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IMPLICATIONS FOR ENGINEERING TEACHING OF "UK-SPEC"

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Key words and phrases: business requirements; engineering science; methods of teaching; technical requirement; university.

Abstract: UK-SPEC has revolutionised the UK university sector. In placing the output standards as the sole arbiter of quality, it has the agreement of all the UK universities. However, it has also greatly reinforced the importance of finance, management and other equally important issues for practicing engineers. In this way it has forced many of the universities to re-think their methods of teaching. Since there is zero probability that the technical syllabus of any one engineering degree will be reduced, this paper proposes that problem/project based learning is a means to satisfy both technical and business requirements. Teaching of engineering students is set to change.

Introduction

The recognition of engineers as having attained professional status has long been the subject of debate in the UK. There has not been a recognised government standard as in most other countries of the EU rather; the profession has been self-regulated by professional "institutions" such as "The Institution of Electrical Engineers" and "The Institution of Mechanical Engineers." Perhaps because of this but also because of the historical roots of engineering since the so-called "industrial revolution", engineers have not enjoyed the same status as has been achieved by lawyers and accountants (for example).

In an attempt to redress the balance, the Finniston report "Engineering our Future" (Finniston 1980) recommended a standardised approach, while allowing every university to retain freedom of action. It laid down standards at each level of university education and provided for a professional qualification that comprised educational achievement coupled with professional practice. To be registered one had to have a bachelor degree of a high level (Batchelor of Engineering, honours grade) and then apply to an engineering Institution for recognition as a professional engineer, but only after a period of relevant industrial experience, figure 1. Thus the institutions became the guardians of engineering standards and an Engineering Council (EC) was established to oversee this. The EC was a government "Quango"[1] that pursued quality within the engineering profession and conferred the title of "Chartered Engineer" on those considered to have achieved an appropriate standard. For the first time, a measure of achievement had been established.

[1] Quango = a semi-public organisation with state finance but given a degree of autonomy, the British Council is another example.

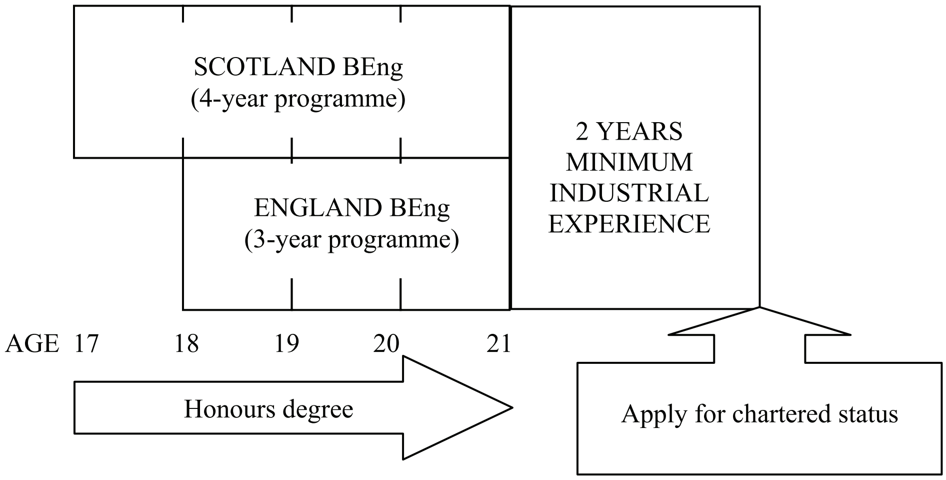

Fig. 1 UK routes to professional recognition

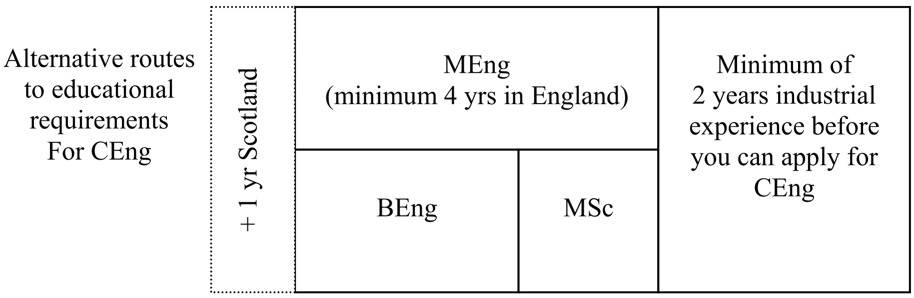

Fig. 2 Masters level for Chartered status (SARTOR 3)

There has continued to be a debate over professional recognition. Finniston was followed by "Standards and Routes to Registration" (SARTOR), then by SARTOR 2 and lastly by SARTOR 3, figure 2. It was this last version that recognised the longer degree programmes within the EU and with Bologna in mind, set the standard for the education of a professional engineer to Masters level.

As a consequence of the funding for universities in the UK, engineering departments found themselves losing students (and therefore funding) to the business programmes. To attract more students, entry requirements were lowered. However, the Institutions thought that this devalued the education of engineers and, by implication, the status of professional engineers. SARTOR 3 attempted to improve the image of the engineer by setting minimum standards of entry to universities. Thus professional engineers were selected from an input group that were themselves selected as the most able students from school leavers. Use of this measure, of course, paid no attention to the teaching capabilities of the universities themselves and it was argued most strongly by the newer universities, who had (in general) less research, that they had placed engineering education at the head of their priorities and were able to improve the capabilities of apparently less able students by improved educational methods. However one views this matter, the use of input standards as a measure of the worth of students was subject to intense criticism for being 'elitist' because only the older or more established universities attracted the best students, leaving the newer universities with no option but to run courses that did not lead to a chartered (and therefore a professional) status. So

SARTOR 3 (so recently established) has been abandoned in favour of output standards alone and is to be seen in the new document UK-SPEC. UK-SPEC (2003) is now the benchmark, it recognises output standards from degree programmes as being what should be measured and it contains quite a lot of issues for the teaching of engineering which will be considered next.

UK-SPEC: implications for teaching of engineering

Whilst the engineering institutions had required engineering education to include transferable skills and knowledge of business, the UK-SPEC clearly provides, in three out of the five sections, that non-technical issues are to be regarded seriously, table 1.

To be quite clear, 60% of the latest specification for a professional engineer is devoted to non-technical subjects. Although there is a large document devoted to this, there follows an overview of the last three sections of the specification; those devoted to non-technical subjects:

Section C (UK-SPEC 2003), includes project management, negotiation, monitoring and control of projects, organising teams, assessing performance of team members and quality, not just in engineering design but throughout the whole supply and demand chain.

Table 1

Requirements of UK-SPEC

A	Use a combination of general and specialist engineering knowledge and understanding to optimise the application of existing and emerging technology.	1. Maintain and extend a sound theoretical approach in enabling the introduction and exploitation of new and advancing technology and other relevant developments. 2. Engage in the creative and innovative development of engineering technology and continuous improvement systems.
B	Apply appropriate theoretical and practical methods to the analysis and solution of engineering problems.	1. Identify potential projects and opportunities. 2. Conduct appropriate research, and undertake design and development of engineering solutions. 3. Implement design solutions, and evaluate their effectiveness.
C	Provide technical and commercial leadership.	1. Plan for effective project implementation. 2. Plan, budget, organise, direct and control tasks, people and resources. 3. Lead teams and develop staff to meet changing technical and managerial needs. 4. Bring about continuous improvement through quality management.
D	Demonstrate effective interpersonal skills.	1. Communicate in English with others at all levels. 2. Present and discuss proposals. Demonstrate personal and social skills.
E	Demonstrate a personal commitment to professional standards, recognising obligations to society, the profession and the environment.	1. Comply with relevant codes of conduct. 2. Manage and apply safe systems of work. 3. Undertake engineering activities in a way that contributes to sustainable development. Carry out continuing professional development

Section D, includes conduct at meetings, presentations, personal relations, leadership and conflict resolution.

Section E, includes professional conduct, legal issues, health and safety, risk management, environment and continuous professional development.

Clearly the teaching of engineering has to change to cater for a broader based syllabus but there is an additional year of formal teaching in which this can be introduced, since the professional level now insists on achieving Masters level.

However, since it is unlikely that the engineering institutions will agree to a dilution of the technical syllabus, one will be forced to look for alternative methods to teach these 'softer' subjects. In my opinion, there are a number of ways with which we may approach the problem but all of them involve cross-disciplinary issues because the nature of transferable skills is such that they must be studied in association with other issues. Thus, issues like business management, team working, negotiation etc., can simply be added to design projects: provided they are based broadly enough.

Design projects

The idea that design projects can be used as a vehicle to teach transferable skills and business concepts alongside engineering principles has been known for a long time (Temple 1996), (Drysdale 1998), (Wellington 1998). What UK-SPEC demands is a new level of awareness of these issues. The UK government, aware of these developments, has funded a large research programme on project based learning (PBL) in engineering (PBLE 1999). It has had the effect of focussing the engineering educators on new methods of teaching engineering and has led to new initiatives.

It is important to recognise the different issues within 'cooperative' teaching, figure 3. Learning projects would normally involve small groups of students and they may be within a single course (such as fluid dynamics or stress analysis). Or they may be between courses within a single degree (fluid dynamics and stress analysis), or they may be inter-disciplinary, such as between mechanical and electronic engineering. Clearly PBL is simple to organise within a single course. These projects help the student learn the course material and improve cooperative activities since students learn to rely on each other and the benefits of doing this. Cooperation between courses will show students how the two subjects can be used in combination to solve more complex problems and will, therefore show them the power of engineering. However, inter-course PBL is more difficult if only because of timetabling conflicts.

In all of these cases, students learn not only to cooperate but also to think and to analyse: all the issues indicated by UK-SPEC. But UK-SPEC goes further; engineers must learn to work within a business environment.

As one moves away from single subject projects towards multi-subject problems, figure 4, so one increases the complexity of the problem. The difficulty of incorporating all the issues within a meaningful and manageable project becomes enormous. In most universities this is almost impossible.

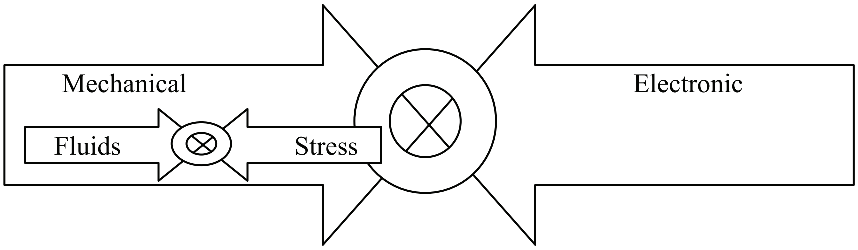

Fig. 3 Degrees of interaction within engineering disciplines

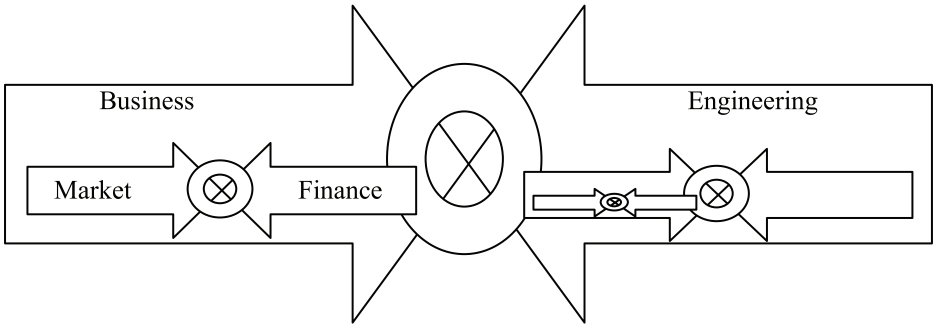

Fig. 4 Cooperation between business and engineering

Perhaps the greatest problem to satisfying UK-SPEC is this need to move outside individual specialisms so that students see engineering as a whole and not just a sum of parts. Often university cost centres are based on localised structures such as faculties or departments and these are subject based. More often than not, individual specialisms, even within the area of engineering, are subject to such compartmentalisation so that electronic engineering is separated from mechanical engineering and so on. Since, in the UK at least, each of these localised structures must be self-financing, there is unwillingness to source teaching expertise outside. Thus cross-disciplinary teaching is impeded. UK-SPEC implies the reverse and so cross-disciplinary teaching is set to increase.

In the light of UK-SPEC, Glasgow Caledonian University's School of Engineering Science and Design is particularly fortunate because all the major engineering disciplines (except civil engineering) are based within the one school. Therefore, it is comparatively simple to conduct multi-disciplinary projects within the school. Across faculties, the problems mount. Within GCU, the degree "Business and Manufacturing Engineering" was introduced in 1992. Containing approximately 50% business subjects, taught from three different faculties, the organisation was a challenge. Each school/faculty operated independently so there were organisation difficulties matching timetables. There were also pedagogic problems where staff from different faculties were not able to properly illustrate their subject using examples from completely separate disciplines. For example, marketing staff were unable to demonstrate that a shaped piece of metal that would best be designed in aluminium, would be better in stainless steel because it had a more aesthetic appeal to the customer; equally, the engineering staff did not emphasise the cost and price relationships of a mechanism.

As a consequence of these issues, the students of this degree were unable, until the final year, to appreciate the global issues involved until a spine of integrated studies was constructed in which both engineering and business subjects were introduced.

Thirteen years after this innovation, GCU continues to have integrated project modules in all years of our degree programmes.

Conclusion

UK-SPEC has revolutionized the UK educational fraternity. In placing output standards as the final arbiter of quality, it has the agreement of all UK universities. However, it has also placed a much greater emphasis on business and management as being important areas for engineers to study. In doing so it has, by implication, forced many universities to re-think the way they teach. Since it is unlikely that the engineering syllabus will be reduced, Problem/Project Based Learning is suggested as a way in which transferable skills may be incorporated within an engineering framework.

No one has said multi-disciplinary work is easy, but it has its own rewards: students get a flavour of the real world and are better prepared to enter to world of work. They say, “I’d no idea that new product development is so complicated. There are so many things to think about”. “I’d not realised that marketing had so much to do when a new product is developed.” We have entered a new and exciting world. Teaching is being transformed and students can only benefit from it.

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Использование «UK-SPEC» в практике преподавания инженерных дисциплин

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Ключевые слова и фразы: требования бизнеса; инженерные дисциплины; методы преподавания; технические требования; университет.

Аннотация: Применение UK-SPEC внесло кардинальные изменения в сектор университетского образования Великобритании. Итоговые результаты стали единственным критерием качества, с чем согласны все университеты Великобритании. При этом уделяется большое внимание экономическим, управленческим и другим не менее важным для инженеров-практиков аспектам. Таким образом, во многих университетах возникла необходимость пересмотра методов преподавания. В связи с тем, что сокращение программы за счет технических дисциплин на любых инженерных специальностях маловероятно, то методика проектов, как предлагается в данной статье, может удовлетворить требованиям, как технических, так и экономических дисциплин. Подготовка студентов-инженеров направлена на перемены.
