

FROM CONCEPT TO CLASSROOM - THE BAE SYSTEMS SPONSORED MEng IN SYSTEMS ENGINEERING

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Abstract — *The following paper summarizes the concept, development and implementation of the only formally taught undergraduate course in Systems Engineering that is available today in the UK. The course was conceived and developed in a strategic partnership between BAE SYSTEMS and Loughborough University. The partnership and sponsorship model developed between industry and academia for this course has helped win a Queens Award for Education for Loughborough University, and has attracted interest from a variety of other sectors of the industry. Notably ARM and Marconi have adopted this model in the development and delivery of programmes in Computer Network and Internet Engineering, and Electronics and Software Engineering. The MEng in Systems Engineering is now viewed as the benchmark for such activity within the UK; and has led to the development of a portfolio of other post-graduate courses by BAE SYSTEMS and Loughborough University.*

Index Terms ¾ Industrial partnership, Industrial sponsorship, Systems engineering.

IDENTIFYING THE BUSINESS NEED

In 1990/91, during the early days of the Eurofighter fighter aircraft development programme, senior management within what was then British Aerospace (BAe) recognized that many of the Company's future systems would be complex, highly integrated, and software driven. The design, manufacture and support of these systems would require engineers with multi-disciplinary skills, who approached complex problems with confidence and ability, irrespective of the specialist nature of the problem. At the time the UK university community was producing; and BAe was recruiting, many high quality graduates in the traditional specialist fields that the Company required. However, there was no university degree in existence that produced engineering graduates specifically targeted at addressing the problem of solving complex multi-disciplinary problems, within an integrated product team environment.

The Company issued this problem as a challenge to a number of Universities. Having reviewed their responses, Loughborough University was selected as a strategic partner with whom to develop an undergraduate course that meet the Company's business need.

THE EDUCATIONAL OBJECTIVE

The objective of the course could be expressed very simply; the course was to produce a stream of young high-calibre graduate engineers that were capable of addressing complex multi-disciplinary problems across a wide range of state-of-the-art technology areas well into the next century. The implementation of this was far from simple!

DESIGNING THE PROGRAMME

The design of the programme was itself a complex multi-disciplinary problem requiring some novel and innovative thinking from both the University and the Company. The approach which was taken was centred on the then emerging field of Systems Engineering, an approach which was eventually to filter through every aspect of the resulting course, and give the course its title.

Over the following 2 years a vast range of issues were addressed, including syllabus content, depth, method of delivery, Company involvement and apportion of costs. It rapidly became obvious that the Company needed to commit significant resources to the programme, if it was to get what was actually required. Realizing the importance and potential of this programme, the Company dedicated several staff to the full time development of the course, embedding one senior employee into the University, to work as part of the University team. In order to ensure that the programme would be designed to achieve the Company's objectives, the staff selected to be involved in the design of the programme were all experienced members of the Company with a clear vision of the type of education required, and with previous knowledge of the UK higher education system.

At an early stage of development it became apparent that the total experience that the students would encounter should not come from the University alone. Consequently, the course was designed with an integrated industrial input in terms of lecture content, project support and periods spent within the industry.

The result was a 5 year MEng programme in Systems Engineering, covering many of the traditional engineering disciplines, along with some non-conventional engineering

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areas (e.g. Human Factors), and a strong theme of Systems Engineering running throughout the programme. In addition to traditional study methods, students spend 80 weeks of the course within the Company, learning from and contributing to the business. This is achieved through a carefully planned and managed series of 'industrial placements', where students are exposed to several areas of the business, including commercial and technical aspects. Each student gets to work on a range of the Company's projects, and at a variety of points in the life cycle of these projects. Financial support to the student was also considered. When the course was first launched, the 5-year format was unusually long for

a UK degree course, and required a significant commitment from students. This, together with the impending introduction of tuition fees, helped shape the Company's sponsorship package. Hence, in addition to receiving a competitive salary whilst they are on periods of industrial placement, sponsored student also receive a bursary during the academic phases of the course at University. The support is further enhanced with the placement of an executive grade employee of the Company being embedded within the University on a full-time basis.

A top-level description of the programme is illustrated below.

TABLE I
COURSE STRUCTURE

Year 1 (SEA)	COMMERCIAL PLACEMENT 8 WEEKS	Year 2 (SEB)	Diploma of Industrial Studies (DIS) Year	Year 3 (SEC)	TECHNICAL PLACEMENT 12 WEEKS	Year 4 (SED)	
Systems Engineering		Systems Engineering	TECHNICAL PLACEMENTS 60 WEEKS			Managing Complex Systems	Applying Systems Theory
Signals & Systems		Signals & Systems				Systems Project	Advanced Systems Project
Computer Systems		Information Systems				Aircraft & Avionic Synthesis	Seven Optional Modules
Programming for Engineers		Human Factors in Systems Design				Financial Management for Engineers	
Electronics		Electronics				Ergonomics	
Circuit Theory		Aerodynamics & Propulsion				Five Optional Modules	
Mathematics		Control System Design					
		Engineering Mechanics					
		Materials					
	Mathematics						

ASSESSING THE OUTCOMES

In October 1992 the first cohort of Systems Engineering students arrived at Loughborough University. Although the course is open to all applicants through the UK's University and Colleges Admissions Service (UCAS), BAe aimed to sponsor 40 students per year through the

course. The course is now in its 10th year, and 4 cohorts have graduated. Although some of the sponsored students elect not to join the Company on graduation, the vast majority (over 80%), seem to have been impressed by what they saw of the Company as an undergraduate and have decided to join the Company on a full-time permanent contract. The sponsorship scheme is popular and well established, and BAe (now BAE SYSTEMS)

currently has over 180 sponsored students enrolled on the course.

There have been teething problems on the programme, as was to be expected, both within the University and the Company. These included lack of specific customer requirements within certain sectors of the University, and poor quality industrial placements within the Company. In these instances the close working relationship established between the partners has ensured that problems were quickly addressed and solutions implemented.

The overwhelming reaction from line-managers and department heads within the Company, is that the Systems Engineering course is producing graduates of a different nature than that traditionally experienced in the Company. They are certainly generally more flexible, confident, quicker on the uptake of new ideas and concepts, and not afraid of tackling big, complex issues. The programme manager within the Company has established a review programme to track graduates progression through the business, and compare this via the internal company 'Measurement of Performance' system with graduates from other single-discipline degrees. Although anomalies do occasionally appear, generally Systems Engineering graduates are demonstrating significantly better performance than their peers.

THE BRITISH AEROSPACE/MARCONI MERGER

During 1998, several other UK based engineering industries started showing interest in the course, and sponsoring students of their own. The strongest interest was shown by Marconi Electronic Systems (MES), who committed to match BAe's involvement in the course in terms of support and sponsored students. Marconi began a student recruitment programme, and identified personnel within the company to manage their Loughborough based activity. Consequently, when the merger of BAe and MES, to form BAE SYSTEMS, was formally announced in early 1999, the 2 companies were already working closely on the programme. The two parallel programmes were successfully merged, and potentially give the sponsored students an increased range of placement opportunities across a much wider spectrum of projects and products. BAE SYSTEMS, is now working closely with the University to examine proposals to increase then cohort size to over 100 students per year.

Quality education does not come cheaply, and it is worthy of note that the cost of this programme to BAE

SYSTEMS is significant, with an annual budget of over £1.0M (US\$ 1.6M), committed to the course and the support of the Company's sponsored students.

EVALUATING THE BENEFITS

The first cohort to graduate from the course entered the Company in August 97, and have only recently left the 'development band' of the Company's career structure. Nevertheless, they are contributing to the success of the Company and by example are also beginning to change the way in which people around them approach problems. Although graduates from the course work in many areas, the majority seem to want to work on new projects that are at an early stage of their development cycle. The majority of these projects are complex and multi-disciplinary in nature; exactly the type of problem that Systems students are trained to deal with, and it is believed that their inclusion on these projects will eventually yield a better product in a shorter time-scale.

The success of the programme has attracted other industrial sponsors. The Defence Evaluation Research Agency (DERA), Pratt and Whitney and Lucas Aerospace have sponsored students through the course. The University has also recently received expressions of interest from other major engineering industries within the UK, regarding sponsorship issues associated with this course. The course is now the biggest in terms of student numbers within the Faculty of Engineering at Loughborough, and if the current trend is maintained will soon be the biggest course in the University.

With up to 40 graduates entering the Company per year, there will be an evolutionary rather than revolutionary realization of the benefits that the programme will bring to the Company. With these people, the Company believes that it will be much better placed to take on and succeed in many of the next century's highly complex high-technology based projects.

FOLLOW-ON DEVELOPMENTS

The success of the relationship that has been built between the University and the Company around the MEng undergraduate course has prompted BAE SYSTEMS to initiate a postgraduate course in Systems Engineering also at Loughborough University. This course was launched in January 2000. It is a part-time modular course, and is focussed towards existing Company employees who have a single discipline first degree and now wish to extend their capabilities in the area of Systems Engineering. In addition the Company has also commissioned the University to run a series of short courses in Systems Engineering, to introduce the

concepts and techniques to managers and practitioners in this rapidly developing field.

The model established between BAE SYSTEMS and Loughborough University for the undergraduate MEng programme, has recently been adopted for 2 new programmes with other sectors of the engineering industry. Marconi and ARM, both high technology electronics based companies have launched courses in partnership with the University, in Computer Networks and Internet Engineering, and Electronics and Software Engineering. Although it is early days for these programmes, both appear to be popular with students.

CONCLUSION

In 1990 Systems Engineering was an emerging field of study, not on offer at any UK university. BAE SYSTEMS and Loughborough University have lead the way in this area. A critical factor in the success of this programme, is the strategic nature of the partnership between the Company and the University and the very high level of commitment made by both partners. This programme has been briefed to academics and industrialists throughout the UK, in Europe and the USA, and to date the author is not aware of any programme that demonstrates a similar level commitment and success. The follow-on postgraduate and short course programmes indicate the level of confidence that the partners have in each other. This success is further endorsed by the adoption of the undergraduate model by other sectors of the engineering industry. It is believed that the MEng in Systems Engineering is a true international 'Benchmark' programme, of which Loughborough University and BAE SYSTEMS are justifiably proud.