

Developing new curricula for engineers' entrepreneurial education: a Romanian experience

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ABSTRACT: The article presents a Romanian experience from the standpoint of the Chair of Industrial Management at the University *Politehnica* of Bucharest (UPB) as far as developing new curricula for engineering education in the area of *management and entrepreneurship*. Following the 1999 Bologna Declaration, the European education system started a complex restructuring process (the Bologna Process). Universities in Romania (currently a new member state of the European Union (EU)) were part of this process. For technical universities, the restructuring process was particularly tough: the curricula redesign, although considering the engineers' competence system, had to proceed to a painful *cutting* of the duration of studies from five to four years, and alter the engineering education curricula accordingly. Based on the client-oriented marketing approach regarding the educational services provided, labour market surveys were conducted among employer organisations, professional associations of engineers and companies. This survey was aimed at identifying the needs of companies concerning the management and entrepreneurial profile of engineers in order to redesign curricula to fit these needs. This article focuses on the survey results of some actions taken by the UPB.

THE EUROPEAN AND ROMANIAN CONTEXT

Following to the Declaration signed in the university city of Sorbonne (1998), an unprecedented process aimed at the restructuring of the European higher education system formally commenced. One year after, in 1999, those Ministers responsible for higher education from 29 European countries signed the Bologna Declaration, which has the major objective of developing a coherent and cohesive European Higher Education Area by 2010. Other meetings followed: Prague (2001) and Berlin (2003), where 33 participant countries agreed to strengthen the initial objectives: *Europe must be the most competitive and dynamic knowledge-based economy in the world* [1]! The European reform took off.

In this article, the author does not question the rightness of the European objectives or their chances of being reached by 2010. The important thing is that Europe accepted the challenge and Romania signed up for the Bologna Process. Romania was engaged in a twofold fundamental transition: from centrally planned to a free-market economy plus the European Union (EU) accession process. Higher education reform was part of this complex process and Engineering Education (E²) was just a component of this. An analysis of the transition strategy is not the purpose of this article either; however, it is important to understand the complexity of the circumstances in which technical universities evolved; among them the University *Politehnica* of Bucharest (UPB), the oldest and largest technical university in Romania.

MANAGEMENT AND ENTREPRENEURSHIP AT THE UPB

The Bologna Process has seriously influenced E²; starting with the 2005-2006 academic year, the duration of engineering studies has reduced from five to four years of study and E² curricula were affected accordingly. The shock was painful for many UPB departments.

Earlier Start

Management subjects at the UPB were traditionally taught by professors within the Chair of Industrial Management (CIM). A core group of CIM professors, well trained in the early 1990s in North America and Western Europe, initiated the change of the old-fashioned subjects and syllabi in the management area and influenced the engineering faculties at the UPB to update their curricula. As a result, the first economics engineering specialisations were established in the Faculties of Electrical and Power Engineering (mid-1990s) with the large contribution of the CIM in the curriculum design. New subjects started to be taught along with management and marketing, such as business strategy, marketing research, human resource management, finance and accounting. Engineering Economics Education (E³) now exists and has its own students.

The process was eased by the existence of the Center for Business Excellence (CBE), which opened its doors in 1991 following a successful cooperation programme between the UPB and US universities as a *business research laboratory* of the CIM. Its mission was to provide services (as consulting and training) to the business community and *stimulate entrepreneurship in Romania*, using academic expertise and its international vocation. As the very first centre of this kind, the CBE has considerably impacted on the business culture in Romania [2].

The year 2000 is a milestone for entrepreneurial education at the UPB with the introduction of the course *Entrepreneurship*, now taught to E³ students since then. Consequently, 2000 is the year when Engineering Economics & Entrepreneurial Education (E⁴) was born at the UPB.

In 2001, the CBE initiated the Business Plan Contest open to UPB E³ students following the Harvard Business School model. The major objective of this contest – now in its 6th edition in 2007 – is to stimulate the entrepreneurship spirit among students.

A series of classes started to be linked to the CBE aimed at connecting the business world and academia. Networking with managers and companies revealed another urgent need: postgraduate studies in management (Master's). Thus, the same kernel of energising professors founded the School for Academic postgraduate studies in Management (SAM) in 1996. The 10th promotion of managers (about half of them are engineers) just graduated and the SAM celebrated its 10th anniversary while the CBE marked 15 years of activity.

In summary, the CIM, in conjunction with the CBE and SAM, has contributed to the development of new curricula at the UPB for Engineering Education (E²) and Engineering Economics Education (E³) aiming at E⁴ (Engineering Economics & Entrepreneurial Education) – well before the start of the Bologna Process.

Curricula Reform Based on Surveys of the Needs of the Labour Market

The main benefit of reformed E² is the experience needed for future engineering employment in the global environment [3]. To better answer to the requirements of the Bologna Declaration and Process, the CIM was largely involved in academic curricula restructuring, always based on competence analysis. The efforts to reform E² were based on the concept of the *entrepreneurial university*: universities should support the development of entrepreneurial spirit and (continuous) education [4-6]. The philosophy of educational marketing assumes that the *client* of a university for educational services is not the student strictly, but rather organisations that employ the university's graduates. Consequently, the CIM has restructured the academic curricula and syllabi based on the conclusions of the labour market surveys and research conducted among professional associations of engineers, companies and managers – a research process that started back in 2001 when the first research project was designed. Significant research projects on E³ and E⁴ were completed over a period of five years (2001-2005) including the following:

- The EFWE research project (2002-2003);
- The EDUCAT research project (2002-2004);
- The IMPACT of entrepreneurial education (2003-2004);
- The ARIES research project (2004-2005).

All of the above were anticipated during the 2001-2002 academic year when a survey was conducted among E³ senior students just before their graduation. The results have signalled that topics and teaching methods should change at the UPB. Thus, further research projects were suggested and their methodology designed and documented.

The EFWE project, which focused on the European structure for recognising the abilities acquired through work experience, was promoted by the Careers Research and Advisory Centre from the UK with the CBE acting as the Romanian project partner. The purpose of the project was to create and implement a European standard of evaluation and certification of basic competences for employing young people. The results of the survey, questioning over 150 companies, emphasised that *young employees lack the managerial and entrepreneurial skills like: customer focus and teamwork* [5].

The EDUCAT project targeted developing the entrepreneurial spirit and education based on the research of the market labour needs. This was promoted and completed by the CBE in

conjunction with the CIM. The overall objectives of the project aimed to answer to these needs and contribute to: developing the entrepreneurial spirit of young E² graduates so that they may better meet the needs of the labour market in the current conditions of a knowledge economy; helping young E² graduates to adapt better and quicker to a free-market economy (single EU and global markets) as managers or entrepreneurs; helping E² graduates to become internationally-accepted professionals based on the European Credit Transfer System (ECTS). Three pilot studies have been carried out (in Bucharest in the field of electronics, software and IT) totalling interviews with 107 general managers and 120 managers – graduates of E² and even E³. The results of the project underlined that *young engineers lack entrepreneurial skills as: pro-activity, initiative spirit, assuming the responsibility, decision-making* [5-7].

The IMPACT project was a joint Slovenian-Romanian project privately funded by a group of professors. It was aimed at evaluating the impact of the *quality of the entrepreneurship education* on students' decisions to continue their education [8].

The ARIES project, initiated by the Romanian Association of Electronics and Software Engineering (ARIES) and the CIM, targeted the following objectives: identify how E² graduates are perceived by the managers of the companies active in the Communication & Information Technology (C&IT) sector; and develop recommendations for reforming the curricula of E², based on the above to mainly electrical engineering faculties. The survey targeted 349 C&IT firms. The companies acknowledged that *certified* continuing E² is important as far as E³ and E⁴, even at the Master's level. Also, E³ and E⁴ should include subjects like business communication, project and team management, entrepreneurship and business planning. When hiring E² graduates, both for management and technical positions, practical criteria are key issues that are just as important as the prestige of the graduate's university [9].

The conclusions of all the research projects were pointed at strategic issues: E³ and E⁴ must complement engineers' technology education, and new teaching methods and tools have to be used in order to stimulate their entrepreneurial skills. Additionally, international educational and research projects should be further developed, and the reform of E² should be correlated and integrated in a more complex set of political and administrative strategies and measures.

All these issues, which were revealed by research, were targeted by the CIM while designing the reformed curricula (applicable since 2005-2006), developing new international exchange projects, disseminating the research results and lobbying national decision bodies.

E², E³ AND E⁴ CURRICULA REFORM WITHIN THE GLOBAL CONTEXT

The Romanian example (presented shortly) is not an isolated case. The role of the government in education reform is commonplace worldwide; likewise the increasing focus on changing curricula and teaching methods with C&IT in order to make engineering education more entrepreneurial. These elements are highlighted below.

The Role of Government in Management Education Reform

Education is increasingly becoming a top issue of government policy – not only in industrialised Europe but also in rapidly

developing large economies (eg India and China). The importance of management education was acknowledged by the Chinese government: it played the change agent role (as a *visible hand*) to influence both the demand (companies) and supply (higher education institutions) sides of management education. This resulted in the synchronous development of the economy and management education [10].

The Role of Entrepreneurship in E²: Technopreneurs

As high-tech industries impact greatly on the economy, high-tech entrepreneurship is an increasing focus for engineering schools and technical universities at both the undergraduate and postgraduate levels. An economy's competitiveness largely depends on the level of innovation, intrapreneurship and entrepreneurship in the engineering professions, no matter if engineers work in larger companies or for themselves.

Studies conducted in three British universities have shown that E² students aim to start firms, although this tends to be cited as later than that reported by other students. They also understand that enterprise skills are relevant to employment and personal development; however, *perceptions of enterprise skills development are less common than for other students (they tend to report that have enterprise skills anyway)* [11].

Studies over three generations, analysing the processes by which engineers become entrepreneurs, found that the uniqueness of the Israeli political, economic and security situations has impacted on their entrepreneurial career [12]. Although the study is based on Israeli data, the current conditions for the third generation anticipate *universal validity: to become entrepreneurs, engineers' learning process is influenced by formal learning, experience, and lifelong learning process* [12]. Similar results were obtained by Cooper: the survey of entrepreneurs in the electronics and software sector demonstrated that the number of individuals able to directly start a business is very limited and *sizeable numbers of firms are established by those in mid-career, after a significant time working as an employee, gaining knowledge and developing skills and networks* [13].

Aimed at improving E⁴, interesting differences were found when comparing the entrepreneurship creativity of engineering to business Master's students in Sweden; both groups displayed high creative potential, but engineering students channelled their potential into practical and incremental efforts, while the business students had a better market focus and were more speculative [14]. The role of entrepreneurship in E² is demonstrated by numerous authors. It educates engineers and scientists by innovative means to become *technopreneurs*, which means *engineering entrepreneurs* [15].

Curricula Design

E² curricula have to be designed to ensure that graduates possess all the qualities of a generalist and all the competences of a specialist, and are capable of life-long learning [16]. At the UPB, new courses in E² curricula (as entrepreneurship) contributed to make it E⁴. Major change in E² started a decade ago when E³ curricula were designed and then implemented. Today, more than half (8 out of 13) of the UPB faculties have E³ profiles too. UPB graduating students have not only solid E², but also consistent knowledge of economics and management.

Masters Programmes

Many engineers realise the need for management education by the time they reach management positions. Masters programmes (business administration, engineering management and technology management) are valid options. The best option for engineers is the one most suitable for their careers – either management or technology [17].

Curricula Implementation

The major difficulties reported in developing countries are chronic under-funding, lack of talent or the poor management of universities [18].

New Tools and Methods of Teaching

An entrepreneurial university also means that educators teach entrepreneurially. Smith used an entrepreneurial education resource inventory to create a more entrepreneurial community and shown its implications for change management in managerial practice in both the USA and globally [19].

Problem solving is essential in E². Souza et al described a collaborative virtual environment for *problem solving* in E² [20]. The implementation of a solution generates a collaborative environment in which the different knowledge or abilities of team members must merge in order to achieve the goal by way of *teamwork*. Suliman demonstrated how a *problem-based learning* philosophy can be used in E²: during the process, E² students are developing the acquisition of critical knowledge, problem-solving proficiency, self-directed learning strategies and team-participation skills [21].

Group projects are effective classroom tools that relate to job performance and knowledge development during classes [22]. Students acquire *teamwork* skills while logged on to the Internet without direct personal interaction [23]. Utilising *online groups*, McLaughlin studied conceptual models of how technology and teamwork can be effectively integrated [24]. The design of support for team processes (like time planning and responsibility allocation) is essential for effective online collaboration.

Decision-making is crucial in management education and becomes more critical as systems grow more and more complex under the stress of competition and time pressures [25]. Computer-based simulations are efficient tools when teaching decision-making in large-scale systems [26].

C&IT is essentially valuable in distance e-learning. For effective and coherent teaching, integrated portal systems are important for the benefit of all stakeholders, ie students, professors and administrative staff [27]. There is also a need for curricula management to generate an efficient and effective teaching-learning environment. Syllabi should contain deliverables that are Web-researched and Web-presentable so that the student-faculty response time is minimised [28].

CONCLUSIONS

Higher education institutions cannot avoid the impact of three environmental changes: economic globalisation, the rise of knowledge economies and C&IT. The emergence of a European higher education and research area should be added for European universities [29]. Under such influences, the reform

of the Romanian E² system was an opportunity to make it, in the case of the UPB, more entrepreneurial (E³ and E⁴).

This reform should be based on a needs analysis of the business community. Several surveys on the labour market completed by the UPB concluded that E² should be more entrepreneurial. Transforming the classical university into an *entrepreneurial university* does not mean changing the mission of the university, but rather changing the curricula and syllabi, teaching philosophy and methods. Besides technology knowledge, E² should focus on entrepreneurial and management skills development, especially decision-making, problem solving, teambuilding and teamwork.

These conclusions regarding E² in the UPB are also applicable to other Romanian or foreign (technical) universities.

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