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A Scottish Degree in Aerospace Engineering with a European Dimension

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With the increased cohesion within the European Aerospace industry, universities are now beginning to address the European dimension in their degree courses. This paper describes the Master of Engineering course offered by the Department of Aerospace Engineering of the University of Glasgow. This degree course has both industrial and European elements, and has been initiated to meet the needs of undergraduates who wish to pursue careers as European engineers. The course is described along with other related initiatives and then, finally, possible future developments are indicated.

1. INTRODUCTION

WITH the progressive removal of trade barriers within the European Community, new opportunities for engineering graduates are emerging. These are being addressed by the Department of Aerospace Engineering at the University of Glasgow where a number of educational initiatives is being pursued in collaboration with European partners. It is hoped that these initiatives, which have already enhanced existing undergraduate courses, will, ultimately, accelerate progress towards Pan-European degrees.

Through EC-funded programmes, in particular the TEMPUS and ERASMUS initiatives, collaboration has been established with educational and research institutions in Braunschweig, Bristol (UK), Delft, Madrid, Munich, Toulouse, Bordeaux, Belfast, Turin, Stuttgart, Prague and Brno, as well as aircraft and component manufacturers in Czechoslovakia and the UK (Fig. 1). The most far-reaching development has been the introduction of a new Master of Engineering (M.Eng.) degree. This course, unlike the existing undergraduate Bachelor of Engineering (B.Eng.) degree, has strong industrial and European elements.

The M.Eng. degree has its origins in the Finniston Report [1], on the basis of which the Council of Engineering Institutions have encouraged universities in the United Kingdom to introduce M.Eng. degree courses for their most able students, particularly those who intend to make their careers in

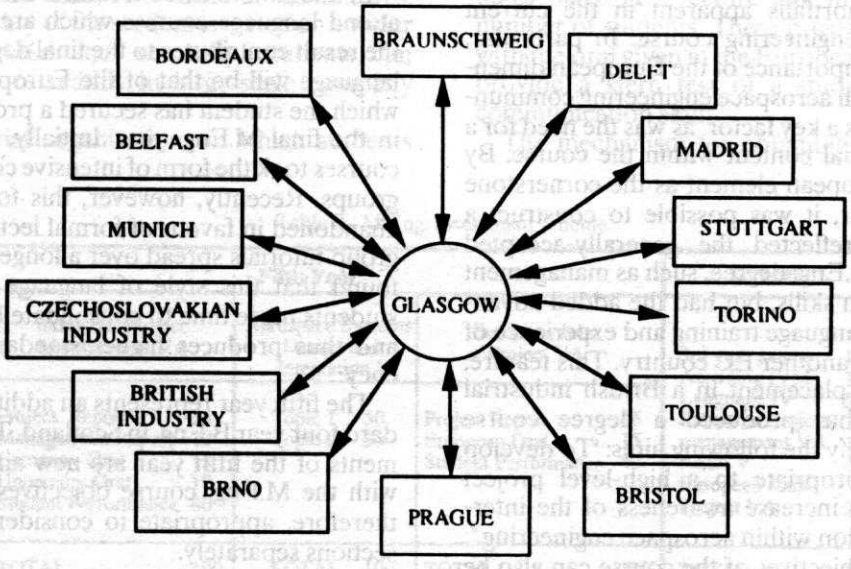

Fig. 1. University and industry collaborations established via TEMPUS and ERASMUS (universities identified by city).

industry. Glasgow University's M.Eng. in Aerospace Engineering is a five-year course which follows the first three years of the B.Eng. curriculum, after which students take an integrated fourth and fifth year course to graduation. Students wishing to take the M.Eng. course transfer from the B.Eng. at the end of third year. Places on the M.Eng. are limited and selection is competitive and based substantially on the students' academic performance over the first three years of the B.Eng. course.

Increasingly, major aerospace engineering projects, such as the Airbus family of aircraft, are conceived on an international scale and are successful only to the extent that strong collaborative links between the participating organisations can be forged at all levels. The M.Eng. course, therefore, is designed to develop skills appropriate to a high-level industrial engineer operating in the European aerospace industry. In particular, the M.Eng. prepares students for the European environment by developing their language skills and then placing them in a European country for an extended period. This gives them first-hand experience of life and work in a foreign country and allows them to gain an appreciation of the interface between educational and industrial establishments within that country.

The present paper describes, in detail, the M.Eng. course structure and the assessment procedures which are currently in operation. In addition, examples of the type of project-work undertaken by students on European placements are given. It is concluded that the first years of the M.Eng. have been a qualified success and that many possibilities exist for future curriculum development.

2. COURSE AIMS AND OBJECTIVES

The M.Eng. course was developed to address some of the shortfalls apparent in the current undergraduate engineering course. In particular, the increasing importance of the European dimension to the British aerospace engineering community was viewed as a key factor, as was the need for a stronger industrial content within the course. By including a European element as the cornerstone of the final year, it was possible to construct a course which reflected the generally-accepted features of an M.Eng. degree, such as management and presentation skills, but had the added advantage of foreign language training and experience of life and work in another EC country. This feature, coupled with a placement in a British industrial establishment, has produced a degree course designed to satisfy the following aims: 'To develop basic skills appropriate to a high-level project engineer and to increase awareness of the international dimension within aerospace engineering.'

The overall objectives of the course can also be identified, as follows:

1. Students should demonstrate competence in a foreign language and should demonstrate the ability to adjust to life in a foreign country.
2. Students should achieve above-average performance in a variety of formal oral and written presentations, as assessed by both academic and industrial personnel, and should develop good informal communication skills.
3. Students should produce high-quality technical project-work as assessed by European and British academic staff, and British industrial personnel.

It is expected that students graduating with the M.Eng. degree should generally be better equipped to deal with the demands placed on the modern engineer operating in an increasingly international environment.

3. M.Eng. COURSE CONTENT

In order to meet the above objectives, the scope of the M.Eng. is such that a wide variety of material is considered in the overall assessment of student performance. For example, results from written examinations, project-work and oral presentations all contribute to the final grading. The overall course assessment is derived from third, fourth and fifth year performance. The main elements of the course are shown in Table 1.

The third year component is entirely based on written examination results and is taken as the average of a core of compulsory subjects such as fluid mechanics, aerodynamics, aerospace design, materials, etc. Similarly, the fourth year component is, in the main, comprised of written examination results in specialist aerospace engineering subjects such as aeroelasticity and aerospace structures. The overall grading for the fourth year is recorded as a compound subject called Aeronautical Engineering IVM.

In addition to these technical modules, students attend language courses which are examined and the result contributes to the final degree grade. The language will be that of the European country in which the student has secured a project placement in the final M.Eng. year. Initially, these language courses took the form of intensive courses for small groups. Recently, however, this format has been abandoned in favour of formal lecture classes and group tutorials spread over a longer period. It was found that this style of language teaching gives students more time to consolidate basic principles and thus produces higher standards of competency.

The fifth year represents an addition to the standard four year B.Eng. in Scotland. Thus, all the elements of the fifth year are new and are designed with the M.Eng. course objectives in mind. It is, therefore, appropriate to consider each of these sections separately.

Table 1. M.Eng. course structure

1st-3rd Year	4th Year	5th Year
Curriculum follows B.Eng course in the first three years with students attending lectures and laboratories.	Aero Design IV Fluid Mechanics IV* Aerospace Structures IV Aerospace Dynamics IV Aeroelasticity IV Prof. Studies IV Language IVA	Industrial Project Management VA Aerospace Systems Design and Integration V European Joint Project VA

* One of a list of optional subjects

Industrial Project Management V

In the fifth year, students work in industry in the UK for a minimum of three months, on project-work which has been suggested by the industrial partner but which is jointly supervised by industrial advisers and teaching staff. Students must write periodic progress reports and must account for time spent on various aspects of the work via, for example, a logbook. Students must also be able to explain how their work relates to larger scale inter-departmental projects and must also show an understanding of the management structures associated with this type of project-work. A number of the aspects of this module are assessed and these are shown in Table 2.

With the exception of the oral presentation given at the university, all of the elements of this course module are assessed jointly by academic and industrial personnel. The nature of the project-work undertaken by the student is particularly important. Unlike some degree courses which have an industrial element, it is preferred that students work on a variety of small projects rather than one major project spanning the entire period of the placement. This has two distinct advantages. Firstly, the ability of the student is tested on a wider range of material and, secondly, students can participate more readily in large-scale company projects.

The industrial organisations in which students are placed are, generally, aerospace companies but, occasionally, organisations whose main activities are related to the aeronautical disciplines are used. In these cases, student projects are in subject areas such as digital control, aerodynamics or manufacturing. Since the M.Eng. was initiated, students have undertaken industrial projects in a variety of subject areas which include flight testing, stealth technology, aerodynamic load estimation, flutter, computational fluid dynamics and superplastic forming. The projects undertaken in 1991, and the industrial organisations involved, are shown in Fig. 2.

One of the areas of emphasis in the M.Eng. course is the development of presentation skills. In the industrial project phase, students are required to give two presentations for which the audiences are entirely different. At the industrial presentation, the audience consists of a small group of engineers from the department in which the student has been working and takes place in a small seminar room. The presentation technique appropriate to this situation is entirely different from that necessary for the university presentation which takes place in a lecture hall in front of a large number of students. These presentations, together with the oral given in the European project section, provide a stern test of a student's formal oral communication skills.

The mechanism for obtaining industrial place-

Table 2. M.Eng. assessment scheme

Fifth Year						Overall	
Industrial Project Management VA		Aerospace Systems Design and Integration V		European Joint Project VA			
Project Report	25	Topic 1	50	Project Report	45	3rd year exams	15
Management Report	10	Topic 2	50	European Oral	15	Aero Eng IVM	32.5
Company Oral	15			Student Performance	40	Language IV	5.5
University Oral	10					Industrial Project management VA	19
Student Performance	40					ASDI V	4
						European Joint Project VA	24
TOTAL	100	TOTAL	100	TOTAL	100	TOTAL	100

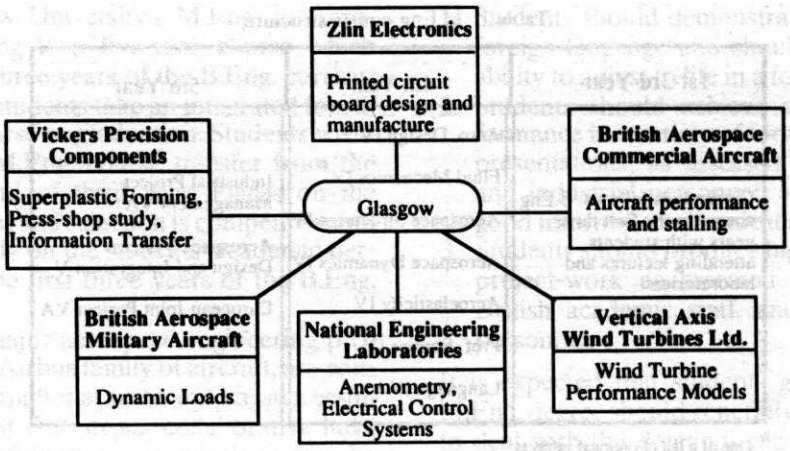

Fig. 2. M.Eng. industrial projects in 1991.

ments has proven difficult to standardise. Indeed, in the current economic climate in the UK, industry has been unable to support the number of placements which it would like. This has been a severe problem for the M.Eng. course.

Aerospace Systems Design and Integration V

On completion of their Industrial Project, students attend a short lecture course, Aerospace Systems Design and Integration V. This lecture course consists of a general introduction followed by tuition in two or more specialist areas which are of current relevance within the aerospace field. The specialist lectures are delivered by European academics via the ERASMUS/SPIN scheme which was established as an attempt to provide high-level aerospace teaching in specific disciplines. The scheme is headed by ENSAE at Toulouse which has created a consortium, with a growing number of European partners, to pool existing pedagogical resources. In the scheme, member institutions submit course titles to a European directory which is regularly circulated. Any institution can then ask for courses from the directory to be delivered at the institution. The Department of Aerospace Engineering at the University of Glasgow participates in this scheme both by providing courses and inviting staff from European institutions to present courses in Glasgow, particularly to its M.Eng. students.

If two of these courses, for example, Advanced Materials in Aerospace Structures and Experimental Methods in Aerodynamics, are presented to the M.Eng. students, each course carries a 50% weighting in the assessment.

European Joint Project V

Finally, in the fifth year, students spend a period of about five months in a European educational institution, during which they undertake an industrially-related project and may spend some time in a collaborating aerospace company. Project topics are chosen to interact with current group activities within the European establishment, but students should also be able to identify the possible benefits of their work to the aerospace industry in general.

The project-work undertaken in the European phase of the fifth year concentrates on one large-scale project. The manner in which the student tackles the project, together with the technical reporting, constitutes 85% of the total mark available to the student (Table 2). In this phase, the emphasis is firmly on the ability of the student to live and work in the foreign environment. Assessment of this stage is carried out entirely by academics from the host institution and considers aspects such as language competency, etc. To ensure parity of marking between institutions, a rigid student assessment scheme is provided by Glasgow University. Where necessary, details of the marking scheme are supplied in the language of the host university. For example, the marking structure used for the European oral of a student based in France is shown in Fig. 3.

Since the introduction of the M.Eng. course, Glasgow students have visited Toulouse, Delft, Munich and Madrid. Typical projects include work on wing design, high-speed passenger aircraft configurations, flight control instruments and propeller performance analysis.

4. SUPPORTING ACTIVITIES

A number of related activities are currently being pursued by the Department of Aerospace Engineering at the University of Glasgow which either directly influence the M.Eng. or provide scope for future expansion of the scheme.

ERASMUS

The EC introduced the ERASMUS programme to encourage student and staff mobility within the EC and to promote curriculum development activities. The Department of Aerospace Engineering at Glasgow University is actively involved in student exchanges in the M.Eng. course, and has

Note	Elocution	Organisation du Contenu
0 - 11	Description verbale insuffisante	Aucun effort visible de presenter le contenu dans un ordre coherent
12 - 14	Soit une description verbale a peine satisfaisante soit une elocution inintelligible	Quelques efforts pour organiser le contenu mais la coherence est a peine satisfaisant du a un classement inapproprie ou a du materiel manquant
14 - 16	Un contenu verbal satisfaisant expose d'une facon intelligible	Une organisation satisfaisante du contenu en general coherent et peu d'omissions de materiel
17 - 19	Un equilibre satisfaisant dans le contenu verbal, expose d'une facon claire	Une bonne organisation du contenu et bien structure
20 - 25	Un bon equilibre du contenu verbal, expose d'une facon exceptionnellement claire et precise	Une tres bonne organisation du contenu. Il n'y a aucun materiel manquant, et la structure en est particulierement bonne
	Aides Visuelles	**Contenu**
0 - 11	Tres peu de contenu visuel dans la presentation. Le contenu est pauvre en qualite et insuffisant.	Toute la presentation manque d'etoffe et est insuffisante en qualite et en quantite
12 - 14	Quelques contexts visuels pour la presentation, mais indifferents en qualite et pas totalement appropries	Le contenu de la presentation est a peine satisfaisant en termes de qualite et de quantite
14 - 16	Contenu visuel satisfaisant d'une qualite raisonnable et en general utile pour la presentation	Une presentation satisfaisante avec un contenu suffisant pour indiquer les objectifs et les realisations principaux du projet
17 - 19	Bon contenu visuel, amenant bien les parties principales de l'oral	Une bonne presentation avec un contenu couvrant tous les aspects du projet
20 - 25	Contenu visuel excellent. Bien prepare et tres utile a la presentation	Une presentation tres complete couvrant tous les aspects d'un projet de haute qualite
Commentaires		**Notes Allouees**
		1) Elocution..... **2) Organisation du Materiel.....** **3) Aides Visuelles..... .....** **4) Contenu.....** **Total.....**

Fig. 3. Assessment form for student oral presentation (French version).

benefited from lecture courses delivered by European academics. Currently, Glasgow coordinates a student exchange programme in collaboration with ENSAE Toulouse, TU Delft and the Technical Universities of Madrid and Munich. The number of partners involved in the scheme will be expanded to include institutions from Belfast, Bordeaux and Torino for 1992/93. The programme is coordinated via a series of short meetings which are generally arranged to coincide with student project presentations or other course-related events.

TEMPUS

In 1990, the Department received a grant from the EC under its TEMPUS initiative (Trans European Mobility Programme for University Studies) to establish a Joint European Project (JEP) in collaboration with European and Czechoslovakian institutions.

The primary objectives of the JEP, for which Glasgow is the coordinating institution, are the enhancement of teaching methods in aircraft engineering in Czechoslovakia and the establishment of mutually beneficial cooperative links between Czech universities and industry. This initiative addresses the shortfall in high-technology methods which currently exists in aircraft engineering teaching practices in Czechoslovakia particularly in areas such as CAD/CAM applied to aircraft design and electronics. The organisations involved in the JEP are illustrated in Fig. 1.

In the course of the project, staff at technical uni-

versities in Prague and Brno will participate in training programmes hosted by European academic institutions in key aircraft design disciplines including aerodynamics, structures and systems design. Here the emphasis will be on new technologies and teaching methods.

The TEMPUS initiative also provides funds for British students to undertake project work in Czechoslovakia. During the summer of 1991, four students from the Department of Aerospace Engineering at Glasgow University worked on aspects of their B.Eng. final year projects at the Czech Aeronautical Research Institute in Prague and at aircraft manufacturing concerns in Moravia. These projects were jointly supervised by Czechoslovakian and Glasgow University staff and are targeted towards the design of three small aircraft. Provision has also been made for undergraduate students from Czechoslovakia to participate in small-scale projects at collaborating European institutions, and the first students travelled to their west European host institutions in September 1991 for study assignments of up to five months.

It is hoped that in the future these links with Czechoslovakia may be used to enhance the current scope of the M.Eng. to include Czechoslovakian-based project-work.

5. FUTURE PROSPECTS

Currently, the M.Eng. degree course has a form which is evolving. Of particular concern is the level of language training provided for students prior to the European project phase. It is hoped that in future years, potential M.Eng. students could begin language training at an earlier stage and, therefore, develop higher levels of competence.

The increased number of partners in the ERASMUS student exchange scheme will provide a greater variety of project-work and increased student capacity. Links with east European institutions are also being explored.

The industrial project module of the fifth year course is constantly under review. Of all the elements of the course, this is the most difficult to sustain. A great variety of factors can influence the type and availability of student placements within industry. Efforts are currently under way to develop a long-term programme of guaranteed placements. This, however, may be difficult to obtain given the current economic climate.

6. CONCLUDING REMARKS

The first years of the M.Eng. have enhanced links with both industry and European partners. The course has been relatively successful but has experienced problems, particularly in obtaining industrial placements for students. It is hoped to develop the scope of the course over the next few years.

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