Curriculum development in Industrial Management: A case study

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Abstract

This paper is abridged from notes describing a project funded by the British Know-How Fund (KHF). The project was involved with the process of restructuring degree courses at the Technical University of Sofia (TUS) and in particular to update the Industrial Management degree courses.

A partnership was developed between the staff of the TUS and the University of Nottingham over a period of three years. The achievements included the development of new curricula, the modularization of courses, the introduction of a TQA system and the development of a system for staff training and mentoring. Information describing the new degree structure and content was submitted to the IEE in the UK for accreditation. Additionally, a study was made of research possibilities and funding that would be appropriate for the staff of the TUS in the new environment in which they would be working.

The emphasis of the paper is on the curriculum development for the new Industrial Management course within the context of the changing economic and educational environment in Bulgaria

Introduction

Bulgarian society is going through a period of dramatic transformation. The changes in the economy are especially difficult and painful and their success will define the level of prosperity that the country can achieve. The transition process and the subsequent restructured industry requires managers that are well trained, have a good business and engineering background, can manage complex organisations and are capable of taking difficult decisions within a much more entrepreneurial environment.

This paper describes the process of restructuring the Industrial Management degree courses at the Technical University of Sofia. The project was funded by the British Government Know-How Fund. The aims of the project were to update the degree courses so as to meet the demands and constraints set by the new market economy and changing political environment of Bulgaria.

The Technical University of Sofia is the oldest and leading engineering establishment in Bulgaria and it is internationally renowned for its good academic and technical traditions. The Technical University has taken a novel approach by introducing courses in Industrial Management and developing an appropriate infrastructure for their delivery.

1.1 Problem Definition

The project, which started in February 1997, was based on the understanding that the teaching, the courses, the infrastructure and the research activities in the Faculty of Management needed modification and refocusing to address the needs of the Bulgarian economy in transition. The aim was to produce new modern courses, consistent with current trends and world best practices, and backed up by well-developed teaching and research practices and appropriate organisational structures. These should develop academic staff with enhanced research, teaching and management knowledge and skills and allow greater self-financing possibilities.

The main project areas were agreed to be:

- Curriculum development,
- Quality Assurance and Enhancement,
- Training and staff development,
- Research development,
- Co-operation with industry,

- Developing teaching and learning resources,
- Strategy and planning
- Institution development.

The emphasis of this paper is on curriculum development.

1.2 The Courses

It was assumed that the competitiveness of manufacturing industry depends on highly competent manufacturing engineers and managers capable of operating in complex interdependent environments that incorporate intelligent technologies, innovative management structures and empowered people.

One of the main strands of the project was the development of new BEng and MSc courses in Industrial Management and an MBA course. These courses course are designed to produce graduates equipped with in-depth knowledge and decision making skills in a wide range of engineering subjects and who are capable of filling senior engineering and management roles in leading manufacturing enterprises. These requirements, together with the constraints provided by the environment and the educational philosophy adopted, determine the curriculum content.

The Overall Approach

A strategy for developing the institution and enhancing the quality of teaching was developed so that the overall activities of the Faculty could be improved. The strategy aimed to develop the management structure of the institution, to develop the curriculum and syllabus and to provide appropriate support to the teaching and provide learning resources and training of the academic staff.

The courses are based on the understanding that industrial managers have to possess knowledge and expertise in the theory and practice of manufacturing engineering and management. They concentrate on providing an integrated view across the key manufacturing activities of design for manufacture, manufacturing technology and processes, business management and human factors in a wide range of industries. The courses provide a flexible structure for developing in-depth knowledge, decision-making skills and industrial awareness in a range of engineering and management disciplines. The courses aim to produce highly skilled graduates who can utilise

technological and human resources effectively in integrated manufacturing environments and are capable of enhancing industry's ability to compete in world markets. The courses also seek to develop personal, communication, analytical and entrepreneurial skills relevant to the engineering profession and industrial and business management.

The proposals were likely to develop and change rapidly during the planning process. Mechanisms were needed for discussions between staff of the University of Nottingham and TUS for knowledge acquisition and to be able to respond rapidly to the improved understanding and external changes.

1.3 The basis for the course restructuring

A variety of sources influenced the course restructuring. The KHF and the Bulgarian Ministry of Education provided the conceptual requirements and the rules governing the constraints. The input from the Technical University of Sofia (TUS) included the rector's wishes, wishes expressed by the TUS staff and documentation about the current course including the syllabuses. The University of Nottingham provided knowledge about:

- their courses,
- Training and Staff Development (T&SD),
- Teaching Quality Assessment (TQA) requirements,
- research expertise,
- experience in modularization
- indications of other changes that had been acceptable within the University of Nottingham

Wherever possible, we sought opportunities to articulate the project with institutional level actors e.g. by visiting Vice Rectors and the Rector in our first week and linking the project to national developments e.g. by also visiting the Accreditation and Evaluation Agency during our first visit. Secondly, the project was designed around a series of working parties created to achieve maximum staff involvement. Thirdly, we were responsive to the changing agenda of the Faculty and took opportunities to connect the project with other faculty concerns as they arose. In these ways, we sought to overcome the difficulties apparently faced by some previous projects suggesting that curriculum change projects were particularly difficult and that projects could easily become isolated, limiting their impact to a few staff with particular interests.

The Curriculum development process

1.4 Developing new curriculum requirements

The Bulgarian Bachelor and Master Degree courses are required to conform to the State Requirements of the respective speciality. These determine the duration of study for full-time and part-time students, compulsory modules together with contact hours, duration of student placements, teaching requirements, etc.

In addition to the State Requirements the following requirements had also to be taken into consideration:

- the requirements of the National Committee for Evaluation and Accreditation;
- the requirements of the Institution of Electrical Engineers in the UK within the context of the future accreditation of the Bachelor Degree in Industrial Management;
- curricula and expertise of the University of Nottingham and other leading Western Universities
- the educational requirements of the Technical University of Sofia
- the experience and traditions of the Faculty of Management;
- the curricula and expertise of similar specialities in the other Bulgarian universities

Initially there were difficulties in determining the Curriculum Requirements because the Industrial Management speciality was not included in the Bulgarian State Register of Specialities for Higher Education. Therefore, one of the first steps in the reported project was to develop new Industrial Management course requirements to be included in the State Register. These were developed in collaboration with all nine Universities aiming to introduce Industrial Management. The draft course requirements were prepared using a two step approach co-ordinated by the Faculty and with participation of all other partners from the relevant Bulgarian universities and a representation from the Ministry of Education.

To help develop the new curriculum similar courses in several universities in the UK were researched. A detailed structure was developed in consultation with the University of Nottingham based upon the Nottingham BEng/MEng Manufacturing Engineering and Management course. This is a high quality UK course, accredited by the Manufacturing Division of the Institution of Electrical Engineers, with a teaching quality assessment mark 24 out of 24. A major strength of the course is the integration of Manufacturing Engineering with

Management principles and so this matched the needs of the new course in Sofia that we were seeking to develop.

The basic principles, applications and best practice in modularization were investigated. A modular scheme was developed with a view to future international accreditation and recognition of the course and its curriculum and also to being acceptable to the European Credit Transfer Scheme (ECTS. Following the University of Nottingham system the course was based on 60 credits per semester. The majority of the modules were of 10 credits with the exception of the final year project of 60 credits.

1.5 Approach to course development

Although a Bachelor course structure previously existed in the Faculty it was necessary for it to conform to the State Requirements. Hence a detailed updated curriculum consisting of a qualification characterisation, contact hours and assessment procedures was developed.

There was a need to match the course with the constraints. The constraints included the requirement for accreditation, views on the MBA, a legislative requirement that the course need to be on the approved list, a desire to reduce the number of contact hours per week and restrictions related to staff qualifications. In order to assist with the curriculum development process, software was developed that assisted the derivation and revision of proposals. This was extensively used as the basis for discussion and rapid modification of any proposals. As many revisions could be produced per day as were required. Essentially this was an iterative procedure carried out in conjunction with the TUS staff to produce the perceived current best balance of activities within the constraints that had been identified.

There was a short-term problem of ensuring a smooth transition when introducing the new course and a longer-term problem to provide flexibility for ongoing review and revision. After several joint workshops and numerous drafts, a curriculum that incorporated several groups of modules unified by the similarity of the taught courses was adopted. The aim of balancing the engineering and management modules was essential to the philosophy of the course

Course Structure and Content

1.6 The developed course

The developed course structure complies with the guidelines set in the National Register of Courses in Bulgaria and the University specific requirements by providing a balanced curriculum of management and manufacturing (or production) engineering subjects. The course structure is modular based on 120 credits of modules per academic year. The majority of the modules are based on one semester and equal to 10 credits but the final year one semester long projects are of 60 credits.

The course integrates several manufacturing engineering and management themes that are evident throughout all semesters. The main structure of the BEng course consists of nine groups of modules (see Figure1): Business Management; Managerial Economics; Law & Social Science; Engineering Management; Production Engineering; Engineering Technology; Information Technology; Mathematics & Decision-Making; and Languages. These modules provide the essential themes. Specific modules are the manufacturing project in Semester 6 and the industrial management projects in Semester 7. The final individual project in Semester 9 provides a practical base for integrating the major themes.

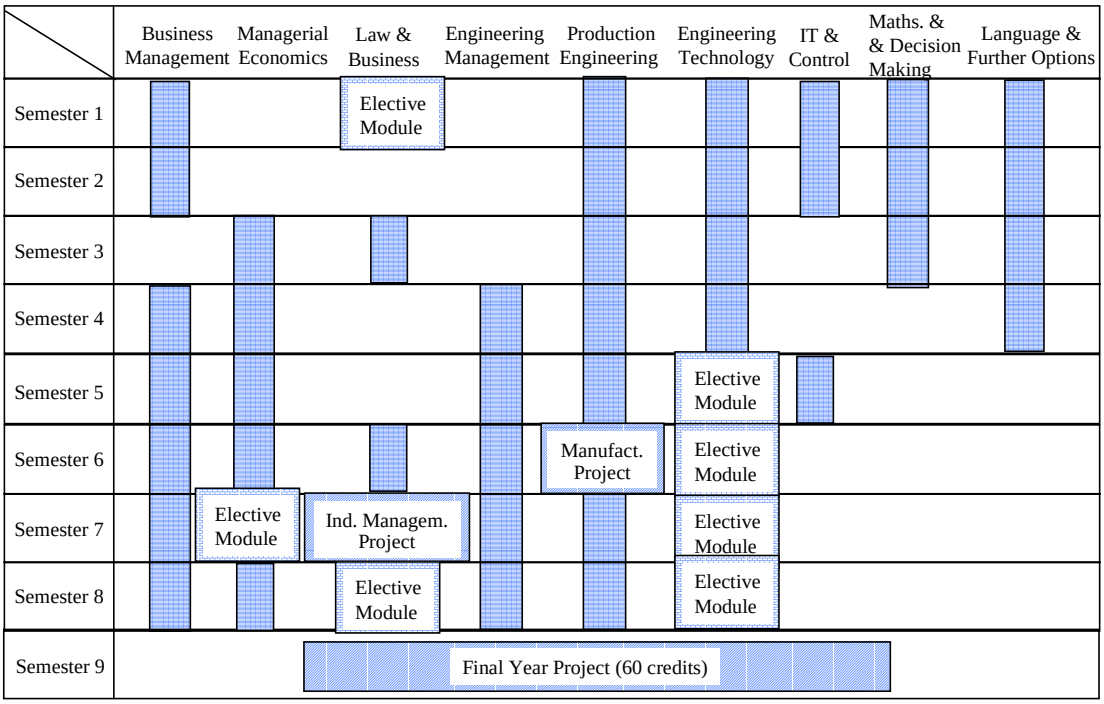

Figure 1. Thematic design of the new BEng course

While providing flexibility, allowing students to select different elective modules, the course is designed to guarantee that, despite the variety of possible routes, all students take the required minimum of engineering subjects. Engineering mathematics, computer studies and quantitative decision making modules in the first two years provide a solid base for developing essential managerial and engineering techniques and skills in the third and fourth years of the course. The practical skills of the students and their abilities to work in teams are enhanced through the two projects in semesters 6 and 7, each of which has the weight of a full module. Marking is based on a combination of the team and individual performance. In the fourth year the course provides a flexible structure for developing in-depth knowledge, decision making skills and industrial awareness in a range of engineering and industrial management disciplines. In semester 9 the students undertake a major individual project, normally industrially based, that provides opportunities for integrating different skills and techniques and applying them to solving manufacturing and management problems. An important feature of the course is the range of options given to the students in the later semesters. Students may select specific modules according to their interests and this allows a student the flexibility to design their own course of study. Full module syllabi for the undergraduate course were developed. Some of them were prepared during the visits of academic staff from the TUS to the UK. The syllabi will continue to be updated.

Semester	Business Management	Managerial Economics	Law & Social Science	Engineering Management	Production Engineering	Engineering Technology	Information Technology	Mathematics Decision Making	Languages
1	Introduction to Industrial Management		*One module from Group D Humanities*		Design for Manufacture	Engineering Chemistry (5c)	Computer Studies 1	Mathematics	Language (5c)
2	Marketing				Engineering Materials & Processes	Engineering Physics	Computer Studies 2	Mathematics	Language
3		Economics	Business Law		Manufacturing Technology	Mechanics		Quantitative Methods & Statistics	Language
4	Business Management	Business Economics		Systems Analysis & Design	Automated Manufacture & CAD/CAM	Electrotechnics			Business Language
5	Organisational Behaviour	Corporate Finance		Industrial Engineering	Robotics & Material Hand	*One module fro Group A0 (Engineering)*	Electronics & Control		
6	Human Resource Management	Business Accounting	Commercial Law	Production & Management	Manufacturing Project	*One module fro Group A (Engineering)*			
7	Business Strategy	*One module group C Management*	Managerial Project	Management of Quality	Computer Integrated Manufacture	*One module fro Group B (Engineering)*			
8	Marketing Management	Business Analysis	*One module from Group E Management*	Innovation Management	Manufacturing system design & analysis	*One module from Group F (Engineering)*			
9	Final Year Project -60 credits)								

Table 1. Course Structure - Themes & Modules

Group A	**Group B**	**Group C**	**Group E**	**Group F**
Microelectronics	Assembly & quality control in Electronics	Entrepreneurialship	Efficiency & Competitiveness	Software Engineering
Electrical Processes & Appliances	Alternative sources of energy	Managerial Behaviour	Engineering Ecology	Advanced Materials and processes
Automotive Transport Engineering	Automotive Maintenance and Repair	Labour Law	Industrial Sociology	*Enterprise Integration*
Fundamentals of Telecommunications	Global Telecommunications	Sales Management	Consumer Behaviour	Robotics
Electrical Technology	Electrical Supply & Equipment	Money Markets and Banking	Risk Management	Human Computer Interfaces
Computer Technology	Digital Technology	Innovation Management	Introduction to Internet & Electronic Commerce	
Electrical Power Systems	Maintenance of power generators	Advanced quality management	Unification Management	
Textile Manufacture	Textile design systems	*Business Analysis*	Intellectual Property Rights	
		Marketing Management	Maintenance Management	
		Design & Ergonomics	Industrial Ergonomics	
		Fundamentals of standardisation and certification	European Standards	
			European Technical Legislation	

Table 2. Elective Modules

The primary skills that the course develops are those relevant to the analysis, evaluation, design and management of effective manufacturing enterprises. Many of these skills are transferable to a wide range of businesses and management functions. In addition the course helps to develop more general personal, communication, analytical and enterprise skills. In particular, effective oral and written presentation is emphasised throughout the course. A whole range of activities encourages the development of group working skills. Computer literacy is a feature of many activities in the course. Research and information sourcing skills are developed in many modules. Analytical skills include the ability to define, model and propose feasible solutions for technological and management problems. A number of modules develop understanding and practice in project management. By the nature of the discipline, enterprise skills are fostered and encouraged. Course assessments are based on examinations, coursework and individual and group project reports. The range of assessment procedures provides a balance that helps to measure student understanding, knowledge, ability and performance in relevant disciplines. The majority of modules are assessed by a combination of coursework and examination.

Course evaluation and accreditation

A working group to deal with the preparation of the accreditation documents was set up in October 1997. The group investigated the requirements of the Bulgarian National Agency for Evaluation and Accreditation and the appropriate documents were prepared. However, at that stage it was not possible to continue the accreditation process because the State Requirements were not published and the Academic Board technically could not approve the curriculum without them. However, the documentation was prepared so that it could be immediately presented after these formalities were sorted out. The Bulgarian National Accreditation Commission has now accredited the course. The requirements of the Institution of Electrical Engineers in the UK were also investigated in detail and there were extensive consultations between the Bulgarian members of the working group and the University of Nottingham. After initial screening of the new course by IEE, the Faculty of Management was invited to officially apply for accreditation. The full documentation was prepared and sent to the Accreditation Department of the IEE. The TUS was visited in October 2000 by an accreditation committee of the Manufacturing Division of the Institution of Electrical Engineers. It is expected that the course will be periodically reviewed and evaluated by these bodies.

In addition the courses are reviewed annually by an internal group comprising the Dean, the Course Director and appropriate academic staff. It is the intention that two external examiners will be appointed. These examiners will be at professorial level at other relevant universities in Bulgaria and will provide a measure of independent peer evaluation, in particular with respect to all aspects of examination and assessment. The Faculty is committed to respond to comments and suggestions of external examiners but this part of the procedures is not yet operational. An industrial liaison group, comprising representatives of senior management in local and national industry, will provide advice on medium and longer term course development in relation to industrial trends and needs.

Support Activities and Infrastructure Development

In the reported project the curriculum development has been an integral part of the overall restructuring process of the Faculty. From the outset it was realised that the curriculum development by itself would not bring about lasting change in industrial management education at the Technical University of Sofia let alone in the country as a whole. Therefore a set of