

CHANGING EDUCATION REQUIREMENTS FOR DESIGN ENGINEERS

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Abstract

In recent years there has been a change in the way that aerospace companies have organised themselves. Most major engineering projects are now so costly that they are only feasible with multinational co-operation. The aerospace industry is no different and the change in funding on military projects from cost plus to fixed price contracts together with rapidly escalating costs has meant that industry has had to become more efficient to remain competitive against global opposition. Industry has reacted to the challenge by changing its organisation from being a collection of skill centred offices to a collection of product focused cross-functional teams and this change in organisation has added to the range of skills required of the graduate engineer.

At the same time the system of higher education was also changing. The main institutions in the old system were the Polytechnics which catered for the practical and academic training of students for particular occupations and the Universities which catered for the academic training of students with an emphasis on research. The education system tended to be geared to the notion that the best

students would go to University. In the 1980's the government placed great emphasis on encouraging more students to go into higher education and encouraged the Polytechnics to become Universities. The outcome of this is the perception by industry that although there are more graduates they are less well prepared for industry than under the old system.

Engineering Council in it's SARTOR report [1] recognised the need to emphasise group design activities within undergraduate courses and the "Dearing" report [2] stressed the need to address the lack of communication and interpersonal skills that employers had noted in their graduate employees (Figure 1).

This paper describes the major initiatives taken by the Department of Aerospace Engineering at the University of Glasgow to address these needs at both the undergraduate and postgraduate levels and an assessment of how successful they have been.

1 Introduction

In the past graduates would enter specialist offices where they could effectively learn the job from their colleagues whereas now they must be more

familiar with basic engineering theory and be able to apply it to practical applications so that they can become useful members of a product team in the shortest possible time. The ability of a graduate to work as a member of a team is vital and employers will now assume that all engineering graduates will have had experience of team working within the context of a multifaceted design project and acquired the necessary communications skills such as report writing and presentation skills. It is increasingly likely that graduates will have to take their place on multinational project teams and the ability to understand the cultural and background differences of their fellow team members is essential if they are to work effectively.

The Engineering Council reviewed their requirements [1] in light of the Dearing committee [2] and foresight panel [3] reports and three of their conclusions were:

- more co-operation was needed between schools, colleges, universities and employers.
- better development of management and team working skills were required in young engineers
- a higher priority should be given to professional development throughout an engineer's career.

BAE Systems (then British Aerospace plc) had come to similar conclusions and set up the Virtual University to co-ordinate the educational development of staff and links with academic institutions.

2 Initiatives

The Department of Aerospace Engineering at the University of Glasgow also recognised the need to try and address the needs of both industry and students. In addition to the contributions of the industrial committee participation in the Royal Academy of Engineering's visiting professor scheme and the close working relationship with staff at BAE Systems at Prestwick have been

valuable sources of direct feedback on what skills new graduates appear to lack enabling a sensible review of the courses to be made. The department has been associated for many years with several European universities through European Union sponsored student exchange programmes, such as SOCRATES and ERASMUS, and so course reviews are considered from both British and European perspectives

2.1 Visiting Professors in Principles of Engineering Design

The University of Glasgow Faculty of Engineering has taken part in the Royal Academy of Engineering sponsored visiting professor scheme and the Department of Aerospace Engineering has been an active and enthusiastic member of this forum. The Royal Academy of Engineering [4] stated "*The Academy's Visiting Professor Scheme, established in 1989, enables senior engineers in business to work with their academic colleagues to provide a bridge for undergraduates from education to industry. The accent is on the multidisciplinary nature of the principles, and the fundamental role of design in achieving commercial success*"

The objectives of the scheme at the University of Glasgow [4] were stated as:

- *To act as a catalyst to the instigation of integrated, product-centred design teaching across engineering disciplines within the Faculty of Engineering.*
- *To complement and rationalise current individual department efforts to bring students into regular contact with industry and senior engineering staff.*
- *To initiate, develop and contribute to interdisciplinary, group-based engineering design project activity.*
- *To stimulate the development of professional communication skills, and an entrepreneurial, innovative and creative spirit and ability among engineering students.*

- *To stimulate an awareness among staff and students of the contribution of engineering design to the long term well-being of the environment.*
- *To complement and extend current efforts to provide an understanding of the concurrent approach to product and process design*

The main outcomes of the scheme have been:-

- assistance in curriculum development
- lectures given by the visiting professors
- assistance with final year design projects
- support of engineering design forums

Typical lectures given by the visiting professors were design study of a fan blade, choice of materials in engineering design, systems integration and the business context of design.

The main areas of influence in the curriculum development have been in the introduction of group design and build laboratories for the first and second year undergraduates and the development of a one week modular course in systems engineering for the final year M.Eng. students [5]. This latter course is jointly delivered by university staff and speakers from a wide range of the aerospace industry and addresses the theory and practice of typical product focused team organisations. The lectures given by the visiting professors cover a wide range of subjects from both technical and business and include case studies with which they have been directly involved. The involvement of the visiting professors in the final year projects has been largely restricted to giving advice and encouragement but it is hoped that their role in developing and assisting in future joint cross discipline projects will be a major one.

2.2 BAE Systems Lecture Series

In order to expose the students to industry, working engineers from BAE Systems at Prestwick provided a series lectures describing their work which covered a wide range of current issues. The feelings of both the students and the

lecturers was that the lectures were a great success and of mutual benefit. A lot of students said that before the lectures the impression they had of BAE Systems was as a very large impersonal company but meeting and talking with the engineers gave them a much more favourable impression.

Typical lectures this year were:-

- accident investigation
- structural testing
- approach to certification of structures
- operational performance
- safety & probability analysis
- new avionics systems (Nimrod)
- project management

2.3 New Postgraduate Initiatives

As a result of the close working relationship of the staff at BAE Systems at Prestwick and the University of Glasgow Department of Aerospace Engineering the idea of an industrial based M.Sc. was discussed. At first the model for this was the group based M.Sc. course that Cranfield University run for BAE Systems. Several prospective candidates for such a course were asked for their views and there was surprisingly little enthusiasm. The main reasons for the lack of enthusiasm were:-

- All the work is additional to their normal working day
- The length of time to complete the course was considered too long
- If some of the group do not pull their weight or drop out there will be an increased burden on the rest
- If some of the group are carried by the others they might be awarded the degree even though undeserved

Despite assurances the overwhelming outcome was a preference for an individual not a group based M.Sc.. Following further discussions on the type of work being undertaken it soon became evident that there was a possibility for some to extend the investigations undertaken as

part of their work to form a suitable M.Sc. project. This was seen to be attractive to potential students and the first student has now been enrolled.

In addition the Department wished to build on the experience gained in the highly successful European student exchange schemes (SOCRATES & ERASMUS) and took a leading role in setting up an international Master of Science programme [6 & 7] a joint venture between the European Community and the United States aimed at giving students the experience of working in a more global environment. As nearly all major projects are now multi-national, e.g. the Airbus family of aircraft, the international space station, Eurofighter, Eurotiger and the Boeing B777, it was felt that there was a need for a new kind of graduate with an international qualification. A key feature of the international M.Sc programme is the mobility of the students. All students will enroll for their degree programme in their home institution but will move between different institutions within the consortium to ensure that they spend at least five months overseas. This programme has now been extended to include all European and U.S. postgraduate degrees.

2.4 BAE Systems Preferred Course

It is a matter of great pride that the University of Glasgow is one of only three undergraduate aerospace engineering courses to be given preferred status by the BAE Systems Virtual University, the others being at Loughborough and Southampton. Hopefully this new venture will strengthen not only the already close links the University has with the Prestwick site but also with the rest of BAE Systems.

The benefits that BAE Systems will bring are support in the following areas:-

- materials
- visiting lecturers
- attendance at steering groups
- project work

- industrial placements
- staff exchange
- graduate recruitment

It should be noted that it would not be in the best interest of the students if the courses were relevant only to one potential employer and so although BAE Systems will be instrumental in enabling course changes to be made these will need to be justified to the various quality checks. The fact that the visiting professors and the industrial committee take an active interest in course development should ensure that any course changes can only be to the benefit of all students.

2.5 Future link with the University of the Highlands and Islands.

Initial negotiations have started with Air Service Training (Engineering) Ltd (AST) at Perth College with regard to a collaboration with the University of the Highlands and Islands into providing a degree for aircraft maintenance engineers. In June 1988 the Joint Airworthiness Authorities (JAA) introduced new requirements JAR-66 and JAR-147 relating to the licensing of maintenance engineers which are binding in the UK. The JAA hold the view that Category C licence holders should have been educated to degree standard. In order to provide this it seems reasonable to combine the expertise of an organisation with a prove record in training licensed engineers (AST) with an existing accredited aeronautical engineering degree. A major aim of this degree is to impart the knowledge and skills required of a category C licensed engineer, whose tasks will include management and supervision of other licensed engineers, inspection, planning, quality control and will require a thorough knowledge of maintenance schedules and the rationale behind them and an understanding of modification and repair documentation. The possibilities in broadening the scope and expertise that this joint venture could bring to both parties are exciting.

3 Conclusion

Chivers [8] commenting on the aerospace industry in the USA said "*....there has been a major change from functional skill organisations to product focused cross-functional team working.*" One of the major recommendations of the Foresight committee [3] was that British industry needed to reorganise itself along similar lines although by 1997 when the report was issued this had largely been achieved. Within the aerospace industry not only has the internal organisation of individual companies changed but all major projects are now produced by complex multi-national collaborations. The new graduate joining industry must now be capable of joining a project team in as short a time as possible and will be expected to move onto a multi-national team with fairly limited work experience.

The changes made to higher education in Britain have not helped to provide the right mix of skills and to the outsider the situation has become more confused. The Engineering Council recognised that there was a problem and reviewed the position with regard to the accreditation of courses for chartered engineer status [1] but the editorial comment in "The Engineer" [9] following the closure of the engineering department at Middlesex University is typical of the questions asked as to the whether the changes are going to produce the desired results.

There appears to be good agreement as to what skills graduates should have [2 and 3] but no clear idea as to how to achieve this in practice. We believe that with the initiatives described and in particular the stronger links with BAE Systems the department is embarking on an exciting future for both the students and the university.

References

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Skill Deficiencies

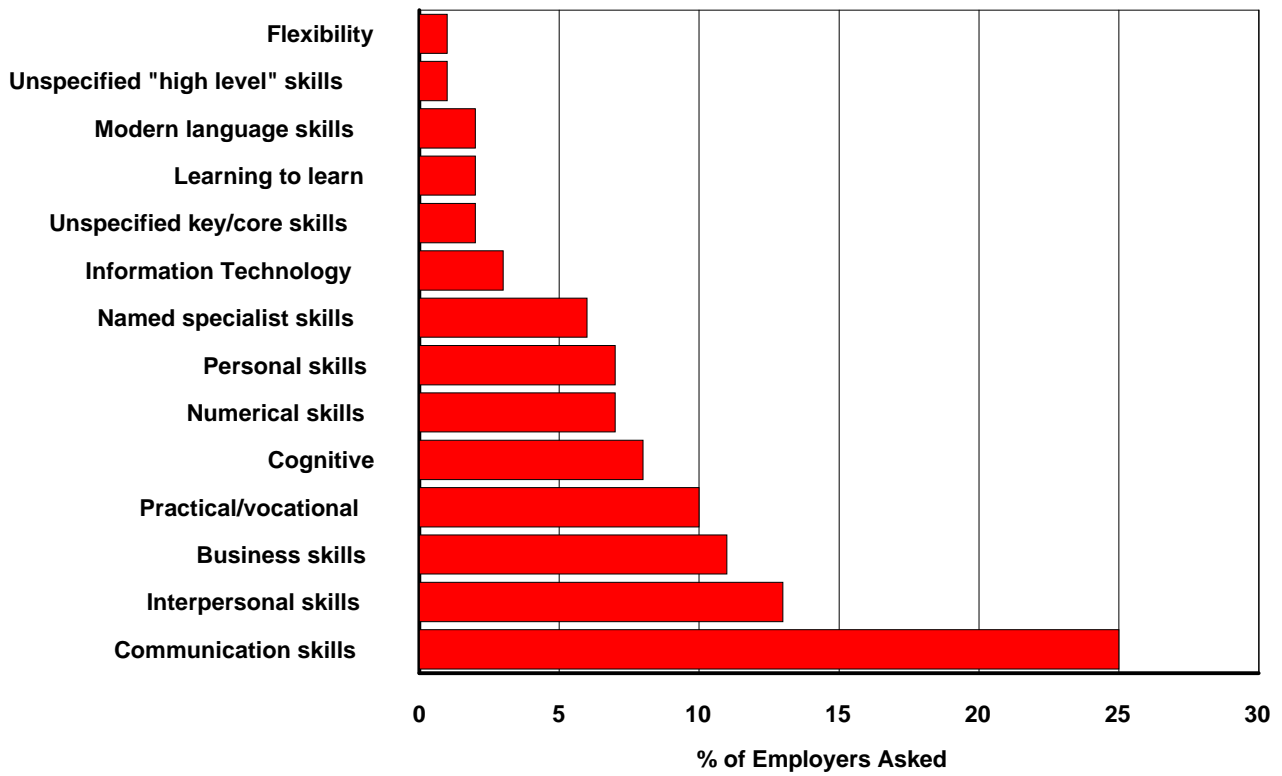


Figure 1. Skill Deficiencies in Graduates as Judged by Employers Asked [2]