating / persuading, contributing to discussions)
3. Business and customer awareness (basic understanding of the key drivers for business success and the need to provide customer satisfaction)
4. Problem solving (analysing facts and circumstances and applying creative thinking to develop appropriate solutions)
5. Communication and literacy (application of literacy, ability to produce clear, structured written and oral work and oral literacy, including listening and questioning)
6. Application of numeracy (manipulation of numbers, general mathematical awareness and its application in practical contexts)
7. Application of information technology (basic skills, including familiarity with word processing, spreadsheets, file management and use of internet search engines) (CBI 2008b)

Self-development skills would appear to be located under headings 1, 2, 3 and 4 above and these will form the focus for the research. The skills above are defined by the activities in which they are expressed, but not in terms of the quality with which they are demonstrated. Both aspects are entirely subjective in nature and one person's judgement of whether an individual possesses a skill to the required competence will differ from another's. Thus a pragmatic, positivist/realist approach is invalid and, at least among engineers, a paradigm shift is required in research philosophy (Kuhn 1970: 175):

> [A paradigm is] "…the entire constellation of beliefs, values, techniques and so on shared by the members of a given community ... [and] ... the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science."

It is proposed to approach the evaluation of transferable skills through two qualitative approaches: the perception of the employer or other stakeholder of the individual's performance in the workplace, and the individual's own perception of their ability.

In the former case, since the main issue raised in previous studies has been employers' perceptions of HE learners, this would appear to be valid, leaving only the same query as that raised in previous studies: that each employer's opinion will be unique, thus affecting repeatability of findings.

In the latter case, an individual's confidence in their own ability has been shown to be a significant indicator of their actual ability (Little 2010), although obviously this raises the same questions of validity and repeatability.

This leads to what will in effect be a constructivist / interpretivist approach to the proposed research activities: any findings will of their nature be relative and to some extent created by the activities and approaches used; the aim will be to understand the overall position and obtain a consensus (Ebbutt 1985); there will be researcher involvement in the process and its outputs, and the applicability of the results to dissimilar situations may be difficult to justify (Cohen and Manion 2011; Wellington 2000).

3.3 Methodology

Research question 1 : *How can employers and higher education institutions work together to ensure work-related learners have the transferable skills required for career development?*

Examining in full detail employer / HEI collaborative relationships for work-related learning and the variety of skills required for career development in various engineering sectors would be a mammoth undertaking. Taking an existing project with an employer and a college co-delivering a combined higher education and skills programme to cohorts of 8-12 learners per year, a case study approach can be used to analyse the effectiveness of the project in developing the learners for their employment function.

The learners' participation in questionnaires and interviews will explore their opinion of both their perceived level of transferable skills and their perception of the relevance of such skills to the workplace. Questionnaires with key personnel from the employer will explore their own opinion of the relevance of transferable skills to the function of the trainees and to their own function in the workplace. Interviews conducted with key participants will explore the development of the programme, changes made as it has progressed, and whether the programme actually delivers the intended outcomes.

The case study approach will be industry-related higher education in microcosm: a programme developed in partnership between employer and college to develop highly effective trainees for a specific role. As a typical case of such a project, and, given the content of the curriculum, also highly relevant to general engineering part-time higher education, the case study will be readily generalisable to the wider engineering sphere (Cohen and Manion 2011; Yin 2009). As a discrete programme dedicated to a specific cohort of learners, it will also be constrained by definite boundaries which will make data easier to organise and conclusions easier to draw (Wellington 2000: 90).

Questionnaires provide “hard” qualitative data for statistical analysis, although care needs to be taken that such analytical findings are not over-signified in areas of subjective questioning (Cohen and Manion 2011: 382). A Likert five-point scale provides the best balance of variety against complexity, with care taken to avoid overlap between criteria and questions (Cohen and Manion 2008: 389). Categories for such questionnaires can sometimes be invalidated by assumptions and interpretations, so the progression model from Dreyfus, Dreyfus and Attanasion (1986), having categories of novice, advanced beginner, competent, proficient and expert, provides groupings which are discrete and readily understood within the engineering profession, although they are subject to differing benchmark opinions between participants (Cohen and Manion 2011: 386), which can be addressed through parallel interviews.

Interviews carried out with key employer representatives and learners will gather further data on their opinions, validate and triangulate the questionnaire data and to evaluate the success of the programme. Since areas of closed, more quantitative questioning will be addressed through the questionnaires, more conversational interviews can seek insight into the situation from each participant’s perspective (Cohen and Manion 2011: 413).

This research will provide evidence of the extent to which a programme of study, not designed with transferable skills in mind, develops such skills, the extent to which they are necessary for the job role and how transferable skills are recognised by the employer and/or the college.

A researcher-participant approach to obtaining data from learners will minimise the effect of employer power in influencing answers to questions; trust will be established in all participants and anonymity of employer and all participants will be maintained to ensure corporate sensitivities are not a biasing factor in responses (Cohen and Manion 2011: 103; Wellington 2000: 41).

Research question 2 : *How can transferable skills be more effectively developed in higher education learners?*

The first of two discrete pieces of research undertaken will be an action research project into the effectiveness of strategies and activities undertaken in college in developing transferable skills in higher education part-time learners. Since the learners in question attend college for short periods in large groups and follow a largely generic programme of academic study, with the remainder of their time being engaged in work (i.e. not training) with their employer, for many of these learners this is their only opportunity to develop such skills.

Action research of this nature, undertaken in situ, is a cyclical process of competency enhancement generating rapid feedback on its effectiveness and its findings will be useable and useful to address immediate problems (Cohen and Manion 2011: 346). From an analysis of relevant theory and creation of activities based thereon, learners take authentic participative roles in testing their own assumptions and responding to problem-solving challenges designed to develop their transferable skills and improve their confidence in applying them. Some qualitative analysis of data is possible, since cohorts undertaking skills development and those not doing so can be compared; the statistical validity of the data must be tested thoroughly. The bulk of the data is qualitative, generated through questionnaires, surveys, focus groups and interviews and by observation, to generate recommendations for future activities (Denscombe 2010; Wellington 2000).

This research will enable the creation of proven interventions and approaches which can be integrated into the college curriculum for an engineering part-time HE learner to develop key transferable skills. Context will be vital here: as Hyland and Johnson (1998) suggest, skills are context-dependent and their transferability can only be attested to if competence can demonstrably transfer from one context to another. What a learner can achieve in a classroom context may not affect workplace performance if work-related contexts are not established.

The second study will evaluate the effectiveness of piloting and implementing the CDIO approach (Crawley 2001; McCartan et al 2008) with engineering learners. The idea of a curriculum delivered, assessed and accredited will be reversed: learners provide evidence for assessment and accreditation through the Conceive, Design, Implement, Operate philosophy as applied to an engineering project, and through developing their own knowledge to support the demands of the project, satisfy curricular requirements.

This approach has been successful in other institutions, mainly in the United States (CDIO 2012; Crawley 2001), in developing the holistic engineer: problem solver, self-developer and communicator, rather than the technocrat with extensive academic knowledge and little understanding of its application; this would address employers' criticisms of graduates' lack of employability skills and provide them with the tools for career progression through self-development. While there are challenges in terms of academic esteem, teacher buy-in and of students' ability to develop their own self-learning skills in parallel with the demands of a valid, realistic project, successful learners, on completion, will have greatly enhanced transferable skills and workplace effectiveness.

This is another form of case study, with evidence generated mainly through interviews with the participants and key stakeholders. The quality of evidence generated by learners for assessment in comparison with parallel learners undertaking regular taught programmes will illustrate the extent to which their self-development is effective. Interview responses will yield insights into their sense of becoming true engineers (Gee 2000; Walker 2001) and analysis of the discourses (Fairclough 2011; Sfard 2001), will explore changes in the learners' use of professional language and status within their community of practice (Wenger 1998).

A phenomenographic approach is of benefit in this instance: exploring learning from the learner's perspective through discussion and understanding their conceptions of the world (Andretta 2007; Franz et al 2010; Marton 1981) although, since students will be working collaboratively as they would in a professional environment, account needs to be taken of the effects of situational and cultural conditions – what Lave and Wenger (1991) refer to as "situated cognition" (Richardson 1999). It is hoped that exploring their deep learning will illustrate their ongoing self-development.

A fundamental aspect of this last study will be critical analysis of discourses of participants and stakeholders. Such analysis will explore the significance of students' burgeoning identity as engineers through their use of appropriate language and terminology in professional environments (Gee 2011). It is important here to examine the structure of the discourse, not its effects (Jones and Ball 1995), without imposing knowledge and language (Kress 2011), avoiding dichotomies (Patel Stevens 2011) and addressing the features in the discourse with regard to context (Lemke 2010).

3.4 Power and ethics

There is increasing pressure in education to accept policy-driven evidence rather than evidence-driven policy: top-down "expert" research presented as universally applicable without justification, as organisational rhetoric without objective verification, with a pretence to neutrality (Kincheloe 1995; Pini 2011). Subservience to policy and audit culture can create an orthodoxy of research without purposely challenging the paradigms and epistemological constraints for empowerment (Hammersley 2004; Hodkinson 2004; LeCompte 1995).

Education could be seen as having evolved into the Benthamite panopticon of covert observation and measurement espoused by Foucault (Dean 2008; Gutting 1994; Rouse 1994) where the discourses of power reinforce the orthodox (Woodside-Jiron 2011).

The same situation exists in many employment situations, where "what the company does is right and anyone who disagrees will harm their career" (personal quote from student, anonymous). As a consequence, where this research involves employers and employees, obviously with their knowledge and consent, anonymity must be preserved to ensure genuine frankness in question responses, to the extent that individuals cannot even be identified by inference and must be permitted to withdraw (either individual quotes or from the process entirely) if they wish to do so (Cohen and Manion 2011: 103).

The development of transferable skills is marginalised in the education process at every stage, and also by many employers, as evidenced in the literature review, and when the Government refers to skills, it tends to be in the context of immediate job functionality. It is therefore essential that an honest opinion without external influence is provided by all participants insofar as is possible. The researcher will also be participating in activities generating research data and the issue of the Hawthorne effect (Cohen and Manion 2011: 245), of reactivity to the researcher, requires consideration. All of the above issues will be explored more fully in the design of each specific research activity.

The proposed research is not invasive or particularly sensitive, so as a result providing the BERA guidelines on research ethics are followed (BERA 2010), there should be no issues.

Although the issues raised above regarding power relations, alongside other methodological issues previously highlighted, will affect the ease of obtaining research information and of justifying its validity and transferability, it is nevertheless hoped that the proposed research will provide valuable recommendations to address the evident shortage of self-development skills among UK work-based HE learners.

Appendix 1 : References

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NOTTINGHAM TRENT UNIVERSITY

Development of transferable skills with part-time HE students in engineering: employer case study

EdD Module 3

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"The greater part of what is taught in schools and universities … does not seem to be the proper preparation for that of business." Adam Smith, Wealth of Nations, 1776.

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Abstract

Transferable skills, of self-development, self-management, problem solving, communication and team working, are essential for entry to the engineering workforce (where they are often termed "employability skills") and for career progression therein.

This study covered the first two cohorts of an employer-specific higher education programme for technical employee development, over a three-year period. None of the participants, or their managers, were familiar with reflection as a learning tool and developing this, in conjunction with interventions to develop and appraise participants' transferable skills, evidenced considerable improvements in their confidence in their self-perceived skills. Other than demonstrating transferable skills in a context-dependent scenario, and project work was integral to the programme of study, confidence is considered a valid proxy for actual transferable skill.

All the students who participated demonstrated improvements in their transferable skills. This was achieved through reflection and also through various valid simulation activities and their own workplace experience. None of the students had given any consideration to the concept of transferable skills prior to the inception of the programme.

All the managers who participated expressed confidence that their own career progression route had been the most effective one for attaining their current level. They, too, had never explicitly considered transferable skills for the workplace other than as knowledge gained through direct experience.

The case study, bounded as it was within an approach to employer-bespoke education which is growing within the engineering sector, illustrates clearly that project-based simulation, providing it is valid and sector-relevant, is an effective means to develop transferable skills for progression and development within the engineering profession, if coupled with reflection.

Introduction

This professional doctorate seeks to explore the development of transferable skills in higher education in engineering, for the purposes of career development and progression.

The bulk of the skills agenda at this level focuses on employability, and the functionalities required to gain graduate employment; while there is significant graduate unemployment nationally, the engineering sector is experiencing recruitment shortfalls. There appear to be currently no ongoing UK projects for the development of transferable skills in those already in employment in technological areas.

Since its boundaries are so clearly and easily defined, the research utilises a bespoke employer part-time HE programme as a case study to both appraise the efficacy of developmental interventions in improving transferable skills and to assess the improvements which occur through reflection on experience.

Section 1: Research

1.1 Purpose of the research

Two questions were posed in Document 2:

1. How can employers and Higher Education institutions work together to ensure work-related learners have the transferable skills required for career development?
2. How can transferable skills be more effectively developed in higher education learners?

This study proposes to examine the nature of transferable skills development from both the employer and employee perspective and to attempt to examine their perceptions of how such skills are developed in the course of a bespoke employer-specific HE programme. As defined below, transferable skills are taken to encompass self-development of knowledge through independent research, problem solving, self-management, team working and effective communication.

The overall purpose of the Professional Doctorate research study is to examine the development of transferable skills in both those who are undergoing the development and in those more advanced in the process and to establish the core principles for transferable skills development to facilitate this more effectively in future projects.

1.2 Professional, educational and industry context

1.2.1 Economically valuable skills

In his Autumn 2013 Statement, Chancellor of the Exchequer George Osborne said: "Access to higher education is a basic tenet of economic success in the global race." In removing the cap on higher education full-time numbers and enhancing the focus on vocational science, technology and engineering courses, he was reinforcing the position of higher education and HE qualifications in terms of human capital (gov.uk 2013).

Human capital theory was initially propounded by Adam Smith in his book 'Wealth of Nations' in 1776. Subsequently refined in an educational context (Becker 1964, Davies, Qiu and Davies 2014, Schultz 1961, 1971, Sweetland 1996), human capital links earnings and investment (years) in education, using this as a proxy for inherent ability. Human capital theory suggests educational qualifications are a direct route to economic success, providing the infrastructure and technology are appropriate to support developments in education and provide employment or entrepreneurship opportunities for a highly-qualified workforce (Olaniyan and Okimakinde 2008). Government education policy of supporting human capital development in this way gives potential short-term gains within a given Parliament (before any inappropriate shortfalls in technology and infrastructure investment are exposed), and neglects the effect of "diploma creep" (Ferguson 1998), where the value of educational qualifications is diminished by the increasing proportion of people achieving them. It also permits Government to pass the blame for any non-achievement of economic growth onto the education profession (Coffield 1999).

In the context of this study, students studying HE qualifications while in employment are seeking to gain human capital to facilitate progression and promotion within employment and gaining the transferable skills to make them more effective both in the current workplace and in future.

The Government first formally recognised the value of skills gained from higher education, rather than pure knowledge, in the Dearing Report of 1997 (Dearing 1997). Subsequent changes in education policy to improve graduate "employability" have been mirrored by changes to professional accreditation processes within engineering Institutions (Engineering Council 2008a). The Leitch review of skills in education (Leitch 2006) recommended a demand-led system for developing "economically valuable skills" in which the UK was apparently trailing its international competitors. There is no clear definition of the "higher level skills" which are discussed extensively in the document.

The theme of addressing skills shortages without defining the skills continues through Government policy and across changes in administrations. There is the suggestion that qualifications are a good proxy for transferable skills (DIUS 2008), discussion of "strengthening the skills pipeline" (BIS 2009a p9) and of the "benefits in social mobility and earning potential" (BIS 2009b p3) through gaining transferable skills, yet even in documents entitled "Skills for Sustainable Growth" (BIS 2010), there is no clear definition of the skills under discussion.

The education sector has the opposite problem: considerable research and extensive study into higher level, transferable and employability skills, without a consistent definition of what they are, as demonstrated below.

The table below was produced by the author and illustrates, for the key studies in the area (which have engineering undergraduate students as a component), the breadth of what is considered to be "transferable skills" and the extent to which they have been incorporated, or not incorporated, into the studies.

	Team/ group work	Communication	Problem solving	Project planning, task management	Personal awareness, self development & management	Leadership	Business awareness
Alpay & Walsh 2008	√	√		√	√		
Archer & Davison 2008	√	√					
Bailey 1995	√	√	√	√	√		
Bennett et al 1999			√		√	√	
Bolden & Petrov 2008					√	√	√
Carter 1985		√	√	√	√		
CBI/UUK 2009	√	√	√		√		√
Drummond 1998	√	√	√		√	√	
Engineering Council 2008b	√	√	√			√	
Gibb 2004	√		√		√		√
Gravells 2010		√	√		√		
HEA 2004, 2005	√	√	√	√	√	√	
Hind & Moss 2005	√	√	√		√	√	
Markes 2006		√	√				
RAE 2007	√				√		
Stiwne & Jungert 2010	√	√	√		√		
Winter 1992		√			√		√
Totals	11	13	12	4	14	6	4

Figure 1: A table summarising the transferable skills under consideration in a variety of studies of their development; all studies featured, but were not confined to, engineering students.

On this basis, a working definition for transferable skills at Higher Education level is required and for the purpose of this study the QAA definition is appropriate:

> QAA (2008b) para 57 “Higher level skills are those which go beyond acquiring basic knowledge and understanding and being able to apply that understanding to straightforward situations. They include analysis and synthesis of a range of knowledge, which may be acquired using research skills; critical reflection on different and

> potentially conflicting sources of knowledge; problem-solving by identifying a range of possible solutions, evaluating these and choosing the solution most appropriate to the situation; developing complex arguments; reaching sound judgements and communicating these effectively."

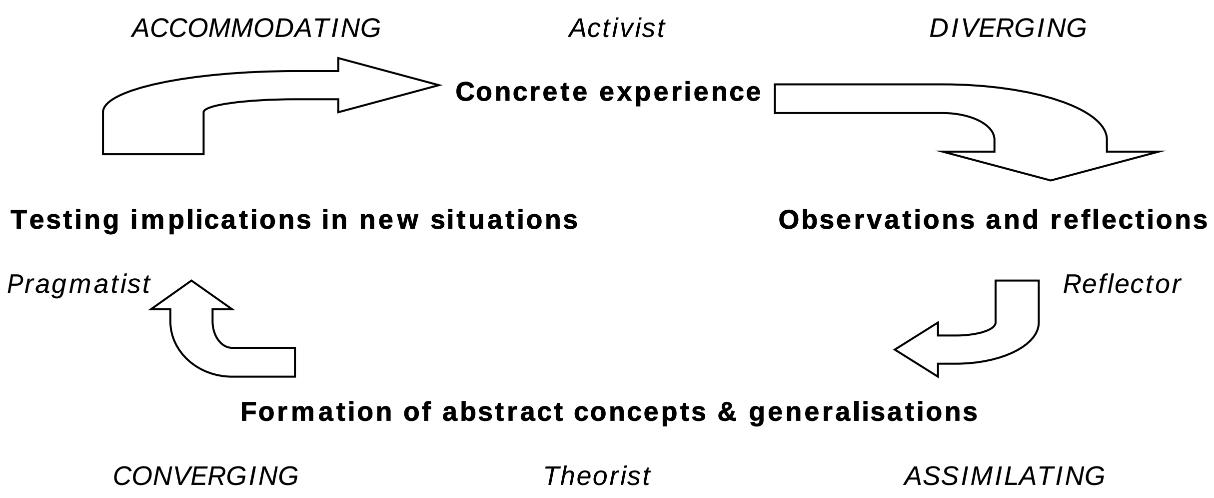
The majority of the above studies concern only HE students not currently in employment in their chosen field of study. The only significant UK study to date of part-time HE learners which includes some engineering students in the data is the ongoing Futuretrack research project (Callender and Feldman 2009, Callender and Little 2014, HECSU 2010). Considering skills from the published elements to date, the project puts forward the view that Government skills policy is dedicated to upskilling for current roles, not providing opportunities for self-development and career progression. There is also evidence from employers that they do not believe that transferable skills development is required in programmes for employed students (Callender and Feldman 2009).

Part-time HE students seeking to gain advancement will mainly gain confidence in their own personal and intellectual capabilities and self-reliance when faced with change (Little 2010), but also gain in terms of their identity capital (autonomy, job satisfaction and credibility) and social capital (social status and networks of contacts) (Callender and Little 2014). This links to the parallel development of the identity of the part-time learner as both student and professional (Callender and Feldman 2009, Gee 2000). There will be some exploration of identity in this document, but this will be explored further in Document 4; this study is focused more on the development of transferable skills *per se.*

1.2.2 Transferable skills development

Theories of learning can be traced back from the initial concepts of cognitive constructivism (Piaget 1972) and social constructivism (Vygotsky 1962, 1978). Bloom (1956, Anderson and Krathwohl 2001, Krathwohl 2002) established the concept of taxonomic learning and levels of attainment. Gardiner (1993) introduced the concept of multiple intelligences. There have been developments in recognising and addressing students' preferred learning styles (Felder and Silverman 1998, Honey and Mumford 1986) linked to cycles of development based on the work of Kolb (1984, Kolb and Boyzatis 2001).

While each of these theoretical standpoints has its merits and its proponents, each has also attracted criticism for narrowness and it is clear that any global theory of learning should incorporate all of these (Case 2000, Coffield 2004, Curry 1990). The diagram below represents the author’s interpretation of Kolb’s experiential learning cycle, with Honey and Mumford’s learning styles superimposed, as a starting point for an approach to learning development which incorporates both the cognitive and social constructivist aspects and the individual and personal levels. In this respect, development of knowledge, skills and attitudes are addressed and progression to higher taxonomic levels can be viewed as a spiral around the learning cycle (Cowan 1998, Tinkler 1993).



It is common in educational literature to separate knowledge, skills and attitudes. Far more useful in considering the development of personal skills for career progression is to consider these aspects as propositional, procedural and personal knowledge respectively (Eraut 1994, 2001, 2004, 2008). One can know about skills, then develop them through a process until proficiency is achieved (van de Wiel et al 2011). Skills can be regarded as a form of tacit knowledge (Polanyi 1967), almost an example of Rumsfeld’s “unknown knowns;” the skill development process is then to make the explicit tacit, while the teaching process makes the tacit explicit (Fuller et al 2003), much as the musician practices a piece until it can be played without conscious thought, yet they will need to deconstruct their playing to teach the piece to another (Littleton and Mercer 2013, Schön 1984).

Integral to the ascent of the spiral to higher taxonomies is the concept of “deep learning,” where the learner independently self-manages assimilation of new knowledge and its application to both the familiar and the unfamiliar, rather than relying on the teacher to spoon-feed knowledge to be returned without understanding (Andretta 2007, Biggs 1999a, b, 2003, Case 2008. Fundamental to the development of deep learning are effective feedback between teacher and learner (Entwistle and Tait 1990), a clear and relevant context (Laurillard 1979) and the use of reflection as a developmental tool (Case 2008, Dewey 1933, Moon 2000).

Reflection on practice and its outcomes, both as *in-situ* reflection in action and *post-hoc* reflection on action (Schön 1984, 1987, van den Bossche and Beausaert 2011), can create a cycle of double-loop learning (Argyris 1977, Argyris and Schön 1974, 1978). West-Burnham (2006) suggests that this process, when applied most effectively, "of knowledge becoming wisdom," transcends this and can be classified as "profound learning." West-Burnham provides a useful table (below), although it is open to argument whether profound learning is not merely deep learning at the next highest taxonomic level.

	SHALLOW – What?	DEEP – How?	PROFOUND – Why?
Means	memorisation	reflection	Intuition
Outcomes	information	knowledge	Wisdom
Evidence	replication	understanding	Meaning
Motivation	extrinsic	intrinsic	Moral
Attitudes	compliance	interpretation	Challenge
Relationships	dependence	independence	Interdependence
	Single loop	Double loop	Triple loop

Table West-Burnham (2006) p2

This form of double-loop reflective approach is integral to transformational learning (Mezirow 1990, 1991, Segers and de Greef 2011, Senge 1990) where critical reflection on assumptions provides insight into the inter-relatedness of concepts and, as this process becomes tacit, a personal mastery of the concepts and their application (Moon 2000).

Participants in this research study were invited to reflect periodically on their learning, specifically to encourage deep learning and their acknowledgement thereof.

Integral to the development of the individual is their role within their community of practice (Wenger 1998), essential for engineers who tend to have independent and clearly defined roles within multidisciplinary teams. This is the process of integrating into a team, learning a role in that team, of "legitimate peripheral participation" (Brown et al 1989, Lave and Wenger 1991, Hargreaves and Gijbels 2011) and developing both a personal and professional identity within that team (Colley et al 2003, Dehing et al 2013). All of the students engaged in this project will be working in teams with multiple levels of experience and expertise, although while engaged in study, they will all be at approximately the same level. Given the nature of the block-release programme, much of the time spent self-developing knowledge for these students will be in the workplace among more experienced personnel.

The learning process where deep, double-loop learning is developed through this cognitive apprenticeship is Houghton's interpretation of Biggs' term "constructive alignment" (Biggs 1999a, b, 2003, Houghton 2004), in respect of easing the transition from student to professional. Problem-based learning, or project-based learning (often conflated in areas where a problem and a project are not so distinct as in engineering) provides this cognitive apprenticeship and development of all forms of knowledge through exploring ill-defined problems and undertaking challenging, often collaborative, projects (Littleton and Mercer 2013, Poitras and Poitras 2011).

Where a learner is required to develop their own propositional knowledge and apply it to an unfamiliar problem, there can be issues with teachers feeling their role is marginalised (Joyce et al 2013); issues with whether theory can be developed experientially or must be taught, in the opinion of some academics; and also of cultural expectations for overseas students where their prior educational experience has been profoundly tutor-led (Folley 2010). Flexibility of teaching staff, moving from the role of pedagogue to supporting colleague, is essential for this approach (McLinden 2013). From the viewpoint of an educational establishment dealing with learners from industry, any simulation activities or environments must be relevant to the professional context and integral to the learning taking place (de la Harpe and Rodloff 2000, Hyland and Johnson 1998, Kneebone 2005, Laurillard 1993). The table below summarises Kneebone's work (with medical clinicians) in this regard:

	Theoretical grounding for key area underpinning simulation-based learning	Criteria for critically evaluating new or existing simulations, based on the theoretical framework
1	Gaining technical proficiency (psychomotor skills and learning theory, the importance of repeated practice and regular reinforcement, qv Ericsson on practice and evaluation of performance).	Simulations should allow for sustained, deliberate practice within a safe environment, ensuring that recently-acquired skills are consolidated within a defined curriculum which assures regular reinforcement.
2	The place of expert assistance (a	Simulations should provide access to expert

	Vygotskyan interpretation of tutor support, where assistance is tailored to each learner's needs).	tutors when appropriate, ensuring that such support fades when no longer needed.
3	Learning within a professional context (situated learning and contemporary apprenticeship theory, qv Lave & Wenger legitimate peripheral participation, Wenger communities of practice).	Simulations should map onto real-life professional experience, ensuring that learning supports the experience gained within communities of actual practice.
4	The affective component of learning (the effect of emotion on learning).	Simulation-based learning environments should provide a supportive, motivational and learner-centred milieu which is conducive to learning.

Lucas (2012) offers a six-point framework for key aspects to consider in the development of propositional, procedural and personal knowledge (Eraut 2001, 2004) through problem- and project-based learning:

1. Functional and basic skills
2. Specialist or advanced knowledge (know-how / know-that)
3. Craftsmanship or professionalism (pride and judgement through experience)
4. Relational and emotional intelligence
5. Business and enterprise skills
6. Innovative and collaborative capacity (enquire, investigate, adapt and respond to change)

The College generally tries to use problems and projects as integral components of the learning experience with part-time engineering learners on the basis of the above so this will be at the core of the students' experience.

The next development in this trajectory is the CDIO initiative, where students **c**onceive – **d**esign – **i**mplement – **o**perate a project; in other words, they take a problem through exploration, solution, implementation, installation and commissioning and evaluation independently of a taught curriculum, self- developing knowledge and self-managing performance, usually within teams. This initiative, originally piloted at MIT (Crawley 2001) is now being piloted in institutions in the UK and Ireland (Creasey 2013, McCartan et al 2008). The CDIO approach is integral to the development of transferable skills – teamwork, self-managed learning, problem solving, and, constructively aligned with Garrison's model, critical thinking skills (Garrison 1991, 1997). Garrison identifies five stages in the development of critical thinking which have considerable synergies with the project-based learning process:

- identification (observe and study elements and their linkages)
- discussion (analysis of values, beliefs and assumptions)
- exploration (proposal of ideas)
- judgement (decision and evaluation)
- integration (application of solutions).

While it is proposed that Document 4 will focus more closely on the CDIO initiative, elements of this, particularly in respect of the criticality, will be part of the developmental experience for these learners (the research for Document 4 took place partly in parallel with Document 3).

A useful summary of the concepts discussed and their impacts on learning is included below:

	Core issues / concepts	Who learns?	Why do they learn?	What do they learn?	How do they learn?
Billett and Ellstrom: the learning curriculum, workplace learning	The 'experienced' curriculum, individual contribution and participation in workplace environment	Individuals and therefore organisations	Updating, growth and development, employability, to resolve non-routine problems	Competence, employable outcomes, qualifications, interactions are central to learning	Participation in individual pathway, direct and indirect guidance, creative learning
Mezirow: transformational learning	Transformative / transformational learning, experience, crit reflection, making meaning	individuals	Disorienting dilemma, disruption of worldview	New meaning perspectives, become reflective critical and open	Making meaning, critical reflection, discourse, action, perspective transformation
Kolb and Boud: experiential learning theory	Experiential learning, experience learning styles	individuals	Conflict, differences and disagreement	Creation of knowledge, relearn ideas	Transforming experience – concrete experience, reflective observation, abstract conceptualisation, active experimentation
Lave and Wenger: situated learning	Situated learning, legitimate peripheral participation, community of practice, social / contextualised learning	Members of community of practice, newcomers and old-timers	Develop skills and knowledge, gain full membership, creative problem-solving	Construction of identities / personality, skills	Participating in community of practice – observing, sharing, legitimate peripheral participation
Senge: systems thinking theory	Learning organisation, fifth discipline strategy, principle of leverage, limits to growth	Individuals and therefore organisations	Individual and business growth, to stay competitive	Become healthy, successful, changes in thinking, manage change	Building blocks – system thinking, personal mastery, mental models, shared vision, team learning, alter limiting factors
Argyris and Schön: organisational learning	Organisational learning, reflection in and on action, espoused theories and theory-in-use, single and double loop learning	Individuals, organisations	Survive in changing environment, become reflective practitioners	Challenge assumptions, reframe descriptions, find solutions	Single and double loop model I and II, reflection
Engeström: expansive learning and inter-organisational learning	Expansive learning, activity theory, contradictions, knotworking, co-configuration, multi-voicedness, historicity, change laboratory	Engagement in activity systems, inter-organisational learning	Contradictions, double bind	New forms of work activity, what is not there yet	Cycle of expansive learning – questioning, analysing, modelling, implementing, reflecting, consolidating

Table 0.1, from Dochy, F. (2011) *Introduction*, in Dochy, F., Gijbels, D., Segers, M. and van den Bossche, P. (2011) *Theories of learning for the workplace: building blocks for training and professional development programmes*, Abingdon, Routledge.

1.2.3 Considerations of context and learning development for the research

It is apparent from the above that there is increasing recognition of the value of "employability" skills at Higher Education level, and that these develop through exposure to work-related environments and activities and through reflection in and on action. Possession of such transferable skills is difficult to measure, but they are mainly manifested through confidence in one's knowledge, ability and criticality. Little (2010) clearly articulates the link between confidence in one's transferable skills and effective performance thereof.

Key criteria for effective development are realistic work-related environments and activities appropriate for professional practice (de la Harpe and Rodloff 2000, Medhat 2007); there is evidence that dedicated generic employability activities are of no impact on such skills without appropriate experience (Mason et al 2009).

Challenges with transferable skills development also exist among higher education professionals: these aspects of the HE provision are marginalised in many cases due to a lack of a clear theoretical curriculum framework or of an established pedagogy; this is particularly true where there is a solid, established theoretical curriculum base and where many teaching staff themselves lack industrial experience (UKCES 2008). Employers also have expectations that "teaching" will follow their own historical experiences closely (Medhat 2007, UKCES 2008).

Engineers are schooled in the scientific method and wedded to rationalist-empiricist epistemologies: problems can be solved through quantitative approaches, generating objective propositional knowledge. The Piagetian cognitive construct of assimilation and accommodation (Piaget 1972) is appropriate to the positivist paradigm which underpins the professional practice of engineering (Savin-Baden and Howell Major 2013). Also, since the unit of measure (an engineered artefact) is arguably more substantial and generally more expensive than the materials employed in scientific experiment (particle physics excepted), there is often, in the experience of the researcher, more emphasis placed on the application of pure theory to problem-solving among engineers than among scientists. You cannot build a prototype bridge!

Transferable skills, gained by experience and developed through reflection in and on action (Schön 1983), relate more to experientialist epistemologies; the personal, perception and value-based perspective falls within a pragmatist paradigm (Savin-Baden and Howell Major 2013), where there is a need for qualitative approaches, since transferable skills development relies on self-perception and confidence. Proximal development (Vygotsky 1962) and legitimate peripheral participation (Lave and Wenger 1991), considered together as a cognitive apprenticeship of skills development within a community of practice (Wenger 1998) is perhaps the closest analogy for engineering self-development through work-related learning. Here, the unit of measure is the self, more akin to the development of musicianship or sporting prowess. The cost of such development is time, which permits more risk in experimentation (in terms of the guaranteed success of the outcome), just as a musician will try different techniques and adopt only those which are most effective in their self-development.

In any research undertaken, the rationalist perspective of engineers (including the researcher) needs to be borne in mind in developing and establishing appropriate reflective opportunities.

1.3 Research question

How are the transferable skills of self-management, self-development, problem solving, communication and team working developed in undergraduates through a bespoke, employer-specific higher education programme, and how effective is this, in the opinion of the students and of their managers?

How can these findings be used to inform future projects to develop these skills more effectively for professional effectiveness and career progression within the engineering industry?

1.4 Research Ethics

The concept of this particular employer/college partnership project forming a case study was discussed from the earliest stages of the partnership, at the highest level within the organisation. The employer, while raising no objection to managers and trainees participating in the study, requested anonymity for the company and all participants in any documents relating to the study which would be read outside the domain of the partnership.

The researcher and his college have engaged in partnerships with a wide variety of sectors where confidentiality is essential to their business practice – motor industry and motorsport, communications, telecommunications and security and power generation, for example – so this is not an uncommon request. Even project reports presented to external examiners have featured redactions. In this instance, the standard employer/college confidentiality agreement was considered by the employer to be sufficiently binding.

As a consequence, it was agreed that the company name would be converted to a random set of initials (hereafter QVD) and that the initials of each participant would be randomised (simple algorithm, grid method) to prevent identification. All references to the company's specific business sector would be expunged.

In parallel with this, standard ethical procedures for the researcher's college, Nottingham Trent University and the BERA ethical guidelines (BERA 2010) were followed; the relevant ethical approval documents are included as Appendix 5. All participants were asked to read and sign an informed consent form explaining the purpose of the study (included as Appendix 2) and their right to withdraw at any point, and to have their contribution to that date removed from the record, was explained. In fact, one participant did request this at a late stage and their contribution has been removed from the documentation.

There were no intrusive procedures involved in the research and no deception was involved.

All participants in the interview research were sent a list of quotations from their interview transcripts for intended inclusion and offered the opportunity to decline their use if they might lead to inadvertent identification. This occurred in one instance only where the participant felt their comment could identify them personally and might be construed as critical of their employer. In addition, relevant sections of the transcripts were forwarded at appropriate stages to the company training manager for agreement, to ensure that no sensitive information had been inadvertently included.

1.5 Initial scoping and interviews

In the Spring of 2010, the researcher’s college was approached by a major engineering employer to tender for a bespoke programme to develop higher technicians for their industrial plant operations.

Initial discussions took place between the researcher (hereafter JM) and two managers from the company (hereafter QVD) on the nature and content of the proposed programme and its delivery. These discussions took place both before tender submission and after the award of the successful tender.

1.5.1 Curriculum considerations

QVD had initially proposed an eight-module Edexcel Higher National Certificate in Operations Engineering and a NVQ2 in Performing Engineering Operations, the former to be delivered over two years, the latter entirely in the first year. Delivery was to be on block release, with 24 weeks’ release from employment in year 1 and 12 weeks’ release in year 2, release weeks constituting full-time study with the students resident in College accommodation.

The Higher National Certificate in Operations Engineering is a 120-credit level 4 qualification aimed at plant operations personnel engaged in mechanical, electrical or maintenance engineering; QVD initially proposed a combination of modules which did not properly agree with the Edexcel rules of combination so it was agreed to insert a further two modules at level 5 to increase the breadth of the knowledge base and ensure the award of a certificate. Modules are stand-alone and are assessed through centre-derived assignments or examinations (Edexcel 2013a).

There is limited reference to knowledge or skills other than module-specific content in the Edexcel specifications and any reference to transferable skills appears to assume that such skills will be developed as a part of the overall programme without additional intervention. This aligns with employer perceptions mentioned earlier.

The NVQ2 is a practical level 2 qualification whereby students develop specific manual manufacturing skills and demonstrate their ability to perform these skills to specific standards on test exercises after a period of training and practice. The artefacts generated and the portfolio of accompanying information generated by the students is their assessment evidence. There is no explicit transferable skills development in the qualification whatsoever; it is solely derived from skills performance related to function in the workplace.

1.5.2 Pre-tender discussions

The two managers involved in the pre-tender meetings, hereafter NU and CD, were questioned about the purpose of the programme and the intended career trajectory for the successful students. Students would initially lead mechanical or electrical maintenance teams under supervision from a graduate engineer with the company aim of introducing a greater element of planned maintenance to the teams and reducing the number of unplanned incidents and stoppages. The programme was intended to be of four years' duration: two years combined between attendance at College and training on the job and two further years in role with additional in-company training. On successful completion of this, there had been no consideration on the part of the employer whether students would have the opportunity to undertake further HE qualifications, progress to graduate engineer status and potentially become plant managers in time.

No consideration had been given by the employer in designing the programme to transferable skills; the HNC modules and NVQ units had been chosen on the basis of content and the in-company training was equally specific to job function. The focus was on practical, taught skills and subject knowledge and its application; any transferable skills developed in the process would be entirely independent of the planned programme. This was agreed between NU, CD and JM.

JM proposed that if the College's tender was successful, support would be provided for recruitment and selection of candidates and further development of transferable skills integrated into the programme. These comments were incorporated into the tender.

1.5.3 Post-tender discussions

On the award of the successful contract to the College, further discussions took place on the nature and content of the programme. The College would provide activities and support for the recruitment process and would add an additional qualification into the programme in year 1, an Edexcel Extended Project. This is a stand-alone qualification at level 3, effectively a smaller, less involved version of the final year project the students would undertake, and would be integrated into the delivery to allow the students, in small groups, to apply the manual skills developed in the NVQ to the production of an artefact as a prototype solution to the project objectives. This was intended to develop the transferable skills of team working, self-development, self-management and problem-solving (Edexcel 2013b).

There were also extensive discussions on potential progression routes post-HNC, with the potential of a distance-learning top-up of six further modules to achieve HND; this would of necessity be through distance learning since years 3 and 4 of the programme contained no provision for College release and the students would be based at plant locations all over the UK.

At this point, the idea of using this project with QVD as a case study for research purposes arose and was discussed with NU and CD.

Both managers agreed to be interviewed for the research and provided initial comments at the early stage of the project; within the first few months of the operation of the programme, both NU and CD were redeployed within the organisation and so did not take part in the surveys conducted with company managers detailed later in this document. The content of these initial interviews was very useful in shaping the subsequent research design, so are detailed below. This took place before the actual research design and since there was no subsequent opportunity for NU and CD to participate in the manager research, these initial discussions have been included ahead of the research methodology.

1.5.4. Pre-programme interviews

NU had come to QVD through what he referred to as "the conventional route": A-levels and an engineering degree studied full-time. He regarded the degree as the most important factor in his job role and had received no formal training or development in what he referred to as "soft skills," which he felt were mainly self-management, team work, problem solving and communication.

NU's belief was that he had always had good transferable skills and had never made any effort to develop himself in these areas; he felt it was a key factor in his rapid promotion trajectory. Having moved swiftly into management from a graduate engineer role, he felt he had made little use of the knowledge gained on his degree and that HE qualifications merely provided a "badge" to open doors to a higher tier of job opportunities. In terms of self-development, the only instance NU could recall from his career to date was developing and extending his own knowledge of corporate business and financial management structures and processes to facilitate career progression, although again this had been easy for him. It is noteworthy that NU was promoted again almost immediately after this programme began.

CD had left school at 15 into employment as an apprentice with another company in the same sector of the engineering industry. He had completed his apprenticeship and worked there a total of ten years before moving to another company which subsequently became part of the QVD group, where he had undertaken a HNC and then a HND on day release, moving into management in the process. He regarded his experience as the most important factor for success in the workplace: "If you know how to do the job, you can manage the man who has to do it." CD felt that "soft skills" were over-rated and even poor communicators and poor team workers can get the job done just as effectively through hard work. He did not consider problem solving or self-management as discrete skills for the modern workplace and felt strongly that employees should be developed by the company for selected functions and roles, rather than develop themselves to achieve promotion and progression. He remained with the programme as day-to-day manager until Christmas of 2010, when the first cohort had completed their first term, and was redeployed by the company.

It is noteworthy that neither interviewee gave much regard for the development of transferable skills in terms of adding value to the employee in the workplace. Neither mentioned transferable skills by any definition (including "soft skills") in discussion on the key skills required for effectiveness in their role until specifically asked. NU felt that this was a question of personal attributes: "You've either got it or you haven't," while CD was more of the opinion that skills were gained through experience, regardless of the nature of that experience and he had no regard for reflection: "If you have time to reflect, you're not working, are you?"

These interviewees also demonstrated between them the two most common routes into the engineering profession, full time study to graduate level and apprenticeships. Some of the candidates in the first cohort which started in September 2010 came from apprenticeships within QVD and others directly from full-time study of A-levels. This contrast may prove significant as the research progresses.

Section 2: Research methodology, data capture and analysis

2.1 Research methodology

2.1.1 Case study research

Given the nature of the QVD project – a discrete programme of study for selected employees from a single employer, conducted apart from other cohorts of students and designed specifically to develop distinct work-relevant knowledge, skills and abilities, a case study approach appeared ideal (Yin 2009). The case has distinct boundaries and temporal characteristics and focuses on role, function and organisational needs (Cohen and Manion 2011 p289).

The core research questions here are of a "how" nature, ideal for an interpretive case study, which is particularly suited to how/why questions, contemporary events and studies of an explanatory and exploratory nature (Savin-Baden and Howell Major 2013, Yin 2009).

The intention of the study is to provide a focusing funnel over time to increase understanding of the issue as knowledge develops (Wellington 2000 p90) in addition to answering the research questions.

According to Yin (2009 p41) the quality of case study findings is dependent on four factors:

- the validity of the construct and the evidence obtained
- the internal validity of the analysis and how the inferences and explanations are built
- the external validity in terms of generalisability
- the reliability of the findings in respect of data management and protocols

With clearly defined boundaries and timescales and appropriate "how" research questions, the research was designed to address the above factors. Generalisability is discussed in section 3.4 and reliability in section 3.3.

For a case study undertaken by a single researcher, it is impossible to cross-check validity or observer bias, so although a mixed-methods (qualitative questionnaire and quantitative interviewing) approach was adopted here for triangulation, generalisation relies on justification from the single instance to a representative broader class (Cohen and Manion 2011, Yin 2009).

In designing the data collection procedures, it is noteworthy that, purely for access timing reasons, the initial scoping interviews with the two managers responsible for setting up the project were undertaken in advance of much of the methodological planning. The interviews, questions and transcription process provided considerable insight to inform the process design thereafter.

Data was gathered in the form of a questionnaire and through interviews with the majority of participants, who were the students involved in the first two cohorts of the project and a cross-section of their managers and site personnel. This provided both quantitative and qualitative data to triangulate findings and draw conclusions from (Yin 2009 p81, 114). Questionnaire data provides empirical data for statistical analysis, although given the small numbers of participants involved, the usual measures of statistical significance cannot be applied (Savin-Baden and Howell Major 2013). It is also worth noting that, in line with the approach that confidence in one's skills is a proxy for those skills, much of the empirical data actually relates to qualitative opinion.

Interview data provides focus and insight, although is open to criticism of bias so reflexivity (researcher self-reflection on their own beliefs) is essential in analysis (Wellington 2000, Yin 2009). Key quotations and themes were taken from the various transcripts and the transcripts were then re-examined for conflicting statements or ambiguities.

These methods were considered the most appropriate to obtain appropriate data on the participants' perceived transferable skill levels. Observation of activities was considered but was considered more appropriate for more directly observable skills in the opinion of the researcher.

2.1.2 Questionnaire design

Questionnaires provide standardised data which can be subjected to statistical analysis. However, there is an issue in interpretation here: the questions are essentially exploratory of individual opinions and understandings, so are as much qualitative as quantitative. Even when using an apparently balanced Likert scale with equal intervals, participants tend to demonstrate a bias to the left-hand side of the scale in their responses; this can be mitigated by the use of verbal labels and not a numerical scale for the responses (Cohen and Manion 2011). The categories of novice - beginner – competent – proficient - expert were taken from Dreyfus, Dreyfus and Attanasion (1986) as fulfilling this criterion and being expressed in appropriate terminology which engineering employees and employers are already familiar with, but which are not utilised differently in an engineering context (as stress and strain, for example).

The questionnaires are included as Appendix 3.

2.1.3 Interviews

The bulk of the findings expected from this study were drawn from interviews with the participants, as knowledge constructed between the interviewer and interviewee (Kvale 2009). The interview questioning engaged participants in describing, then explaining and analysing their experience of a phenomenon – in this instance the development of their own transferable skills. In this case the interviewer is both miner (unearthing knowledge) and fellow-traveller (extracting knowledge from the tale of the journey undertaken). It is essential to recognise both the Hawthorne effect, where participants provide over-positive responses and the power asymmetry extant in the tutor – student relationship between researcher and employee participants (Kvale 2009 p10, 33, 48).

A pragmatic approach is required in exploration of the practical implications of the researcher's own epistemological position in respect of paradigmatic conclusions. Having conducted the initial interviews, it was apparent that two conflicting opinions of transferable skills development were likely to be prevalent and as a consequence, in designing the interview questions, it was essential that neither perspective was favoured: in fact, all initial interviews explored whether transferable skills (problem solving, team working, communication and self-management and development) *per se* could be definitively said to exist.

In designing these interviews, reference as made to Kvale (2009) who defined seven stages for effective interviews:

Stage 1, thematise: the researcher has knowledge and experience of the development of transferable skills in both workplace and educational contexts and through in-depth study – the work of Schön (1984) on the influence of reflection on personal practice is integral here; through overview and review of the data, the researcher spirals forward and backward in exploring the participants' experiences.

Stage 2, design: the "how" questions from the questionnaire were developed into "how much" to gain maximum value from the mixed-methods approach.

Stage 3, conduct of the interview: interview questions were developed from the research question, staged to explore, clarify and interpret. The initial scoping discussions were also useful to guide questioning. Interviews were intended to be conducted on a 1:1 basis to establish and explore a single viewpoint. In a limited number of instances, two participants were interviewed together for reasons of time and/or participant availability; in these cases, it was necessary to explore a question with one participant and accept that on some occasions the other would merely concur. Focus groups were used in certain circumstances to explore the breadth and variety of viewpoints, rather than seeking consensus. While Yin applies no specific quality criteria in evaluation of effectiveness in interviewing, care was taken in questioning to ensure knowledge is developed sensitively and participants had adequate opportunity to clarify and expand on points.

Stage 4, transcription: the transcript is the only form of solid empirical data derived from the interview. Audio recording was used for completeness, combined with note-taking to record key points or significant emphasis. Care was taken in transcription with punctuation, with transcription being undertaken as close in time as possible to the interview and by the interviewer, to preserve emphasis where audio recording might not be entirely clear. As Yin notes (p185) there is a significant difference between "I hate it, you know. I do" and "I hate it, you know I do."

Stage 5, analysis: avoiding the danger of "stamp collecting" key points or words from transcripts, a process of meaning analysis was adopted – categorisation and condensation of key issues or opinions, then a mixed-methods approach to finding patterns, themes and assessing their plausibility.

Stage 6, validity: as discussed further in section 3.4, a reflexive approach recognising potential researcher influence was adopted to ensure freedom from bias. Common responses from diverse people offer correspondence and coherence and indicate an objective truth has been achieved; some consideration is required when analysing information on opinions. Tests against competing interpretations provide clarity and verification.

Stage 7, reporting: Kvale recommends avoidance of a hyper-empirical reporting style of absolute precision and conformance to the words and phrasing and conclusions drawn therefrom; the reporting style adopted here is intended to emphasise readability while remaining true to the expressed views of the participants.

2.2 Research plan and data collection

2.2.1 Students

For the quantitative element of the research, a questionnaire was devised to issue to all participating students; this is included in Appendix 3. The questionnaire probes the participants' own perceptions of, and confidence in, their transferable skills, which can be regarded as a good proxy for the actual skills themselves (Little 2010). Brenda Little's study suggests that confidence in one's ability in terms of teamwork or problem solving, for example, generally reflects actual ability since one is aware one can perform well.

Participants were asked to rank ten transferable skills criteria which could reasonably be developed in Higher Education in order of importance for their career progression; these criteria were drawn from all the various definitions and criteria collated in the production of Figure 1 in section 1.2 above.

These criteria were:

- Higher-level subject knowledge
- A qualification for my CV
- Literacy / numeracy / IT skills
- Communications skills
- Research and information-finding skills
- Business awareness
- Self management skills (time management, researching etc.)
- Self-development skills (building your own knowledge etc.)
- Team working skills
- Problem solving skills

Some, such as communication, self-management and self-development, are core transferable skills, while others, for example the qualification, were included to indicate the participants' perceptions of what is required for success in the workplace.

Participants were then asked to rate their current level of performance and ability in four core transferable skill areas – group work, communication, project planning and management, and personal awareness. This was done with five sub-questions for each skill category, the questions being adapted from Alpay and Walsh's skills perception inventory (Alpay & Walsh 2008), which offered the best "fit" for the purpose of this study of the various similar instruments explored. This was contextualised to increase the relevance to the participants' level of knowledge and experience (since the Alpay and Walsh inventory was aimed at postgraduates with a greater vocabulary of Higher Education terminology). The ranking was on a modified Likert scale, using categories of novice, beginner, competent, proficient and expert, which were considered by the researcher to be the most appropriate and understandable headings to generate valid feedback (Dreyfus, Dreyfus and Attanasion 1986).

Participants completed the questionnaire three times each, at the start of their programme of study (during the induction phase), at the end of the first year (almost all of which is spent studying at the College) and on completion of the HNC (at the end of the second year, which is 40:60 College/on-the-job training). Responses to previous questionnaires were not available to participants when asked to complete them. In this way, it was possible to explore the changes in perception of the relevance of transferable skills as participants became more familiar with their workplace role and also their perceived level of ability in terms of these transferable skills as they progressed through the Higher Education programme.

Interviews were carried out with the participants, ten students from each of the first two cohorts of the programme; some 1:1, infrequently 1:2 and some with the whole cohort (partly for convenience of access and partly to explore whether these generated more or less comprehensive responses). The interviews were intentionally exploratory, based around the content of the questionnaires and any emerging findings, to provide further information on individual participants' perceptions (Cohen & Manion 2011, Savin-Baden and Howell Major 2013, Wellington 2000).

The cycle of three questionnaires and interviews (where all student participants were interviewed at least twice during their programme of study) was carried out for two cohorts each of ten participants, the first between September 2010 and June 2012 and the second between September 2011 and June 2013. Obviously, these processes overlapped, but the data has been disaggregated by cohort rather than assembled chronologically for clarity.

2.2.2 Employer representatives

Nine managers all completed questionnaires at a recruitment event in February 2012. Unstructured interviews, based on their responses to the questionnaire, were conducted with six of them in the following nine months on a 1:1 basis.

The qualitative questionnaire, modelled along the lines of the student questionnaire, is also included in Appendix 3. Participants provided their highest level of qualification for benchmarking against the subsequent findings.

The ten transferable skill criteria used with the students above were replicated with employer representatives ranking them in order of importance for the trainees' career. This will provide evidence of whether the students' perceptions of the relative importance of their various skills correlate to their managers' perception of them, and this was tracked through the programme to record any changes.

The same ten criteria were then addressed twice more: the managers were asked to identify the three they gained the most from their Higher Education experience and the three that have been of the greatest benefit to their career since then.

Section 3: Research Findings

3.1 Analysis of research findings

3.1.1 Student questionnaire data

For cohort A (2010 intake), it is apparent from figure 2 that the relative perception of the importance of the transferable skills criteria changed, mostly following a linear trend, over the two-year period. Scores for the ten participants were averaged, and low numbers denote high importance, as with the Likert scale employed. The following conclusions can be drawn:

- Higher-level subject knowledge – *decrease in importance*
- A qualification for my CV – *sudden increase at end of year 2*
- Literacy / numeracy / IT skills - *decrease*
- Communications skills - *increase*
- Research and information-finding skills - *decrease*
- Business awareness – *slight increase*
- Self management skills - *increase*
- Self-development skills - *increase*
- Team working skills - *decrease*
- Problem solving skills - *decrease*

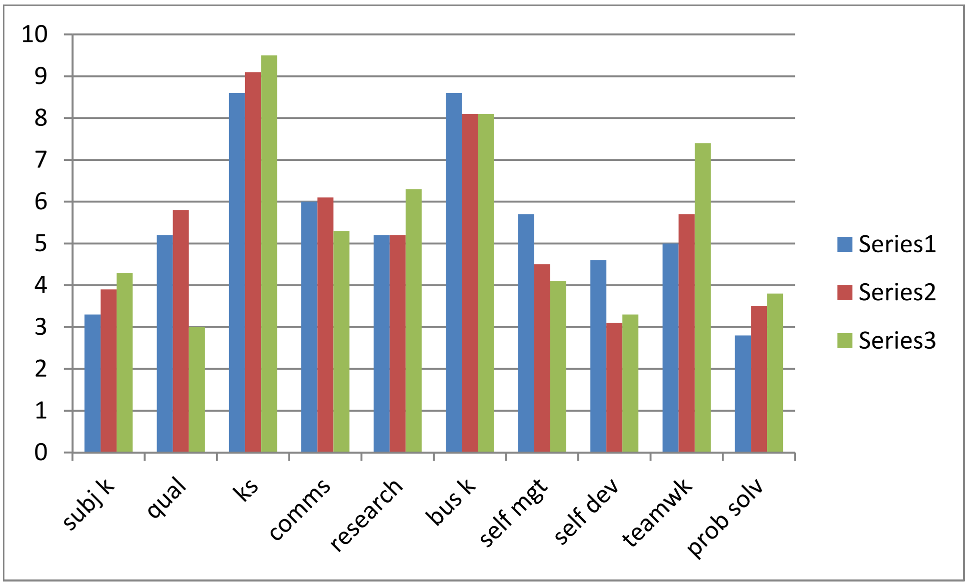


Figure 2. Cohort A mean value of perception scores for the importance of key aspects to their career aspirations at the three survey stages.

If it were expected that over the programme students would recognise the increasing importance of transferable skills for the workplace and so their importance should increase, this would be borne out in terms of communication, self-management, self-development, team working and problem solving. Team working was consistently regarded as being of the greatest importance on average, with problem solving a close second, and the others all increased in perceived importance over the two year period. Literacy and numeracy skills and business knowledge and awareness were consistently regarded as being of least importance. There was a sudden increase in the perceived importance of the qualification itself at the end of the programme (summer 2012). These emerging trends were explored in interviews.

For cohort B (2011 intake), the picture is less consistent, as shown in figure 3. It is possible that the inconsistency is related to structural changes within the company which were taking place throughout 2011-12, discussed later, which changed the employer's focus on this development programme and its trainees. The relative importance of both self-development and teamwork declined, while the remainder of the criteria remained constant. Business knowledge and awareness was again regarded as of least importance. There was a marked increase in the importance ranking of the qualification itself, which occurred at the end of year 1 (2012) and coincided with the similar step at the end for cohort 2. These emerging trends were explored in interviews.

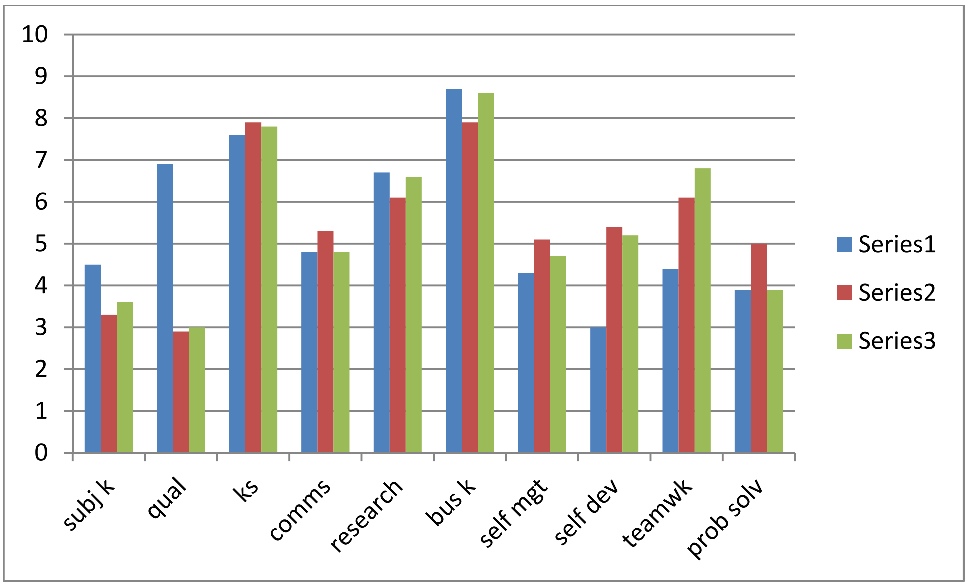


Figure 3. Cohort B mean value of perception scores for the importance of key aspects to their career aspirations at the three survey stages.

For the skills perception questionnaires, the cohort A data shown in figure 4 depict a clear pattern of increasing confidence in the participants' abilities in the four key areas when averaged. The increase is greatest in personal awareness and least in communication skills.

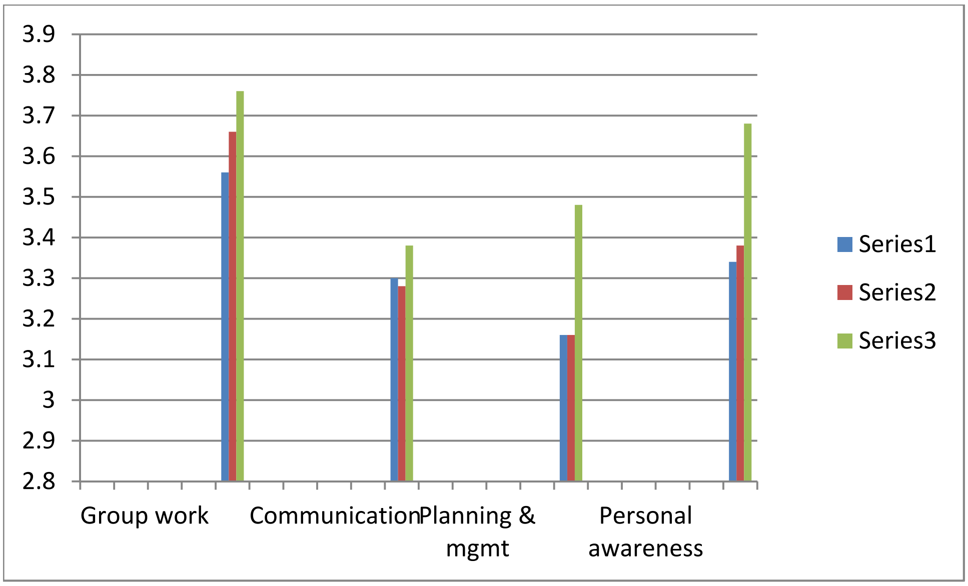


Figure 4. Cohort A mean value of personal skills perception surveys at the three survey stages.

The cohort B data in figure 5 below show similar, and equally marked (allowing for differences in chart scale), increases in perceived level of the four transferable skills, with the final "scores" being higher than for cohort A. Relative increases reverse any trend given in the cohort A data.

It is worthy of comment that with only ten candidates per cohort and three survey interventions, no valid numerical analysis of statistical significance can be performed, although clear trends can be demonstrated. The raw data is in Appendix 4, along with mean (as used here), modal and median averages. The latter measures were too broad to reflect upon, with a statistically small sample and only five numerical criteria; substantial changes in whole-group perception scores would be required to change the modal or median value by +/-1. Since all participants are male and of approximately the same age, no cross-correlations can be made in these respects.

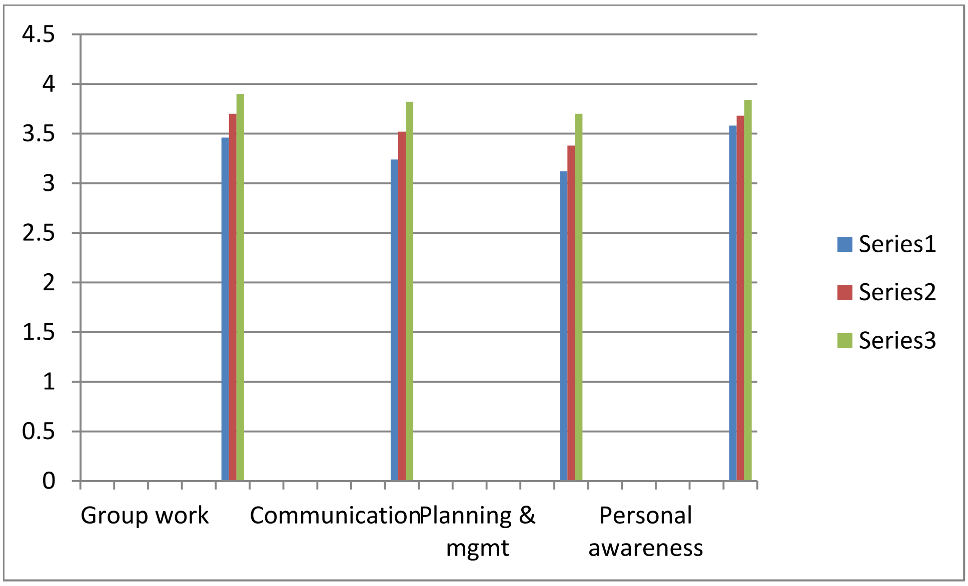


Figure 5. Cohort B mean value of personal skills perception surveys at the three survey stages.

3.1.2 Managers' data

From Figure 7 below, the managers rated subject knowledge, followed by qualifications and self-development skills, as the most important aspects of an education programme, with business and communications skills and generic literacy and numeracy ranked lowest. The high value placed on self-development skills appears to be at odds with the literature.

When asked which skills they themselves had gained from their education, the same three criteria came top and bottom respectively, as can be seen from figure 8.

In terms of the criteria of most value in the workplace, problem solving, communications and qualifications were considered most important.

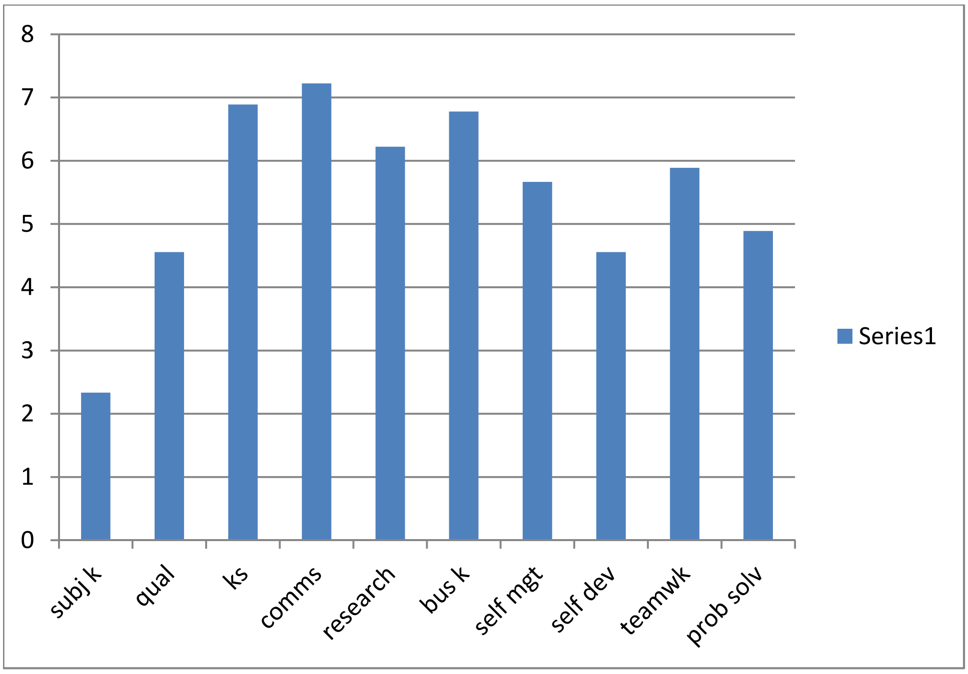


Figure 7. Managers' survey mean score for the importance of the key aspects in an education programme (low scores = more important) for nine managers.

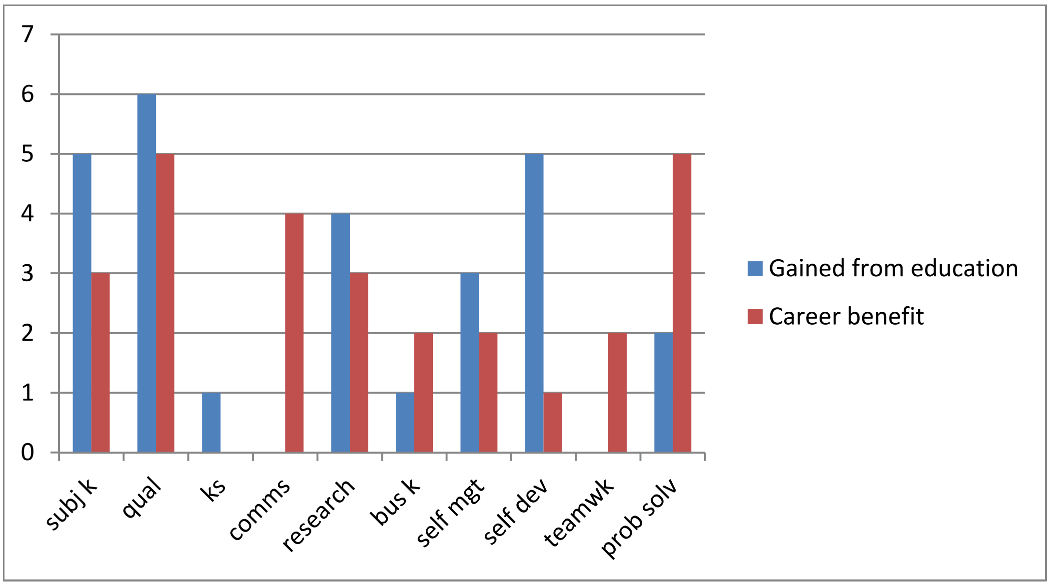


Figure 8. Managers' survey mean score for the extent to which the key aspects were required by education and were of benefit to their careers, for nine managers (high scores = more important).

3.2 Interview findings

3.2.1 Emerging trends for exploration

The interviews conducted followed a round of completion of questionnaires as closely as possible. Beforehand, a broad analysis of the questionnaire data was undertaken to identify particular trends, for example an increase or decrease in reference to or perceived importance of particular criteria, and interview questions incorporated exploration of these areas.

Similarly, each round of interviews conducted was analysed for emerging trends on the basis of counting references to the skills and experiences under discussion and those which exhibited high or low frequencies, were highlighted for further exploration.

For cohort A, there was a general trend that transferable skills increased importance to the students for their perceptions of their importance and their ability to perform them. Literacy and numeracy skills and business knowledge and awareness were consistently regarded as being of least importance. There was a distinct "blip" in the perceived importance of a HE qualification around the end of the 2011/12 academic year, as previously noted.

For cohort B (2011 intake), the same "blip" occurred relating to the importance of a HE qualification at the same time. The perceived value of transferable skills to the students remained generally constant and any declines could be explained as changes in relative importance. Business knowledge and awareness was again regarded as of least importance.

From the managers' questionnaires, it was immediately apparent that their opinion of what should be contained in an educational programme at this level closely resembled their own experiences, while the aspects of value to their professional career differed. The relatively high importance of the qualification *per se* to the managers was noteworthy, particularly as these questionnaires were done in early 2012, a few months before the unexpected "blip" with the students' opinions. These trends and areas of significance were also explored in interviews, which took place with six of the managers.

3.2.2 Student interviews

3.2.2.1 Cohort A, first interview

The first meeting with cohort A was done as a focus group with the whole group present, after completion of the questionnaire but before analysis of the data. The ten students were all articulate but most displayed a tendency to speak first and consider answers later, for example:

> JM: "Why do you think self-management skills would be important?"
>
> ID: "Because we spend a lot of time working on problems in teams so we... No, that's problem solving, and team working, isn't it?"

Findings from this focus group were more difficult to disaggregate as a result, so focus groups were used as infrequently as possible thereafter.

Of the ten students, four (hereafter IC, KK, LS and TK) were former apprentices and were familiar with the site and job role. The other six (hereafter RV, ID, MN, BI, KU and KI) had all come via A-levels or other full-time study in sixth form or College. They had no experience of working or of living away from the parental home. Since they had all just started in their role, and most in their first employment role, a significant proportion of this first interview was taken up with their perception of their job role, what they thought it would entail and the challenges they thought they would face.

> KU: "I would have thought QVD would have taught us management on this, because we'll all be managing technicians and I've no idea how to do that. Can you teach management?"
>
> JM: "Do you think managing people can be taught?"
>
> KK: "No, not directly, you have to just do it, but you could teach us what mistakes to avoid."

The interviewer pursued the company's business and the students' awareness of their role in the corporate structure; there is evidence in the literature that trainees lack this awareness on entering employment.

> JM: "Do you know how much income your job role brings to the company?"
>
> LS: "None. We don't have anything to do with the customers, we're just keeping the plant operational. The business stuff is handled by accountants and such."

This was the general view of the group.

All the students were new entrants to Higher Education and this interview paralleled some classes in the early phases of the programme on developing students' study skills, researching and reading skills. The classes utilised a generic set of materials used by the College at that time.

> JM: "We've done some work on researching material to add to your knowledge. How important is that for your career role?"
>
> RV (not a former apprentice): "Very important. Well, we don't know anything so we'll have to find it all out and I guess it'll have to be quick."
>
> KK (former apprentice): "No, you just ask the people around or phone someone at another site. There are manuals and stuff, but most of it is laid down in procedures and instructions."

The most apparent findings from this first focus-group interview were that the students at this stage understood very little of their role or of the programme ahead of them, and also that whole-cohort interviews tended to be confusing and difficult to analyse, with everyone trying to talk at once; as a result, focus groups were employed a little as possible thereafter. It was clear, though, that none of the students had considered transferable skills as elements of their learning for job effectiveness until specifically introduced into the questioning.

3.2.2.2 Cohort A, second interviews

These were conducted on a 1:1 basis (two were on a 1:2 basis for reasons of expediency), some at the end of the first academic year and some over the summer or at the start of year 2. Results of the first two questionnaires had by this time been gathered and analysed.

All students were asked in which specific areas they felt their transferable skills had improved, and why.

> IC: "Subject knowledge, because we've done so much work and learnt so much this year. There's some of it I guess I won't use on site, but lots I know would have been useful already. And research, there's a lot we haven't been taught but we've been expected to find stuff out."
>
> JM: "How did that go?"

IC: “Well, we all kind of shared out the workload and did a bit each, then put it together on our own. Am I supposed to say that?”

JM: “Is that not team work?”

IC: “Well, yes, but we didn’t all do all the work. I guess it is, so long as it’s OK.”

RV: “The one area I’ve really struggled with has been the self-management and time management. I’ve never had to plan out my time with so many deadlines and submissions over the three week block. I’ve got a diary now.”

KK: “I think I brought a lot of skills from being an apprentice on site. Apart from the College bit, QVD threw you in at the deep end and so I needed to find out for myself a lot.”

ID: “I needed a lot of help with the maths from the start, and the lads helped and so did you, and I always seemed to be up all night to hand work in. I’m getting better but the others are really organised. I’ve started going back over my course notes, too, and I reckon I understand it better.”

LS: “A lot of what I learned in my apprenticeship has helped, but this work is really hard and I’ve been hitting the books a lot.”

JM: “We don’t recommend texts for all the modules, do we?”

LS: “No, and the library, well, they were OK but they didn’t understand what I wanted all the time. When you get to this depth, Google’s crap and you don’t let us use Wikipedia.”

JM: “So how have you coped when you needed information?”

LS: “We’ve all mucked in and found stuff. [RV] is best at this, just finds odd sites, some of them are universities like Harvard, where we can download information. He’s been a real help.”

MN: “I wasn’t really a team member before, I’ve always done individual sports and not had to work with other people before. I guess I pissed some of them off a lot at the start because I wanted them to give me their bit so I could write it up. Now I get it – finding the information is as useful as what you do with it and takes loads of time.”

BI: “Definitely it’s all about communication. Before, I’d never done presentations or anything like that. That was really difficult and I didn’t feel comfortable at all. Talking to teachers, they expect you to remember all the technical terms and that, and I’m still struggling to remember what things are called sometimes.”

Business awareness had scored very low in the questionnaires, so the students were asked why they felt it was unimportant.

KU: “I’ve only spent a couple of weeks on site, but really we’re not involved in the money side. Except that everything we want we have to justify the spend and get quotes if it’s over £500. The managers don’t want to spend on stuff even when it’s needed. For example, at the last outage [plant shutdown for maintenance] there weren’t enough tools and me and [MN] were just running around giving tools to people.”

JM: “Do the managers explain why they are controlling costs?”

KU: “No, I guess it’s obvious really, that they don’t want us to spend on stuff we don’t really need, but they’re tight on stuff when we do need it.”

TK: “My manager told me once I cost the company twice what I’m worth until I’m trained but I can’t see how he can work out what I’m worth, because, well, the work is done by a crew and there’s lots of times where we’ve nothing to do because we’re waiting for an outage.”

It was apparent in this second round of interviews that the students perceived that their transferable skills become more developed, and that they had the confidence to reflect on their experiences and express that. It was also clear that, having initiated the discussion on the importance and relevance of such skills for the workplace, the students were much more aware of this; care was taken with future interviews to balance transferable skills development with the development and application of knowledge in questioning, to prevent the focus of the research becoming the focus of the students' learning.

3.2.2.3 Cohort A, final interviews

Having analysed data from the third round of survey questionnaires, the importance of the qualification to their careers had increased unexpectedly. This was explored with a number of the students.

> KI: "QVD have a new structure, they're changing jobs for a lot of the operatives, maintenance men and drivers and so on. You need a qualification to keep those jobs and to get promoted. We can't get promoted without HNC. It's changed and I think we're all worried about our jobs."

> ID: "There's a lot more work on sites, we're getting worked harder and finding stuff for you to do between outages, even clearing drains and that. Everyone's talking about this restructure, not sure it'll affect us because we're on the programme but there are supposed to be jobs going."

This led to questioning about the importance of understanding the company business and finances.

> LS: "No, we don't really know about the costs and stuff. They quote us massive figures and say if we're on outage or shutdown how much money it's costing but then we have weeks without a shutdown [unforeseen cessation of plant operation] and they're still on about it."
>
> JM: "How could you find out more about the costs of the business?"
>
> LS: "Don't know. Don't think my manager knows, or the shift leader. They're all just trying to save money everywhere. We can't

be going under or anything, because we’re worth billions, but I guess profits are screwed.”

The students perceived they had developed considerably over the two years and all achieved high grades in their HNC; they were not only adept in the application of propositional and procedural knowledge but also had demonstrated their facility in the use of personal knowledge in self-management and self-development through the independence demonstrated in attaining the high standard. This aspect would not have been made explicit without involvement in the research study and several of the students commented that the reflective opportunities provided through the study had been beneficial in developing their confidence in these personal skills.

3.2.2.4 Cohort A, focus group on Extended Project

At the request of the employer, the four former apprentices, who had already achieved their NVQ2 as part of the apprenticeship, piloted the Extended Project. These were IC, KK, LS and TK. They undertook the initial conceptual design and product analysis for a table-top miniaturised wind tunnel. The requirements of the Extended Project are not as stringent as the HNC Project Design, Implementation and Evaluation module (which was individual and company-specific, at the request of the employer), but required a log of the processes and procedures followed and a reflective record of the learning which took place. This could be presented in a variety of ways – online blog, video diary, reflective journal – and this focus group formed a part of the reflective element for the four candidates.

> JM: “How was this work different from your other experiences, both in company and at College?”
>
> TK: “Very different; just so open. At work you get told what to do but here we were given a project, it wasn’t the same.”
>
> KK: “We were told what to achieve instead. Like an engineer, not a technician. Some of the College work has been like that, too, but not as hard or as, well, totally free.”

JM: “What about the team working aspect?”

KK: “We all tried to do everything at first, then realised we had to split it up. We discussed having a team leader but in the end we ran the team ourselves, sort of democratically.”

IC: “There were times when none of us knew what to do, though. We had to hit the books and find out what we needed...”

LS: “We didn’t know what we didn’t know. I remember you saying that now.”

KK: “That was kind of the main issue: finding out what we needed to move the project forward. Sort of real engineering.”

JM: “What did you learn about the real engineering aspects, then?”

KK: “I guess mainly we felt out of our depth at the start, too much new to take in and we knew nothing about [wind tunnels]. Had to find out about all the elements, why they are designed like that, what they do. One of the engineers at site was a help.”

TK: “He gave us some places to look and some key words.”

JM: Overall, how do you feel the project went?”

LS: “Badly. We started out thinking we’d have a finished product and we’ve only done the first bit.”

TK: “Learned a lot, though. You said you’re going to get the next lot to carry it on, so we’ve produced a file of all our stuff for them. Given them a head start.”

JM: “What support did you need, what did you get, and was that OK?”

KK: “Yes, we wanted to be told more, given more, at the start, but then everyone kept asking questions, not giving us information, and we had to think for ourselves.”

LS: “We were allowed to make mistakes. The whole first design was wrong and you must have known that. You let us go wrong so we’d

> realise our own [mistakes]. The only time you ever said 'No' was the smoke blower, when we would have set off the fire alarms."

Overall, the students' experience was of a steep learning curve into the role of an engineer within a team, and the staff supporting them did so them only by providing avenues to explore and key resources. It is noteworthy that all four students gained 'A' grades for their Extended Projects and Distinctions for their HNC Project modules a year later. Their democratic approach to project management proved effective, since all participants were fully engaged, and once they had realised their initial plans, schedules and proposals were unrealistic, they worked together effectively. Observation of this taking place was a component of the assessment for the Extended Project.

3.2.2.5 Cohort B, first interviews

Of the ten students in cohort B, four (hereafter EI, TH, EB and CO) were former apprentices, five (hereafter MT, KS, MD, BL and SG) had come directly from sixth form or college, and one (BH) was a graduate in an unrelated discipline. Having established that the first cohort lacked understanding of the nature of transferable skills in their own context at the start, this cohort received more specific skills development as part of the programme induction: the generic materials were improved and contextualised and delivered over a longer period of three weeks. The questionnaire was administered beforehand and the interviews took place during this introductory phase. All students were asked about the relevance of transferable skills in the workplace in individual interviews.

> MT: "It's all about being in a team. I suppose there are times when you need to be independent, like when you find a problem on the weekend shift and there's nobody else, but mostly it's about working with other people. Some of them are really thick and it's hard not to tell them."

> BH: "You've put tutorials in here. When I did my degree it was just the deep end, you had to know how to research and reference or you had to find someone to tell you. I didn't really get any of it in my first year, but I'd done most of the really hard stuff already so I

> spent a lot of time finding out how to do things instead. It’s better to be taught things, except it helps to know how to teach yourself. I guess that’s coming. I think communication is important. On our site, it’s really crap and nobody knows what’s going on a lot of the time. Then you get told to do stuff and you don’t know how – I’d only been there two weeks when we came here.”

> BL: “Yeah, we did a lot of stuff on communication, presentations and stuff, at my college, and I was really good at that, but it never counted, it was only the maths and stuff which counted. I’ve only been on site for two weeks, but everyone seems to be standing around talking all the time.”

> EI: “I’ve been at site three years already and we’ve never thought about transferable skills being something you can learn, you just develop as you go along in terms of managing and building your knowledge and your career.”

In common with Cohort A, these ten students had never considered transferable skills, or even recognised them as such, prior to them being made explicit in study skills development sessions and in discussions related to the study.

3.2.2.6 Cohort B, second interviews

The second interviews, all completed with pairs of students during the summer vacation on a visit by the researcher to a training course where all were participating, coincided with the phenomenon relating to the sudden increase in the perceived importance of qualifications to the students.

> MD: “Everyone’s been re-graded and stuff. You can’t get promoted without qualifications and loads of guys on the maintenance crew have been asked to do NVQs or get sacked. They’re saying my site’s not profitable any more and we’re not spending on anything.”

> BH: "It's also about the degree. Mine won't count for a graduate engineer's job and there's others in the same boat. We need to get this qualification or we're out. Without a HNC I don't have a placement when we finish."

Other questions related to the value of transferable skills and the students' responses to the questionnaire, which were generally fairly consistent.

> KS: "I think we were all aware at the start of what you need to succeed. I think we've all got better at the team work and the research. And the self-management. I'm not struggling to get work in on time now. Problem solving is what engineers do, isn't it? We get lots of that and they tell us it's important on site, but at the moment the team leaders just tell you what to do and you get on with it."

> EB: "Going to need all the thermodynamics and stuff in the next outage, there's a load of tech upgrades going on. I'm still a labourer really and get told what to do but I'm learning on site as well as here."

3.2.2.7 Cohort B, final interviews

These interviews were conducted at the end of the programme, just after the final project presentations, to groups of two at a time (due to time constraints). The last round of survey data had shown that the relative perception of the various skills had remained mostly level throughout the programme for the students, although their perceived competence in the various aspects had improved significantly in their opinion.

> SG: "Yes, I've learned a lot. I can research for myself a lot better, not just Google, although I don't think I'll be using journals at work much. Presentations, that's communication and mine went OK. I couldn't have done that at the start."

> TH: "And all the science and maths. I had to go back and remember loads of the first year for my project, even the business unit, and I

can understand what the engineers are talking about now with some of the problems on site.”

EI: “I believe I’m a better engineer now. I know what I’m doing more on site and I’m getting my own maintenance crew when I go back. Don’t know how that will go, I’ll probably just call them all idiots the first time it goes wrong and I’ll get a shovel round the head.”

BL: “They are all idiots, though. I don’t say that on site, though. You have to keep your mouth shut. Is that a transferable skill?”

CO: “I know that when I came on this programme I didn’t know anything. Now I can do the maths and I know what it’s for and I understand all the thermodynamics and the stresses and the electrical, did a project and all. My shift leader reckons I’ll be leading a crew soon, when I’ve got some more experience.”

MD: “Still don’t really understand the business stuff, like you said. I get the whole return on investment and payback time stuff from the project, and why you don’t do a project if it doesn’t pay for itself, but day to day that doesn’t make sense on site. I asked how they calculate my costs and that, and my team leader didn’t know. We’re all getting much more to do, nobody’s standing still between outages, we’re all given jobs.”

It was apparent that the students felt they had developed considerably in the two years, as reflective individuals whose transferable skills and confidence had improved; there was general agreement that without the involvement in the research study, it was unlikely any of them would have focused on these skills or their development. Their general view was that their skills would have developed through experience nonetheless.

3.2.2.8 Cohort B, focus group on Extended Project

Having seen the outcome of the first group project, the employer requested that all ten students undertook the Extended Project, which had only been undertaken by a few of them from the previous cohort.

Three projects were identified: continuing development of the miniature wind tunnel, developing a fluid flow demonstration platform, and investigating innovative storage solutions for examination tables. One focus group was conducted with all ten students, to enable them to compare experiences for the reflective journal.

> JM: "[Those of you who took on the wind tunnel,] how did it feel to pick up someone else's project to develop?"
>
> EB: "Actually, like a lot of what happens at work. Shift changes, staff changes. Really cool to have the early background research done for you."
>
> CO: "Yes, we could start making something straight away."
>
> MD: "Although we started too soon on that, should have done more research."
>
> JM: "What about those of you who started from scratch?"
>
> BH: "Great project, we didn't think we needed any information so just started. That worked OK, because when we realised we needed stuff on the strength of cardboard and how to fold it, we could pinpoint the research at the important questions."
>
> KS: "We knew we would need some technical information, but had something we could start straight away. I'm really pleased with our project, I think we could sell the finished design and it would be a solution to storing all those individual tables for exams in schools."
>
> BH: "Lots more work to do first, no idea yet of how long the folds would last."
>
> JM: "And the hydraulics apparatus?"
>
> SG: "Wow, there was so much we didn't know how to do. I learned all about flow and valves off the internet and we didn't use most of it. We [messed] up on time, though. So much to do at the end and it still doesn't work."
>
> TH: "We didn't realise how much work building the prototype would take, we'd like to finish this off because it's nearly there and you could use it with lower students. I suppose we learned a lot about planning, too."

> SG: "Planning, definitely, yes. Wasted lots of time on stuff we didn't need, or where we could get [information] from site. Got bogged down in the whole miniaturisation thing."

> JM: "Overall, what did you learn from the experience?"
>
> BL: "Loads about managing yourself and time. We set everything up at the start, planned it and stuck to the plan."
>
> KS: "Except the plan went wrong and we missed all the deadlines."
>
> BL: "Yes, I mean we learned a lot about planning when it went wrong. Like every engineering project, I suppose."

This group also demonstrated considerable independent learning and self-development skills through their respective projects, all of which were passed to other students or groups to progress further. This particular cohort experienced difficulties with time management at the start of their first year and it became apparent that the team management of this project work aided them in developing a deeper understanding of working toward objectives. It is noteworthy that all students in this cohort gained Distinction grades for their HNC Project module in their second year. It is rare for an entire cohort on a qualification to achieve this; it was queried by Edexcel who confirmed the grades after standards verification.

3.2.3 Student interviews commentary

It was apparent from the interviews that the students were clearly able to relate the transferable skills discussed in the interviews with the requirements of the academic programme and, in time, of the workplace. As the demands on them increased, in terms of independent research and problem-solving and of increasing challenge, they were able to articulate in interviews how they felt their development in these areas was progressing.

One aspect which became apparent through the interviews was that none of the students was aware of their developing transferable skills until questioned and asked to reflect on such development. Once introduced to reflection, through the interviews, several of the students became progressively more articulate in expressing how and where their transferable skills were developing.

Two students in particular, KK in cohort A and BL in cohort B, had a very high opinion of their skills on entry to the programme. Both were very capable but possessed a higher opinion of their capabilities than their peers. KK retained this opinion for the first year, which impeded his self-development and it was only once the demands for independent working began to impact during the second year that he admitted in interview he had additional skills and experience to gain. BL, although academically bright, lacked social interaction skills and tolerance of others, which caused a number of arguments in the first year of the programme. Interviewing him, it was apparent that he had never really changed in personality terms, but had just learned to keep his opinions quiet in some circumstances.

The students did not discuss the company's business in financial terms, even when it became apparent that profits were down dramatically in 2011/12. They appeared unaware of the value of their contribution to operations in monetary terms and their managers were equally unable to quantify this themselves.

3.2.4 Managers' interviews

Six managers participated in interviews, which took place over an extended period between early 2011 and late 2012. Three of these, SA, CV and ES, had been apprentices in the industry who had achieved their HE qualifications part-time while in employment, sponsored by their employer. The other three, TS, OV and CB, had entered the industry via the graduate route. It was apparent that these two groups had disparate opinions on the development of transferable skills which directly aligned with their respective backgrounds.

The interviews were structured around how each individual felt they had developed their own transferable skills, focusing specifically on communication, problem solving, team working, self-management and self-development and business awareness, and how they felt these skills could be best developed. This comprised the five skills forming the focus of the study plus business awareness due to identification of this as a weakness in the literature.

3.2.4.1 Former apprentice managers

It was immediately apparent that these three individuals all felt strongly that a practical apprenticeship and "starting at the bottom" was the best way to develop the key skills for career progression and self-development.

> SA: "You develop team-working skills working in a team. It's OK to go on these development days out where you're all moving barrels round a field or something, but real team working is about having to live with your decisions the next day and work with people long term. It's about playing to people's strengths and you can't learn that in an artificial environment."

> ES: "A lot of what was expected of me as an engineer, and then as a manager and team leader, I didn't know and learned for myself, but I'd seen my own managers and the engineers I worked with doing it. I couldn't have managed this without some experience."

These managers' experiences were strongly focused on the apprenticeship approach. Although none of them were familiar with the work of Lave and Wenger, they all concurred with the concept of "legitimate peripheral participation" (Lave and Wenger 1991) as the process of inclusion into a community of practice (Wenger 1998), when this concept was discussed with them.

> CV: "Doing my HNC in the evenings I met other engineers from other companies in the same position. I was frustrated when sometimes the college I was at made the course very theoretical and academic and not about the job you do at all. The theory is important, but I thought I knew which bits were important better than the college did. I think I learned more real thermodynamics at work, from the team."

All three individuals were strongly of the opinion that experience is the key to development of transferable skills, and they had gained that experience in the workplace from an early career stage. There were a couple of comments about learning from mistakes made, but the individuals were reluctant to go into detail.

The three also regarded pure technical knowledge, gained from their higher education qualifications, as being of lower importance than their knowledge of the actual practices and processes of the industry.

3.2.4.2 Graduate entry managers

Here, the general opinion of the three individuals was that their chosen route to their current position had provided them with sufficient opportunity to develop the relevant transferable skills, despite entering the profession later.

> OV: "My role is highly technical, I use all the elements of my degree. When you get to finals, there's a great amount of learning for yourself and the pressure situation of that learning and having to know and understand to succeed is excellent preparation for a career. Most of what I use at work in terms of self-development and self-management comes from that time. Communication, too, presentations and report writing. What you might call management skills, well I've picked that up I suppose."

> OV: "The company recruits graduates for engineering roles. I think it's clear that this policy is to get people with the right skills."

> BA: "I did a group project and an individual project on the way to my MSc. That involved all your transferable skills on the way, including business and management. You certainly cannot develop those sort of skills without experience, but universities have woken up to that and the experience is in the course, you don't even need a sandwich degree. All I needed when I started [in the industry] was the company-specific knowledge – specifics of the plant, and systems and processes and procedures."

In terms of the best route to developing the key skills for effectiveness and career progression, all three were consistent in recognising the need for experiential learning, but that it need not be located wholly in the workplace.

> SR: "You need all those skills at work, but companies want people who are work-ready. If those skills are developed in your degree, then you're fit for the job from the outset. There's always an induction to procedures and operational requirements. You need some experience of team work and so on, but I learned all that at university. Some from the course, some from playing hockey."

> OV: “It’s vital to experience the way an engineer works, but if that’s not part of your degree course, how can it be an engineering degree?”

It was also noteworthy that these three managers placed a very high value on the technical knowledge gained through higher education, regarding it as essential for their roles in the industry.

3.2.4.3 Managers’ interviews commentary

It is clear that one’s own experiences define one’s opinion of the optimum approach to developing the skills one possesses and attaining the position one has reached. All six managers agreed that transferable skills cannot be developed without experience, however, their opinions on simulation and developing skills in an artificial context rather than a genuine workplace differed on the basis of their own experiences. The graduate managers had direct experience of both skills development in an educational context and experiential development in the workplace; they all placed greater value on their formal educational experiences.

There was a clear indication that a HE qualification itself held significance for managers but, as with the students, it was apparent that an internal company restructure had focused their attentions on this, as with the students. Certain career progressions would be barred to people not possessing certain qualifications.

As with the students, none of the six managers had given specific consideration to the development of transferable skills or explicitly reflected on their abilities in these areas prior to participating in this project. In each case, their reflections expressed in interview were the first time they had considered their skills and abilities in these areas in detail and as discrete aspects of their professional capabilities.

3.3 Conclusions and Recommendations

Transferable skills are obviously developed through experience. It is clear from the above that the participants believed that not only does this take place most effectively through direct experience within the workplace, but it also takes place through project work and other relevant simulation activities in a work-related environment. Some participant managers who had experience of both approaches actually valued this simulation approach above direct workplace experience, although this possibly related to their first experience in developing and applying such skills, where the development takes place rapidly, rather than the incremental, evolutionary development which takes place thereafter.

There was a distinctive difference in attitude between those managers who had learned and developed their skills wholly through workplace experience and those for whom the development had taken place in an academic context. Intriguingly, all managers felt that their own experience provided the optimal approach in this regard. Since all the students, and all the managers, were in approximately the same roles and career positions, it is apparent that either transferable skills are not essential for career progression (and all of the managers disagreed with that) or that both experiential and simulation approaches are equally of value.

All participants expressed clearly that experiences where they were utilising specific transferable skills were the most valid means of developing confidence in those skills. It was almost always increasing confidence which led participants to identify where their skills had improved.

All participants who had experience of simulated workplace environments agreed that these needed to be directly relevant in context and valid in terms of activities undertaken to be of value as a developmental tool. "Engineers develop through doing engineering," (CV, manager interview).

Two other significant considerations emerged from the research: firstly, that neither in their previous academic or professional experience had transferable skills development been explicitly considered by the participants; these skills were put down as experience gained, rather than abilities developed. The experience was seen as peripheral to experience of the job function and therefore not as valuable, rather than adding to their competencies and abilities for effective function in the workplace.

By making such skills development explicit through participation in the study and relevant activities, participants were more aware of these aspects and of their impact on career progression.

Secondly, consideration of such skills development required reflection *post hoc*, which is something none of the participants had previously formally engaged in. The act of reflecting, through participation in interviews and project-related reflective activities, made a significant contribution to participants’ confidence in their transferable skills and the manner in which they were developing.

Any simulation activities to be deployed in future in an educational context therefore require relevant simulation and a reflective element to maximise the development of transferable skills for the engineering workplace.

3.4 Validity of the findings in a wider context

Although the questionnaire generated a volume of “hard” empirical data appropriate for engineering study, it is apparent that with small cohorts, this has little statistical validity in a wider context. The data did, however, provide effective correlation against the findings of the interview process and in particular clear chronological correlation with expressed confidence in the student participants’ skills development.

The only significant area of conflict in the findings was that all managers appeared confident in themselves that their own experiences in attaining their current position represented the ideal route to that position. While some participants had very limited experience of skills development through simulation in an academic environment to contrast with workplace experience, even those who had experienced both aspects in their career progression felt that their own experience had been the most appropriate one at each stage and level of their development.

The conclusions drawn from the interview evidence are credible and valid, since they reflect the findings of the literature and appear reasonable and sensible to both the author and the participants with whom they were shared (two students, two managers). Conclusions were triangulated against theory and epistemology from the literature where appropriate. In this case, the participants’ responses were wholly internally and externally consistent and satisfied basic empiricist and experientialist epistemologies, since the participants were non-reflective individuals whose experiences were explored through encouraging reflection.

Conclusions were in part validated through communicating them back to participants in the interviews and in part through tests of pragmatic validity: whether findings have practical applications in addressing the research questions and improving practices through instigation of action and change (Kvale 2009). The project has provided suitable evidence for further research in the field and for modifying practice with future programmes and cohorts.

Kvale suggests that interview research can be idealistic, credulous and can neglect the emotional aspects of knowledge. Its focus is cognitive – on experience not action – and can only be self-legitimising, disregarding as it does physical interaction and theory. In this study, participants were significantly outside their “comfort zone” at the outset and a cognitive focus is entirely appropriate, since the exploration is of experience itself and of participants’ expressed confidence in their development therein.

It is apparent from the literature that transferable skills in a workplace context are highly valued and their development is important alongside the propositional knowledge required for the job role. This is emerging in parallel with the "employability" agenda for those seeking to progress into the workplace. Such transferable skills can be difficult to measure objectively, so their demonstration in practice and participants' expressed confidence in their abilities are considered the most valid measures of transferable skills development (Little 2010).

That these two aspects were evidenced in tandem throughout this study confirms that the case study itself satisfies the general requirements of completeness and sufficiency of evidence (Yin 2009 p185).

There are a number of misunderstandings relating to case study research which Kvale (2009) recognises: that general knowledge is superior to context-dependent knowledge (and that case studies and interviews do not generate this); that case studies, and interviews in particular, generate hypotheses rather than test them (which is an issue if an untestable hypothesis is generated), and that there is a bias towards verification of hypotheses and that generalisation is not possible on the basis of a single case. In this example, transferable skills are specific to context and therefore a case study approach is most valid. This study was an exploration of skills development, although its findings approximate more to a hypothesis for effective transferable skills development design which could then be tested in future research.

For the case to be generalisable to a wider engineering context, its representativeness to a broader class must be established (Denscombe 2003, Yin 2009). This study concerned a bespoke single-employer block release programme. At its inception, this was only the second such project the researcher's College had been involved with, and the first at HE level; since then, three new programmes of similar nature have been commissioned.

To quote a leading engineer on one of these new programmes:

"This is going to be the way forward for the industry... Block release gives flexibility of attendance and where you have a national project, you can ensure that everyone gets the same experience at your best choice of college... Programmes can be designed around specialist employer needs."

Section 4 – Concluding Remarks

Research question 1: How are the transferable skills of self-management, self-development, problem solving, communication and team working developed in undergraduates through a bespoke, employer-specific higher education programme, and how effective is this, in the opinion of the students and of their managers?

It is apparent that the development has been effective, as evidenced here, through both promoting reflection on actions and their potential for self-development, and valid activities within the programme aimed at developing these skills in a work-relevant context. Engineers are of nature pragmatists and as such it could be argued that all approaches to transferable skills development must be equally valid, since each individual manager held that their own experience was most effective in attaining their current position.

Research question 2: How can these findings be used to inform future projects to develop these skills more effectively for professional effectiveness and career progression within the engineering industry?

It is clear that both workplace experience and simulated workplace experience are effective in developing individuals’ perceptions of their transferable skills. It is equally apparent that engineers are not reflective individuals, but that through encouraging reflection, their confidence in their developing transferable skills increases.

This would provide a basis for future action research projects. The CDIO approach to project-based learning is a relatively new and effective initiative to promote self-managed learning and transferable skills development through team projects, and would provide an excellent theoretical basis for this.

Appendices

Appendix 1 : References

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Appendix 2 : Participant consent

The document on the following page was presented to and signed by all participants in this project.

Research Project: Transferable higher-level skills for work-based learners

There is considerable research evidence that the skills demanded of graduates from engineering higher education programmes, particularly part-time employed students, do not match with Government objectives or higher education qualifications and programmes, even where these have been developed in collaboration with engineering employers.

Jon Melville is undertaking independent doctoral research into this area with government, employers and engineering HE students, to determine whether this mismatch can be resolved and to design materials and activities to develop the skills the engineering industry needs from its graduates.

As part of this project, Jon is interviewing students at various stages of part-time higher education programmes and also their managers, and would appreciate your participation.

The first questionnaires ask for participants' initials; this is to allow questionnaire results to be aligned for participants who complete more than one at different stages of the project and to tie together questionnaire results and subsequent interview transcripts. All responses will be anonymised during processing so that individuals cannot be identified. The consent forms will be confidential to Jon alone.

If you are prepared to participate in this project, please can you sign below, providing your consent for me to use the data generated, in anonymous form. It is also proposed to undertake interviews of some key participants in this process, and if you are prepared to be interviewed at a later stage, please indicate this below as well. You retain the right to withdraw from the process at any stage.

Thanks in anticipation, *Jon Melville*

- I am willing to complete the attached questionnaire:

Signed *Print name*

- I am also willing to participate in interviews: *Signed*

Appendix 3 : Research questionnaires

Questionnaires given to participants (students and managers) are on the following pages.

Student Questionnaire

Initials: **Stage of programme: entry / mid / end**

(Please circle appropriate response)

Please rank the following list of knowledge and skills you could potentially gain from Higher Education from :

1 (most important to my future career aspirations)

to 10 (least important to my future career aspirations)

	Rank
Higher-level subject knowledge	
A qualification for my CV	
Literacy / numeracy / IT skills	
Communications skills	
Research and information-finding skills	
Business awareness	
Self management skills (time management, researching etc.)	
Self-development skills (building your own knowledge etc.)	
Team working skills	
Problem solving skills	

Please use the space below to comment on how you feel this HE course will benefit your career aspirations:

Skills Audit

For each of the following skills, please fill in the circle which you feel most accurately describes your level at this moment in your career.

A Group Work

1. Working with others on an interdisciplinary group project

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

2. Being able to appraise the strengths of other group members

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

3. Having my ideas listened to by other group members

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

4. Being aware of the different roles within a good team

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

5. Being able to develop co-operative relationships

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

B Communication

1. Being able to give constructive feedback to peers and colleagues

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

2. Dealing with conflict with superiors

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

3. Having to communicate with people I don't know well

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

4. Understanding how my and others' personality types influence work interactions

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

5. Receiving feedback and dealing with criticism of my work

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

C Project Planning and Management

1. Effectively prioritising my work to minimise distractions

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

2. Using effective strategies to plan my work over the course of a term

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

3. Making use of feedback opportunities in the planning of my work

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

4. Being able to realistically monitor the progress of my work

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

5. Being able to set realistic work goals

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	O	O	O	O

D Personal Awareness

1. Recognising and dealing with excessive stress in myself

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	**O**	**O**	**O**	**O**

2. Having a realistic awareness of how I am perceived

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	**O**	**O**	**O**	**O**

3. Understanding and maintaining my motivation for work and study

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	**O**	**O**	**O**	**O**

4. Having an awareness of my strengths and weaknesses

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	**O**	**O**	**O**	**O**

5. Being aware of my specific areas for further development

novice	beginner	competent	proficient	expert
1	2	3	4	5
O	**O**	**O**	**O**	**O**

Note: Questions adapted from Alpay, E. and Walsh, E. (2008) *A skills perception inventory for evaluating postgraduate transferable skills development*, Assessment and Evaluation in Higher Education 33(6) pp 581-598. Criteria for Likert scale taken from Dreyfus, H.L., Dreyfus, S.E. and Attanasion, T. (1986) *Mind over machine: the power of human intuition and expertise in the era of the computer*, New York, Free Press.

Manager Questionnaire

Initials: **Role:**

Highest level of formal qualification:

Please rank the following list of knowledge and skills you could potentially gain from Higher Education from **1** (most important for the trainee's future career) to **10** (least important):

	Rank
Higher-level subject knowledge	
A qualification for my CV	
Literacy / numeracy / IT skills	
Communications skills	
Research and information-finding skills	
Business awareness	
Self management skills (time management, researching etc.)	
Self-development skills (building your own knowledge etc.)	
Team working skills	
Problem solving skills	

What is the purpose of Higher Education in your organisation's development plan for the trainees you manage?

From the following list of knowledge and skills, please list 1, 2 and 3 alongside the ones which you feel you gained most from your highest level of formal education:

Higher-level subject knowledge	
A qualification for my CV	
Literacy / numeracy / IT skills	
Communications skills	
Research and information-finding skills	
Business awareness	
Self management skills (time management, researching etc.)	
Self-development skills (building your own knowledge etc.)	
Team working skills	
Problem solving skills	

Please list 1,2 and 3 alongside the three skills below which have been of most benefit to your career since you completed formal education:

Higher-level subject knowledge	
A qualification for my CV	
Literacy / numeracy / IT skills	
Communications skills	
Research and information- finding skills	
Business awareness	
Self management skills (time management, researching etc.)	
Self-development skills (building your own knowledge etc.)	
Team working skills	
Problem solving skills	

Are there any other skills you think are important which are not included in the above lists?

Appendix 4 : Empirical data

The attached spreadsheet contains the following raw questionnaire results:

- *Raw data, processed for mean, mode and median where appropriate, for all student questionnaires.*

Cohort A was 2010 – 2012, surveyed at three stages: at start of programme, at end of year 1 and end of year 2.

Cohort B was 2011 – 2013, surveyed at the same three stages.

In both cases, ten of the students chose to participate.

- *Raw data for the nine managers from QVD who agreed to participate, again with basic mean/mode/median processing.*

- *Student questionnaire results arranged by individual students.*

- *Student questionnaire results aggregated for each cohort.*

Appendix 5 : NTU ethical approval form

Professional Doctorates

Ethical Approval Checklist – Form A

Form A must be signed off by one of the student's supervisors and a course leader, to signify that the proposed research conforms with good ethical principles and standards, before commencing any research in preparation for **Documents 3 & 4** within any of the professional doctorate courses.

Assurance that all research will conform with good ethical standards is provided by the supervisors when signing this form. A separate form has to be submitted for document 3 and for document 4.

Please complete this document following the Professional Doctorate Ethics Guidelines.

Award title	*Doctor of Education
Cohort	2009
Research Student's Name	Jon Melville
Document No.	3
Document title	Development of transferable skills with part-time HE students in engineering: employer case study

Supervisors (State Lead supervisor first)	1. Dr Jane Ching 2. Dr Adam Barnard 3.
Date	October 2013
Identify any questions in the completed form which indicate that approval by PDREC is required.	

Section “OA I Familiarisation and Policy” should be completed by a supervisor. All other sections should be completed by the research student. The answers provided must be discussed with the supervisor before the form is signed and submitted.

At the end of each section, it is indicated whether ethical approval must be sought from the Professional Doctorates Research Ethics Committee (PDREC).

1. Supervisor

Section OA I: Familiarisation with policy

Please indicate whether the research student has been familiarised with the policy guiding ethical research:

• NTU research ethics policy, and the procedures for ethical approval in the professional doctorate courses	**Yes**	No
• The guidelines for ethical research promulgated by a professional association, as appropriate	**Yes**	No
• The Regulations for the Use of Computers (*see* NTU website)	**Yes**	No
• Guidelines for Risk Assessment in Research (Appendix 3)	**Yes**	No

If you answered **NO** to any of these questions, please note that all students must be introduced to these guidelines and regulations before proceeding to complete the remainder of this form.

2. Research Student

Section OA II: External Ethical Review

OB.1 Has a favourable ethical opinion been given for this project by an NHS or social care research ethics committee, or by any other external research ethics committee?	Yes	No
OB.2 Will this project be submitted for ethical approval to an NHS or social care committee or any other external research ethics committee?	Yes	No

If you answered **YES** to either of these two questions, please ask your supervisor to sign the declaration at the end of the form, and submit it (together with a letter confirming ethical approval from the external committee) before starting any research.

If you answered **NO** to both questions, please proceed to Section A

Section A: Participants & Method/Procedures

A.1 Does the research involve vulnerable participants? If **not**, go to Section B

A.2 If the research does involve vulnerable participants: will participants knowingly be recruited from one or more of the following vulnerable groups?

Safeguarding Vulnerable Groups Act 2006: http://www.legislation.gov.uk/ukpga/2006/47/contents

Definition of vulnerable adults can be found here: http://www.legislation.gov.uk/ukpga/2006/47/section/59

• Children under 18 years of age	Yes	No
• People over 65 years of age who are perceived to be vulnerable	Yes	No
• Pregnant women	Yes	No
• People with mental illness	Yes	No
• Prisoners/detained persons	Yes	No

- Other vulnerable group

Yes	No

  - please specify: _______________________________

A.3 Have you been asked to obtain a Disclosure and Barring Service Check (DBS) (previously CRB) check as a condition of access to any source of data in the UK for this document?

Yes	No

A.4 To the best of your knowledge, please indicate whether the proposed study:

• Involves procedures likely to cause physical, psychological, social or emotional distress to participants	Yes	No
• Is designed to be challenging physically or psychologically in any way (includes any study involving physical exercise)	Yes	No
• Exposes participants to risks or distress greater than those encountered in their normal daily life	Yes	No
• Involves the use of hazardous materials	Yes	No

If you have answered **YES** to any of questions A.1-A.4, an application for ethical approval needs to be made to the PDREC.

Section B: Observation/Recording

B.1 Does the study involve data collection, or the observation or recording of participants?	Yes	No
B.2 Will those contributing to the data collected (being observed or being recorded), or the appropriate authority, be informed that the observation and/or recording will take place?	Yes	No

If you have answered **NO** to question B.1, because you are not undertaking empirical work, proceed to the declaration at the end of this form. If you have answered **NO** to question B.2, an application for ethical approval needs to be made to the PDREC.

Section C: Consent and Deception

Informed Consent & Data Withdrawal

C.1 Will participants, or the appropriate authority, give informed consent freely?	Yes	No

C.2 Will participants, or the appropriate authority, be fully informed of the objectives and of all other particulars of the investigation (preferably at the start of the study, but where this would interfere with the study, at the end)?	<u>Yes</u>	No
C.3 Will participants, or the appropriate authority, be fully informed of the use of the data collected (including, where applicable, ownership of any intellectual property arising from the research)?	<u>Yes</u>	No
C.4 For detained persons, members of the armed forces, employees, students and other persons who may not be in a position to give fully independent consent will care be taken over the gaining of freely informed consent?	<u>Yes</u>	No
C.5 Will participants, or the appropriate authority, be informed of their right to withdraw from the investigation at any time (or before a specific deadline) and to require their own data to be destroyed?	<u>Yes</u>	No

If you have answered **NO** to any of questions C.1-C.5, an application for ethical approval needs to be made to the PDREC.

C.6 Does the study involve the deception of participants (i.e., withholding of information and/or misleading participants) which could potentially harm and/or exploit them?	Yes	<u>No</u>

If you answer **NO** to question C.6, please proceed to section D.

Deception

C.7 Is deception an unavoidable part of the study?	Yes	No
C.8 Will participants, or the appropriate authority, be de-briefed and the true object of the research revealed at the earliest stage upon completion of the study?	Yes	No
C.9 Has consideration been given to the way(s) that participants, or the appropriate authority, may or will react to the withholding of information or deliberate deception?	Yes	No

If you have answered **NO** to questions C.7-C.9, an application for ethical approval needs to be made to the PDREC.

Section D: Storage of Data and Confidentiality

Please see University guidance on https://www.ntu.ac.uk/intranet/policies/legal_services/data_protection/16231gp.html. If you are a member of NT staff you can obtain direct access to this with your staff username and password. If you are not a member of NTU staff, please request of copy from your supervisor or course leader.

D.1 Will all information on participants be treated as confidential and not identifiable unless agreed otherwise in advance, and subject to the requirements of the law of the relevant jurisdiction?	Yes	No

D.2 Will storage of data comply with the Data Protection Act 1998 and the law of any non-UK jurisdiction in which research is carried out?	<u>Yes</u> | No
D.3 Will any video/audio recording of participants be kept in a secure place and not released for use by third parties?	<u>Yes</u> | No
D.4 Will all relevant video/audio recordings be destroyed within six years of the completion of the investigation?	<u>Yes</u> | No

If you have answered **NO** to questions D1-D4, an application for ethical approval needs to be made to the PDREC.

Section E: Incentives

E.1. Have incentives (other than those contractually agreed, salaries or basic expenses) been offered to you by any funder of the research, to conduct the investigation?	Yes	<u>No</u>
E.2. Will incentives (other than basic expenses) be offered to potential participants, or the appropriate authority, as an inducement to participate in the investigation?	Yes	<u>No</u>

If you have answered **YES** to questions E1-E2, an application for ethical approval needs to be made to the PDREC.

The design of the participant information sheet/consent form and of any research instrument (including questionnaires, sampling and interview schedules) that will be used, have been discussed with my supervisor(s).	<u>Yes</u>	No

Compliance with Ethical Principles

Please sign the declaration below, to confirm that this form has been completed to the best of your knowledge and after discussing the answers provided with the DBA research student. If at any stage you have been asked to submit an application for ethical approval to the PDREC please also complete and submit the appropriate form.

Signature of Research Student ....J A D Melville...................... Date ....24.10.13..............................

Signature of Lead Supervisor .... Date ....

Signature of Course Leader ....Date ....