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## IEM Graduates Transition to the Labour Market: The Importance of Internships

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### Abstract

*This paper addresses the role of internships for the transition of IEM graduates to the labour market. We conducted an exploratory study with former graduates from the University of Aveiro, Portugal, in order to develop our understanding about the role of internships for: i) the consolidation of knowledge acquired by students in IEM academic subjects; ii) the development of other competences which are not prevalent in IEM curriculum; iii) students' subsequent professional integration, and their specialization in a given IEM sector or functional area. The paper provides a contribution for the development of knowledge about IEM internships, and offers insights for their improvement, notably for the articulation between the academia and the industry.*

**Key words:** *Industrial Engineering and Management; Labour market transition; Internships*

### 1. INTRODUCTION

In Industrial Engineering and Management (IEM) education the enrolment of students in company projects and/or in internships is typically an important component of the curriculum. The contact of IEM students with industrial practice is attributed a key role both for the development of specific competencies that IEM professionals are expected to hold and, for the later integration of graduates in the labour market. IEM professionals are expected to address industrial problems which require the application of knowledge from diverse domains (e.g. basic sciences, engineering, management...), as well as to have the ability to manage the implementation of the devised solutions with the organisation co-workers and other members, which often have very diverse profiles.

IEM curriculums are designed to provide students with a comprehensive knowledge base both by including subjects from a diversified range of areas (e.g. natural sciences, social sciences, engineering...) and by involving learning approaches that aim to develop competences which prepare them to conduct work with teams in more effective ways (e.g. group projects). However, it is widely accepted that the engagement of

students in real company projects can play an important role in leveraging the knowledge acquired in the university. First, internships provide students the opportunity to use and implement the methods, techniques and tools learned during the years of study. By exposing students to industrial problems that require a multidisciplinary approach, internships contribute for the development of their ability to combine knowledge from different sources and to engage in autonomous learning habits. Second, the integration in an organization and, usually also, in a team, fosters the development of soft skills of social nature (e.g. communication, leadership, etc.) which, although being important for the pursuit of the work of IEM professionals, often cannot be extensively addressed in the curriculum of IEM degrees. Moreover, internships provide students with important opportunities for their future integration in the labour market. On the one hand, the internship experience enables students to better understand the diverse functional areas in which IEM professionals can be involved. On the other hand, the internship period can be very important for students' exposure and integration in the network of professionals.

In this paper we address the importance of internships for the transition of IEM graduates to the labour market by looking at the following three topics: i) the role of internships for the consolidation of knowledge acquired by students in IEM academic subjects; ii) the acquisition/development of competences which are not prevalent in IEM curriculum; iii) the importance of internships for students' subsequent professional integration, and their specialization in a given IEM sector or functional area.

This study builds on the experience of the internships of the IEM master students of the University of Aveiro. In the first part of the study we draw from University data to characterize the internships offered to IEM students regarding different areas of specialization (e.g. logistics, quality management, etc.). We then conduct a set of exploratory interviews with former students to investigate how their internship experience contributed for the achievement of the goals described in i), ii) and iii). Building on the analysis of this data, the paper provides a contribution for the development of our understanding about IEM internships, offering insights for their improvements, namely in what regards the articulation between academia and industry. The paper is structured into three main sections. First we provide an overview of the profile of competencies required from IEM professional, as well as summary of the key characteristics of IEM education. In the following section we review some concerns typically associated to the transition of graduates to the labour market. Section 4 is devoted to the analysis of the data about the experience of IEM internships at the University of Aveiro. This section provides a characterization of the University and of IEM internships, as well as the analysis of a set of exploratory interviews conducted with IEM graduates. The remaining part of the paper offers some final remarks and directions for further research.

## 2. EDUCATION OF IEM PROFESSIONALS

In this section we provide an overview of the profile of IEM engineers, notably the diverse set of competences which are typically associated to this profession. We offer as well a summary of the key characteristics of IEM education. In particular we highlight how the Universities have been responding to the demand for IEM professionals with of curricular programs of multidisciplinary nature.

### 2.1 IEM Professionals

The range of competences of IEM professionals is rather diversified, and is subject to continuous updates which follow the evolution of industrial production systems. The consolidation of the field of IEM took place while other engineering areas evolved towards an increased specialization, in response to the growing industrial demand for more narrow competences [1]. In general the engineering field evolved in response to the developments in industry and in the urbanization of societies, by becoming increasingly diversified and specialized around a few disciplines (civil, electrical,

mechanical, etc.). The specific field of Industrial engineering progressively emerged as the "scientific management" of industrial production, and embraced the overall responsibilities for the management of production systems. Notably, the scope and depth of the work of industrial engineers grew, and a number of specialized IEM sub-disciplines, started to emerge and to be applied to industrial problems (e.g. operational research, systems engineering, design of industrial systems, etc.).

A prevalent approach to define the field of IEM therefore is through the identification of its key distinguishing characteristics towards other established engineering fields. The engineering profession has been defined as the utilization of "fundamental knowledge of physical and social sciences and mathematics to design and construct useful products and services that improve the quality of life for mankind" [1 p.146]. Whereas the emphasis in the application of multidisciplinary knowledge is common across the various engineering fields it is highlighted as being particularly important for the IEM profession.

IEM has requires the combination of traditional engineering competencies with the ability to address the human aspects, and the economic viability, of production problems [2]. Broadly speaking IEM professionals embrace responsibilities which go beyond the development of specific technical solutions, but include the overall design and the management of industrial operations and processes [3]. Along with this distinction in the range of responsibilities addressed, other differences in the nature and the depth of knowledge required for the execution of IEM tasks have also been pointed out. For example, IEM has been observed to require "much broader and more substantial grounding in mathematics, economics, management, service processes, information technology and statistics than do other branches of engineering" [3]. More recently the task of industrial engineering has been associated with the pursuit of goals of lean manufacturing and the management of flexible production systems [2]. As such the profession of IEM requires technological knowledge, but also the ability to follow marketing trends and observe customer requirements. Moreover professionals increasingly need to have some familiarity with knowledge of services, financial management, as well as corporate social responsibility issues (e.g. environmental concerns) [4, 5].

It is also important to remark that whereas the initial development of IEM profession is tightly linked to the industrial sectors, nowadays this is no longer its exclusive field of work. Today IEM professionals hold also responsibilities in the management of other sectors, such service industries (e.g. logistics service providers, health services, etc.) as well as in the public sector [6-9].

Important insights about the professional profile of IEM professions can be also found in the specifications of industry accreditation bodies (e.g. Institute of Industrial Engineers in US), as well as in organizations involved in

the accreditation of higher education and training. In summary, the set of skills associated to the profession of IEM (i.e. including knowledge, abilities and attitudes) includes: i) general management skills, which involve problem formulation and solving abilities, teams management and negotiation skills, and general understanding of economics concepts ; ii) general scientific and engineering knowledge, such as mathematics, physics, etc.; iii) specific IEM scientific knowledge including applied statistics and data mining techniques, simulation and programming, multi-criteria decision making, etc.; and finally iv) specific knowledge relevant to the industry or service sector where the IEM professional is integrated [10-12]

## 2.2 IEM Academic Education

Universities have responded to the demand for IEM professionals with a diverse offer of curriculum programs which have a remarkable multidisciplinary nature. The main curricula of many industrial engineering programs in US and Europe offer an ensemble of physical sciences, mathematics, and humanity and social science courses.

The early and influential work of R. Roy [13] provided an vision of IEM education which has influenced the design of numerous IEM curriculum programs worldwide. Roy identified the objective of IE education as the preparation of students in the quantitative, economic, and behavioural ingredients and processes of analysis and synthesis in design and decision making. The curriculum proposed in this document devised the following 8 broad areas of knowledge: social sciences (e.g. economics), behavioural studies, mathematics statistics and probability, natural sciences, engineering science (e.g. mechanics, electrical science) , a specific domain of industrial engineering (e.g. including areas as engineering economics, computer science, etc.), an area of manufacturing methods (i.e. including techniques such as quality management tools, systems engineering, etc.), and a more broad area of liberal studies.

Whereas there have been some criticisms and reviews to the early Roy proposition [14, 15], in general, the basic traits of IEM curriculums have remained fairly stable since then. The curriculum programs maintain, in general, a substantial volume of disciplines devoted to the areas of natural sciences, and mathematics, plus some core engineering disciplines, a set of specific engineering and management subjects, and some subjects from management and/or economics. There is some diversity in the relative number of courses from each area offered at each institution. Some programmes tend to offer more courses in management, human factors and business-like courses, while others tend to offer more courses in manufacturing processes, engineering design and engineering science [1, 16]. To a great extent the design of IEM curriculum programs is also influenced by the expertise, training and background of the program's faculty, and overall on the context of each University [1]. Overall, the calls for strengthening the alignment between the IEM curriculum programs and industrial

and/or regional needs are multiple [17-19]. Therefore they are likely to continue to exert an important influence in the design of IEM education.

An important evolution in IEM programs concerns the development of a very diverse set of more specific disciplines, evolving from in industrial problems and methodologies. Prevalent areas include quality management, simulation, engineering systems design, etc. [20]. Some of these areas later became major components in the field of study in industrial engineering.

Another important feature of IEM education programs is an emphasis placed in the utilization of active learning methodologies, in order to enrol students in problem solving and project based learning formats [21, 22]. Such courses provide an experiential learning activity in which the analytical knowledge from previous courses is joined with the practice of engineering and a more or less real hands-on work [23]. Such applied learning approaches aim to address several purposes including: i) the inclusion of the "perception context" in the curriculum, in order to develop students ability to deal complexity in problems solving [24, 25]; ii) the development of students ability to address unstructured problems; iii) the development of social skills, including orientation for teamwork, leadership, communication skills, etc; and, in general for fostering self-learning habits. These approaches are consistent with the nature of the IEM profession, and meet the current recommendations for the future of IEM education, notable the need to make the curriculum more problem-driven than tool-driven [26]. The formats adopted for such active learning alternatives range from the utilization of practical cases; the introduction of project based components in the curriculum (e.g. where students develop prototypes, or address an industrial problem proposed by a local industry player); final year projects and student internships at hosting industries and organizations. An illustration of this can be found in Vitner & Rozenes [27] which provide the following detailed list of objectives of final year projects: enabling the exposition of students to a working environment experience, making students implement IEM tools and techniques, helping students to acquire presentation skills, exposing students to a literature survey as a supportive tool and, helping students to acquire problem-solving abilities.

## 3. TRANSITION OF IEM GRADUATES TO THE LABOUR MARKET

There idea of Universities engaging actively in the promotion of students' integration in the labour market after graduation is shared across many institutions.

Saraiva, Coelho and Rosa [28] claim that nowadays the competitiveness and economic development of countries is heavily dependent on their human capital quality. And the fact is that if one looks at the countries' leading world competitiveness rankings one can easily conclude that these are also countries where education is given high priority, not only in terms of knowledge transmission but also concerning the development of

attitudes, skills and values. Thinking contemporary societies is then and foremost recognising “that their competitiveness and economic development is highly dependent on the knowledge they will be able to produce and disseminate among their people and organisations” [28].

In 2000 the European Union has established as its strategic goal to become “the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion [29]. To this endeavour universities were given a vital role as fundamental pieces for the construction of the “Europe of Knowledge” [30], once they are by excellence the ‘producers’ of the most qualified workforce a country can have.

Besides the existent relationship between a country’s educational and training system’s state of development and its growing economic potential, at individual level the motivation to access higher education is also reinforced by the evident relation between employability and educational level (at this respect see the periodic OECD publications *Education at a Glance*).

Furthermore a growing pressure is being exerted over higher education institutions (by political decision makers, but also by students, parents, employers and even the society as a whole) to make them offer study cycles and to ‘produce’ graduates that will meet labour market needs.

This growing relevance of higher education to the construction of a knowledge society imply that graduates face now new challenges in the labour market, namely regarding the competences they must have to succeed. It is not enough anymore that a graduate be an expert in its professional field; the dynamic nature of labour market and the increasing mobility imply that graduates possess a high level of flexibility and a set of generic competences that will allow them to secure their own employability in a large range of situations and during their entire professional career. According to Allen and van der Velden [31], higher education graduates should have competences on the following five areas: professional expertise, functional flexibility, innovation and knowledge management, mobilisation of human resources and international orientation.

But for graduates to have all these competences, universities have to work in order to develop them in their students, which pose new challenges also for these institutions. How should higher education institutions (and its study cycles) be conceived so that its graduates have the competences necessary to successfully succeed in the knowledge economy? [31]. Furthermore the competences that HEIs should promote among their graduates are somehow difficult to specify [32]. In fact, the new demands placed upon graduates seem to determine that they must develop simultaneously professional expertise and a growing notion of flexibility that may help them to secure long-term employability [33].

These new challenges that graduates face, and the need for them to have a large range of competences is perhaps even more relevant in the case of IEM graduates, once these, as previously referred, are characterised by their flexibility. According to the Institute of Industrial Engineers (2012), industrial engineering and management is essentially about choices; while in other engineering disciplines the acquired competences are applied in very specific sectors, industrial engineering and management offers to its professionals the opportunity to work in a great variety of professional areas. This makes more relevant the need for higher education institutions to provide their students the knowledge and skills capable of allowing them to take full advantage of this large number of possibilities in terms of labour market opportunities.

In this paper one argues that curricular internships are a privileged way higher education institutions have to increase and further develop these whole set of competences graduates should have to successfully succeed in a labour market, and that go behind the scientific and technical knowledge that can be more easily taught in study cycles’ formal classes. Internships contribute to assure that students acquire autonomy in the analysis and synthesis of real problems with a certain degree of complexity and scope, using the knowledge and skills provided by the remaining disciplines of their study cycle. Furthermore internships may contribute to an easier and rapid integration of graduates in the labour market, either in the organisation they do their internship or in other one. This research work offers a timely contribution answering recurring call for the development of our understanding of the role and the success of IEM internships in the overall learning experience and professional integration [34, 35].

#### **4. THE EXPERIENCE OF IEM INTERNSHIPS AT THE UNIVERSITY OF AVEIRO**

University of Aveiro (UA) is a public institution, founded in 1973. The university is located in the city of Aveiro, in the coast centre region of Portugal and enrolls about 15000 students. Its mission is to create knowledge and spread it in benefit of people and society, through research, education and cooperation. Moreover, the University seeks to be a player within Europe in the development of research and education, and in the development of a regional model based on innovation and on scientific and technological knowledge ([www.ua.pt](http://www.ua.pt)).

The University offers graduate and post graduate studies across the main scientific domains, namely, humanities, social sciences, natural sciences, formal sciences and applied sciences. Administratively, the university is organized in 15 departments and one autonomous section. Additionally, UA offers several polytechnic/professional courses in four polytechnic schools located in the same Aveiro district. In the academic year of 2011/2012 UA offered 51 graduation courses, 75 MSc courses and 41 PhD programs.

Although being a recent university – e.g. comparing for example with the earliest University of Portugal, the University of Coimbra, created in XIII century (1290) - UA is acknowledged as a prestigious research and teaching institution, both in Portugal and abroad (see for example Times Higher Education ranking of 2012 [36]).

#### 4.1 IEM curriculum program at the UA

IEM program is offered by the department of Economics Management and Industrial Engineering of the University. The department, as well as the curricular program of IEM, were established in 1988. The underlying objective of IEM course of UA is to provide students with the skills and the knowledge to analyse, project, change and implement integrated business processes, constituted by people, materials, equipment's and energy, aiming at optimizing its performance. Additionally, the profile of IEM-UA engineers gives them the ability to interconnect the different functions of a company, as a consequence of the multidisciplinary education scheme offered in several different areas, such as, management, operations management, information systems (applied to operations management), production technologies and applied quantitative methods.

IEM curriculum is organized in two cycles of 3 plus 2 years. The first 3 years are associated with the graduation and the following two with the MSc degree. The course *numerous clausus* has been for 40 students in each cycle and, over the past (until present) both cycles admissions were fully occupied.

The graduation cycle is composed by 180 ECTS and the MSc of 120 ECTS. Both cycles include a set of compulsory subjects per semester, together with some optional subjects. The master degree includes as well an annual subject area devoted to the development of a master thesis. Tables 1 and 2 provide information about the ECTS distribution of the IEM graduation and MSc, by scientific area. The area of Industrial Engineering and Management includes three thematic sub-domains: i) applied quantitative methods; ii) information systems and technologies / simulation; and iii) operations management / logistics and supply chain management / quality management/energy systems management. For obtaining the IEM MSc degree, students are required to complete a total of 84 ECTS in the areas of IEM area (including 48 ECTS attributed to the writing of the master thesis).

The learning methodology in IEM curriculum results from a combination of theory and practice. However, there is a clear investment on practical knowledge, namely through team works and projects, most of the times in interaction with companies, and through the exploitation of software's in the resolution of practical problems. Furthermore, during both study cycles the students have the opportunity to attend several workshops and seminars, have lessons ministered by practice specialists and participate on study visits to industry and/or service corporations, promoted by the professors community and/or by the department. The student's capability to self-learning and research is also

well developed, through small homework's, tutorial orientations, team works and projects.

**Table 1.** IEM ECTS distribution by scientific area – graduation

Scientific Area	Number of ECTS	
	Compulsory	Optional
Industrial Engineering and Management	54	
Mathematics	30	
Management	18	6
Physics	18	
Mechanical Engineering	18	
Informatics	12	
Accounting	6	
Economy	6	
Chemistry	6	
Materials Science and Engineering	6	6
Total	174	6

**Table 2.** IEM ECTS distribution by scientific area – MSc Degree

Scientific Area	Number of ECTS	
	Compulsory	Optional
Industrial Engineering and Management	84	
Management	12	24
Environmental Engineering	6	
Mechanical Engineering	6	18
Informatics/Management Systems		12
Materials Science and Engineering		6
Total	108	12

#### 4.2 The experience of IEM internships at UA

As stated the MSc IEM curriculum of UA includes the completion of a thesis, to be done in the second year of the program, corresponding to 48 ECTS. This thesis can result from the conduction of research work, or be developed from the experience of an internship that can take place in industry, services or in a public administration. The internship facilitates student's insertion into the labour market and gives them the opportunity to study practical problems during their thesis, allowing the consolidation and approximation of scientific knowledge acquired during academic activities with practical knowledge. In addition, potentially, internships strengthen student's autonomy to develop, analyse, and solve complex problems, and their personal relationship competences (e. g., responsibility, decision making, leadership, communication and team work).

The internship lasts for one academic year. During the first semester students are also engaged both in the internship and in the frequency of two curricular subjects. For this reason, during this period students typically allocate four days per week to the internship work in the attributed company, and reserve one day to be at the university.

The allocation of students to internship opportunities can result from several alternative processes. The University offers a selection of opportunities in each year, which result from a close collaboration with companies located in the region of Aveiro. A substantial number of companies offer internship opportunities each year, and some bigger companies have a history of offering two or three placements per year. Nevertheless, students are also free to find an internship opportunity independently, by applying to a company of their preference. More recently the University has also been fostering students to find placements abroad, using European support programs to fund their experience, and using that experience to build their thesis. Most students find a placement using the portfolio of offers provided by the University, and find an internship predominately in industrial companies located in the region. The region hosts several companies working on the automotive supply chain, as well as in other sectors, such as construction, energy, etc. Often students also find placements in service companies, and public organizations, such as local health institutions, research units, etc.

During the internship the work developed by the student is typically supervised by, at least two people: 1) a company supervisor which is responsible for the overall proposition of the IEM project/tasks to be developed by the student; 2) a University Professor, which is selected after the student's internship placement is chosen, and which conducts research work in the area of the internship (e.g. supply chain management, quality management, etc.). The supervision of the work conducted by the student is articulated between the two advisors, and typically includes some visits of the Professor the hosting company, notably to define a project and task list that are adequately aligned with the objectives of IEM education pursued by the University. The involvement of the Professor in the development of the work of the student ranges from: the provision of assistance for the identification of an adequate theoretical support, and for the overall writing of the thesis document, to the direct involvement in specific research tasks to address a specific industrial problem assigned to the student.

The majority of students choose to follow an internship, rather than to conduct pure research work to complete the thesis. This was an additional motivation for investigating the reasons which explain students' choice, as well as the implications of the internships to student's overall IEM education and future integration

**Table 3.** Total N. ° of internships and thesis concluded per year and average classifications

Academic Year	07/08	08/09	09/10	10/11
<b>Total N.° Students</b>	31	51	29	30
<b>Average Classification</b>	15.55	15.53	15.95	15.67

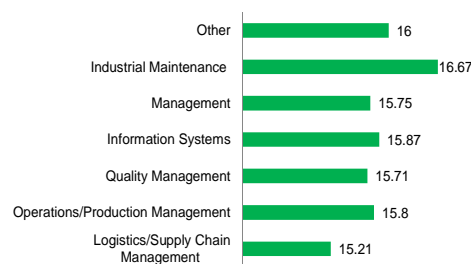
into the labour market. In order to address this we used two sources of data. First we collected information about students' internships placements over the last years, from the University records. This enabled us to draw some summary information about the overall internships placements and experiences. Second, we conducted a set of exploratory interviews with former students who had internship experiences. The option for using the experience of former students follows similar approaches in the field of studies about the design and improvement of IEM education [37].

### 4.3 A portray of IEM internships at UA

The results reported in this sub-section were obtained through the analysis of university data about internships of IEM students of UA, from the last four academic years (2007/2008, 2008/2009, 2009/2010 and 2010/2011).

Regarding the students success in concluding the internship and consecutively the MSc thesis, from a universe of 194 students enrolled in an internship over the studied period, 141 succeeded (about 73% of students). This included 90 male students and 51 females. The average classification obtained for students completing the thesis was of 15.65 (out of 20). The distribution of students that completed the internship and thesis by year, as well as their average classifications per year are presented in Table 3.

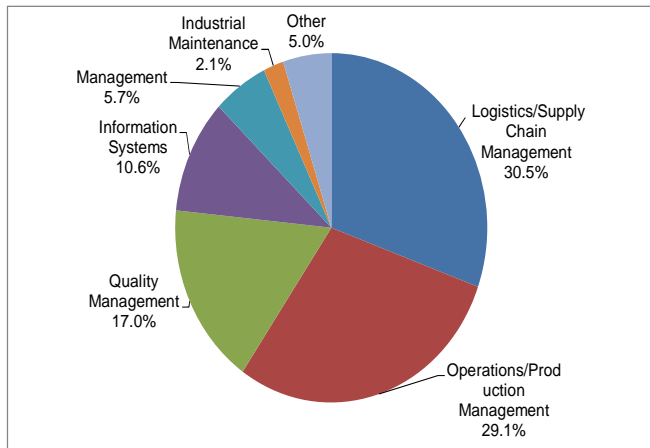
In order to develop an deeper understanding of the University data, we divided the areas of IEM internships into in seven representative functional domains: (1) Logistics / Supply Chain Management; (2) Operations / Production Management; (3) Quality Management; (4) Information Systems; (5) Management; (6) Industrial Maintenance; and (7) Others (including internships conducted in the areas of Ergonomics, Energetic Efficiency, Human Resources, Marketing and Industrial Costing). Figure 1 presents information about the average classifications obtained by students who conducted internships in each IEM functional area. The average classifications obtained were of 15.59 for male students and 15.76 for female students.



**Figure 1.** Average classifications by IEM functional area

Figure 2 provides more information about the representativeness of volume of internships conducted in each area. In addition, in Table 4, we present the

total number of students per IEM functional area, as well as distribution of internships by gender.



**Figure 2.** IEM functional areas representativeness

The areas of Logistics/Supply Chain Management, Operations and Quality Management absorb the majority of the internships. This distribution is intimately linked to the characteristics of the industrial companies in the region. A substantial volume of the work done by internship students addresses the areas production management, namely the optimization of flows and production stocks. The pursuit of continuous improvement projects, in the field of quality management is also very representative.

**Table 4.** IEM Internships by functional area (2008-20011)

IEM Areas	Students	Male
Logistics/Supply Chain Mgmt.	43	78,0 %
Operations/Production Mgmt.	41	67,4 %
Quality Management	24	54,2 %
Information Systems	15	46,7 %
Management	8	50,0 %
Industrial Maintenance	3	100 %
Other	7	28,6 %
	141	63,2 %

**4.4 Building on graduates experience – some insights**

After the characterization of IEM-UA internships, we conducted a set of group interviews with IEM engineers that concluded their MSc course during the academic years addressed in this study. In the sample selection we tried to select students from the several years and from the most representative IEM functional areas. Six graduates were interviewed. The interviews were performed in two groups, to foster the discussion and the sharing of multiple views, and were audio taped.

The interviews followed an protocol which included indicative questions addressing three main themes: i) the role of internships for the consolidation of the knowledge acquired by students in IEM academic subjects; ii) the acquisition/development of competences which are not prevalent in the IEM

curriculum; and, iii) the importance of IEM curriculum, notably of the internship experience, for students' subsequent professional integration, and their specialization in a given IEM sector or functional area. The questions addressed the experience of graduates during the internship period, as well as their experience at the current job. Sub-questions were added, when necessary to foster the group discussion or to understand specific issues referred by the graduates.

In the following sub-sections the main conclusions of the interviews are highlighted and discussed.

i) Internship experience and the consolidation of the knowledge acquired in IEM academic subjects

The first set of questions we aimed to assess how deep is the alignment between the subjects learned in the curricular part of the IEM program, and the ones applied in the internship. Moreover we aimed to understand how internships enable the consolidation of the acquisition of theoretical grounding for the profession. Among the subjects referred as having most direct application in the internship work respondents mentioned: statistics, mathematics, logistics, operations management, lean manufacturing, risk management and simulation. One of the respondents highlighted that at the beginning it was difficult for him to apply what he learned at university. Specifically the graduates seemed to share a vision that the application of the subjects and tools acquired earlier in the course is not straightforward. In particular they referred that the pressure for a rapid conclusion of work, and for a quick the identification and implementation of the devised tools and solutions was very strong. It was highlighted that under these circumstances, the application of tools and methodologies was frequently "abbreviated", and that interns get used to apply only the key principles of a given methodology or tool, rather than to conduct their exhaustive implementation. To some extent this practice might reflect the medium and small size of some of the companies which host the students, and the relatively moderate size of the projects in which they are likely to be enrolled.

The majority of the respondents pointed out that when they went to the internship they had little knowledge about the practice and about their future responsibilities, i.e. they "simply do not had very much expectations about the world they were going to get in".

Regarding the main difficulties encountered in the internship experience, most of the respondents considered the first one/two months very difficult, i.e. they "felt kind of lost", and not knowing very clearly what "their specific tasks were".

The respondents identified a set of key difficulties experienced in the internship. Examples include: the lack of a clear project established and previously defined; lack of specific work to do at the very beginning of the internship; lack of confidence to engage in decision making processes; the pressure to quickly make decisions; and occasionally some difficulties in integrating in the organizational work environment, mostly due to the adaptation to a new group of people, and to some difficulties in communicating with the shop

floor operators, and their resistance to change (e.g. to specific suggestions or indications given by the interns). However, all the respondents perceived those difficulties as having been important to their learning process and experience, and all them agreed that, in general, after the first two months they were fully adapted to the new reality, i.e. they “felt comfortable to work”.

- ii) The acquisition or development of competences which are not prevalent in the IEM curriculum program

The competences that respondents consider they most developed or broadened during the internship were: working with specific applications and software (e.g. spreadsheet programs); communicating with different people (both from inside and from outside of the company) and in different languages; enhancement of their capacity of adaptation to different people and different realities. This suggests that the culture of the company can have a significant impact in the respondents experience in terms of team work and social relationships. The respondents that developed their internship in traditional and bureaucratic companies had more difficulties to develop their work in teams and experienced more relationship problems. Other respondents mentioned that the company culture was very informal and that the company workers were always ready to help.

- iii) Importance of the IEM curriculum and internship experience, for professional integration,

This topic discussion will be divided in two parts: importance of IEM MSc degree to practice and importance of the internship to the integration in the labour market and to professional path.

In general, respondents considered that the MSc degree prepares them very well, and gives them the opportunity to work in several areas of expertise, which they consider is an advantage over engineers from more specialized areas of knowledge. In general the respondents mentioned that closer links to practice, and the adoption of more project based components during the academic experience, would be desirable to improve the acquisition of knowledge.

The Msc is important, but the bases acquired during the graduation are also mentioned as being very important. Two of the respondents mentioned for example technical drawing as an important subject for the work they develop nowadays.

All six respondents consider the internship to be fundamental for the transition between University and practice of work, and to prepare them for their future career. The respondents highlighted the importance of the role of the supervisors is very important. The fact that they have support from both the industry and the academia world, in the development of their work was considered key. Being at the same time at university and at a company is considered positive and important, namely in increasing their self-confidence, and their ability to make suggestions and decisions. One emphasized issue was the huge learning process that

internship offers them, both in technical areas and in soft skills. One of the respondents, for example, mentioned the importance of the internship as a facilitator to getting into the labour market.

The interviews touched also some questions about the graduates’ actual work, in order to understand their professional path after the internship experience. This topic included two main points of discussion: the first work experience after the internship, and the current job. Three of the respondents first work experience was at the same company of the internship. Two of them remained in the same area of the internship, and the other one, changed to a different department (and functional area) of the company. Regarding the respondents that changed of company after the internship, only one of them remained at the same area of internship. For the majority of the respondents their actual work is the first one. This is quite normal since they finished their studies in the last recent years. Nevertheless, none of the respondents consider that the internship restricted his/her professional path, and all of them think they have expertise and potential to embrace new projects.

## 5. FINAL REMARKS

The IEM education offered in the University of Aveiro has a long tradition of having curricular internships as a discipline making part of the curriculum. The existent master program in IEM includes it in its second year of studies, which allows associating the integration of students in the labour market with the possibility that students develop their dissertations based on the organisations’ real problems. This contributes to the establishment of closer links between scientific knowledge development and the reality of the business world.

In this study we analysed the experience of IEM internships at the University of Aveiro, by looking at data about the students’ placements in the last years, and by conducting a set of exploratory interviews with recent graduates. Data analysis revealed a concentration of IEM internships in three main areas: Logistics/Supply Chain Management, Operations and Quality Management. These results are tightly linked with the characteristics of the companies in the region, and their industrial management key concerns in the current context, namely, the optimization of production processes and flows. An interesting avenue for further research would be the study of the allocation of students to IEM internship areas across distinct industrial contexts and regions, to further understand specific industry needs and priorities. The results from the exploratory interviews confirm that internships play a key role in the preparation of IEM professionals. The respondents expressed the importance of this type of learning experience to develop their understanding of the applicability of the subjects and tools acquired in the earlier years of study. Moreover, the findings support the articulation of the internship with the academic subjects, and the academic guidance of the assigned Professors, is of substantial importance for the success



of this first work experience. This suggests that the integration of internships explicitly in IEM curriculum programs is adequate (rather than adopting a program exclusively devoted to academic subjects, and leaving the internship experience to the initiative of the graduates alone). The graduates explicitly referred that they combined the work and the support of company advisors with the guidance from the assigned advising Professor to devise their way in the problem solving process in their specific projects. The importance of internships is furthermore reinforced by the role they play in the provision of specific competences which the curricular part of IEM programs cannot typically address in an effective ways (e.g. communication skills, practice of decision making, etc). This exploratory work also suggests some key points for the improvement and excellence of IEM internships (e.g. the duration of the internship, the importance of the articulation between the work and the academic context, the existence of IEM areas which offer a more rich internship experience because they provide a richer contact with more diversified aspect in the companies, etc.). These results reinforce the need to develop routine research and dialogue about the experience of IEM internships among all partners (i.e. graduates, academia and organizations), for the pursuit of their excellence.

## 6. REFERENCES

- [1] Elsayed, E., Industrial engineering education: A prospective. *European journal of engineering education*, 1999. 24(4): p. 415-421.
- [2] GALLWEY, T.I.M.J., Europe Needs Industrial Engineering Degrees in Order to Enhance Its Competitiveness. *European journal of engineering education*, 1992. 17(1): p. 51-57.
- [3] Marin-Garcia, J.A., et al., Profile and competences of Spanish industrial engineers in the European Higher Education Area (EHEA). 2011.
- [4] Gallo, G., Operations research and ethics: Responsibility, sharing and cooperation. *European Journal of Operational Research*, 2004. 153(2): p. 468-476.
- [5] Maffioli, F. and G. Augusti, Tuning engineering education into the European higher education orchestra. *European journal of engineering education*, 2003. 28(3): p. 251-273.
- [6] Fliedner, G. and K. Mathieson, Learning lean: A survey of industry lean needs. *The Journal of Education for Business*, 2009. 84(4): p. 194-199.
- [7] Jiao, J., Q. Ma, and M.M. Tseng, Towards high value-added products and services: mass customization and beyond. *Technovation*, 2003. 23(10): p. 809-821.
- [8] Apte, U.M. and C.H. Goh, Applying lean manufacturing principles to information intensive services. *International Journal of Services Technology and Management*, 2004. 5(5): p. 488-506.
- [9] Liker, J.K. and J.M. Morgan, The Toyota way in services: the case of lean product development. *The Academy of Management Perspectives ARCHIVE*, 2006. 20(2): p. 5-20.
- [10] Ferguson, C., Defining the Australian mechanical engineer. *European journal of engineering education*, 2006. 31(4): p. 471-485.
- [11] Yannou, B. and M. Bigand, A curriculum of value creation and management in engineering. *European journal of engineering education*, 2004. 29(3): p. 355-366.
- [12] Sheppard, S., et al., What is engineering practice? *International Journal of Engineering Education*, 2007. 22(3): p. 429.
- [13] Roy, R.H., The Curriculum in Industrial Engineering. *Journal of Industrial Engineering*, 1967. 18(9): p. 509-520.
- [14] Buzacott, J.A., The Future of Industrial Engineering as an Academic Discipline. *IIE Transactions*, 1984. 16(1): p. 35-43.
- [15] Mullenix, J.B., et al. *An Industrial Engineering Curriculum Renewal Process for the Enhancement of Industrial Engineering Degree Programs*. 2004: SAGE Publications.
- [16] Eskandari, H., et al., Enhancing the undergraduate industrial engineering curriculum: Defining desired characteristics and emerging topics. *Education+ Training*, 2007. 49(1): p. 45-55.
- [17] McMasters, J.H. and J.D. Lang. *Enhancing engineering and manufacturing education: industry needs, industry roles*. 1995.
- [18] Nicolai, L.M., Viewpoint: An industry view of engineering design education. *International Journal of Engineering Education*, 1998. 14(1): p. 7-13.
- [19] Black, K.M., An industry view of engineering education. *Journal of engineering education*, 1994. 83(1): p. 26-28.
- [20] Kuo, W., Educational Programs for the Industrial Engineer, in *Maynard's Industrial Engineering Handbook*, K.B. Zandin, Editor. 2001, McGraw Hill: New York. p. 1.39-53.
- [21] Dym, C.L. and P. Little, *Engineering design: A project-based introduction*. 2004: Wiley.
- [22] Mills, J.E. and D.F. Treagust, Engineering education - Is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education*, 2003. 4(1): p. 16.
- [23] Dutson, A.J., et al., A review of literature on teaching engineering design through project-oriented capstone courses. *JOURNAL OF ENGINEERING EDUCATION-WASHINGTON-*, 1997. 86: p. 17-28.
- [24] Moesby, E., Curriculum development for project-oriented and problem-based learning (POPBL) with emphasis on personal skills and abilities. *Global J. of Engng. Educ*, 2005. 9(2): p. 121-128.
- [25] Liebman, J.C., Designing the design engineer. *Journal of professional issues in engineering*, 1989. 115(3): p. 261-270.
- [26] Kuo, W. and B. Deuermeyer, IE curriculum revisited: Developing a new undergraduate program at Texas A & M University. *IIE solutions*, 1998. 30(6): p. 16-22.
- [27] Vitner, G. and S. Rozenes, Final-year projects as a major element in the IE curriculum. *European Journal of Engineering Education*, 2009. 34(6): p. 587-592.
- [28] Saraiva, P.M., I.P. Coelho, and M.J. Rosa, *Economia do Conhecimento e Instituições de Ensino*. 2009, Porto: Principia Editora Lda.
- [29] European Commission, *Presidency Conclusions*, Lisbon European Council 23 and 24 March 2000. 2000, European Commission: Brussels.
- [30] European Commission, *The Role of Universities in the Europe of Knowledge*. 2003, European Commission: Brussels.
- [31] Allen, J. and R. Van der Velden, The Flexible Professional in the Knowledge Society: Required Competences and the Role of Higher Education., in *The Flexible Professional in the Knowledge Society. New Challenges for Higher Education*, J.A.R.v.d. Velden, Editor. 2011, Springer Verlag: Dordrecht.
- [32] Barnett, R., *The limits of competence: knowledge, higher education and society*. 1994: Taylor & Francis.
- [33] Brown, P., H. Lauder, and D. Ashton, *The global auction: The broken Promises of Education, Jobs and Incomes*. 2011, Oxford: Oxford Univ Press.
- [34] Gault, J., J. Redington, and T. Schlager, Undergraduate business internships and career success: are they related? *Journal of Marketing Education*, 2000. 22(1): p. 45-53.
- [35] Clark, S.C., Enhancing the educational value of business internships. *Journal of Management Education*, 2003. 27(4): p. 472-484.
- [36] Times Higher Education, *World University Rankings 2011-2012*. 2012 [cited 2012 15-04-2012]; Available from: <http://www.timeshighereducation.co.uk/world-university-rankings/>.
- [37] Nair, C.S., A. Patil, and P. Mertova, Enhancing the quality of engineering education by utilising student feedback. *European Journal of Engineering Education*. 36(1): p. 3-12.

# **Prelaz diplomiranih studenata Industrijskog inženjerstva i menadžmenta na tržište rada: značaj studentskih praksi**

**Marlene Amorim, Carina Pimentel i Maria João Rosa**

## **Rezime**

*Ovaj rad se bavi značajem studentskih praksi kao prelazom diplomiranih studenata Industrijskom inženjerstva i menadžmenta (IIM) na tržište rada. Sprovedena je istraživačka studija sa bivšim studentima Univerziteta Aveiro u Portugalu kako bi se razvilo naše razumevanje uloge pripravnštva u: i) utemeljivanju znanja koje su studenti stekli u okviru akademskih kurseva za IIM; ii) razvoju drugih kompetencija koje nisu dominantne u studijskom programu za IIM; iii) profesionalnoj integraciji studenata nakon toga, kao i njihovoj specijalizaciji u datom sektoru ili funkcionalnoj oblasti za IIM. Rad predstavlja doprinos u razvoju znanja o studentskoj praksi vezanom za IIM, i nudi uvid u njegovo poboljšanje, pre svega kod spajanja akademskih oblasti i industrije.*

**Ključne reči:** *Industrijsko inženjerstvo i menadžment; prelaz na tržište rada; pripravnštva*