

# Developing industry-ready engineers: a regional university perspective

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**Abstract** – Recent studies show that today’s employers are increasingly focused on hiring graduate engineers who possess a broader skill-set than in the past. Consequently one of the challenges facing regional universities is how to produce engineering graduates who have not just the traditional technical skills but who also have the necessary business acumen and managerial know-how to contribute positively to local business development. It is accepted that good communication skills and team-working ability are the two most important soft skills for graduates but it is often difficult to develop these adequately in an already packed curriculum. Commercial awareness is also identified as a key employee attribute however students on undergraduate engineering programmes often struggle to understand its significance. This paper describes an innovative approach taken by course designers within the School of Engineering at the University of Ulster to narrow the skills gap in interpersonal and business management skills as identified by graduate employers. The approach aims to produce engineering graduates that have the necessary business management skills to be ‘industry-ready’. Opportunities for developing key soft skills have been embedded across the whole curriculum and across all years of the mechanical and engineering management programmes. Practical examples of industrial collaboration are provided and the benefit to the student, industry and to the university is described. Surveys designed to assess the students’ attitudes towards these softer skills were completed by undergraduate students and results are presented. The National Student Survey 2008 shows that 85% of mechanical and production engineering graduates from the University of Ulster are employed in graduate positions. This is the highest graduate employment rate of any UK institution recruiting at 220 UCAS points - evidence that engineering graduates from the University of Ulster have developed the necessary industry-ready skill set and are meeting the needs of local industry.

**Index Terms** – curriculum development, employability skill-set, industry-university synergy,

## INTRODUCTION

A number of studies have been carried out on how academia can better meet the needs of the engineering industry [1-4]. Whilst all agree that engineers are employed primarily for their technical skills, there is a general consensus that employers are looking for graduates who have excellent interpersonal skills, are commercially aware and who can contribute to the business success of the organization. This is particularly important for small to medium-sized enterprises (SMEs) who, unlike the large multi-nationals, do not generally have customised graduate training programmes and where the graduate engineer is often in a managerial position within a very short time of taking up employment. The majority of engineering employers within the UK and Ireland are SMEs, and since the vast majority of employers within Northern Ireland falls within this category [5], it follows that engineering courses within a regional university such as the University of Ulster should seek to embed these essential skills within its engineering programmes.

The challenge for programme developers within Higher Education is to maintain the technical excellence within engineering degrees whilst simultaneously developing the business awareness and soft skills that industry has identified as being so important when recruiting graduate engineers. Engineering programmes in many UK universities offer curricula that are already packed with modules that lay the foundations for the mathematical, scientific and technical knowledge base that is fundamental to the formation of the Chartered Engineer. It is accepted that the theoretical understanding and the ability to apply it to real-life engineering problems are key employability attributes for any engineering graduate [4]. Although most engineering students can immediately understand the need to develop their technical and interpersonal skill-set the majority tends to underestimate the importance of acquiring business management know-how and struggle to appreciate its significance in the workplace.

## GRADUATE EMPLOYABILITY

Enhancing the employability skills of university graduates is an area that is receiving much attention at present. Communication skills, team-working skills, integrity, intellectual ability and self confidence are ranked by 80% of

graduate recruiters as the five most important skills and capabilities sought by employers [6]. As engineering educators, we recognise that our graduates require all the generic skills previously identified together with those attributes and skills that have been identified as important by engineering industry. Six key attributes have been identified as of importance to engineering employers. They are practical application, theoretical understanding, creativity and innovation, team-working, technical breadth and business skills [7].

Each university approaches the development of these essential skills in its own way. Some use Career Development departments to offer optional additional training in employability skills; some use the thick-sandwich work placement approach and others rely on loose industrial partnerships to nurture the students' professional development. As a regional university, the School of Engineering at the University of Ulster has sought to embed these soft skills and commercial awareness as integral and substantive within its mechanical engineering and engineering management programmes. These programmes develop highly employable graduates able to immediately contribute to the business success of local enterprises. The National Student Survey of 2009 shows that 95% of students from mechanical and production programmes from the University of Ulster are employed in graduate positions [8]. The survey of 2008 reported a graduate employment rate of 85%. The two programmes in the University of Ulster that are classified in this category are Engineering Management and Mechanical Engineering. This is the highest employment rate of any UK university recruiting at 220 UCAS points - evidence that our graduates have developed the necessary industry-ready skill set and are meeting industry needs.

### MAIN SUBJECT AREAS

Both the Engineering Management and Mechanical Engineering programmes share a number of common subject themes associated with most professionally accredited programmes: maths and science; engineering analysis; design and innovation; economic, social and environmental context; and engineering practice [9]. These themes are introduced in year one of the programmes and then progressively developed during subsequent years. The differences between the courses arise mainly from the relative emphasis placed on these common themes.

Students from both courses were surveyed as to their perception of the relative importance of a number of subject areas in their curriculum. As shown in Figure 1, both cohorts rated Design and Innovation as equally important. As one might expect, the key subject themes for mechanical engineering students were engineering science and manufacture; whereas the engineering management students placed a greater importance on manufacture and business.

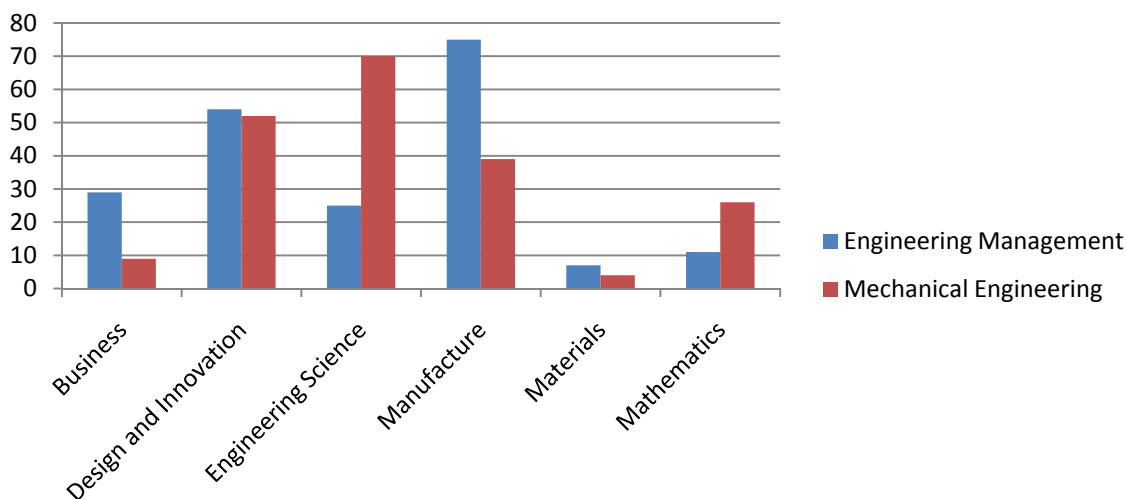


FIGURE 1  
RELATIVE IMPORTANCE OF MAIN SUBJECT AREAS AS PERCEIVED BY FINAL YEAR STUDENTS

### DEVELOPING SOFT SKILLS WITHIN THE ENGINEERING CURRICULUM

Many young people nowadays prefer to communicate with each other remotely. Consequently, educators are challenged to find ways of enabling students to better interact face-to-face with others. Our approach has been to embed the development of these skills initially within an extended induction period and then progressively within the subject area of Design. The extended induction period involves the students visiting a local manufacturing company where they get the opportunity to meet past graduate engineers from the University and are introduced to the business environment via the industrialist's explanation of the commercial pressures faced by companies.

Over 80% of our year 1 modules contain team-based coursework elements that involve students from the same cohort working with each other. Just under one-fifth of them contain an element of oral presentation. In year 2, all modules contain team-based coursework tasks, some of which involve students from one programme working with students from other programmes. One-third of modules involve an oral presentation. A year-long work Placement in an industrial setting is a compulsory part of the programmes. To-date the vast majority of our students have been successfully placed in relevant paid positions – proof that students on our programmes can contribute to engineering enterprises in a positive way.

Final year students on the programmes are assessed by oral presentations in at least one-quarter of their modules and team-working is involved in at least three-quarters of their modules. Student teams in final year use a peer marking process to assess the contribution of team members. This has proved particularly effective as students are working in multi-disciplinary groups to solve real-life engineering design problems. Negotiating skills, conflict resolutions skills, self and time management skills are all developed using this approach [10].

Students completing the final year of their programmes were asked to judge the extent that their course had developed their team-working, IT, oral and written communication skills. There was a high level of satisfaction that these skills were being adequately developed as shown in Figure 2.

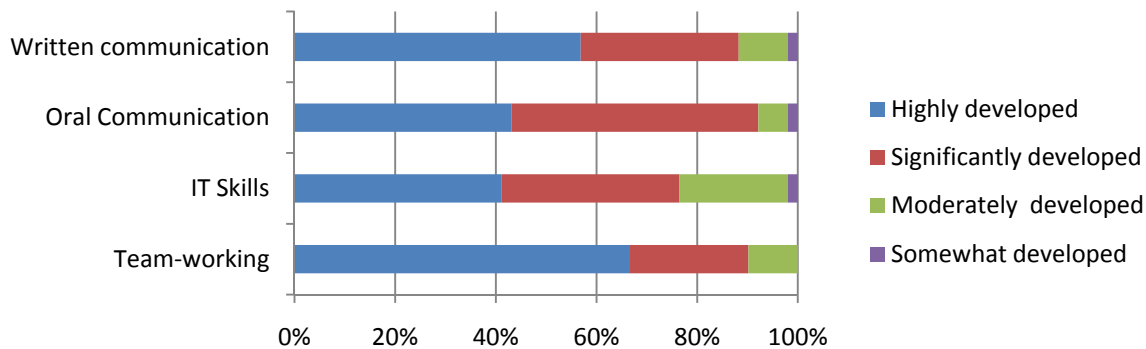


FIGURE 2  
FINAL YEAR STUDENTS' ASSESSMENT OF THEIR SOFT-SKILL DEVELOPMENT

### DEVELOPING COMMERCIAL AWARENESS WITHIN THE ENGINEERING CURRICULUM

In year 1 each student's Studies Advisor concentrates on the student's development of practical management skills, for example, self-discipline, independent study-skills and time management. Students on the engineering management programme have a formal taught module in business and management.

One particularly innovative module in year 2 involves the participation of a number of local engineering companies hosting a series of visits for students to hear at first hand about manufacturing methodologies, business management techniques and manufacturing processes. Mechanical engineering students especially, often underestimate the importance of acquiring business management skills and we have found that these visits are an excellent way to 'sub-consciously' improve students' business knowledge and broaden students' understanding of the engineering function within the business enterprise. They are also an excellent way for companies to promote themselves to prospective employees and develop further our University's links with local industry.

In the third year, commercial awareness, communication skills, ability to work with others, self confidence and self esteem are all attributes that are significantly enhanced by the work Placement experience.

Having had the benefit of work Placement, final year mechanical engineering students are much more receptive to formal lectures in industrial management and since the material is delivered with reference to typical scenarios in the work environment, the student is well equipped to link management theory to its practice. Overall, the students' satisfaction levels are summarised in Figure 3.

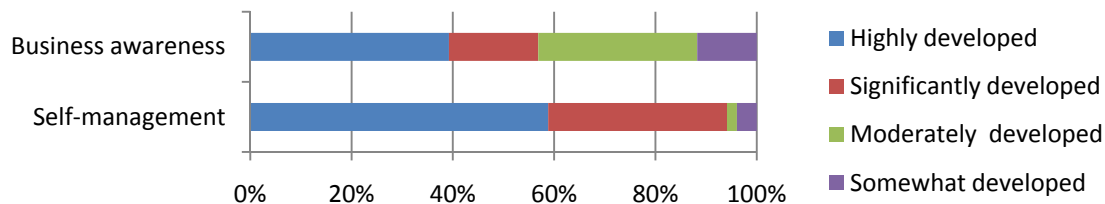


FIGURE 3  
FINAL YEAR STUDENTS' ASSESSMENT OF THEIR BUSINESS MANAGEMENT SKILL DEVELOPMENT

A range of engineering companies within the region have worked with us to provide real-life design projects for final year students. Final year Design is a team-based module that involves students working in a multi-disciplinary team environment where engineers from a local company prepare a project design brief, the students then work on concepts and designs for the duration of the semester and finally they present their detailed design solution to the company in a semi-formal business environment. A detailed business plan is part of that presentation. Sometimes the company will give a monetary prize to the most innovative and/or cost effective solution. Examples of organizations that have offered real-life Projects include Leckey Design – a company that designs and builds support chairs for disabled children; Terex – a global organization that designs and builds stone crushing equipment for the quarrying industry.

These are examples of active industrial involvement where everyone involved, the university, the students and the company benefit from each other’s involvement. Students understand better the commercial pressures and constraints of industry and industry understands better the students’ perspectives. A learning synergy is thus established.

## INDUSTRY-READINESS

Our methodology for the development of students’ soft skills and commercial awareness can best be described using a ‘Hierarchy of Skills Development’ approach similar to Maslow’s ‘Hierarchy of Needs’ concept [11]. The approach is shown schematically in Figure 4.

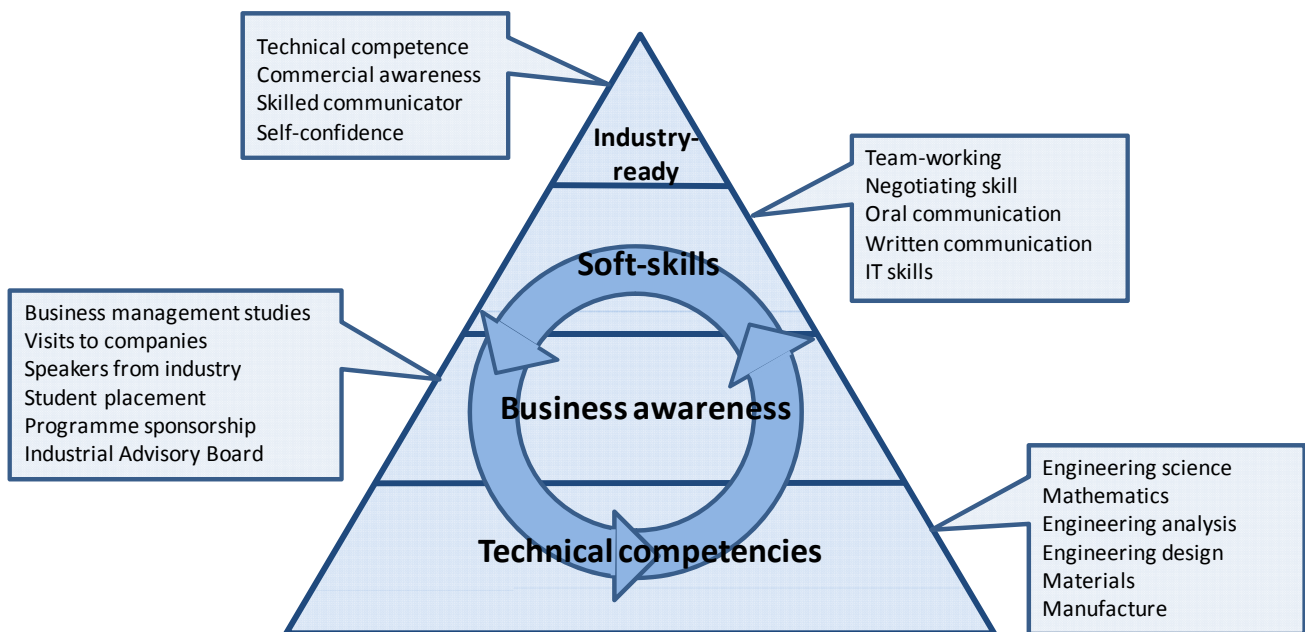


FIGURE 4  
HIERARCHY OF SKILLS DEVELOPMENT

Technical knowledge and skill, together with the ability to apply it, is central to our curriculum design. Competent graduate engineers need to be able to relate relevant scientific and mathematical principles to practical applications. Engineering programmes at the University of Ulster provide students with many opportunities to develop these practical skills. Business skills and commercial awareness are also of key importance. The development of the students’ communication skills is interwoven throughout the technical and business areas. Our philosophy integrates the development of all three areas in a developmental continuum, interfacing with industry as opportunities arise.

## CONCLUSION

Our methodology for developing engineering students at the University of Ulster has been described. The approach delivers the traditional scientific, technical, analytical and mathematical subjects that are fundamental to the area of mechanical and manufacturing engineering but with an emphasis on developing the students’ business awareness and communication skills that employers within Northern Ireland, and beyond, have identified as being so important. Survey results show that students finishing the programmes have high levels of satisfaction in the way that their business awareness and soft skills have been developed. Finally, employers are very satisfied in that a very high percentage of our graduates obtain suitable employment in graduate positions within a short time of completing their studies.

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