PROJECT WORK AND INTERNSHIP

IMPACTS ON LABOUR MARKET AND SOCIETY
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SECTION 1

COOPERATION BETWEEN LABOUR AND EDUCATION
CHAPTER 1

ALMALAUREA’S ROLE IN HELPING GRADUATES IN THE ITALIAN JOB MARKET

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AlmaLaurea is a consortium among 65 Italian universities, accounting for 80% of the nation’s graduates. It pursues a variety of goals pertaining to the provision of information to member universities and the creation of networks linking the latter, graduates, and the business world. The chapter provides information concerning the context in which AlmaLaurea operates and the main foundations on which its activities are based: an annual “graduate profile” survey on the internal efficiency of the higher education system; an annual “graduates’ employment conditions” survey on the system’s external efficiency; an on-line databank of graduate résumés. Some examples of findings drawn from the two most recent annual surveys are provided. A more in-depth presentation is devoted to describing Italian graduates’ experience of traineeships during their studies. The final section of the chapter briefly discusses other AlmaLaurea activities that contribute to helping youths’ decision-making processes as regards higher education and the job market and its international initiatives.

Keywords: AlmaLaurea, Italian higher education, graduate profile, graduate employment, traineeships.
An Introduction to AlmaLaurea

AlmaLaurea is a consortium among Italian universities - supported by the Italian Ministry of Education, University, and Research - that pursues a variety of goals having to do with collecting, processing, and providing information to member universities and linking them, their graduates, and the business world. It was originally set up in 1994 as an initiative of the Statistical Observatory of the University of Bologna. Since then it has experienced constant growth; 65 universities, accounting for 80% of all Italian university degree-earners, are currently members.

Among AlmaLaurea’s objectives, one may identify the steady production of up-to-date data regarding the academic and post-academic careers of degree-holders; the monitoring of academic programmes chosen by students and graduates’ characteristics and performances; the provision of data allowing direct comparison between programmes, faculties and universities; the analysis of the effectiveness of study opportunities offered by member universities; the collection of data concerning degree-holders’ position on the labour market.

AlmaLaurea databanks are drawn from different sources, including:

- official data provided by member universities (concerning, for example, each graduate’s faculty, degree programme, programme duration, title of degree thesis, name of thesis supervisor);
- data provided by graduates shortly before concluding their academic studies (military service, learning experiences abroad, work experience, traineeships, foreign language proficiency, information technology skills, availability to work abroad, etc.);
- data provided by graduates concerning their job positions 1, 3, and 5 years after earning their degrees (occupational status, sector and location of activity, income, job satisfaction, use of university-acquired skills, etc.).
AlmaLaurea also manages a vast collection of graduate résumés, allowing graduates to provide up-to-date information to potential employers and the latter to access detailed information for their hiring needs.

Every year AlmaLaurea publishes two major reports concerning:
- the graduates’ “profile” survey, pertaining to degree-holders’ situation at the moment they graduate, and
- the graduates’ “employment situation” survey, pertaining to their work experience.

These reports are the central focus of two major conferences held every year, which take place, respectively, five and three months after the end of their reference years; major findings are simultaneously made available on AlmaLaurea’s website (www.almalaurea.it/en), which moreover provides ample opportunities for interactive data analysis. In addition, AlmaLaurea regularly produces other analyses and studies, published on its website and its AlmaLaurea Working Papers series.

AlmaLaurea’s activities have grown increasingly crucial for member universities in the light of the implementation of the Bologna Process promoting the harmonisation of higher education systems at a European level. The Bologna Declaration was aimed at introducing a more transparent and comparable system of university degrees, fostering mobility of students and scholars, assuring educational quality and placing emphasis on the European dimension of higher education. The need for convergence also finds expression in the establishment of the European Higher Education Area (see [8], [2], [4]).

In Italy, the Bologna Declaration has had considerable impact in terms of reform of the Italian university system, in particular with regard to teaching curricula. It should be pointed out that Italy, before the start of the Bologna Process, was one of relatively few European countries that did not have a two-cycle type degree structure.

Two sets of legislative measures were adopted in Italy to implement the Bologna Process. The first reform, implemented since the academic year 2001-2002, introduced the so-called
“3+2” system, with a two-cycle degree structure consisting of a first-level (a bachelor’s-level degree - or laurea - requiring at least 180 credits) and a second-level (a master’s-level degree - laurea specialistica - requiring at least 300 credits, including those obtained for a first-level degree), replacing the programmes of the old university system lasting four, five, or six years). Some disciplinary areas feature a single-cycle programme, lasting five or six years, fundamentally replicating the pre-reform system.

The second reform (enacted in the 2004-07 period) aimed at reducing the number of the new degree programmes and the number of exams in each programme, in addition to establishing the laurea magistrale (the former laurea specialistica) with a total workload of 120 credits, and increasing the number of single-cycle laurea magistrale programmes (with special regard to the replacement of the law degree based on the “3+2” system with a single-cycle degree programme).

The “3+2” reform was also aimed at achieving specific convergence goals which were not expressly mentioned in the Bologna Declaration, including the addressing of some endemic weaknesses of the Italian university system: low numbers of graduates; high university drop-out rates; strong discrepancy between allocated time-to-graduation and actual duration of studies.

The “3+2” solution originally generated a fast and partly uncontrolled increase in educational provision: whereas in the 2000-01 academic year, 2,262 degree programmes (and less than 1,000 “short” university diploma programmes) were available within the framework of the “old”, pre-reform system, in 2003-04 the educational programmes included more than 3,800 first-level degrees, almost 1,300 second-level degrees and approximately 180 single-cycle master’s degrees (for a total of 5,326 different programmes). In 2007-08, the same types of programmes varied: 3,163, 2,444 and 272, respectively (for a total of 5,879 post-reform programmes, their highest level). These values have since mostly declined, respectively, to 2,334, 2,010, 5,462 and 318 (for a total of 4,662 programmes) in the
2013-14 academic year (see [1]), as a result of government measures aiming at “rationalization”.

These changes - along with others, including drastic funding cuts and the need to interact more closely with the business community and the labour market in the creation of new degree programmes, as well as other consolidated features of the Italian social system (a sharp drop in number of 19-year-olds over the last 25 years, a relatively low incidence of higher education degree-holders in both older and younger segments of the population and among entrepreneurs, a prevalence of small and medium businesses in the economy) have made it imperative for higher education institutions to have greater knowledge regarding the performance of each of their degree programmes; for some aspects of their performance, indeed, national legislation requires universities to engage in tracking initiatives. Many Italian higher education institutions effectively satisfy this mandate via their membership in AlmaLaurea.

Two Examples Drawn from AlmaLaurea’s Annual Surveys

In the Spring of 2014 AlmaLaurea published its 16th annual report drawn from its graduate profile study (see [6]), presenting data involving approximately 230 thousand graduates, 212 thousand of whom also filled out the questionnaire mentioned in the preceding section. The database houses information on about 100 variables, referring to basic demographic traits, social background, previous upper secondary schooling, academic performance, study conditions, work experiences, evaluations of study experiences, language and computer skills, future study and job intentions. For instance, Figure 1 shows that 2013 graduates continue, as in the past (AlmaLaurea conventionally uses to the 2004 cohort as the most recent representative group of pre-reform graduates), to have relatively “poor” social backgrounds, at least in cultural terms, operationalised via their parents’ educational credentials. Three out of four graduates belong to their families’ first generation of tertiary degree-
earners. This is an important point, in that it reflects both the fact that Italy’s older population does not display high educational levels and implies that a great majority of parents have no firsthand experience of advanced education and are thus ineffective sources of guidance.

Figure 1: Percentage of 2004 and 2013 Graduates Whose Parents Are Both Lacking a University Degree

Source: [6]

Figure 2: Employment Rate at One Year from Graduation by Kind of Degree Programme

Source: [5]
In the Spring of 2014 AlmaLaurea also published its 16th annual report drawn from its graduate employment conditions survey (see [5]), presenting data involving almost 290 thousand graduates interviewed 1, 3 or 5 years after completing their studies. The database contains information pertaining to basic demographic features, participation in additional post-graduate education, current employment, features of job market entry, employer characteristics, income, relevance of university studies for current employment, job satisfaction, and new job searches.

The example portrayed in Figure 2 highlights the consortium’s ability to track changes over time and document change in higher education outcomes, an essential but often difficult-to-achieve feature of graduate surveys (see [7]). More specifically, the results show the dramatic contraction in graduate employment rates over recent years, during Italy’s ongoing recession.

Traineeships and Italian Higher Education

Since the introduction of the above-mentioned reforms inspired by the Bologna process, the role of traineeships in higher education has expanded considerably. So-called “curricular traineeships”, in particular, are an integral part of degree programmes and allow participating university students to earn credits towards their final degrees, as they accumulate workplace experience and gather information that will prove useful for their entry into the labour market. Such traineeships can take place in external venues (private businesses, public authorities, etc.) or within the universities themselves (laboratories, research centres, administrative offices, etc.), either in Italy or abroad. The growth and utility of traineeships can be documented by selected findings drawn from AlmaLaurea’s latest surveys on graduate profiles and employment conditions.

Among the 2004 cohort of graduates (as mentioned previously, this cohort is the most recent representative pre-reform group), only one of five degree-earners had taken part in officially recognized traineeship programmes, whereas in the
2013 cohort traineeships had been experienced 57% of all graduates and, in particular:

- 61% of first-level programme graduates (the percentage was even higher - 69% - among graduates who did not intend to continue their studies, versus 55% among those hoping to earn a higher degree);
- 41% of single-cycle programme graduates;
- 56% of second-level programme graduates (see Figure 3).

As regards the latter group, the percentage refers only to traineeships that were part of two-year laurea magistrale programmes completed in 2013. However, one must consider that 15% of those graduates, although they had no traineeship experience during their master’s-level studies, did participate in a traineeship in their priori bachelor’s-level studies. Consequently, approximately 71% of all two-year programme completers can be said to have participated in traineeships during their university careers. Evidently, the change that has occurred in the span of a decade is exceptional.

Figure 3: Percentage of 2004 and 2013 Graduates Having Taken Part in Officially Acknowledged Traineeship Programmes

Source: [6]
Of course, although one might feel that a greater incidence of university graduates with working experience is a favourable development, this might not be the case, i.e., graduates might not really benefit from the experience. Fortunately, a more in-depth analysis performed on graduates one year after programme completion suggests that traineeships do have a decisive impact in the labour market. A logistic regression model was developed in order to identify factors positively affecting the probability of having a job. Other things being equal (gender, area of residence, parents’ level of education, type of upper secondary school diploma, field of study, type of degree programme, location of university, mean exam marks, programme completion time, foreign language proficiency, study experiences abroad, willingness to travel for work reasons, intention to pursue further studies, and job aspirations), having participated in a traineeship programme improves a graduate’s chances of being employed by 14 percentage points - a considerable advantage. However, in a more in-depth study of graduates’ traineeship experience, performed by AlmaLaurea some years ago, most graduates expressed criticism towards at least some aspects of their experience; and one in four found that the activities performed during their traineeships were not relevant for their degree (see [9]).

Traineeships, moreover, are not uniformly widespread in the Italian higher education system. As Figure 4 shows, for example, the integration of work experience in the teaching programme is some fields of study tend to be appreciably more intense than in others. In particular, graduates have this opportunity and take advantage of it to a greater degree in programmes centred on education, health professions, chemistry and pharmacy, physical education, and agriculture. Among single-cycle medicine (training physicians and dentists), humanities, economics and statistics, hard science and engineering majors, less than half of all graduates have exploited traineeships. The incidence of work-related experiences in particularly low (15%) among graduates from law programmes.
Variability is observable not only between fields of study but, in some cases, within them as well. If for example, one looks at first-level graduates in medicine and health professions, one finds that internships are widespread in all 32 universities offering a pertinent degree: traineeship incidence varies between a maximum of 94% (in the university with the highest incidence) and a minimum of 77%. In economics and statistics programmes, however, university-specific traineeship rates are above 80% in 12 out of 52 institutions, but below 20% in another 13 institutions.

Figure 4: Percentage of 2013 Graduates Having Taken Part in Officially Acknowledged Traineeship Programmes, by Field of Study

Another source of variability concerns the location where traineeships occur. As previously mentioned, they may take place in external venues or within the university itself. Overall, almost two out of three experiences (63%) involved external actors; the incidence of extra-university traineeships is even higher among
graduates majoring in education (83%), health professions (78%), psychology (71%), or chemistry and pharmacy (73%).

One out of five traineeships (20%) took place within the university, and the incidence is higher among graduates enrolled in single-cycle medicine (60%), geology and biology (53%), maths, physics and natural sciences (42%), and engineering programmes (39%). About one-sixth of all traineeships stem from graduates’ personal work experiences that administrators acknowledge on a post hoc basis as pertinent for the student’s studies; this type of activity is more widespread among graduates who were engaged in political and social science, economics and statistics, foreign language, and law studies. The high degree of variation in graduate performance and in programme characteristics across fields of studies and across single universities is a constant, and usually under-appreciated, feature of the Italian higher education system (see [3]).

**Additional AlmaLaurea Activities**

AlmaLaurea also engages in other activities which are relevant to young people’s entry into the labour market.

As mentioned, AlmaLaurea provides graduates from its member universities with the opportunity to publish their cvs in an on-line database. Potential employers have been able to access approximately 2 million (multilingual) résumés. Each year about 150 thousand new graduates are added to the database. Employers have purchased 3.5 million cvs over the last ten years. Through AlmaLaurea, graduates may also publish video job candidacies. The consortium has strengthened its potential to help employers with the opening of offices in Rome, Milan, and Padova and the development of personnel screening and selection services. It has also developed placement platforms for its member universities. AlmaLaurea’s research activities are expanding in order to include students participating in higher artistic and musical education, as well as post-graduate programmes, such as doctorates.

AlmaDiploma is an association among upper secondary schools aiming to develop guidance tools for school-leavers choosing a university and field of study in which to pursue higher
education; facilitate youths’ entry into the job market; help employers recruit qualified personnel; reduce the time required for matching labour demand and supply; offer schools detailed information about the efficacy of their educational programmes (see the association’s website: www.almadiploma.it. In its most recent 2014 edition, AlmaDiploma’s services include the on-line access to the cvs of approximately 43,000 upper secondary diploma-earners, drawn from 300 schools located across the country (Lombardy, Liguria, Emilia-Romagna, Tuscany, Lazio, Campania, Puglia, and Sicily).

AlmaOrientati is an evidence-based, on-line orientation service for youths undertaking a decision-making process about continuing their studies at the university level. More specifically, the service allows individuals to acknowledge their strengths and weaknesses as regarding academic endeavours, gauge their knowledge about post-secondary training and education and the workplace, identify degree programmes that best reflect their disciplinary interests, and create a comprehensive profile as regards future job aspirations (see the website: www.almaorientati.it). In 2013, about 50 thousand individuals used the service.

AlmaLaurea is also developing the international scope of its activities. The European Commission has approved 3 three-year projects in which AlmaLaurea will collaborate with universities from the Mediterranean area (Morocco, Tunisia, Armenia, Serbia, Bosnia, Croatia, and Montenegro). The consortium is also developing new collaborations with universities from South America and South-East Asia. The AlmaLaurea model was presented to the World Bank in June 2013.

In Italy AlmaLaurea provides national and local governments and member universities with reliable and up-to-date information on the evolution of graduates’ academic careers and foster graduates’ employability by tracing their working achievements and promoting their access to successful careers and lifelong learning in a knowledge-based society and economy. AlmaLaurea’s activities are based, as shown in this chapter, on three pillars: its annual “graduate profile” survey and report on the internal efficiency of the higher education system; its annual
“graduates’ employment conditions” survey and report on the system’s external efficiency; an on-line databank of graduate résumés, a powerful tool that improves the match between supply and demand of graduates, as well as their transnational mobility.

Exhaustive, periodic, well-timed and updated documentation is provided to the governing bodies of member universities, authorities dealing with teaching activities and career guidance and generally any stakeholder group involved in higher education issues (including families, students, employers and policy-makers) as a solid basis for fostering all decision-making and planning processes.
References


CHAPTER 2

UNIVERSITY-INDUSTRY COOPERATION: TICASS REGIONAL INNOVATION HUB APPROACH

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Education, training, research and development and firms' propensity to innovation are largely recognized as main pillars of innovation system. The level of integration between these three elements could be a proxy of the degree of development of an economic area. Many efforts have been made to improve innovation system efficiency and its elements integration. We will focus on Ticass consortium experience, a bridging institution able to generate trust between the different subjects involved into the local innovation system and to accelerate cross fertilization and technology transfer mechanisms. Ticass strategy will be explained paying special attention to training initiatives developed.
Introduction

To properly approach the issue of tools for strengthening employability for higher education graduates, we believe a focus is needed to analyse how the paths and the processes of research and development have changed in recent years. The last three decades have witnessed how basic research in the proverbial University ivory tower has given way to a more market-oriented, interdisciplinary approach to solving problems [1]. Etzkowitz and Leydesdorff in the ‘90s elaborated the concept of the “triple helix of University-Industry-Government” [2,3,4]. In the same years the “innovation system” concept was elaborated [5,6] based on common hypothesis, later on declined at national and regional level. Education & training, research and development (R&D) and firms’ propensity to innovation are nowadays largely recognized as main pillars of regional economic development and the level on interaction and collaboration between corresponding bodies is a critical success driver for innovation system efficiency.

The science system faces the challenge of reconciling its traditional functions of producing new knowledge through basic research and educating new generations of scientists and engineers with its newer role of collaborating with industry in the transfer of knowledge and technology [7].

The emerging context asks for a holistic approach considering education & training, R&D and industrial innovation as a whole, where industry should be involved as much as possible to collect useful inputs in terms of both training requirements and possible application for research’s results. At this aim governments have launched numerous initiatives since the 1980s to link universities and basic research to industry more closely. In particular, bridging institutions and science parks are devoted to strengthen and stabilize the linkages among firms, universities and governments, to provide competitive advantage through faster learning, to faster information diffusion and to foster knowledge spill over and knowledge transfer [8,9].

According to these trends TICASS, acronym for Innovative Technologies for Environmental Control and Sustainable Development - was established in March 2010.
Regional innovation hub as bridging institution

TICASS is a non-profit Consortium, composed of research authorities and large, medium and small companies, which performs, promotes and enhances research activities, as well as transferring excellence technologies in the “Energy and Environment” area with regards to Sustainable Development and Quality of Life [10].

In contrast to the majority of bridging institutions, established at the behest political, TICASS’s birth followed a bottom up approach: the initiative came from a group of subjects mainly consisting of private companies and University of Genova that shared common problems and research goals. We would emphasize this aspect because it has generated positive implications in terms of mutual trust between consortium members and in terms of collaborative environment, which are prerequisites to let the organization work properly [11].

The consortium role is also the coordination of the above mentioned activities at regional, national and international level. Its main goal is to widen knowledge and introduce innovative technologies by the cross-border cooperation, with universities and other public and private bodies.

TICASS promotes highly profiles training courses such as PhD courses, I and II-level Master degrees, through the award of scholarships, research grants and collaboration contracts.

Since May 2011, according to the Regional Resolution n.553 del 20/05/2011, is officially recognized as managing body of the “Energy-Environment” Regional Innovation Hub.

The Hub goal is therefore to expand the know-how and introduce innovative technologies to be applied to key areas of development identified in the framework of European cooperation and integration and to set up active collaboration with universities and public and private bodies.

TICASS is the managing authority for the hub, whose role is to aggregate companies with different expertise in planning,
research, production focused on environmental themes (air, water, energy, waste, noise, chemical hazard, etc.) which allow interdisciplinary developments.

The Consortium brings together the expertise of different companies and private and public research centres putting a common factor skills, knowledge, laboratories and equipment resources to achieve their goals. At present the consortium is composed of 44 members including large medium and small enterprises and University of Genova (9 different University Departments are actively involved).

**TICASS’S MODUS OPERANDI AND TRAINING PROJECTS**

Ticass leads research activities and technological innovations in the fields of energy and environment to improve the life quality and the sustainable development. Consortium activities are finalized to carry out, promote, diffuse, transfer and exploit research and innovative technologies for: energy saving, environmental control and management, sustainable development, improvement of life quality.

In each of the above domains, Ticass carries out research and training activities based on an interdisciplinary approach bridging together private and public bodies in order to promote an active and fruitful interaction. Moreover Ticass aims to support valorisation and exploitation of outcomes of University’s research and promoting technology transfer and cross fertilization processes.

At this aim Ticass developed an organizational tool called “working group”. The institution of Ticass’s working groups aims to support and accelerate the development of close relationships between the consortium’s members, to exploit possible synergies and to foster the virtuous circle among companies, university’s departments and research centres. The final goal is to identify targeted and customized project ideas according to Ticass’s member needs, paying particular attention on SMEs inputs. The most promising project concepts, evaluated by the technological point of view as well as by the competitive and sustainable point
of view, are translated into research projects as well as into training projects. Often the two activities are conducted and developed in parallel, one as consequence of the other.

We believe that this kind of approach applied to training activities design, planning and development could foster and improve the employability level and its quality. A brief excursus of Ticass’s experience in the training field follows.

**POST GRADUATED TRAINING**

Italian graduates are traditionally extremely prepared and skilled by the theoretical point of view, but they are not familiar with the industrial reality and production issues, and few of them have a real perception of how a company works.

To address this gap, for some years, it has become compulsory an internship during the course of study, but it is still difficulty recognized and perceived as a real formative moment. The business environment is not yet fully perceived as a real place of formal learning and, much less, the company tutor is enabled on the role of the teacher.

For this reason the supply of specialist post-graduate training program (of variable length, up to a year), if actually designed and managed in strict collaboration with companies, is an important opportunity, a feasible way to accompany young people from knowledge to competency. Post-graduate training programs, if really targeted to business needs, are an excellent tool to support the acquisition of specific skills and of the “soft skills” (knowing how to behave in that specific context that is the company).

Over the past few years we have coordinated some relevant training initiatives at national as well as at international level: including the University Master in Environmental Monitoring and the Specialization Course in Water Treatment. Thanks to the strict collaboration with leading companies operating in the specific industries and their involvement into the project till its first steps (training needs identification, design of the course program, active involvement in the teaching activities, organization of visits and testimonials, hosting of
internships/stagers), all of our students have continued brilliantly in the chosen career fields. Positive implications emerged also in terms of the satisfaction perceived by student and by the partner companies.

We would emphasize that all the courses include a section of field experience (stage-project work) made in the company’s boundaries under university’s supervision. The duration of this period is never less than 2 months and it has been generally extended at the request of the student or of the company itself.

**RESEARCH GRANTS**

With the Regional Law 2/2007 “Promotion, development and exploitation of research, innovation and higher education and university activities” Liguria Region activated, since 2011, 400 research grants, through its eight regional innovation hubs, correlated to research projects involving University and local firms. This initiative, which will conclude on the first half of 2015, gives the possibility to taste an innovative model, highlighting strengths and weaknesses, which we summarise in the follow.

The direct involvement of companies in the design of the research is one of the main strength point: all projects required the mandatory presence of at least one partner company (with special attention to SMEs). This strategic element turned out soon of complex management. University, used to managed financed research grants (by enterprises, public institutions, or even by Foundation), had many difficulties to recognize a formal role of company in the project, attributing them rather the role of “end user” of the research’s outcomes. For example, University rule doesn’t allow to include any external person into the Evaluation Board.

This issue is one of the emerging critical and strategic factor. In many cases this issue has been faced and managed in a collaborative way and we observed: an increasing cooperation between firms and University: the updating of research’s goal according to outcomes, an increasing integration of the grant
holder within the firm’s organization and job opportunity to continue the collaboration after the end of the project.

By the employability point of view, this initiative allows grant holders, in many cases post doc researchers aspiring to so-called academic career (a sector characterized by very high entry barriers), to rethink their career aspirations concretely considering the alternative of job placement in different sectors. This consideration is very interesting because it changes the cultural approach of young people regarding research activities which are still considered prerogative of Universities or of large enterprises. Projects involving SMEs demonstrate their sensitiveness to R&D and to its implications in terms of industrial innovation as competitive advantage. This consideration shows the high importance to engage as much as possible the SMEs into the innovation process in order to foster and support the regional innovation system competitiveness.

Ticass is coordinating 11 research grants, correlated to 8 research projects, involving 22 companies (10 of which are SME’s) and 4 different University departments. According to Ticass’s approach frequent events are organized (every three months) at the presence of grant holders, academic and industrial tutors. Meeting goals are numerous: to share research’s outcomes, to discuss possible issues and next steps of the research, to identify and exploit possible synergies between different research projects, to adapt the search path to actual production requirements or to future company’s R&D’s strategy.

**EUROPEAN PROJECTS**

The European Commission has paid attention to education and training since long time launching dedicated programs like Erasmus and Tempus, recently unified into the Erasmus +.

Ticass has been involved into two Tempus projects: NetWater, [http://netwater.tstu.ru/](http://netwater.tstu.ru/), and GreenMA, [http://greenma.tstu.ru/](http://greenma.tstu.ru/). In both projects TICASS has designed, coordinated and managed training courses (a post graduate master and an intensive course) in strict collaboration, on one hand with University of Genova, and on the other with its
associated companies. The contents of programs have been developed based on the results of survey on training requirements and they were updated based on questionnaire regarding trainees’ knowledge, skill and expectations, filled in at course start. The right balance between knowledge background of trainees, their expectation, teaching contents, industrial testimonials and visits to production sites emerged as critical success factor of Ticass training supply.

Moreover, more and more frequently we see that training activities are included in European research project, FP7 and Horizon 2020, as effective technology transfer tool. In particular Ticass is partner of GeoSmartCity project, which main goal is the creation of a framework in which Geo Open Data from the cities are exploited towards the Smart City paradigm allowing the developing of various added value applications and new specialized services, www.geosmartcity.eu. Project includes a specific task dedicated to “Capacity building and training”, considered a fundamental tool to transfer existing knowledge and the results of the project towards potential stakeholders. This task is part of the working package “Dissemination” and represent one of the most important pillars on which to ground the exploitation of the project results and the sustainability of the project after its conclusion.

SCOUTING REGARDING INSTRUMENTS, INCENTIVES AND CONCESSIONS SUPPORTING WORKPLACEMENT

Ticass, thanks to its relationship with public bodies, policy makers and University, is constantly updated regarding legislative tools and economic incentives to support job placement and companies which hire.

Italian government offers numerous interesting new instruments to support companies which hire skilled personnel, and new ones will be offered within the new National Plan of Research in Italy (2014-2020), but they aren’t always well promoted and when they are, their adoption requires heavy administrative fulfilments. The lack of communication regards in particular labour consultants who usually supports SMEs for all
issues related to employment relationships. A strong investment in communication and promotion is needed to spread information and opportunities, also to rehabilitate the general perception of this tool still perceived in a negative way.

Ticass seeks to bridge this gap disseminating information through its communication channels and providing support services to interested firms. Special attention is paid to SMEs, that rarely use this kind of tools.

We will focus here on “Research apprenticeship”, recently reformed (DLG. 167/2011), that allows the placement of young graduates in business through the establishment of a research program agreed with a university or research institution. This tool, which offers substantial tax relief for the company, together with incentives free grant, is still poorly used at national level. It represents instead an exceptional chance to improve the cooperation and support technology transfer processes, and at the same time it could generate new job opportunities for young people. As an example, Ticass has recently supported an associated company, a SME, who hired 2 graduates by September 2014 and an additional resource by October 2014. The same enterprise would otherwise have offered a fixed term contract of 12 months.

HOW TO NARROW THE UNIVERSITY–INDUSTRY GAP

We briefly presented TICASS’s strategy aiming at narrowing the University-industry gap, to support the matching of supply and demand in the labour market and to foster technology transfer and regional innovation system competitiveness. The consortium works as a brokerage subject between University and Industry and local public authorities (PA). Putting together technicians with different background in the same melting pot, the consortium tries to cover cultural distances and to create personnel relations and trust to increase the interaction level of the overall system.

As a private, bottom up and autonomous initiatives, Ticass works, as first, in favour of its own members and then to the
external environment, connecting and promoting the interaction between different subject at the aim of their mutual benefits and of the overall system competitiveness, through the following actions:

1. Improve the level of coordination between the different public institutions involved in the field of R&D education and training, facilitating the communication of information and opportunities, to maximize exploitation opportunities with special attention to SMEs;

2. Promote and coordinate research projects involving more than one company in order to bring SMEs closer to the research world and to promote trust mechanisms which are needed to establish a collaborative environment and to facilitate the sharing of results and their concrete industrial applications;

3. Develop actions of cross fertilization between the local production system and the university to address and finalize the research in order to meet the needs of the local production system;

4. Develop actions to promote the knowledge of local production system, in order to show possible employment opportunities and the great potentialities offered by SMEs;

5. Develop actions to bring closer the academic careers, like PHD, to industrial careers to offer job opportunities to young researchers and at the same time to promote the research culture at private enterprises;

6. Launch projects of specialized training, in collaboration with industry, to allow young people to acquire specific skills through applied research activities;

7. Encourage the dissemination of knowledge of the incentives for research in SMEs and among university graduates;

8. Facilitate the matching of demand and supply in the labour market by setting up a “repository” of young researchers, sorted by areas of expertise and by job profiles, to be shared with companies for recruitment and selection.

This approach’s application takes the form, in the education and training field, of training projects, whose goals
and programs are shared by companies, University (or other training bodies) and local PA. Common goal is to develop targeted training projects designed on real local requirements coming from local economic system and coherently with the public planning, supported by public financial opportunities where possible. Companies engagement and their active involvement in all the step of the project (design, training activities, assessment, internship...) is one of main critical success factor in training project, ensuring the highest possible convergence between training needs and skills transferred to trainees, making internship period fruitful for both the trainee and for the host company and increasing the interaction level among labour market demand and supply.
To work effectively in the education and training field an holistic approach is required, involving the three pillars of the innovation system. A local private initiative is presented to show how the strong local rooting, the well established relationships and positive past collaborations with public authorities could support to achieve common goals.
References

SECTION 2

MATCHING MARKET NEEDS / COMPETENCES AND SKILLS FOR LABOUR
CHAPTER 3

QUALITY IN HIGHER EDUCATION AND BENEFITS FROM THE INTERNSHIPS

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In this work we examine how the quality of education is enhanced and affected by the students’ internships. In doing so, we exploit survey data in the form of quality performance indicators concerning the off-campus training of electronic engineering students. More specifically, our evaluation indicates that the internship period, which is a constituent part of the educational programme at the Technological Educational Institution of Crete - Greece, is associated with a series of benefits. Taking into account the relevant international methodologies, trends and initiatives, the framework adopted for our students’ internships seems to be quite effective in terms of various educational and market needs. In other words, the experiences acquired so far indicate considerable gains for our future engineers and the tertiary educational institution, and correspond to employer expectations.
Introduction

Students’ work placements are recognized as one of the primary mechanisms for initiating partnerships between Higher Educational Institutions (HEIs) and entities from various business sectors. By the establishment of such partnerships, students have the opportunity to enhance their skills and competences in real life working environments. Moreover, the resultant internships for engineering students are of great importance in our knowledge-based economy, where the collaborative and coordinated action of HEIs, professional societies, industry players and education policy makers is a necessity in order to address the shortage of highly qualified engineers.

In such a framework, workplace learning (WPL) of students constitutes an integral part of the engineering curriculum at the Department of Electronic Engineering-Technological Educational Institution of Crete (DoEE/TEIoC). More specifically, the six months’ WPL duration of our students is carried out through internships between the DoEE/TEIoC and Host Entities (HEs). The HEs may be either private (prHE) or public (puHE). For example, a prHE may be an electronics assembly facility, a telecom operator, a microenterprise involved in ICT projects, while a puHE may be the biomedical electronics department of a hospital, a research institute, the ICT department of a municipality, national military units involved in electronic warfare applications [1].

According to a North American study [2], critical components of a high quality work experience of students include adequate mentoring, supervision and guidance by more knowledgeable professionals or peers; engagement in meaningful authentic tasks that advanced the work of a community of practice; a sense of ownership over a real world project; and ample opportunity to work independently and think creatively. On a national level, the quality dimension for internships and WPL of students is addressed by the Hellenic Quality Assurance
and Accreditation Agency (HQA) through a series of criteria. For example, in response to HQA’s criterion “How monitoring and support of students during their WPL period is achieved?”, we have adopted among others a Web 2.0-based communications environment (http://practice-elec.chania.teicrete.gr) as a facilitator of the electronic collaboration of all parties involved in our internships [1]. Overall, in the framework of a project (October 2010- October 2015) financed by European and national resources, we have introduced a series of good practices aiming to support internships between DoEE/TEIoC and appropriate HEs. In other words, we are striving for the effective WPL of our students through the formation of a learning triad in our internships (the student, the HE supervisor, the academic supervisor). The aforementioned practices span throughout all stages of a student’s internship (individual mentoring and other supportive actions before student’s placement, formative assessment through Web 2.0-based monitoring and on-site visits provided by the academic supervisors during the WPL period, summative assessment carried out by all members of the learning triad at the end of the internships).

Taking into account our approach for internships and WPL briefly discussed above, the aim of the paper is to present assessment results of our experience in line with HQA’s requirements and targets. Thus, the main contributions of this paper are summarized as follows:

• We quantify the effectiveness of our students’ internships in terms of students’ ability to apply their knowledge in a real workplace environment.
• Identification of students’ prospects in the labour market at the end of their internship, especially in our recession times.
• Identification of labour market’s attitude for students’ internships, as it is influenced by its needs and expected benefits.

The rest of the paper is organized as follows. In Section 2, taking into account ongoing discussions and HQA criteria about quality and higher education, we provide assessment results related to our students’ internships in terms of specific Quality
Performance Indicators (QPIs). More assessment results, as they relate to the benefits of internships in engineering disciplines for all parties involved, are presented in Section 3. Finally, in Section 4, conclusions concerning our approach within the greater relevant context in EU, are derived.

**Quality aspects of internships**

As argued by the author in [3], there are contested views over quality and its measurement which inform the preferences of different stakeholders in higher education. Therefore, in order to understand quality, it is necessary to recognize that it has contradictory meaning that can lead to different assessment methods, and thus different practical outcomes. To make matters more complicated, due to the fact that HEIs have undergone major transformations in support of the knowledge economy, the power base and direction of quality is moving from the hegemony of the academy into the pragmatism of the marketplace. Thus, in the context of student internships, the authors in [4] support that what is needed is a fresh look at quality as it is embedded in work-based learning and the relationships between its stakeholders. Moreover, they claim that this will not be achieved with an approach in which one party, the HEI or industry, suggests merging its values into the others.

In the light of the above discussions, national authorities such as the HQA and the UK Quality Assurance Agency for Higher Education have recently paved the way to assure the standards and quality for students studying at various academic levels, including the WPL mode of study. With regard to the HQA, a series of criteria covering the undergraduate and graduate programmers, teaching aspects, research activities, connections with social, cultural and economic entities, the strategy for academic development, the administrative services and other infrastructures, has been issued and is now being used for assessment purposes. As it concerns the assessment of undergraduate programmes, the aspects covered include the programme structure and design, the students’ assessment, the impact on society, internationalization aspects, and the students’ internships.
Two of the internship-related HQA criteria with their associated QPIs will be our focus in this paper. Thus, on the one hand and following NQA’s notation, we consider the 1-I.5.6 ((a) “How internships address the application of students’ knowledge?”, (b) “How successful is the familiarization of students with the workplace environment?”) and the 1-I.5.8 (“Are internships a facilitator for future students’ recruitment?”) criteria. On the other hand, the QPIs used are contained in three questionnaires completed by the student, the HE supervisor, and the academic supervisor at the end of the six months’ WPL period. A depiction of the analogy between these HQA criteria with their directly or indirectly corresponding QPIs is shown in Table 1.

Table 1: A depiction of the analogy between these HQA criteria with their directly or indirectly corresponding QPIs

<table>
<thead>
<tr>
<th>HQA criterion</th>
<th>Corresponding QPIs</th>
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<tbody>
<tr>
<td>1-I.5.6 (a)</td>
<td>Degree of students’ preparation for internship</td>
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<td></td>
<td>Efficiency of students’ prior theoretical knowledge</td>
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<td></td>
<td>Efficiency of students’ prior technical skills</td>
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<td>Students’ efficiency in qualitative terms</td>
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<td></td>
<td>Students’ efficiency in quantitative terms</td>
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<tr>
<td>1-I.5.6 (b)</td>
<td>Students’ adaptability to the workplace environment</td>
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<tr>
<td></td>
<td>Degree of satisfaction with the working environment</td>
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<tr>
<td></td>
<td>Overall rating of students’ collaboration with the HE (HE supervisor’s view)</td>
</tr>
<tr>
<td>1-I.5.8</td>
<td>General prospects for recruitment</td>
</tr>
<tr>
<td></td>
<td>Prospects for recruitment in the prHE after completion of WPL</td>
</tr>
<tr>
<td></td>
<td>Prospects for recruitment in the prHE for electronic engineering students</td>
</tr>
<tr>
<td></td>
<td>Overall rating of students’ collaboration with the HE (student’s view)</td>
</tr>
<tr>
<td></td>
<td>Degree of HE’s correspondence to students’ needs</td>
</tr>
</tbody>
</table>
Compliance between individual internships and the scope of DoEE/TEIoC
Continuation of the internship collaboration between DoEE/TEIoC-HE
Usefulness of student internships
Other engineering disciplines for internship consideration

By the use of a five-point Likert scale (unacceptable, not satisfied, neutral, good, very good) the perception of each respondent is expressed, and thus a multitude of items related to students’ internships is quantitatively measured. The subsequent evaluation performance can provide useful insights to the whole WPL process and can identify any mismatch issues concerning the “academy-practice divide” [5]. Based on the data provided by a total of 118 (number of students) * 3 (number of questionnaires per student) questionnaires available at the time of writing this paper, we present a series of QPI results (Figure 5 - Figure 14).

Figure 5: Degree of students’ preparation for internship according to the academic supervisor, the student and the enterprise’s supervisor
Figure 6: Efficiency of students’ prior theoretical knowledge according to the student, the academic supervisor, and the enterprise’s supervisor

Figure 7: Efficiency of students’ prior technical skills according to the academic supervisor, the student and the enterprise’s supervisor

Figure 8: Students’ efficiency in qualitative terms according to the academic supervisor and the enterprise’s supervisor
Figure 9: Students’ efficiency in quantitative terms according to the academic supervisor and the enterprise’s supervisor

Figure 10: Students’ adaptability to the workplace environment

Figure 11: Degree of students’ satisfaction with the workplace environment
Figure 12: Degree of academic supervisors’ satisfaction with the students’ workplace environment

It should be noted that, due to restrictions for recruitment in the public sector, we got the more pragmatic QPI results of Figure 13 and Figure 14 by excluding the student internships at puHEs.

Figure 13: Prospects for recruitment from the viewpoint of students
Figure 14: Prospects for recruitment from the viewpoint of enterprises

Benefits from internships

According to the “2014 Talent Shortage Survey” by Manpower Group across 42 countries, 42% of 750 surveyed employers in Greece reported they are experiencing difficulty filling jobs due to lack of available talent. The largest proportion (42%) cited a general lack of experience, followed by a lack of hard skills (29%), soft skills (19%), and unavailability of applicants (18%). Furthermore, from an engineering education point of view, a major shift still in progress for engineering curricula is that emphasis on design is constantly increasing. Along the on-campus approaches followed by HEIs (capstone design courses, first-year or cornerstone engineering design courses, incorporation of engineering design issues in the sophomore and junior years), it is evident that the off-campus WPL of students during the internship period presents an additional tool. Moreover, as evidenced by other studies, students’ benefits from internships include that of having a more positive view of the learning experience of the programme in general, better academic performance, and higher graduate employment rates. Thus, our students’ aggregated perception for the benefits acquired, as quantified by the “Overall rating of students’
collaboration with the HE” QPI (see Figure 15), more or less validates the aforementioned findings and issues.

Figure 15: Overall rating of students’ collaboration with the HE

The resistance to the employability agenda and the belief in the pure academic pursuit may explain why many HEIs show limited interest in developing their students’ work experience [6]. Some find the experiential learning agenda politically driven, while others believe that experience is just not an appropriate source for scholarly knowledge. However, students’ internships may definitely be regarded as a means of quality enhancement for both HEIs and individual academics. Thus, potential benefits of internships include useful feedback for curriculum design and modifications, the enrichment of on-campus learning with trustworthy real life examples, as well as the establishment of closer links for research and development purposes. Such beneficial outcomes concerning the internship of 79 students (for a more pragmatic and fair assessment, students who carried out their WPL at laboratories or other units of TElIoC were not considered) are expressed in terms of three QPIs, as shown in Figure 16. Actually, these QPIs indicate the perception of the academic supervisors about the HE’s suitability, correspondence
and compliance to be in conjunction with our electronic engineering students’ needs and the DoEE/TEIoC’s scope.

Figure 16: Perception of the academic supervisors about the HE’s suitability, correspondence and compliance

The HE’s benefits may range from a matter of getting unpaid or low-cost manpower to a positive contribution to organizational development and the culture of the workplace. However, a true added value for the HE exists in cases where the students undertake activities in a specific project (design project, research project, etc.) due to various human resources constraints at the workplace. These HE’s benefits are recognized by the workplace supervisors (excluding, again, the internships with TEIoC as a HE), as indicated in Figure 17 and Figure 18.
Without considering other factors (size of company, current projects, etc.), their assessment (“Usefulness of internships” QPI) and their expression of interest to host internships with engineering education students from other disciplines (computer engineering, electrical engineering, mechanical engineering), present to be a clear indication of their positive attitude.
It is widely accepted that European education and training systems continue to fall short in providing the right skills for employability, and are not working adequately with business or employers to bring the learning experience closer to the reality of the working environment. Taking into account that these skills mismatches are a growing concern for a country’s competitiveness, we have adopted a Web 2.0-supported framework for the WPL of our electronic engineering students. In particular, through the appropriate internships, we are continuously striving to lessen the “academy-practice divide” and, thus, to improve the overall quality of education provided by the DoEE/TEIoC. The survey data with the corresponding QPIs presented in Sections 2 and 3 provide a clear indication that internships can facilitate “competence-based education” and support “student-centered learning”. Overall, our approach regarding internships (the establishment of connections with prHEs and puHEs, monitoring of students’ learning, quality assessment, etc.) is in line
with current EU initiatives, such as the “Rethinking Education initiative” [7] launched in 2012. This initiative aims to redress education systems across Europe to cater to the increasing demand for higher skills and to reduce unemployment. Within the context of internships, envisaged actions of the “Rethinking Education initiative” are to ensure that, by 2020, education systems are equipped with new ways of teaching and learning, and that acquisition of the right skills for employment is achieved. These actions will be undertaken either by the member states (strengthening the provision of transversal skills that increase employability, scaling up the use of ICT-supported learning and access to high quality open educational resources) or through a European level coordination (acceleration of improvements in WPL, creation of a European Area for Skills and Qualifications, partnerships between education, business and research).
References


Acknowledgments

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CHAPTER 4

PROJECTS AS STEPPING STONES TO EMPLOYABILITY IN THE ICT FIELD IN SOUTH WEST FINLAND

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This exploratory study charts the types of projects that the Information Technology students at Turku University of Applied Sciences can participate, identifies the types of thesis projects and explores the relationship between thesis projects, and entry to labour market. The study focuses on those students who graduated in 2013. Data were collected from a number of sources. Results indicate that the degree programme offers a large number of project-based courses in its curriculum and environments conducive to projects. The majority of thesis projects were commissioned by mainly by companies but also by governmental agencies and voluntary organisations which indicates strong links with the industry and the society respectively. The majority of the employed graduates are employed by the commissioning companies. Finally the study identifies areas for future research and development of graduate employability.

Keywords: project-based learning, thesis projects, graduate employability, Finland, ICT
Higher education in the 21st century is evaluated in terms of attainment and completion rates as well as the employability of its graduates [1]. Graduate employability is linked to economic competitiveness in the contemporary knowledge-based economies [2]. In the current economic climate, higher education institutions shape their curricula and develop student competences in accordance with the demands and trends of the regional, national, European, and global labour market. For example, the degree programme in Information Technology at Turku University of Applied Sciences (thereof referred to as TUAS) established specialisations in: Health Informatics to respond to the societal and, in general, global trend of ageing population and the needs of the local health industry; Game Development to respond to the needs of the flourishing game industry; and developed a range of initiatives to support entrepreneurship as a means of boosting the regional economy in the aftermath of the decline of Nokia.

In order to cater for the diverse and challenging needs of the labour market, higher education institutions need to design curricula that develop skills which will render their graduates workplace-worthy. Research [3, 4] indicates that employers expect graduates with critical thinking, problem-solving, teamwork and communication skills in addition to subject knowledge. Therefore, higher education institutions are challenged to utilize pedagogical methodologies and foster learning environments that nurture those skills. Traditional teaching and learning methods limit the development of the above mentioned employability skills [5] whereas active learning methods develop such skills. In particular, project-based learning enhances communication and problem-solving skills [6]. Furthermore, project-based learning is more effective than problem-based learning in promoting self-regulation and autonomy [7]. Another crucial argument in favour of project-based learning especially in connection with industry-based projects is that the students develop T-employee skills, that is, depth of subject knowledge combined with width of related
subject knowledge; and critical links with the industry and such projects act as stepping stones to first entry to labour market [8].

**Purpose of the study**

The Faculty of Life Sciences, ICT and Business at TUAS runs two degree programmes in Information Technology, one using Finnish as a language of instruction and the other one in English, mainly having international students. The focus of this exploratory case study is the Finnish language of instruction IT programme. This study first aims to map out the types of projects that the Finnish language Information Technology students at Turku University of Applied Sciences can participate; and secondly explore the relationship between these projects, topics of thesis and entry to labour market. In particular, the questions this study aims to answer are:

1. What types of projects TUAS students can participate (e.g., university-based, industry-based, own project)
2. What types of projects students take on as thesis topics?
3. How many of those projects are commissioned by companies?
4. Is the thesis project related to labour market entry?

This exploratory study focuses on those students who graduated in 2013. The reasons for choosing this sample is that a year after graduation has passed and locating those graduates is easier than locating those who graduated five years ago. In addition, this sample reflects the current trends and challenges in the contemporary labour market.

**Methodology**

To answer the research questions outlined in the previous section, a case study approach was adopted, in other words a variety of sources was used.

To answer the first question, what types of projects the IT students can participate, we first looked at the curriculum 2013-2017 which can be found in the SoleOPS system [9], the database
of curricula and course implementation plans and we noted which courses involve project work. We then validated these findings by asking the IT degree program manager for comments and corrections concerning the accuracy of these findings. Finally, we also searched the TUAS website to find out what type of R&D projects belong to the Faculty of Life Sciences, ICT and Business and which of these projects are related to IT.

To answer the second and third question, what types of projects the students take on as thesis topics and whether they are commissioned, we obtained a list of those IT graduates in 2013 from the Student Office and then we studied the thesis abstracts from the Theseus database [10] a thesis database of the Finnish universities of applied sciences. TUAS students have the option to either upload a digital copy of their thesis to Theseus or submit a hard copy to the library. In our case, few thesis abstracts were not included in the database. However, since those were recent graduates, the thesis abstracts could be retrieved from the author’s personal archives of the English language abstracts. From those abstracts we aimed to establish if there was a mention of the thesis being commissioned.

Finally, to establish a link between the thesis project and first labour market entry, we traced the graduates LinkedIn profiles and studied their employment history.

Results and discussion

PROJECTS IN THE CURRICULUM FOR THE IT PROGRAMME

The 2013-2017 curriculum for students places a strong emphasis on project work. The following table gives an overview of the curriculum and the light blue blocks indicate in which year the course entities occur.
Table 2: IT Curriculum for IT 2013 - 2017 indicating the course entities that involve project work.

<table>
<thead>
<tr>
<th>COURSE ENTITIES FOR IT CURRICULUM 2013 - 2017</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Studies</td>
<td>Y1 Y2 Y3 Y4</td>
</tr>
<tr>
<td>Professional Orientation</td>
<td>8</td>
</tr>
<tr>
<td>Communication &amp; Language Studies</td>
<td>17</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>33</td>
</tr>
<tr>
<td>Information Technology</td>
<td>24</td>
</tr>
<tr>
<td>Common Professional Studies</td>
<td></td>
</tr>
<tr>
<td>Project work &amp; Entrepreneurship</td>
<td>19</td>
</tr>
<tr>
<td>Information Technology</td>
<td>12</td>
</tr>
<tr>
<td>Optional Professional Studies</td>
<td>(up to 57)</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>30</td>
</tr>
<tr>
<td>Information Technology</td>
<td>72</td>
</tr>
<tr>
<td>Other Optional Professional Studies</td>
<td>33</td>
</tr>
<tr>
<td>Specialization Studies</td>
<td>27</td>
</tr>
<tr>
<td>Free Choice Studies</td>
<td>30</td>
</tr>
<tr>
<td>Work Placement</td>
<td>30</td>
</tr>
<tr>
<td>Thesis</td>
<td>25</td>
</tr>
<tr>
<td>ECTS involving project work</td>
<td>153 (223)</td>
</tr>
</tbody>
</table>

Note 1: * = courses involving project work

Note 2: (*) = courses that may involve project work

Note 3: (N)= N ECTS involve project work

The IT students need to acquire 240 ECTS in order to graduate. The curriculum in question offers project work courses worth of 153 ECTS. In practice, this means that approximately two thirds of the curriculum is project-based. In theory, the students could acquire a maximum of 235 ECTS. Project-based
courses start from the first year and they continue until graduation.

The projects in the first year are generated by the students themselves. For example, in the Product Development course which belongs to the Project work entity the students, working in small groups, have to provide a solution to a technical problem and, they are required to produce a project plan and the subsequent documentation. In this type of projects, there is no customer involved. For the rest of courses, there is typically a customer involved. The customer can be internal, external, either from the industry or from government organisations [11]. For example, an internal customer can be a teacher who wants an IT solution, or a member of the R&D team. An external client can be any company or the local hospital or library.

**R&D PROJECTS RELATED TO IT**

At the time of writing, TUAS has 48 active R&D projects [12] out of which 8 are Applied ICT projects. The following table summarizes their profile.

<table>
<thead>
<tr>
<th>Applied ICT R&amp;D projects</th>
<th>Scope</th>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMedic</td>
<td>international</td>
<td>6</td>
</tr>
<tr>
<td>Gamified Solutions in Healthcare</td>
<td>international</td>
<td>10</td>
</tr>
<tr>
<td>GeoSmart City</td>
<td>international</td>
<td>13</td>
</tr>
<tr>
<td>Global Spectrum Opportunity Assessment- Global IRF</td>
<td>international</td>
<td>4</td>
</tr>
<tr>
<td>WISE</td>
<td>international</td>
<td>11</td>
</tr>
<tr>
<td>Mini Engineers</td>
<td>regional</td>
<td></td>
</tr>
<tr>
<td>Turku Game Lab</td>
<td>regional</td>
<td>2</td>
</tr>
<tr>
<td>ICT Portti III</td>
<td>regional</td>
<td>2</td>
</tr>
</tbody>
</table>

Five out of these projects are international projects with international partners ranging from Europe, Asia to the U.S.A and
belong to public sector, industry, educational institutions, NGOs. IT students can also take part in these projects and enhance their skills.

It is worth mentioning that the degree programme has systematically created an environment conducive to projects are generated. This is consistent with the Conceive Design Implement Operate (CDIO) educational approach [13] which focuses on active and experiential methods of learning. The CDIO approach has been adopted since 2006.

In the recent years, efforts have been focusing on creating startups to boost the regional economy. Examples of mechanisms and initiatives include:

1. Turku Game Lab [14], a working environment shared by TUAS and the University of Turku, where students from both the technical and artistic fields can meet and develop games together.
2. ESCfi, a company-like learning environment at TUAS in which students deal with customer support requests and develop an entrepreneurial mindset.
3. CloudIT, a student-run cooperative which offers webpage and graphics solutions and sells IT equipment. (http://cloudit.fi)
4. ICT Portti, or ICT Gate in English, is a project running since 2009. In this project, TUAS, the University of Turku and Turku Science Park collaborate to support SMEs in SouthWest Finland to exploit ICT more efficiently. ICT Portti acts as a portal to support the transition to working life and enhances the students’ professional skills [15].

In addition, the students are encouraged to enter regional and global technology competitions such as the ICT Showroom and Imagine Cup [16, 17] respectively.

PROJECTS IN THESES

In 2013, 43 students, 37 male and 5 female, graduated from the Finnish language of instruction IT programme. For the purposes of this study, we examined their abstracts to determine
the type of project they carried out. In some cases, the abstracts indicated that the thesis was commissioned by a client, implying a company. In other abstracts, it was stated that there was a company that commissioned the thesis, and in some cases the name of the commissioning organisation was mentioned. In those abstracts, that no commissioner was mentioned, based on the context, we classified the thesis projects as the student’s own project (e.g. establishing and maintaining a WordPress blog) or own projects based at TUAS (e.g. optimization of a technical 3D model for real time graphic engine) since the latter project would require a test environment that would logically be located on TUAS premises. In some cases, it was indicated that the thesis project was part of a larger R&D project. The thesis projects these students carried out are categorized in the following figure.

Figure 19: Types of Thesis Projects in 2013

The majority of thesis projects (48%, 20 projects) are commissioned by companies which mainly belong to the Information Technology Services field specializing in game or health care technology. Interestingly, a thesis was commissioned by a professional sports team and two theses were commissioned
by startup companies that the students had founded. The former indicates the links of TUAS with the wider regional industry not only with Information Technology industry. The latter demonstrates the trend for start-ups as a means of boosting economic growth.

Seventeen percent of the thesis projects were independent projects carried out at TUAS, using facilities in the Turku Game Lab, for instance.

Independent projects constituted 12% of the thesis projects. It must be noted here that thesis projects that mention links to companies or R&D projects may be parts of assignments. There is also the possibility that they may have been commissioned by a company but the company may not want to be mentioned or they may not allow the student to mention that their project is associated with their company.

TUAS R&D projects accounted for 9% of the thesis projects.

Projects carried out in government organisations, such as hospitals and the City of Turku accounted for 7% and non-governmental organisations, such as the Scout District and a local sports team, account for 5% of the thesis projects. With the exception of one thesis project, all the other thesis projects were carried out in South West Finland.

**AFTER GRADUATION**

A year after graduation, the employment status of the 42 graduates was as illustrated in the following figure.
The majority of graduates (57%, N=24) were employed in positions matching their qualifications. Two graduates were confirmed unemployed, out of which one was in employment until May 2014 while the other one had been unemployed since graduation. One graduate was currently raising her family. For the remaining 16 graduates, there is no information about their status on professional networks. This does not necessarily mean that they are unemployed. In Finland, the percentage of unemployed young people aged 15-14 stood at 7% in July 2014 [18]. If we apply this percentage to the number of graduates, expected number of unemployed graduates would be 3 or 4. We will next examine the employed graduates.

The majority of the employed graduates have been working for their current employer for over 2 or 3 years. This means that their employment started before graduation. The following figure illustrates the duration of the graduates’ employment.
Half of the employed graduates (N=12) are employed by the Information Technology Services but a small number of graduates are employed by a Higher Education Institution (N=3) and a governmental organisation (N=1). Overall, the industry constitutes the main employer as 19 out of 24 graduates are employed there (See following figure).
Concerning the size of the 18 employing organizations, 11 organizations are either micro-entities or small enterprises, two medium-sized organisation, and 5 large organisations (See following figure).

Figure 23: Size of employing organisation

This distribution of companies in terms of size reflects very well the structure of businesses at a national level. In Finland, 99.5% of businesses are SMEs and in 2011, approximately 60% of the working population was employed by SMEs [19]. Therefore, economic growth in Finland is driven by SMEs.

The 3 largest organisations with over 10 000 employees are government organisations and long established international corporations. With the exception of the Tampere-based accounting firm, all the employing organisations are located or at least have offices in South West Finland. In other words, the graduates are absorbed by the regional labour market.

If we examine when the employing companies were established (See following figure), the majority of them (N=11) were established after 2002.
Table 4: Year of establishment of the employing companies

<table>
<thead>
<tr>
<th>Type of Industry</th>
<th>Founded in</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Services</td>
<td>2012</td>
</tr>
<tr>
<td>IT Services</td>
<td>2012</td>
</tr>
<tr>
<td>E Learning</td>
<td>2011</td>
</tr>
<tr>
<td>IT Services</td>
<td>2011</td>
</tr>
<tr>
<td>IT Services</td>
<td>2011</td>
</tr>
<tr>
<td>IT Services</td>
<td>2010</td>
</tr>
<tr>
<td>IT Services</td>
<td>2010</td>
</tr>
<tr>
<td>IT Services</td>
<td>2008</td>
</tr>
<tr>
<td>Internet</td>
<td>2008</td>
</tr>
<tr>
<td>IT Services</td>
<td>2003</td>
</tr>
<tr>
<td>IT Services</td>
<td>2002</td>
</tr>
<tr>
<td>IT Services</td>
<td>1999</td>
</tr>
<tr>
<td>Sec &amp; Invest</td>
<td>1999</td>
</tr>
<tr>
<td>IT Services</td>
<td>1993</td>
</tr>
<tr>
<td>Computer Software</td>
<td>1975</td>
</tr>
<tr>
<td>Accounting</td>
<td>1961</td>
</tr>
<tr>
<td>Telecom</td>
<td>1950</td>
</tr>
<tr>
<td>Glass</td>
<td>1918</td>
</tr>
</tbody>
</table>

From these 11 companies, 7 were established after 2010 which reflects the trend of setting up start-ups to boost regional growth and utilise technological expertise. Only three companies were established in the 1990s and two of them towards the end of the 1990s just when Finland was getting out of recession. The older companies are large international corporations with the exception of the accounting firm which is a micro-entity.
This exploratory study has demonstrated that the Finnish language of instruction IT degree programme at TUAS utilises a massive number of project-based courses in its curriculum gradually starting from course-based to customer-based projects, which are facilitated through environments such as Turku Game Lab. The majority of thesis projects are commissioned by companies in the region which indicates strong links with the industry. Furthermore, some thesis projects were commissioned by governmental agencies and voluntary organisations which signifies links with the society. Thesis projects are positively linked with employability. However, since the majority of employed graduates were employed for more than 2 years with the same employer, in other words, they were employed at least one year before graduation, we need more research into what types of projects the students take on during their internship periods and how they connect and establish contacts with the industry. In particular, channels of communication, “touch points” with the industry and their management would be
target areas for the development of the Work Placement courses. Finally, almost all employed graduates are employed regionally. This is a strength for the regional economy but this also raises a number of questions, for example, whether the graduates are competitive in an international context and whether the companies are internationalizing.
References


CHAPTER 5

FOSTERING AN EFFECTIVE TRANSITION BETWEEN EDUCATION AND LABOUR

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The ultimate purpose of higher education is to prepare students for the labour market. To some extent, professional life is dependent on transversal skills, on interpersonal abilities and on mobility requiring professionals to perform at international, cross-cultural environments. However, transversal skills, let alone international exposure, are barely addressed by undergraduate curricula. Innovative teaching paradigms are required in order to develop transversal skills and to facilitate international contact to higher education students. An adequate transition between education and labour is a matter of supply and demand alignment, the backbone of a market economy. Any initiative that fosters the cooperation between enterprises, representing the demand for professionals, and higher education, representing the supply of professional, is a contribution to a more efficient labour market. In this chapter we review the matching between employers’ expectations with regards to fresh graduates and the offer from higher education. We also discuss best practices to promote students transversal skills and employability in general.

Keywords: Transversal skills - Employability - Transition to labour market
The days of rigid hierarchical work organizations where someone tells you what to do and when, where no one demands more from a worker than performing the planned operations and where no one expects employers to have initiative and a critical view are long gone. Today, employees are expected to be committed to the success of the company and not only to be worried with performing the tasks that were assigned to them. Progress in the professional career is very much dependent on one’s ability to understand the core business and take the opportunities that arise in the daily work of the company and its surrounding.

In the past gaining and maintaining a job was dependent upon a set of skills that fit the function. Employability was mainly, not to say exclusively, related to the factual and procedural knowledge - what I know, what I can do. The technical (hard) skills acquired with traditional learning paradigms and by repeated experimentation were the core asset of fresh graduates looking for a first job. People could stay in the same job, doing the same thing for a lifetime.

Nowadays, the intellectual capital is still relevant but it is not it that guarantees a job, let alone building a successful professional career. Academic qualifications are taken for granted. You need them to play the game but, once in it, your value to market is defined by other aspects that reflect our attitude before life and society. Emotional intelligence, social capital and ethical assets - what I am, behaviours, soft skills - are very important aspects that determine to a large extent your value in the labour market. These findings are supported by several studies performed by employers and researchers during the last few years (see Section Employability).

The role of the academia in developing the broad competencies that promote students’ employability, including critical thinking, analytical reasoning, problem solving, teamwork and communication is crucial but doesn’t seem to be a top concern of higher education institutions in general. The key actors in the system seem to have conflicting interests, imposed by external factors. Teachers are concentrated in research. Teaching seems to have been relegated to second place.
Administrators are focused on international rankings and highly pressured by tight budgets and financial aspects. Government funding agencies are focused on the production of scientific knowledge [1]. Of course, all these concerns have their merit but, preparing students to succeed and become agents of development in the labour market should also be considered a top concern by all stakeholders.

Students, on their own, should be active players and the first ones committed to assure the conditions for a better future. The globalization of economy together with the ever increasing opportunities for students’ mobility creates many opportunities contributing for students to achieve their professional goals. Improving employability has to do with higher education institutions, acting in the development of technical and transversal skills and competences, and with students’ attitude towards active citizenship, job search strategies and networking. There are several opportunities being offered by many different stakeholders.

In the remaining of this chapter we will review the concept of employability and present best practices to improve the employability of undergraduate students.

**Employability**

The employability concept is defined in several distinct, although related, manners. Mantz Yorke [2] defines employability as “a set of achievements - skills, understandings and personal attributes - that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy”.

The student exhibits employability in respect of a job if he or she can demonstrate a set of achievements relevant to that job. Employability is a (multi-faceted) characteristic of the individual. Still according to the author, it is a mistake to assume that provision of experience is a sufficient condition for enhanced employability. Work experience, does not, of itself, ensure further development of the various prerequisites (cognitive, social, practical, etc.) required to succeed in the labour market. Still according to the author, the same argument applies to whole
curricula. The curricular process may facilitate the development of prerequisites appropriate to employment, but does not guarantee it. Hence it is inappropriate to assume that students are highly employable on the basis of curricular provision alone. This conclusion is generally accepted by the players in higher education. Due to several reasons, such as time restrictions, curricular provisions necessarily cover mainly hard skills. Most times it is not feasible to include courses or curricular activities focused on transversal skills. Designing innovative teaching paradigms might be a more reasonable approach to practice transversal skills while working on hard skills courses’ assignments.

In the words of Lee Harvey [3], employability is not a set of skills but a range of experiences and attributes developed through higher-level learning, thus employability is not a “product” but a process of learning.

According to a more pragmatic definition from 1998 [4] employability is about three abilities:

• gaining initial employment
• maintaining employment
• obtaining new employment if required.

This last definition is very focused on the immediate final outcome and it might be somehow outdated. This is a self-centric view not considering concerns that relate to the capacity of the graduate to function in a job - bringing added value to the company that go beyond just executing directives - and be able to move between jobs.

For the rest of this chapter let us assume that employability is a set of skills/competences allowing a person to develop a professional career in a certain area. This is a straightforward, maybe narrowing, definition that will keep us focused on the core aspects we will be discussing.

MISALIGNMENTS BETWEEN STUDENT COMPETENCES AND LABOUR NEEDS

There are several studies from companies and researchers that point out the misalignments between fresh graduates’
competences and employers’ needs. Similar mismatches are recurrently identified. Communication skills, leadership and management skills, teamwork capacities, problem solving and analytical skills are frequently mentioned [6]-[8].

A survey performed in Germany in 2009 [9], addressed to employers, identifies several competences that are considered to be very important by employers but very poorly taught at university. These competences include: hands-on know-how, methods/systems know-how, ability to work in teams, communication skills, working techniques, foreign language proficiency and leadership skills. This same survey reveals that employers find theoretical expertise very well taught at university yet not that important for the job.

Further evidence that higher education goals might be too biased towards academic aspects is provided by another survey [10] that ranks “students’ grades in final exams” in sixth place with a score of 29%. This same study ranks “unsatisfactory grades” in last place out of the five criteria surveyed to realize which criteria commonly lead to eliminate job candidates from the selection procedure. According to this study the most common reason to put a job candidate out of the running is lack of practical experience immediately followed by lack of soft skills.

The fact that these misalignments are getting notorious to the society - according to the Federal Reserve Bank of New York 44% of the graduates in the US were unemployed in 2012 while the same figure was of 35% in 2001 - associated to the cost of getting a higher education degree might generate a general feeling in society of little value for money associated to higher education. When a higher education degree is of doubtful benefit to one's future life, starting a professional career four or five years earlier might pay the cost of opportunity of not graduating.

WHAT IF WE MISS IT?

If higher education misses to properly develop undergraduates’ employability then employers have to do it themselves through specific on-the-job training activities.
However, this has a financial cost that should be minimized. Moreover, on-the-job training requires generic competencies - combination of competencies providing a strong basis for further learning including learning abilities, problem solving and analytical competencies - to adjust vocational competencies to the requirements of the job [5].

If students lack also these generic competences, then we get to an impasse probably leading to unexpected difficulties that might seriously frustrate students expectations and their family that have paid for their education.

**Embedding employability in curricula, best practices**

In [11] the authors systematize the common approaches to embedding employability in the curricula, as of 2006. Their main results consider five categories of approaches to include specific employability oriented content in higher education curricula.

**EMPLOYABILITY THROUGH THE WHOLE CURRICULUM**

This approach consists of an educational plan that favors training key transversal skill for employability. Each student is required to demonstrate eight broad abilities at progressively more complex levels in both general education and the specialist subjects:

- Communication (reading, writing, speaking, listening, visual, quantitative, and technological literacy)
- Analysis
- Problem solving
- Valuing in decision-making
- Social interaction
- Global perspectives
- Effective citizenship
- Aesthetic responsiveness
EMPLOYABILITY IN THE CORE CURRICULUM

This category refers to the approaches that designate existing core modules as vehicles for the formal development of the transferable skills.

WORK-BASED OR WORK-RELATED LEARNING INCORPORATED AS ONE OR MORE COMPONENTS WITHIN THE CURRICULUM

Work-based learning is generally accepted as being of significant relevance to promote employability. Sandwich degrees, typically involving a one-year placement, are a common approach under this category. Other similar approaches distribute the placement experience in several placement periods of shorter duration. The experience improves students’ self-confidence and raises awareness of the challenges commonly faced in the world of labour.

EMPLOYABILITY-RELATED MODULE(S) WITHIN THE CURRICULUM

This category includes the study programmes emphasizing the early development of students’ skills based on freestanding skills’ modules of varying kinds.

But teaching soft skills through traditional classroom courses is somehow a paradox. It seems more natural, simpler to deploy and eventually more efficient to develop innovative teaching paradigms that provide students an environment where they can experience and improve soft skills in an informal way while working on their hard-skills assignments. MUTW, Multinational Undergraduate Team Work, is one such paradigm [12].
WORK-BASED OR WORK-RELATED LEARNING IN PARALLEL WITH THE CURRICULUM

Includes work experiences taken by students on their own initiative and outside the scope of their study programme. Commonly refers to part-time or summer-time employment that students undertake in parallel with their studies.

Pitch Bootcamp job accelerator

Pitch Bootcamp is a two-day program that brings together 120 newly graduated and university students, and 100 companies. Pitch Bootcamp can be organized in different sizes: 30 bootcampers with 15 companies; 100 bootcampers with 50 companies, and so on.

During two days, participants dive into post-its, work and develop of a business model for their career. They improve their skills, get to know their future employers, learn how to communicate with impact and present to companies in a vivid, furious and empathic atmosphere.

Pitch Bootcamp is a concept by Sparkagency addressed to students looking to anticipate the job market and recently graduates looking for job opportunities. With an average age of 24 years old, students come from Economics, Management, Marketing, Engineering, Health, Programming, Law, Architecture, among other areas. The participating companies are looking to recruit people and being closer to the new generations of talent. Companies recognize the added value of this program and put their best efforts to make it successful. Pitch Bootcamp grant students an intensive contact with CEOs, Human Resource Directors, Marketing Directors, Production Directors and other business professionals from the banking, services, technology, retail, commerce and manufacturing sectors.

This type of event raises students’ awareness to understand that their own skills determine the value of their work in a company; allow them to identify their own transferable skills and connect them up to specific experiences and teach
them how to present their experiences and skills with measurable results.

It also allows them to understand the differences between companies; the methods used by companies to find talent and how the recruitment works and to understand their value proposition and how they can help the employer.

During the programme students develop efficient communication tools including an improved résumé, crafting their business card, setting up their e-mail signature, developing their presentation and follow-up e-mails, exploring their ambassadors’ network and reviewing their online presence through LinkedIn and Facebook.

Pitch Bootcamp is a fully hands-on experience running for two days. The first day is dedicated to training and the second day is reserved for the pitch and presentation to companies.

**DAY 1: TRAINING**

On Day 1 morning the bootcampers:

- Identify life experiences: training, professional experience and other activities that can be used to show talent and value
- Describe each experience using numbers and presenting results
- Identify the strongest employability skills
- Connect skills with life experiences
- Prepare and train a 2 min pitch
- Identify different customer segments and specific customers in each segment
- Design a value proposition for each segment or specific company

On the end of Day 1, bootcampers welcome 3 invitees from companies, successful professionals and entrepreneurs, to share their career experience and advice. During two hours, in an informal Q&A format, bootcampers discuss:

- Career options and different paths
- What is their job like, in a day-by-day basis
• Which skills are more important for their career progression
• Which skills are more valued by their companies-market
• Other doubts and questions about the world of work

DAY 2: PITCH AND PRESENTATION TO COMPANIES

COMMUNICATION
The bootcampers develop communication tools:
• Curriculum Vitae
• E-mail signature
• Business card
• Follow-up e-mail
• Presentation e-mail
• LinkedIn profile

COMPANIES
The bootcampers have 3 different interactions with the companies:
1. Icebreaker
2. Pitch
3. Open Networking

What can we do?
There are several possibilities available for those seeking to improve higher education students’ employability.

TO START WITH
Coping with today’s knowledge-based economy requires education paradigms that are grounded on critical thinking, problem solving and internationalization of education. In most study areas, education cannot be based on information transfer that does not trigger questioning, exploration and autonomous learning.
SUPPORT TO START-UPS

Supporting young talents wishing to setup innovative ideas with commercial potential is also a valuable service in the portfolio of initiatives promoted by higher education institutions on behalf of their students. National and international student competitions, like Imaginecup from Microsoft for instance, are also a way to support the kick-off of an innovative idea. More than just this support, participating in these competitions assures by itself a significant boost of students’ employability.

COOPERATION EDUCATION/LABOUR

There are notorious examples of effective cooperation between university and industry, such as the Intel eLite Program. The eLite program is a university-industry cooperation aiming to identify the soft skills required by local and multi-national companies and to identify the contributing factors of graduates’ unemployment [14].

Deeper cooperation between the worlds of education and work, focused on common concerns, will probably be the best contribution to a smooth transition from education to labour. Several barriers and drivers of university-business cooperation have been found to exist in Europe [13]:

- Business lack awareness of HEI research activities/offerings
- Differing motivation/values between HEI and business
- HEIs lack awareness of opportunities arising from University-Business cooperation
- Difficulty in finding the appropriate collaboration partner
- No appropriate initial contact person within either the HEI or business.

PROMOTE STUDENTS’ INITIATIVE

Promoting students’ initiative via the internationalization of education and, in general, by offering students more opportunities for international exposure and mobility - Erasmus+.
Offer students a range of opportunities for volunteering work.

**CURRICULUM DEVELOPMENT**

Promote innovative teaching paradigms that place students in an environment where they can experience soft skills in an informal way, such as:

- Flexible internships
- EPS - European Project Semester
- Mind The Gap
- MUTW - Multinational Undergraduate Team Work (blended mobility, non-formal learning, overcoming barriers to mobility).

**BEYOND SKILLS AND COMPETENCES**

Employability is not just about skills and competences. It has to do also with career guidance, contacts and opportunities. It has to do with tools like PRAXIS [15] that open the doors of the European labour market to all students, promoting equity and equal opportunities to all.
Employability is a hot topic in the European agenda involving significant efforts from several players. There are many different approaches and initiatives to promote employability arising from both the academia and business stakeholders. Project work and internships is probably the best approach to boost undergraduates’ employability. It is also a remarkable and natural bridge between the worlds of work and education with impact in society and in economy. Exploiting its full potential opens the doors to efficient transfer of knowledge, raises awareness to the needs and interests of institutions, creates opportunities for cooperation and promotes students employability in the global market. Yet, fostering employability has to be assumed as a critical success factor by all stakeholders including its main beneficiaries, the students. Students must take the initiative to search, explore and use the many opportunities facing them in order to start and develop a professional career according to their interests and expectations.
References

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Acknowledgements

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CHAPTER 6

CURRICULAR ELEMENTS OF WORK INTEGRATED HIGHER EDUCATION

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All degree programs in the Institute for Applied Production Sciences are designed according to the principles of “Cooperative and Work Integrated Education” (CWIE). Up to date two bachelor programs ("Production Technology and Organization" and "Sustainable Food Management") and one master program ("Engineering and Production Management") are the only such efforts in higher education in Austria. This status enabled academic staff, student representatives and participating enterprises to develop a unique and innovative set of measures to integrate two distinct learning environments. Academia delivers regular workloads representing a challenging higher education in engineering. Industry provides a minimum of three work terms with seven to 16 months of practical application, varying among the three programs according to their specific scope. In this paper a selection of curricular elements will be presented which together give a profound insight into the opportunities of CWIE in higher education. These elements can be included in almost every curriculum or organizational model and range from curriculum design and planning, to the application procedure and preparatory elements for work readiness in the first semesters to "reflection on
doing" in the workplace and as an integrative part of teaching and learning at the university.

**Introduction to CWIE**

“Cooperative and Work Integrated Education” (CWIE) has been chosen as the term best describing the unique characteristics of educational programmes promoted and supported by the World Association of Cooperative Education (WACE) and was therefore included in the organization’s logo in 2010 and described as follows:

“Cooperative & Work-Integrated Education (CWIE) is a term created by WACE to acknowledge and embrace all forms of experiential learning utilized by industry and educational institutions to prepare the next generation of global professionals. CWIE is an encompassing term that includes: cooperative education, internships, semester in industry, international co-op exchanges, study abroad, research, clinical rotations, service learning and community service.”

The core elements of CWIE are the close and continuous cooperation between higher education and enterprises and their representatives, and a wide range of specific elements to integrate academic curricular and professional tasks and temporary employment to form a unique and individual educational system for each participating student.

**History of CWIE**

The first “coop” programme in higher education was developed at the University of Cincinnati by Herman Schneider. He was Dean of Mechanical Engineering, and started his first pilot programme in 1906 with local machine tool companies and 27 male students. This first model consisted of a succession of two-week periods at university and in a company, with each company

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1See [www.waceinc.org](http://www.waceinc.org)
employing two in alternating rotations. Herman Schneider wanted to add important elements of “reality” to the practical education mainly relying on lab experiences. In his eyes economic constraints, communication issues with superiors and co-workers, typical failure occurrences and surprising incidents in everyday operation were learning opportunities crucial for future engineers. Furthermore, cooperation with the leading companies of the industry made sure students would only get to know and work with state of the art technology.

Since 1906 the basic concept, rotating of students between work and academic terms in a close collaboration with partner companies, has stayed the same and was “exported” around the globe. The most profound changes affected the duration of work terms with three (“quarter”), four (“trimester”) or six (“semester”) months being the typical choice.

In 1974 the „Berufsakademie Baden-Wuerttemberg“(since 2010 “Duale Hochschule Baden-Wuerttemberg” - DHBW) was created and has since become the largest single institution to offer cooperative education in the world (> 30.000 students in work-study programmes), passing University of Waterloo in Canada (15.000 Coop-students), the largest programme in North America.

In 1991, a new law in France required companies to spend a portion of their salaries for apprentices. Companies were allowed to employ young people aged 15 to 25 years and education could be on secondary or post-secondary level. This led to the development of work integrated education programmes by French universities.

The first CWIE programme in Austria was started in 2002 at FH JOANNEUM in Graz. From the beginning, elements of international initiatives were included and transformed to meet the requirements of the Austrian accreditation system.

Differences of organizational concepts

To highlight the evolution of CWIE at FH JOANNEUM, the differences of three concepts will be described in a little more detail:
NORTH AMERICAN MODEL (USA AND CANADA)

Students pass a first year at university to acquire basic academic skills and a preliminary insight into the skills needed in the selected field of industry. They are also offered preparatory courses in professional practice and conduct and are supported in their first application process for an internship, typically between their first and second year at university. They then continue their studies by rotating between work and academia, respective periods ranging from three to six months with four months being the typical choice (trimester system). Students are free to choose their employer but are in competition with colleagues for the most attractive positions. They usually go to different companies and complete three to six work terms until graduation. A typical coop undergraduate programme adds a year and can be completed within five years.

GERMAN MODEL (DHBW)

Students have to apply at a company offering a place for the “dual degree programme”. The selection is done by the company and only students with a valid contract can start the first semester. Throughout the three year bachelor degree the student is employed at one and the same company as a trainee with officially 50% occupation, therefore working for 18 months (an equivalent of 4 ½ work terms in the typical North American system). Actual rotation times vary according to the needs of industry but amounts to an average of three months both at the university and the company.

AUSTRIAN MODEL (FH JOANNEUM)

From the beginning in 2002 the GERMAN MODEL was used at FH JOANNEUM but extended to four years to qualify as officially accredited diploma programme. Another important difference was that application had to be done at the university and only admitted students were then supported in receiving one of the pending contracts from partnering companies.
When Austria changed to the “Bologna System” with six semester bachelor and four semester master degrees, the coop programme was also transformed. Since 2011 students first complete one academic year, similar to the situation in North America, before starting a two year coop contract with an employer. Thus, the model could be called a “hybrid” between the above mentioned: A combination of a one year preparation and guidance through the application process, and a two year contract with one single employer.

In the academic year 2014/2015 the first graduate coop programme will start at FH JOANNEUM with mostly graduates of the first cohort of coop bachelors participating. Students have to provide a contract with an employer for the duration of the studies and the academic courses are delivered during two extended periods of attendance at the university with a duration of eight months overall (January to May for 1st and 2nd semester; January to March for 3rd and 4th semester).

The pedagogical concept

Cooperative and Work Integrated Education is a special form of Experiential Education as described by David Kolb\(^2\). Kolb’s work contributes two important elements to the design and management of CWIE programmes:

- **Learning Cycle:** Experiential learning occurs in a cyclic process, similar to the PDCA cycle (Plan-Do-Check-Act) traditionally applied in industry for continuous improvement and quality management tasks. Learning can be seen as a process of continuous improvement of a student’s skills towards a goal of higher education by completing multiple cycles. In the case of experiential learning according to Kolb the different elements are Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation.

Learning Styles: Entrance into the learning cycle can occur at any of the four elements and is thought to define four different learning styles according to individual preferences. Knowing about one’s learning style helps interpret strengths and weaknesses and design a specific approach to holistic experiential learning.

To apply Kolb’s findings to the design of a bachelor degree programme the following simplification of the learning cycle shows the succession of work and study terms and the key role of reflection in integrating both pedagogical worlds.

Alternating study and work periods, combined with continuously higher levels of competence, turn this cycle into an upward spiral of learning. This is especially true when students return to the same company, transformed by their academic semester and ready to transform their role and their learning in practice, too.

Figure 26 is a representation of the degree programmes at FH JOANNEUM after the Bologna transformation. The programme is delivered in a three-way partnership between university,
company and student. Each of the three assumes a specific responsibility. The student is responsible to make the most out of the unique succession of movements between university and company, each occurring with a broader skills and knowledge set than the previous. The red dotted line represents the transition from undergraduate to graduate programme. The yellow arrows show possible entrance and exit times.

Figure 26: CWIE degree programmes at FH JOANNEUM - work / study succession (Haas, 2011)

Curricular Elements

FACILITATION OF WORK TERM INTEGRATION

In a CWIE programme a number of elements facilitate the cooperation between university and employers to supervise the learning process of the student. This communication is a prerequisite for designing suitable projects at the company and integrating acquired competences into classroom learning and vice versa.
One of the critical issues in accreditation and quality management of CWIE programmes is the provision of actual learning in the work place in accordance with the overall academic goals of the programme, down to the syllabi of single modules. This has to be proven by clear guidelines for design and assessment of practical tasks and by providing continuous support and guidance by academic staff.

At FH JOANNEUM the following elements are included into programme design and delivery:

- An employer manual is part of the documentation for the degree programme. It includes typical tasks to be assigned to students at specific times throughout the programme and all organizational issues of cooperation.
- After each work term a learning diary (task description + reflection on connection to the degree programme) and a short report have to be submitted by the student and is assessed within a course module of “Work Term Supervision”
- A standardized evaluation of student performance by the company supervisor has to be included into report. This evaluation is discussed in person with the student both by company and university supervisors.
- Company representatives are required to be part of the commission for last option exams before dropout (without actually taking part in the examination and voting). Failing this exam can lead to losing the job at the company or to an offer to repeat one year. Both option have to be decided by company and university.
- 11 ECTS of work term workload are directly assigned to 10 selected core modules of the curriculum. Module coordinators have to assess and accept by signature a short report on the respective projects completed by the student before graduation. A complete document with all documented activities is submitted.
- The required first bachelor thesis consists of a reflective account on the personal professional development during the studies. It has to highlight the development of
professional competences and specific learning occurring by bridging classroom with shop floor.

- During the last year at university a “Students’ Conference” is organized by the class of students. Key company projects are presented by every student before faculty, fellow students and company representatives.

- Four semester hours of teaching load is assigned to work term supervision for all faculty employed for the programme. Tasks include work term design and task definition together with the company supervisor, expert support for projects assigned to the student and supervision of the final thesis. Especially the latter has developed into the key element of cooperation between companies and university.

- For up to five days per semester students can substitute attendance at the university for selected tasks at their employer. These absences have to be officially requested by the company supervisor and approved by the head of the degree programme in the case of adequate competency acquisition through participation. Typical incidences for this procedure are: project planning meetings, internal audit participation, start of production, participation at meetings with suppliers or clients.

USING FEEDBACK FROM PROFESSIONAL COMPETENCE NEEDS FOR CURRICULAR CHANGES

The following example highlights the method by describing an actual procedure performed after three years of bachelor programme with integration of a full time study first year.

After choosing their future employer during the first year of study, students in the second semester are introduced into work with personal learning objectives. For more than a decade,

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3 Johannes Haas et al., Presented first at: WACE International Symposium on CWIE Research, Trollhättan, Sweden, June 2014
a list of competences developed by the University of Cincinnati was used. Students of the first three cohorts (85 students overall) of the bachelor programme had to assign highest priority for their personal expectation in the first work term to exactly 10 of the listed criteria.

In the following tables the list of criteria and the selected criteria with the highest number of mentioning are shown. Reflection and interpretation of the results were done together with the students and give an interesting insight in the perception of career development and professional competences seen by students just entering their coop rotation.

The results were then used to review content and delivery of key first year courses and their contribution to a good preparation of students for entering the work rotation.
Table 5: Learning objectives for professional practice

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>LEARNING OBJECTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A COMMUNICATION</td>
<td>Speaks with clarity and confidence</td>
</tr>
<tr>
<td></td>
<td>Writes clearly and concisely</td>
</tr>
<tr>
<td></td>
<td>Makes effective presentations</td>
</tr>
<tr>
<td></td>
<td>Exhibits good listening and questioning skills</td>
</tr>
<tr>
<td>B CONCEPTUAL AND ANALYTICAL</td>
<td>Evaluates situations effectively</td>
</tr>
<tr>
<td>ABILITY</td>
<td>Solves problems / makes decisions</td>
</tr>
<tr>
<td></td>
<td>Demonstrates original and creative thinking</td>
</tr>
<tr>
<td></td>
<td>Identifies and suggests new ideas</td>
</tr>
<tr>
<td>C LEARNING / THEORY AND</td>
<td>Learns new material quickly</td>
</tr>
<tr>
<td>PRACTICE</td>
<td>Accesses and applies specialized knowledge</td>
</tr>
<tr>
<td></td>
<td>Applies classroom learning to workplace situations</td>
</tr>
<tr>
<td>D PROFESSIONAL QUALITIES</td>
<td>Assumes responsibility / accountable for actions</td>
</tr>
<tr>
<td></td>
<td>Exhibits self-confidence</td>
</tr>
<tr>
<td></td>
<td>Possesses honesty / integrity / personal ethics</td>
</tr>
<tr>
<td></td>
<td>Shows initiative / is self-motivated</td>
</tr>
<tr>
<td></td>
<td>Demonstrates a positive attitude toward change</td>
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<tr>
<td>E TEAMWORK</td>
<td>Works effectively with others</td>
</tr>
<tr>
<td></td>
<td>Understands and contributes to the organization's goals</td>
</tr>
<tr>
<td></td>
<td>Demonstrates flexibility / adaptability</td>
</tr>
<tr>
<td></td>
<td>Functions well on multidisciplinary team</td>
</tr>
<tr>
<td>F LEADERSHIP</td>
<td>Gives direction, guidance and training</td>
</tr>
<tr>
<td></td>
<td>Motivates others to succeed</td>
</tr>
<tr>
<td></td>
<td>Manages conflict effectively</td>
</tr>
<tr>
<td>G TECHNOLOGY</td>
<td>Uses technology, tools, instruments and information</td>
</tr>
<tr>
<td></td>
<td>Understands complex systems and their interrelationships</td>
</tr>
<tr>
<td></td>
<td>Understands the technology of the discipline</td>
</tr>
<tr>
<td>H DESIGN AND EXPERIMENTAL</td>
<td>Displays the ability to design a component, system or process</td>
</tr>
<tr>
<td>SKILLS</td>
<td>Demonstrates ability to design and conduct experiments</td>
</tr>
<tr>
<td></td>
<td>Analyzes and interprets data efficiently</td>
</tr>
<tr>
<td>I WORK CULTURE</td>
<td>Understands and works within the culture of the group</td>
</tr>
<tr>
<td></td>
<td>Respects diversity</td>
</tr>
<tr>
<td></td>
<td>Recognizes political and social implications of actions</td>
</tr>
<tr>
<td>J ORGANIZATION PLANNING</td>
<td>Manages projects and / or other resources effectively</td>
</tr>
<tr>
<td></td>
<td>Sets goals and prioritizes</td>
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<tr>
<td></td>
<td>Manages several tasks at once</td>
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<tr>
<td></td>
<td>Allocates time to meet deadlines</td>
</tr>
<tr>
<td>K EVALUATION OF WORK HABITS</td>
<td>Professional toward work assigned</td>
</tr>
<tr>
<td></td>
<td>Quality of work produced</td>
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<tr>
<td></td>
<td>Volume of work produced</td>
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<tr>
<td></td>
<td>Attendance</td>
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<td></td>
<td>Punctuality</td>
</tr>
</tbody>
</table>

Source: Manual for Cooperative Education, University of Cincinnati
The top three ranked criteria can be summarized as follows:

- Personality development (Ranking 1-3)
- Quality of work (Ranking 4-6)
- Individual role as a knowledge broker (Ranking 7-9)

**PERSONALITY DEVELOPMENT**

There is a clear triad of top ranked criteria of clear communication, problem solving and conflict management. These three learning objectives turned out to be direct translation of the students‘ main expectation of success factors for their first work term. The decision is at least partly rooted in experience students already gained through application procedures and job interviews.

All top priority learning objectives are describing general personal competences and are not directly work related. This fact indicates the high awareness of the intrinsic potential of work integrated learning in personal development and personality shaping.

**Consequences for learning opportunities at the university:**

- All three criteria can be included in a number of courses and should be given high emphasis at the beginning of the program: Presentation skill within
project work, problem and project based learning strategies but also highlighting the value of mathematics, engineering basics and similar courses in respect to problem solving competence.

- Giving students the main responsibility in selecting employers for interviews and going through the entire application process also helps them practice clear communication and conflict management skills.

**QUALITY OF WORK**

The next three criteria all deal with the quality of „work“.

Students are very much aware that „work“ is the focus of their learning and contribution at the company. In the discussion it became clear that perception of what „work“ actually is varies widely within the cohort of students. This is due as well to personal traits as to prior work experience. One of the main overall effects of a well managed series of work terms within a degree program, enabling reflection and exchange among the students and with faculty, will be a certain synchronization of this perception and a much more clearer framework of what „work“ is about and which competences are needed to succeed.

The three issues selected are project management, work quality and team work. In the perception of the students these three criteria can be assigned to „organization“ (management), „technology“ (quality) and „communication“ (team). Together they give a clear picture of who they want to become within the first work term.

**Consequences for learning opportunities at the university:**

- Project Management should be taught and practiced very early and best be combined with challenging tasks that are dependent on good cooperation and innovative strategies developed in teams (this coincides very well with the top ranked criteria).
- Students should be given clear feedback on their key engineering skills during the courses so they enter the company with a realistic self image.
- There should be clear communication between university and companies concerning the work to be expected by students at this stage. It is crucial that assignments are tailored to course content and competencies gained at university. Close cooperation, any kind of written manual and involvement of staff are success factors at this stage.

**INDIVIDUAL ROLE AS A KNOWLEDGE BROKER**

The rest of the top ten criteria together give a very good characteristic of what a successful „cooperative“ education program can become for all stakeholders and which role a student can play. The following issues all describe the student as a valuable „external expert with internal knowledge“ to be included in problem solving and innovation in the company:

- Initiative and self motivation mean students want to find issues they are actively interested in and can make use of for advancing their learning and their position. These are typically issues only to be solved with a synthesis of in-company experience and university expertise.
- Accessing and applying specialized knowledge includes making use of the support and competencies of faculties, of research results and literature available at the university. In short: Students want to make the most out of their access to both worlds.
- Understanding complex systems always includes both stances: direct involvement to physically „understand“ technology and processes, and scientific and academic distancing to understand basic concepts and wider implication. The interpretation and analysis of data is one direct practical application of this more general situation.
• **Consequences for learning opportunities at the university:**

Students have to be supported in their role as „bridges“ and knowledge brokers. Any access to personal mentoring at the university and in the company facilitate involvement of the right university staff in innovation processes.

• Application of knowledge and interpretation of data have to be clear learning objectives in key engineering courses during the first year of study.

• Reflection of personal learning within work term reports and diaries should be used to highlight reflect specific issues of knowledge transfer.

• Additional activities of the participating faculty should be selected to provide support to students (f.e. innovation projects, applied research and development, guest lectures on critical issues within the industrial field of the degree program).

**CONCLUSION**

Students in their second semester of the coop program „Production Technology and Organization“ already have a clear perception of what „work integrated learning“ will mean for them during the upcoming first work term at the coop employer. By selecting from a list of criteria of professional competences students place highest emphasis on personality development, followed by work quality and their role as experts with a university background to generate new knowledge for their companies.

Translating these findings into curricular activities and organizational practices yields the following recommendations:

• Start early with course design and assignments that reflect and train key competencies needed for a good start in the company.

• Provide support and mentoring for students in their role as mediators between company and university. This should be an ongoing partnership starting with
the application process and following through until a final thesis or project.

- Constant personal and team reflection is a key to actual „integration“ of work and study and helps make the most not only of personal experiences but also of the variety of specific situation encountered by students of one cohort.

**SPECIFIC ELEMENTS IN THE CURRICULUM**

The following elements represent a long time evolution of dealing with the specific challenges of a degree programme in which companies play an important part in design and delivery and students experience a unique sequence of learning opportunities surpassing the respective environments of university and company. They should motivate readers to develop similar ideas to actually integrate work into education and vice versa.

- The completion of an engineering college at the secondary level makes **entry after the first semester** (in some cases after the first year - see Figure 26) possible. This enables faculty to concentrate on less experienced students during the first months of the programme.
- **“Engineering First”**[^4]: There is evidence from engineering programmes around the world, that creating a concrete vision of later responsibility and necessary skills enhances personal drive and reduces dropout rates. To project modules (mechanical engineering in the first, production management in the second semester) are included into the curriculum before the respective engineering science is delivered. Students learn to understand the discipline and key issues to be taught later on.

[^4]: Concept taken from the School of Engineering of Northwestern University in Evanston, Illinois
• Course “Work Term Supervision” in every semester to prepare for and reflect on the experiences at the companies. Elements of personal development are included into this course (e.g. successful application, presentation, communication, conflict management, leadership).

• Mechanical engineering and design projects from participating companies during the second year. The concept includes the following elements: A company visit at the start and/or for the presentation of the results; evaluation of performance through an actual assessment by the company (with the possibility of realization); some form of non-monetary remuneration for the students.

• Excursions to employers in all courses to highlight specific technologies and deepen the contact between all stakeholders. Experts usually give a lecture on a specific topic at the company, followed by practical demonstration.

• A large number of guest lectures from graduates of the programme. Graduates have proven to be key actors in the evolution of the programme. After three to five years they become the most active and successful advocates of a partnership with their employer. They also know exactly what type of knowledge is useful and how it has to be delivered in a CHWIE programme. Lectures are used by students to discuss possible employment or inquire on suggestions for career development.

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5 Personal information from colleagues at traditional US and Canadian CWIE universities
Cooperative and Work Integrated Education (CWIE) is a successful strategy to combine higher education and work. If university, students and employers agree on a strong partnership with clearly defined responsibilities and procedures, added value can be generated for all.

Experience at FH JOANNEUM has shown that attention has to be given to all elements of a degree programme to make the most of this partnership. This needs support from the university to adapt teaching loads, deal with exceptions from attendance requirements and create new pedagogical and organizational elements.

The benefit for the university is the active role both students and employers are playing in programme design and delivery. The former taking responsibility for his individual path towards skills acquisition, graduation and entry into the labor market, the latter through delivery of competences better acquired directly through “real life” work and including himself into feedback and assessment procedures for students and degree programme.
Through this active role a number of key tasks for a university degree programme can be fulfilled with higher quality: continuous improvement of curriculum, providing work readiness for graduates, exploring opportunities for research and development.
CHAPTER 7

VIRTUAL INTERNSHIP GAME AND STUDENT PROJECTS IN LATVIA

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It is a challenging task for a student without any work experience to start his/her professional career. Students at university are just acquiring knowledge and skills needed in the particular industry, but working as a professional requires application of these knowledge and skills in the business environment. Participation in real projects and internship programs while a student is still at the university can facilitate the adaptation to the working life.

Nowadays, web-based and other virtual platforms are widely used not only in education, but also in organizing and implementing internship and student projects. The term “virtual internship” may have different meanings. Virtual internship can denote either working in a virtual team with remote team members or a computer-based virtual reality game simulating a real workspace in a particular profession.
The present article discusses the experience of using virtual tools for internship, as well as student project implementation in Latvia.

Typical project/internship implementation models with the application of virtual platforms are described. Case studies are presented considering the experience of the Latvian internship portal prakse.lv and the implementation of international innovation collaboration platform DEMOLA network activities in Latvia.

Keywords: Internship game, virtual platform, DEMOLA network.
Advancements in information and communication technologies (ICT) have changed working environment and habits in many professional fields, opening new opportunities for the students to gain professional experience. Nowadays, work in many professions is organized in virtual teams using web-based or intranet platforms. Currently, virtual platforms are also widely used in education. This makes it easier to establish a link between learning and working.

Different web tools and virtual platforms are now being widely used in organizing and implementing internship programs and student projects. A virtual platform can be also used to create a virtual reality game on internship as a web-based internship simulation. There are several advantages of such approach. For example, web-based internship simulations are good solutions that help gradually acquire professions characterized by very stressful working conditions, which impose a high level of responsibility, such as medicine [1, 2].

The aim of this chapter is to present the experience of using virtual tools for internship, as well as student project implementation in Latvia.

Several model applications of virtual platforms for the implementation of internships and student projects are reviewed. Case study on the experience of the Latvian internship portal prakse.lv and the implementation of the international innovation collaboration platform DEMOLA network activities in Latvia are presented.

**Virtual Platforms for Projects and Internship**

There are many examples of how web-based or intranet virtual platforms are used to support projects and internship course. Virtual platforms could be used for:

- Presenting/choosing and approving project/internship topics;
- Virtual teamwork within a project or internship course;
- Virtual simulation game.
Many Higher Education Institutions (HEIs) use virtual platforms for organizing student projects and internship.

Student Industrial Internship Web Portal (SIIWP) is developed and used at Technology University PETRONAS, Malaysia [3]. This portal by functionality is similar to the virtual learning environment used for a course. It covers the entire process of choosing the place for internship, registration, assignment of the supervisor, visit schedule, student logbook and final grading.

University of Girona (Spain) is using a web-based intranet portal for implementing Work Internship Placements (WIP) course [4]. At this portal, companies and institutions propose internship places. These are revised and approved by the HEI staff and then students can choose and fill in the application form for the internship placement. Both students and companies are provided with the opportunity for ranking preferences – students can choose several companies and companies can choose several students for one placement. Academic staff and administration have access to all data on internship assignments in their section of the portal.

Within the framework of the PRAXIS Project the portal has been developed - The European Centre for Excellence in the field of Project/Internship (PI) initiatives maximizing students’ chances to find a project course matching their needs (PRAXIS, 2011) [5].

Virtual internship is an opportunity to experience virtual teamwork in practice. Virtual internship is a kind of a virtual mobility. The EU defined benchmarks for international mobility promoted for students and academic staff in higher education, which must be reached by 2020 “…at least 20% of higher education graduates should have had a period of higher education-related study or training (including work placements) abroad „, [6]. Virtual mobility could be an option for reaching the stated goal. Virtual mobility is defined as “a set of ICT-supported activities that realise cross-border, collaborative experiences in a context of teaching and/or learning. These activities can take place in a fully ICT supported learning environment or as a complement to physical mobility (before, during and after).” [7]. The authors present the EU-VIP project on “Enterprise-University
Virtual Placements” (2009-2011), and distinguish two options for virtual internship:

1. fully virtual internship;
2. virtually supported internship.

The definition of the fully virtual internship (work placement) is adopted from the INTERN project (2000-2002): “A virtual work placement involves the use of an information and communication technology (ICT) supported environment, where students interact with each other and companies independent of time and space and across traditional geographical boundaries. In this environment, effective communications are created between students, faculty and company representatives, in order to carry out a specific and meaningful work-based activity that fits within the student’s compulsory educational curriculum”. In case of the second option, students use virtual tools just for getting support before or during their internship abroad. In both cases careful planning is important and the choice of appropriate technology tools, as well as combining virtual with face-to-face meetings, is recommended.

The Best Practice Manual [8] on Virtual Mobility presents more project case studies and recommendations on virtual internships (work placements).

Virtual teamwork is used within MUTW - Multinational Undergraduate Team Work Project [9, 10]. Teams of students from different countries working on a common software development project are created. The team members attend several meetings; there is also a virtual teamwork part. Online tools supporting the communication among team members are used. MUTW Project is a good example of how to combine real teamwork with the work in the virtual team.

In engineering and other areas, software packages are widely used for simulation and new product design. Computer-based simulation is used as an efficient learning tool, for example, within the courses on Electrical and Electronic Engineering [11, 12].

Computer simulations do not stand too far apart from the virtual reality and Games and Professional Simulations. A special web tool MACROSIM or Massively Adaptive Complex Realistic
Online Simulation with Interactive Mentoring proposed another definition of the virtual internships [13]:

“Virtual internships are web-based simulations that help students learn to think like scientists, scholars, artists, and workers in the real world do. They simulate not only the content that students are supposed to learn but also the ways of thinking—the epistemologies—that some groups of people use to solve problems.”

For introducing students into the engineering profession at the University of Wisconsin, Madison has developed Nephrotex, a virtual simulation game of authentic engineering practice [14]. This game develops an epistemic frame of the engineering profession and promotes students’ understanding and interest in the profession.

**Latvian Internship Portal Prakse.lv**

The following section presents a case study from Latvia, where a web portal is used to enable young people to find a place for internship and also experience virtual game as an option for internship.

NGO “Jauniešu konsultācijas” (JK) was established in 2003 by students and recent university graduates. Right now JK has 20 members (individual persons), who are HR experts in the leading Latvian companies or run their own HR consultancies. The main aim of JK is to educate and train Latvian young people to be successful and competent in the national and global labour market, to help young people find their passion in life and show them the opportunities how to develop and use their talent on their way to successful career. The main target groups for JK activities are students and pupils from the institutions of secondary education.

JK is running the portal Prakse.lv in Latvian [15]. Direct translation of the term “prakse” into English is “practice”. The main aim of Prakse.lv is to ensure fast and effective communication between young people, employers and educational institutions. The portal is operational since February, 2008, and has become an adviser for young people in Latvia searching for internship, education and future employment. Since
opening, more than 65,000 young people, 2,800 enterprises, 250 NGOs and 1,000 educational institutions have registered as portal users and numbers are increasing day by day. Every day around 3,000 users visit the portal.

Virtual platform project “Virtual Practice” is a further development of the portal. The main idea of the project is to support mobility of young people to other EU countries using interactive platform for virtual internship. This platform enables user to find practical placement or internships. It also provides an opportunity for the users to test and train their professional skills in virtual work situations predefined by employers.

Virtual platform was launched in August 2013 as a portal in Latvian [16] and JK launched an international version of the platform called Practican [17] in August 2014 and make it available for every EU citizen.

The mission of the virtual platform is to help young people build their career more successfully and faster integrate into the labour market, increase employment rates, educate new talents for employers and society in general.

The project aims to create the database with work episodes from real companies, considering which young people and adults will be able to find the most suitable company for internship or work, as well as to learn and improve their skills. The platform must become recognized worldwide; it is envisioned as a turning point in the development of the labour market-oriented educational system.

Virtual practice is like a game consisting of work episodes from several professions offered by employers. A user can search episodes by enterprises, industries or professions. Right now more than 230 employers (enterprises, NGOs, public entities) are involved in the development of the virtual platform and offer virtual internship. Each episode includes:

- A photo featuring enterprise environment;
- Introductory part of the question;
- An open question related to the context;
- A multiple-choice question with four possible answers;
• After answering the question, the correct answer is presented in a video or text paragraph. All portal users are ranked according to the number of correct answers given and the difficulty level of the question. It is an important feature of this portal. Playing virtual practice games of different levels of difficulty can increase user’s ranking.

Young people can use the platform registering in the portal or logging in using their Facebook, Twitter or LinkedIn account. The portal offers registered users an option to create their CV containing basic data.

The virtual platform will contain all elements needed for effective learning using new approaches such as immersive learning and game-based learning [18]. The Virtual Practice Project will focus mainly on bottleneck vacancies in the EU in such fields as Engineering, ICT, Health Care, Finances and Sales [19], however, the participation of other professions in the project is not limited.

**International DEMOLA Network Activities in Latvia**

According to the data from PRAXIS project, database, students want to work in teams for a longer time period (several months). Students select project/internship by the topic or subject as the most important selection criteria. The analysis also confirms that students during their studies want to solve real life problems connected with their study field and DEMOLA project is a perfect solution [20].

DEMOLA is an open innovation platform and a university-business collaboration model for the development of new products and services. Student teams work to solve challenges handed to them by companies and other organizations. The projects lead to ‘demos’ and prototypes, the majority of which are bought by the companies and organizations via a licensing system devised for the DEMOLA framework.
The DEMOLA platform was first established in Tampere (Finland) in 2008, and since then has spread to other cities and countries. Currently there are eight DEMOLA centres in 6 countries and one centre is located in Riga, Latvia (DEMOLA Latvia, 2014). The platform aims to boost a multidisciplinary, agile innovation culture and encourage entrepreneurship. The project topics cover business concepts, information technologies, design and art, education, engineering, environment, governance, healthcare, media and communications and social science, so everyone can find the best challenge for him.

The DEMOLA project cycle can be divided into three stages:

1. The company publishes a real-life problem (a “challenge”) on the web page.

2. The project is commenced and the student team starts working for 3 - 4 months going through DEMOLA milestones and co-creation.

3. If the company is satisfied with the result, it can license shared rights for the end result or purchase all rights on the project results.

The project ideas or challenges come from the industry and other organizations, thus ensuring that the products, services and concepts developed have practical business importance. The students’ work is supported by both industrial and academic partners, whose role is to provide guidance to the student team throughout the project. DEMOLA as a neutral platform provides the workspaces for team work and co-creation with simple tools.

The end result is often different from the initial expectations and priorities may change in the course of work. Unexpected end results are a regular outcome of the open innovation process. The companies’ original idea is tested in an environment that differs from the companies’ R&D department.

The DEMOLA platform is based on teams formed by students from academic institutions. The selection of the student teams takes place on the basis of the students’ own motivation. Students are encouraged to find a problem from the list of the available projects on the webpage [21] and apply for the project. Often being multidisciplinary, the teams are formed on the basis
of the students’ common interests, knowledge and skills. Working in team, students acquire valuable skills for working life and learn cross-discipline collaboration (e.g. a technology student cooperates with a media student). Working on real projects raises motivation of the students and improves their employment opportunities.

Since 2008 DEMOLA Network has developed significantly and now unites 27 partner universities, cooperates with 150 companies, has involved 500 students, who participated in 308 projects. It gathered approximately 1 million EUR in licensing fees for students.

Latvia joined DEMOLA Network at the beginning of 2014 and has already contributed for all Network indicators with 7 projects, 12 academic partners, 6 organizations (5 companies and 1 state agency) and 28 students. Riga Technical University (RTU) successfully started its collaboration with DEMOLA Latvia. Students from RTU are involved in 6 project teams representing a skill set starting from business management to engineering and IT. For example, one of the projects is searching for new applications of CaptureIn, a unique technology for smart phone assisted complete password replacement [22].

DEMOLA platform acts as the connecting hub between the companies and the educational institutions. The cooperation taking place within DEMOLA project is seen to some extent to have contributed to an increase in trust between the business community, the academia and our future students.
ICT technologies are opening new opportunities in the implementation of the projects and internships at higher education institutions.

Three options in using ICT could be distinguished: 1) tools for presenting project and internship topics/places and managing internship implementation, 2) tools for support of virtual teamwork, 3) tools for computer simulation and virtual reality.

Web and intranet tools are used for presenting internship places and project topics offered by academic staff and companies, as well as for managing and approval of student choices and the entire process of internship/project implementation. In most cases, web pages or portals (DEMOLA) and Learning Management Systems are used for this purpose, but specially designated portals (SIIWP, WIP) may also be developed.

Common ICT tools are used for supporting virtual teamwork within a project or internship. Alternatively, a special virtual simulation game for internship and appropriate software tools (for example, MACROSIM) can be developed. It should be
admitted that the term “virtual internship” (or work placement) can represent at least two notions: 1) working in a virtual team with remote team members, 2) computer-based virtual reality game simulating real workspace in a particular profession. INTERN, EU-VIP and MUTW projects use the term to denote virtual teamwork, while Nephrotex and Virtualaprakse.lv offer virtual reality games.

DEMOLA project popularity grows as virtual environment used well fits to student needs and choices - to select the project topic they are interested in, work in multidisciplinary team for several months and, as a result, solve a real life problem related to their study field.
References


CHAPTER 8

“BANAT” AUTONOMOUS ROBOT-A MULTIDISCIPLINARY PROJECT

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Since 2012, a Romanian team participated to an international contest, called “Field Robot Event”, for agricultural autonomous robots, with the objective - to test new technologies for precision agriculture in real environment. This contest offers young researchers and students, the opportunity to invent, develop, to integrate and to compete with participants from countries worldwide.

The team was formed of teachers and students from University of Agricultural Sciences and Veterinarian Medicine (USAMV) from Timisoara and Politehnica University Timisoara (UPT), faculty of Mechanics and faculty of Automation and Computers.

A lot of companies were supporting the team financially and with materials, making possible building the robot and participating to this competition.
The project shown how students of different specialties can cooperate in a successful project, managed by their professors, how a lot of companies in the agricultural field encouraged the team supporting them, how local and central media (press, TV, radio) described the efforts and results of participants.

„Field robot Event” contest was launched in 2003 by Wageningen University - Holland, in order to gather young researchers in the field of agricultural autonomous robots. This facilitates the exchange of technical information between all stakeholders (students, teachers, tutors, researchers, farmers, agricultural organizations). Moreover, this contest aims to support development of devices and equipment in precision agriculture.

Romanian team called “Banat” -that is the name of historical region, started to participate in 2012 at the initiative of a Agricultural Foundation - CLASS, a leading producer of machinery in this field.

The Field Robot Event

The Field Robot Event (FRE) contest runs simultaneously with top world exhibitions or is organized by universities with agriculture tradition.

-2012 edition [1] was organized together with Decade „Floriade 2012” World Horticultural Expo - Venlo, Holland, 1.8 million flowers, 5000 roses and 3000 trees were displayed at that exhibition.

The participants came from Iran (2 teams), The Netherlands (2 teams), Slovenia, Germany (7 teams), Czech Republic, Denmark (4 teams), Turkey, Finland, Romania.
Logo of FRE in Venlo, Netherlands, 2012

-2013 edition [2], [3], was organized by Czech University of Life Sciences in Prague, Engineering Faculty, Mechanization Department, endorsed by Czech Ministry of Agriculture.

Logo of FRE in Prague, Czech Republic, 2013

-2014 edition [4],[5], was organized by University of Hohenheim together with „DLG - Feldtage 2014” exhibition, within International Crop Production Center (IPZ) in Bernburg - Strenzfeld (Saxony - Anhalt, Germany), the greatest open-air european exhibition gathering 360 companies of plant growing, fertilizers, plant protection, agricultural machinery.
The Objective and Tasks of contest

The objective of contest is to build an autonomous mobile robot that has to perform some tasks without the human intervention. For every edition there were common tasks and specific tasks.

The common tasks for all edition of contest were:
- follow the path between regular rows of plant of different types (flower in pots, corn)
- follow the path between rows with irregularities or obstacles
- free style task - original idea for every team

The specific tasks, for last three editions were:
- recognize a mark between rows and go towards it
- recognize a different plant among all and give a beep signal
- recognize a coloured golf ball and record its position by GPS

The multidisciplinary Team

In order to build a robot to fulfil the contest tasks, a multidisciplinary team was formed, based on the initiative of agronomy professor. A mechanical group and an automation group were added. Three professors had managed the team, formed initially of 4 students.
• an agronomy student took care of plantation where to test the robot and was the technical reference for agricultural specifications (types of plants, soil, sizes, etc),

• a mechanical student that made the mechanical project of robot according to agricultural specifications, and also decided the type of motors,

• two automation students connected the motors to a microcontroller board, added two ultrasonic sensors, designed the algorithm to control the robot and wrote the software.

Eventually, the robot was tested to fulfil all the tasks. Some changes were made and the robot was ready for its first try. Even all these activities were performed in short time, about one ad a half month, the first participation of “Banat” team was a real success, it ranked 5\textsuperscript{th} out of 20 participants.

For next editions, based on the experience, the algorithm was refined, same students were involved on the team, but the result in 2013 was poorer, “Banat” was ranked 10\textsuperscript{th} out of 20. In 2014 the team was changed, one automation student was replaced by another four, so five students worked on control. The automation part of robot was dramatically changed. Unfortunately, due to technical problems, in 2014 the team was ranked also 10\textsuperscript{th} out of 20.

For all editions, it was good experience for all members, as they had to communicate scientifically. The students were acquainted to different scientific languages, they had to exchange information, to clarify things, and finally, to make a robot to work.
Team in Venlo, The Netherlands

Member of team in Venlo, The Netherlands

Team in Prague, Czech Republic
The structure of “Banat” Robot

In order to fulfil all the tasks, the robot was built with a very robust structure.

The wheels have several replaceable tyres that are suitable for different types of soil and humidity.

The electrical motors have to provide enough power and torque to move a rather heavy chassis. For this purpose, the wheels are tied with chains on every side, actuating like tanks.

The control part has a microcontroller that gathers data from two ultrasonic rotating sensors that sense the obstacles and plant rows. According to these information, and following a control algorithm, the controller provide the signals towards motors to establish a certain path for robot.

In 2013 the original motors were replaced with two more powerful motors. In 2014, the structure was changed, the microcontroller was replaced with two more powerful processors and also the number of sensors was increased from 2 to 7.
First version of robot

Robot with camera for coloured ball recognition

Robot in field in Bernburg, Germany

Participation in Romanian Exhibitions

In order to promote the robot and to obtain more funds from sponsorship, and also to promote the actual sponsors, the team participated with robot at three local exhibitions. The robot was a real attraction, the goal was achieved, some
sponsors were convinced to help the team. Moreover, many farmers understood what automation can do in their farms, and even intended to purchase some autonomous robots.

For students was another gain, they had to present the robot, to explain details, technical and management, interacted with visitors.

The Sponsors that supported the team

The material support for romanian team “Banat” was provided only by sponsors.

It consisted of:

- financial support for materials to build the robot
- financial support for accommodation and transport
- advertising materials

The sponsors of our team were great european producers of agricultural tools and machinery as: John Deere - USA, CLAAS - Germany, CLAAS Foundation- Germany [6], Westfalia Surge - Germany, Fendt - Germany, Maschio Gaspardo - Italy, Case - USA,
Massey Ferguson - USA, Manithou - France, and also their distributors in Romania, as: Agrocomert Holding, IPSO Agricultura, Titan Machinery, Vest Tract, Tehnodisel, DLG InterMarketing.

First year project in 2012 was supported entirely by Claas Foundation. Anyway, the first participation of “Banat” team was Claas Foundation initiative. In following two years, due to personal and university contacts, and after a rather successful entrance into the contest family, a lot of companies agreed to support the team for next editions. It was an effort of mr. Prof. Bungescu from University of Agricultural Sciences who had a lot of meetings with all kind of representatives of big companies in order to obtain their support.

All the sponsors provided also advertising materials, like t-shirts, caps, banners, stickers, that were displayed during contest.

The Media presenting “Banat” Team

The results of romanian team were presented in national and international media for every edition of contest. The members of team were invited and interviewed at journals, radio and TV:

- Newsletter 1.12 of“Claas Stiftung” in 2013 contains the performance of Romanian team in the article: “Robots at the war of roses” - “CLAAS Foundation sponsors Romanian Team for the Field Robot Event”;
- In “Agroinfo” blog it was inserted a Reportage performed by “Ferma” (The Farm) magazine (posted also on YouTube) - “Banat - 5th on robot contest” [7]
- In “Agroinfo” blog was inserted a reportage performed by “Ferma” (The Farm) magazine (posted also on YouTube) - “Technical News at Agriplanta - RomAgrotec 2014” (Romanian Agricultural Exhibition) [8]
Newsletter of Claas Stiftung, 2012

- Radio Romania Timisoara, 6 interviews, 2 for each edition of “Field Robot Event”;
  - Romanian Television - local station Timisoara (TVR Timisoara), 30 minute within “Viata la Tara” (Village Life) TV show - 2014;
- Article in Journal “Fermierului” (Farmer’s) - “Banat Robot - achieved 10th place in Field Robot Event” - 2014;
The students’ competences gained in robot contest activities

Professional knowledge:
- every student developed his personal professional knowledge by building its part of robot, following the product development process, fulfilling all the phases of it, working with real applications,
- every student developed also cross professional knowledge, due to all information from other domain (agricultural, mechanical, automation) he had to use in his own part.

Skills:
- communication- the students learned how to communicate with students from other domain, in order to transmit and receive relevant information. It was a great challenge, but eventually they succeeded. Also, they had to communicate with
Project Work and Internship Improving the Cooperation between Employers and Universities

professor in informal environment, with other competitors in contest, with visitors in exhibition, with sponsors, with media,

- team work
- language (especially English)
- project management - they learned how to organize activity, obtain funds, logistic, time planning, task planning,
- correct evaluation of environment, opportunities and possibilities - they learned that they have to have competences to solve a problem, and instinctual and approximate solutions are not leading to success.
- Initiative, problem solving, proactive attitude.
“Banat” was and still is a long-term successful project that integrates three different groups of students, together with their professors, in order to achieve an objective: an autonomous robot that competes with other robots. The effort was not only technical, but also of communication, because of the cultural differences between groups. The management of project was performed efficiently by the professors of three faculties. An important role in activity of team was the support of sponsors and media that were near the members. There were some drawbacks encountered, but they are identified and hopefully will be overcome.
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CHAPTER 9

ENHANCING ENGINEERING EDUCATION THROUGH ACADEMIA INDUSTRY COOPERATION AT THE MASTER’S DEGREE LEVEL

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Electrical Engineering Education at the Master’s Degree Level is presented through three perspectives of collaborative projects involving industry and academia. The presented perspectives originate from three Portuguese Higher Education Institutions representing the University, Military Academy and Polytechnic School viewpoints. The described collaborative projects share the aim of enhancing the learning experience of students and the creation and dissemination of applied engineering knowledge, contributing for the generation of high value in industry and institutions, while pursuing the qualification of individuals with a high level of scientific, technical and cultural education. This cooperation between academia and industry produces interesting outcomes, bringing effective improvements into electrical engineering education, particularly at the master’s degree level. Throughout the presented projects, an increasing student motivation was observed, driven by the practical experience provided through the industrial sector approach. This cooperation also generates opportunities to develop new perspectives and
ideas for follow-on projects as well as innovative academic publications. The three degree programs objectives, competences, structure and organization, follow the Portuguese Law, the main principles of the Bologna Process and are in accordance with the Tuning project’s recommendations. However, given the different historical backgrounds, engineering education cultures and specific missions and objectives, three different master profiles are established, which are described in this chapter.
Modern societies require fast and effective development of the different areas of our life especially and moreover the technological ones. The collaboration between academia and industry produces interesting outcomes, bringing effective improvements into electrical engineering education, particularly at the Master’s Degree Level [1], [2].

The academia-industry cooperation provides significant opportunities to both parties, especially if cooperation is on a local, regional and/or national scale [3]. Previous studies describe some of the expected benefits from the collaboration between academia and industry, as follows: to access industrial funding, collaboration with industry is a strategic institutional policy, to find an exploitation outlet for research capabilities, to access complementary expertise, to provide an outlet for research results, to access state-of-the-art equipment and facilities, to contribute to local economy, government policy and/or political pressure and to contribute to national economy [4].

Nevertheless, some pragmatic issues and difficulties can arise related to the differences between the educational and industrial environments. These problems can be an obstacle to academia-industry cooperation, particularly in exchanging knowledge and relevant information between institutions. The most important questions can be summarized as follows: from the industry viewpoint there is a deficit of technology at educational institutions, the industry is more interested in practical services, educational institutions predominantly highlight theory, counselling firms are more valuable than specialized lectures and researchers, and there is a lack of proper communication involving academia and industry [3], [5].

The continued globalisation of manufacturing and service delivery has led to a concomitant globalization of the engineering profession. Engineers are increasingly engaged in international projects, including service in multinational teams at different points around the globe, collaborating in a real-time common project using electronic communication. Effective collaboration requires not only the ability of participants to communicate in a common language, but also the assurance of a common level of
technical understanding. Such issues are not trivial, given the
global diversity of systems for educating engineers, for different
goals and skills and for the quality control of their education.

One way to meet new challenges is to incentivise the
students to prepare their dissertations and projects in the
industry or to get an internship. It contributes to the
improvement of engineering education at large scale. From the
engineering perspective, the dissertations in an industrial
environment or the internships are vital in order to integrate the
students in the modern and international engineering world,
namely if the internship is abroad [6], [7].

An interesting internship is a new, very good and exciting
experience for students. Mostly everyone has more responsibility
during their internship than they expected and has more work
than predicted. After an internship all the students reflect the
positive aspects of this experience: the diversity of work that
they have done; the first contact with the professional life; a
creative opportunity.

During an internship from the first day, the students will
be totally immersed in their work as they will develop their skills
in a known company. Generally, there are also lots of
opportunities to run their own challenging and rewarding
projects. The students can learn from some of the most
experienced people in the business to develop their flair and
knowledge in an innovative culture and develop a network of
like-minded interns and professionals. These approaches
facilitate and encourage learning as well as social interaction,
reinforcing the understanding of previously studied subjects.

As a result of these collaborations effective
improvements to the Engineering Education are expected:
understanding how to address social needs by facing actual
industrial problems, increased motivation of the students given
by the applicative approach typical of the industrial sector,
achieving higher standards of analysis by using state-of-the-art
industrial technologies, obtaining financial support through
contracts with outside stakeholders, active business involvement
of the university staff, academic publications or novel insights
and ideas for follow-on projects, opportunities to enhance career
paths and improve employability [8].
In this chapter Electrical Engineering Education at the Master’s Degree Level is presented through three perspectives of collaborative projects involving industry and academia. The presented perspectives originate from three Portuguese Higher Education Institutions representing the University, Military Academy and Polytechnic School viewpoints. The described collaborative projects share the aim of enhancing the learning experience of students and the creation and dissemination of applied engineering knowledge, contributing for the generation of high value in industry and institutions, while pursuing the qualification of individuals with a high level of scientific, technical and cultural education.

The three degree programs objectives, competences, structure and organization, follow the Portuguese Law, the main principles of the Bologna Process and the recommendations from national and international professional organizations. However, given the different historical backgrounds, engineering education cultures and specific missions and objectives, three different Master profiles are established, which are described in this chapter.

Higher Education System in Portugal

From the late 1970s Portugal has a binary Higher Education (HE) system, with Universities and Polytechnics. In March 2006 the government published the long awaited law reforming the Portuguese HE degree system in accordance with the Bologna process, introducing namely the ECTS crediting system. The new three-cycle degree system is [9]:

1. Licenciatura of a duration of 3 years of full-time study (180 ECTS), offered both by Universities and Polytechnics;
2. Mestrado (M.Sc.), of a 2 year duration (120 ECTS), of which at least 35% (42 ECTS) are dedicated to work on a dissertation/project/internship. The Mestrado can be conferred both by Universities and Polytechnics, subject to the requirement that the institutions are engaged in R&D activities in the area of speciality.
3. Doutoramento (Ph.D.), of which the first year can consist of course modules. The Doutoramento can only be conferred by Universities, subject to the requirement that the institutions
have a consistent and high-quality R&D track-record in the area of speciality.

The law allows also Universities, not Polytechnics, to offer Integrated Master programs of 300 ECTS, in areas where, according to EU rules or to established tradition in the EU, access to a profession requires such a length of studies. That is the case in Medicine, Architecture and in the more traditional Engineering areas [9].

**Faculty of Engineering, University of Porto**

The Faculty of Engineering of the University of Porto (FEUP) offers an Integrated Master in Electrical and Computer Engineering (MIEEC) that lasts five years (300 ETCS) and is organized in three major specialization areas: Automation, Energy and Telecommunications, Computers and Electronics. After the completion of the first three years of the course (180 ECTS) a diploma in Electrical and Computer Engineering Sciences will be awarded. The branches of specialization all have the same 252 ECTS syllabus covering compulsory curricular units, a dissertation with 30 ECTS and 48 ECTS distributed by elective curricular units. In each semester to all curricular units totalize 30 ECTS. Each ECTS corresponds, on average, to 27 hours of overall student work.

The dissertation and/or the internship were introduced at FEUP with the Bologna reform in 2006. At FEUP the students are very motivated for dissertation developed in an industrial environment or internship work. The students work very hard during this period. A significant problem is to get enough projects in industrial environment or internships for all the students (approximately 500 students).

Although the MIEEC course is not legally obligated to contemplate internships in professional environment there is the possibility of conducting dissertations in enterprise environment. In these is circumstances, there should be protocols that indicate objectives of the partnership, define the responsibilities of the parties, the circumstances in which the necessary resources are made available and the level of participation and accountability in the specific work supporting the scientific and technical
guidance of the student. The participation of students in scientific and industrial activities is mainly promoted in the dissertation work. Therefore, students have the opportunity to develop applied research, with academic and industrial gains.

In projects in the industrial environment or in an internship, there are two supervisors, one from the Faculty and another one from the industrial partner. The internship abroad is an opportunity to the promotion of EU-wide mobility of engineers in accordance with the Directive 2005/36/EC on the recognition of professional qualifications [10].

At FEUP, around 40% of dissertations/internships are undertaken in companies and within mobility programmes, around 4%, mainly within the ERASMUS Programme. With the internships students can also gain practical experience, foreign language skills and cross-cultural competences if the internship takes place abroad. One of the difficulties associated with internships is that the number of grants available is very limited. The students understand that many doors are open on account of an internship; this is the reason why internships have a great demand. This facilitates and encourages learning as well as social interaction.

During the completion of the dissertation the student has to prepare a webpage for the dissertation that must include: student CV, student motivation for that dissertation/internship, bibliography, main objectives of the dissertation/internship, work planning, weekly reports about the work done and dissertation structure. The dissertation/internship webpage is periodically checked by the supervisor to monitor the work that the student is carrying out.

When the dissertation/internship is completed, the student introduces the written document in the webpage. The quality of the webpage will be considered in the final assessment of this subject. Typically, the duration of the dissertation is 15 weeks (from March to June) and the workload is equivalent to 30 ECTS [11]. When the internship is finished, the student has to complete the writing of the dissertation. About three/four weeks after the thesis submission there is a public discussion of the dissertation (oral exam) in front of a jury with three professors (two professors from FEUP and a third one from a different
University) and a professional from the industry that has oriented the student during the internship in the company.

For the evaluation of the dissertation/internship the jury takes the following valuation factors into account:

Table 7: Jury's valuation factors

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall assessment of the work</td>
<td>Presentation of the work and outcomes</td>
</tr>
<tr>
<td>Autonomy of the student</td>
<td>Organisation and the content of the presentation</td>
</tr>
<tr>
<td>Difficulty of the proposed work</td>
<td>Professionalism and posture</td>
</tr>
<tr>
<td>Depth of the work done</td>
<td>Thesis Discussion</td>
</tr>
<tr>
<td>Relevance/impact in the institution of the obtained results</td>
<td>Degree of security and confidence in the given answer</td>
</tr>
<tr>
<td>Quality work and produced volume</td>
<td>Demonstrated level of expertise</td>
</tr>
<tr>
<td>Integration in working groups</td>
<td></td>
</tr>
</tbody>
</table>

The oral exam has a duration of 45 minutes. The student has 15 minutes to present his/her work (generally a PowerPoint presentation is prepared by students). Afterwards the external professor has 15 minutes to inquire the student and the student has the same time to answer the questions. At the end of the oral exam, the student gets a final assessment for the dissertation/internship in a scale of 0-20 values (being 10 the minimum grade for approval).

The final assessment of the master is a weighted average of the assessments obtained in each subject weighed by the course ECTS. As the dissertation/internship subject has 30 ECTS, for the final Master’s classification, this classification is very important.

Two examples of projects developed in collaboration with an industrial partner in 2013/2014 scholar year are presented. The first one, entitled “Energy efficiency measures in public lighting networks” was developed in collaboration with a village municipality and a factory of lighting equipment. The main
The objective of this project was the study of an efficient public lighting network to a village in Azores [12]. The financial savings from efficient public lighting are based on the underlying technology and the related reduction of energy used and maintenance costs, when compared to older public lighting models.

Figure 27: Replacement of lighting equipment

The second example project entitled “Test and commissioning of a synchronous generator in Baixo Sabor” was developed in industrial environment. The objective of this project, realized with the collaboration of EDP (Portuguese Electricity Company), owner of the hydroelectric dam and the generators manufacturers (Andritz Hydro GmbH, Weiz, Austria) was to test the generators characteristics when they were being mounted. The methodology applied follows the approved Inspection Test Plan (ITP), the appropriate IEEE and IEC standards, as well as national regulations on the subject [13]. Measuring equipment and special tools were certified and surveyed by an independent laboratory.
The hydropower plant *Baixo Sabor* is located in the lower course of *Sabor* river a tributary of *Douro* river.

**Military Academy**

The mission of the Military Academy (*Academia Militar*, AM) states that it is a higher education military establishment that pursues teaching, research and community support activities, with the core objective of educating officers for the permanent staff and services of the Army and National Guard. The Military Academy has two campuses. The main campus is in Lisbon, where the Military Academy’s Command and support services are located, together with the facilities for students attending the various courses. The Detachment in *Amadora* is located in the outskirts of the city and it is here that almost all the curricular activities of the early years of the different courses are provided.

The Military Academy offers six years integrated master degrees, within the Bologna Framework, including the Military Electrical Engineering Master with two profiles: Telecommunications and a Computer Science specialization programmes. The first four years are completed in the Military Academy, being the first year dedicated to the acquisition of military skills, whereas in the last two years, the students (*cadetes*), complete their courses in *Instituto Superior Técnico* (IST), in the frame of a protocol between the two institutions. The Master thesis must focus on subjects with military application and is usually supervised by a professor from the Military Academy and a professor from IST.
About three/four weeks after the thesis submission there is a public discussion of the dissertation (oral exam) in front of a jury with three professors (two professors from IST and AM and a third one from a different University or Department or a specialist from the industry).

The oral exam has 60 minutes of duration. The student has 20 minutes to present his/her work (usually a PowerPoint presentation with a demonstration of the piece of equipment or prototype developed). Afterwards, the external examiner has 20 minutes to inquire the student and finally 10 minutes for each of the remaining members of the jury. At the end of the oral exam, the student gets a final assessment in a scale of 0-20 values.

Two examples of thesis developed in 2013 are presented. A new planar integrated antenna with a configurable radiation pattern beam, was developed, using genetic algorithms, to establish communication between the unit and an autonomous surveillance robot [14]. The antenna was designed, constructed and tested using the anechoic chamber at IST.

In another Master thesis [15], a crossed dipole antenna was also designed, constructed with a collaboration from EID, a high tech company involved in research for military applications, and tested afterwards. This antenna provides Near Vertical Incidence Skywave (NVIS) communication, in the High Frequency (HF) band, allowing communications in scenarios with rugged terrain and steep mountains as is the case in Kosovo and Afghanistan, with low cost and simple set-up procedures. The
radiation pattern for three frequencies of operation and the antenna configuration are presented in the following figures.

Figure 32: Vertical radiation diagram of the NVIS antenna

Figure 33: Configuration of the NVIS antenna

After the completion of the Master’s thesis, the students are sent to specialized headquarters “Escola Prática de Transmissões”, where they acquire hands-on experience with the different equipments used in military transmissions and software developments such as a Cisco certificate.

**Coimbra Institute of Engineering**

The Coimbra Institute of Engineering (IPC/ISEC) Master degree integrates the Automation, Energy Systems and Communication areas in a coherent framework, to create a study profile specially oriented to the present development needs of the industry and organizations. Two transversal Specialization Areas in the electrical engineering domain were established, sharing a partial common structure: “Energy and Automation Systems” and “Industrial Systems” [16].

The Master in Automation and Communications in Energy Systems is composed of a Specialization Course, which has a set of course units representing 55% (66 ECTS) of the total number of credits (120 ECTS), and an Industry Internship, or an original Project, that represents 45% (54 ECTS) of the total credits. It has a highly industry oriented profile, and an after-work schedule. It targets competences in the production, distribution and management of energy as well as in integrated automation and communication solutions in the industry and organizations. The following table shows the profiles and competences of the two specialization areas.
Table 8: Profiles and Competences of Specialization Areas

<table>
<thead>
<tr>
<th>Energy and Automation Systems</th>
<th>Industrial Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targets competences in the production, distribution and management of energy, allowing the analysis and intervention in electrical and renewable energy systems</td>
<td>Targets competences for integrated automation and communication solutions in the industry and organizations</td>
</tr>
<tr>
<td>Specialized courses on: Energy systems supervision and control</td>
<td>Specialized courses on: Robotic systems</td>
</tr>
<tr>
<td>Renewable energies</td>
<td>Industrial networks</td>
</tr>
<tr>
<td>Environmental management</td>
<td>Integration of industrial systems</td>
</tr>
<tr>
<td>Electrical vehicles</td>
<td>Mobility and wireless communications</td>
</tr>
<tr>
<td>Energy markets</td>
<td>Industrial computer vision and multimedia</td>
</tr>
</tbody>
</table>

The evaluation of the project/internship includes an informal distributed component resulting from the meetings between all involved persons. It also includes a progress report when planned and the public oral presentation and discussion of the project work or the internship report in the presence of a jury with three professors (two professors from IPC/ISEC and a third one from a different Polytechnic or University or a Specialist from the industry). This presentation is performed according to the master regulation document. The evaluation is defined by the jury considering at least the following aspects: quality of the technical and scientific contents, quality of the presented document, quality of the presentation and ability to discuss arguments and the contribution of the work to the company, school and society.

The oral exam has 90 minutes of duration. The student has 20 minutes to present his/her work (usually a PowerPoint or Prezi presentation). Afterwards, the external examiner has 40 minutes to inquire the student and finally there are 30 minutes for the remaining members of the jury. At the end of the oral exam, the student gets a final assessment in a scale of 0-20 values.
In five completed editions of the master (2008-2013), about 30 internships and 40 projects have been organized, involving close industry collaboration and successfully grabbing many applied research opportunities. Projects and internships included collaborations with very representative Portuguese and multinational companies such as Siemens, Refer Telecom and the Portuguese Electricity Company (EDP).

Two examples of projects developed in cooperation with the industry are first presented here. The first one, entitled “Identification of the Horizontal Network Interconnecting the Portuguese and Spanish Electrical Power Systems” [17] was developed in collaboration with the REN-Redes Energéticas Nacionais (Portuguese Transmission System Operator). In this project, a technique to identify the relevant neighbouring electric power systems using the Horizontal Network methodology, was proposed. The relevant network of the Spanish system was established, taking into account the actual interconnections and the new cross-border tie-line in Douro International with a voltage level of 400 kV.

The main purpose of the study was to identify the relevant Spanish electric power network due to the new cross-border interconnection between Portugal and Spain, since it is essential to understand how the National Transmission Grid will be affected. It is expected that this new tie-line will improve the security and the competitiveness of domestic energy supply.

Figure 34: Cross-border tie-lines between Portugal and Spain
Figure 35: Relevant external network of Portugal

The second example project entitled “Project and Implementation of a Linux-based Real-Time Embedded System”
aimed at studying and implementing emerging technologies associated with the development of embedded systems [18]. Its main objective was to design and develop an integrated solution that included several novel and useful features for real-time industrial automation applications. The presented project included all the necessary steps, from research and specification to the validation and simulation, passing through the design of electronic circuits, hardware design and software development.

Figure 36: Main Board
Figure 37: CPU Board

Figure 38: Developed Embedded System

Embedded Systems are electronic devices that include information processing and are usually developed for a specific application.

In addition to the industry collaboration projects just described, two examples of projects which were fully developed during industry internships are also presented. The first internship example took place in the company Refer Telecom, Serviços de Telecomunicações, S.A. which is a group company from REFER EPE (public company responsible for providing the public service of managing the national railway network infrastructure in Portugal). The title of the internship report was
“GSM-R Implementation in the National Rail Network - Pilot Project - Internship at Refer Telecom” [19]. The work intended to provide a description of all phases of the Pilot Project GSM-R implementation in Portugal, from the preparation of the technical elements for the public invitation to tender, through its field implementation, to the study and discussion of the main aspects related to the operation and maintenance of some tools required to support the GSM-R network and service.

Regarding the project itself, it is one of the most important rail telecommunication projects installed in Portugal in recent years, as it seeks to project the national railway for the future, with better communications in terms of quality, safety, reliability, interoperability and sustainability. It was therefore an important professional and personal experience, very enriching, and that opened a whole set of new perspectives for the future.

The second internship example took place at EDP Distribuição (EDP-D). The title of the internship report was “Analysis and a Proposal for the Revision of the SDH Technology Maintenance Procedures in the Automation and Telecontrol of the Electrical Grid - Internship at EDP Distribution” [20], [21]. This Internship Report presents the study carried out with the objective of knowing the architecture and technologies that support the EDP-D network. The National Electric System, EDP and the Telecommunication Systems used by EDP-D are presented, together with the technologies that support the Automation and Telecontrol of the Electric Grid, with special emphasis on the SDH technology. This study includes the role of the Telecommunications Systems on the supervision and operation of the electrical network. A set of field activities performed by the department where the Internship took place was also described. These activities provided a better and more applied knowledge of the network. Having a detailed knowledge of the network telecommunications systems, together with the identification of the criticality associated with the SDH equipment, and with the aim to extend its useful life without compromising the risk associated with its failure, a proposal for the revision of the maintenance plan for the SDH equipment was developed, and integrated in the EDP-D standardized Risk Matrix, which should serve as a basis for its policy for asset management.
The methodology developed for the SDH equipment can be extended to other telecommunications equipment.

The resultant risk matrices for each scenario are shown in the following figures.

**Figure 39: Resultant Risk Matrix for SDH equipment located next to SCADA Front-Ends**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business losses</td>
<td>High</td>
</tr>
<tr>
<td>Safety</td>
<td>High</td>
</tr>
<tr>
<td>Environment</td>
<td>High</td>
</tr>
<tr>
<td>Public and Population reaction</td>
<td>High</td>
</tr>
<tr>
<td>Economy</td>
<td>High</td>
</tr>
<tr>
<td>Impact Probability</td>
<td>Low</td>
</tr>
<tr>
<td>Recovery Time</td>
<td>High</td>
</tr>
<tr>
<td>Results</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Risk Level</td>
</tr>
<tr>
<td></td>
<td>Risk Category</td>
</tr>
</tbody>
</table>

**Figure 40: Resultant Risk Matrix for SDH equipment located in intermediate points of the network**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business losses</td>
<td>High</td>
</tr>
<tr>
<td>Safety</td>
<td>High</td>
</tr>
<tr>
<td>Environment</td>
<td>High</td>
</tr>
<tr>
<td>Public and Population reaction</td>
<td>High</td>
</tr>
<tr>
<td>Economy</td>
<td>High</td>
</tr>
<tr>
<td>Impact Probability</td>
<td>Low</td>
</tr>
<tr>
<td>Recovery Time</td>
<td>High</td>
</tr>
<tr>
<td>Results</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Risk Level</td>
</tr>
<tr>
<td></td>
<td>Risk Category</td>
</tr>
</tbody>
</table>

From these results it is possible to conclude that the risk level for both scenarios is moderate (although higher in the last one), which implies, according to EDP’s policy, that the risk level should be reduced or a contingency plan should exist in case of failure occurs.
Nowadays, projects in an industrial environment or internships are a reality and students are very motivated to engage on them. Projects, whenever possible, should be developed under a cooperation agreement with an industry partner or with an institution. On the other hand, the internships allow the students to be integrated in an industrial or company environment, where he/she will have the opportunity to apply the knowledge and techniques learned in the academic course, as well as to work in teams and to envisage a professional career.

The ability to design, fabricate and test, providing hands-on experience is very valued by the students and is the essential part of the engineering paradigm. The number of students asking for projects in an industrial environment or internships is growing every year. Most of the students are of the opinion that the internship is a good opportunity to get relevant experience and if possible go abroad, but it is difficult to get enough scholarships for all interested students.
After projects in an industrial environment or an internship, many students get a job in a company. Some interns find permanent, paid employment with the organisations where they served as interns. This can be also a significant benefit to the employer as experienced interns often need little or no training when they begin their regular employment. Unlike a trainee programme, however, employment at the completion of a dissertation or a project or an internship is not guaranteed.

In general, the internships/projects have proved very good quality, with an excellent acceptance by industry and having achieved very good ratings, many with juries integrating professors and outside experts.
References


18. Adriano Campos, “Projecto e construção de um sistema embebido de tempo real baseado em Linux”, Projecto do Mestrado em Automação e Comunicações em Sistemas de Energia, April 2012. (in Portuguese)


CHAPTER 10

UNIVERSITY-ENTERPRISE COOPERATION FOR KNOWLEDGE AND SKILLS REQUIREMENTS
SHARED DEFINITION

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The "INSPIRE phenomenon" in the evolution of GI (Geographic Information) and SDI (Spatial Data Infrastructure) requires expert skills in data management, data/metadata harmonisation, IT services, standardisation, and the INSPIRE compliancy understanding.

There are several INSPIRE focused EU projects with results that were utilized into eLearning training materials providing the themed knowledge. The current GI era suggests exploitation of this for a wider audience spread across national level.

This Chapter introduces findings of three EU projects - LINKVIT, Geographic Information Need to Know (GI-N2K), and eLeanor - where activities are also aimed to reach common definitions of knowledge and skills requirements for professions in the geospatial field in Europe.
Key INSPIRE Business Processes and potential Job Profiles are identified in the LINKVIT project, and Learning Paths needed to cover the required knowledge are defined. Vocational training needs for professionals of EU water industry and services in private and public sectors are also addressed by the eLeanor project, while in the GI-N2K project it is proposed to reach consensus at European level about what geospatial professionals in Europe should know (knowledge requirements) and be able to do (skills) by establishing a Body of Knowledge as agreed ontology on a specific professional domain.

The presented experiences are characterized by the university-industry cooperation as privileged way to anticipated labour market and competence needs and to foster people mobility promoting tools for competence certification and validation at EU level.
INSPIRE\textsuperscript{6} brings a revolution in Geographic Information (GI), both for public administration and GI stakeholders. The INSPIRE Directive establishes a conceptual/technical framework for distributed management and access to GI and for Spatial Data infrastructures (SDI) supporting environmental policies and the policies or activities with an impact on the environment.

INSPIRE developed Implementing Rules (IR) that are binding for the Member States, touching areas such as Metadata, Data Specifications, Network Services, Data and Service Sharing, and Monitoring and Reporting. INSPIRE has been adopted and is currently being implemented by the Member States, a process that will last several years (at least till 2020) with a strong impact on GI operators.

Specific skills are required: data management and harmonization, web services development, the application of international standards, as well as methods, procedures and tools for INSPIRE compliancy. These are key issues to be addressed in all the public and private organizations working with GI and its wide applications.

The INSPIRE State of Play states the need to train experts for INSPIRE and NSDI implementation: “The organization of a good INSPIRE eLearning offer at the European level by relevant European stakeholders and the exchange of experts among NSDI, should be envisaged” \cite{1}.

A number of European projects already achieved results for INSPIRE, exploiting them to produce eLearning training content to transfer the acquired knowledge and to support improvement of GI skills. It is the right time to exploit and rationalize this for a wider GI audience of new users, scattered at national level.

A wide audience of beneficiaries (target groups) is individuated:

primarily people already employed (e.g. in public administration, companies providing geo-based services) who need to be re-qualified to face the new competences required by INSPIRE; post-graduates willing to enter the GI labor market and needing a specific post-degree specialization in the field, also through university courses and Master programmes.

The presented experiences are in line with the Lisbon strategic priorities, since they intend to improve the quality and quantity of jobs throughout the positive impact of ICT, both as learning methodology and through the use of ICT skills in new and former jobs. Moreover, they anticipate the labor market and skills needs, in line with the EC Communication “New Skills for New Jobs” [2] and the priorities for the Copenhagen process, revised in the Bruges Communiqué of 2010 [3].

Leveraging INSPIRE knowledge into Vocational Innovative Training - The LINKVIT project

LINKVIT is a Leonardo da Vinci - Transfer of Innovation project built on the results of various GI & INSPIRE European initiatives that got (also) important training results, now exploited to transfer the achievements to support improved GI skills in a wider audience of national users, and the creation of knowledge to support INSPIRE implementation. Competences in geo-information are crucial in the new European context and the implementation of the INSPIRE Directive. LINKVIT aims at creating such competences through a set of training modules developed in different European initiatives.

The modules to transfer (streamlined to Learning Paths) are classified into:
• Context knowledge for INSPIRE
• Advanced technical Modules
• Modules addressed to stakeholders of Nature Conservation and Geology & Civil Protection, respectively
• Technological trends & innovative solutions

and are being reframed for a user oriented modular learning with positive impact on:
• Vocational training, for new basic skills about geo-spatial services or to update/upgrade skills of people already active in the GI field
• Curricular training, for post-graduates quickly operational vs. the needs of INSPIRE implementation
• Target groups are:
  o Employed people to be re-qualified on new competence required by INSPIRE,
  o Postgraduates, for easier access to the GI-labor market with a post-degree specialization,
  o and professional profiles within public and private sector (both technicians and decision makers)

LINKVIT is primarily contributing to rationalize and organize vocational training about GI & INSPIRE in public and private sector, also as regards an easy access to training standardized and validated at EU level. To this purpose, the available training material is being reframed into specific Learning Paths.

The definition of Learning Paths in the context of INSPIRE starts from the analysis of the INSPIRE implementation process and the different sub-processes that are part of it. In this chapter we first describe the major INSPIRE processes. Secondly we describe the job profiles related to them, i.e. the type of experts that should carry out activities in the context of these processes.
BUSINESS PROCESSES RELATED TO INSPIRE

A business process, sometimes also called a work process, is defined as the way in which organisations create products, services and policies [4]. It is a succession of interconnected activities that, starting from an identifiable input, result in a clearly defined output in the form of a product or service. Although a process can take place entirely within a single organisation, processes in which more than one organisation is involved are gaining in importance in contemporary society [5].

We can consider the INSPIRE implementation as a complex business process, spanning many organisations. INSPIRE implementation consists of a series of sub-processes that in their turn consist of a series of activities / tasks.

According to the INSPIRE Directive and related regulations, the following activities / tasks should be performed for each data set:

- Creation and maintenance of metadata;
- Data should be harmonized according to INSPIRE data specifications which might entail the re-engineering or transformation of spatial data sets and conformity testing activities;
- Establishing and operating network services, including the creation and maintenance of metadata for these services, as well as their conformity testing;
- Determining the conditions applying to access to, and use of the data, and, where applicable, corresponding fees;
- Monitoring the use of the data and related services.
These activities can be grouped into four main INSPIRE business processes:
1. BP1 - Managing and reporting INSPIRE implementation
2. BP2 - Transforming data and metadata
3. BP3 - Creating and managing access mechanisms (services)
4. BP4 - Access, bind and use of spatial data (through services)

Figure 41 provides a schematic overview of the INSPIRE implementation process and its sub-processes, in which the above described activities fit. Notice that the data production process itself is strictly speaking not part of INSPIRE implementation. Also notice that (conformity) testing and validation is part of BP2 and BP3, although it could be seen as a separate process. However, conformity testing is usually closely linked to the activities related to the spatial data transformation, the services that are set-up and the metadata for these data and services.

Figure 41: Schematic view of the INSPIRE implementation process


**JOB PROFILES RELATED TO INSPIRE**

The different activities to be performed in the context of the business processes require different types of expertise, knowledge and skills. We can distinguish four different job profiles corresponding to the different INSPIRE activities (Business processes).

1. INSPIRE Manager (BP1)
2. INSPIRE Data Expert (BP2)
3. INSPIRE Service Expert (BP3)
4. INSPIRE Service Consumer (BP4)

Each of those profiles could be split, e.g. in larger organisation, or merged, e.g. in the case of Small and Medium Enterprises with few personnel. The specific expertise, knowledge and skills required for each profile are defined (and hopefully acquired) in the corresponding Learning Path.

**LEARNING PATH DESCRIPTIONS**

A Learning Path is defined as the chosen route, taken by a learner consisting of a series of learning activities, which allows a learner to build knowledge and skills progressively [6]. With learning paths, the control of choice moves away from the tutor to the learner, although paths are usually designed by involving both the tutor and learner. In the context of the development of the Body of Knowledge for GIScience & Technology [7], learning paths were considered as one of the key applications supporting a diverse array of educational outcomes. Each outcome consists of several competency levels, as described in Marble’s pyramid model [8]. A learner may acquire the knowledge and skills needed to achieve a particular outcome by traversing the GIS&T Body of Knowledge, as well as supporting topics in allied domains, and synthesized in integrative experiences like internships and projects[7].

Learning Paths in the context of INSPIRE implementation are linked to the duties of the different types of experts and the activities that are part of the sub-processes of the INSPIRE implementation process. The learning paths should be built up
gradually. It means that experts can start with basic knowledge and skills and then go to the more advanced modules which usually include hands-on and/or real training.

In the next sub-section we describe an example of a basic learning path for a particular type of expert, the INSPIRE Manager. The numbers in the figures refer to the minimum number of hours required to build the basic knowledge and skills about the different topics and concepts covered. It is felt however, that for some specific sub-domains, more in depth-knowledge and more training hours might be required in order to master the subject in such a way, that the learner can apply the knowledge and skills in a total independent way.

EXAMPLE OF LEARNING PATH FOR INSPIRE MANAGERS

Managers should first master the general aspects of INSPIRE. An introductory seminar should be enough, followed by specific aspects on data policy (data & service sharing in the INSPIRE Directive). Also recent developments in INSPIRE (e.g. the integration of INSPIRE and e-Government) should be part of the knowledge base although this module could be followed eventually at a later stage. The expert should not have hands-on regarding the implementation of INSPIRE components, but should at least understand the search-find-bind mechanism and how geo-portals are used. Finally it is important that the INSPIRE manager has a good insight how INSPIRE can help to support different policy fields. In practice, also other policy fields might be covered. The Figure below provides the example of the policy related to biodiversity and nature conservation, describing a basic learning path consisting of 6 modules.
It should be stressed that the competences required for the job profiles need regular updates.

Indeed, INSPIRE is evolving over time: new legislation (Implementing Rules) will be implemented, technological solutions and standards will appear and this will be reflected in the evolving technical guideline documents. This should be reflected also in the training modules and in the learning paths at some stage.

**Towards a more demand-driven geospatial workforce education/training system**

The geospatial industry is a rapidly growing industry and involves high value/high tech jobs, innovative services and fast evolving technologies. Additionally, in the European context of the objectives of Europe 2020 (Capacity building), Horizon 2020, the Digital Agenda for Europe, Smart cities, the European Union Location Framework, Shared capacity building across Europe....it is clear that there is a need to prepare Europe’s GI S&T workforce competently to answer to the requirements of this rapidly evolving, innovative European knowledge society.

But, currently there is a mismatch identified between the geospatial sector and its workforce. This means that there is an inadequate supply of geospatial professionals and/or the geospatial workers appear to be inadequately prepared to answer to the challenges and opportunities of this field. Hence, there is
a clear need to make the geospatial workforce training system more demand-driven.

In order to set up a more demand-driven workforce educational program, there needs to be consensus about what geospatial professionals in Europe should know (knowledge requirements) and be able to do (skills). For the identification of the specific knowledge areas that professionals need to master for proficiency and success in their field or profession, there is a need to develop curricula in a more systematic way. Therefore it is proposed to use the methodology of the Body of Knowledge (BoK) which is basically the agreed ontology of a specific professional domain (reference framework), in this context applied to the GI Science and Technology (GI S&T). Moreover, the GI S&T sector is becoming broader and interwoven with other disciplines and knowledge areas. This is the reason for which we need a BoK to be able to cover and describe all the knowledge areas and skills to be convened. Many sectors have already developed or are currently developing their domain-specific BoK. The GIS&T BoK (2006) is designed for use by curriculum planners and evaluators, certification and accreditation bodies, current and prospective students, human resources personnel, and geospatial professionals in government, industry, and academia [7].

Currently however, there is no European BoK for GI S&T that is dynamic and up-to-date, easy to use, in-line with the constantly evolving technologies, and that takes into account the recent developments and needs of the public, private and academic geospatial sector in Europe.

The GI S&T BoK was developed by the University Consortium for Geographic Information Science (UCGIS) and has been published in 2006 by the Association of American Geographers. The GI S&T BoK includes ten knowledge areas, 73 units (26 of which are designated as “core” units), 329 topics, and over 1,600 formal educational objectives.

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7 Examples: the European BoK on Public Relations, the European BoK for Tourism, Civil Engineering Body of Knowledge, Software Engineering BoK, BOK for medical practice management, Interior Design Profession's Body of Knowledge, ...
The GI S&T BoK can serve as a basis for

- Curriculum planning e.g. identifying the needs of the profession, specifying job performance measures, determining educational objectives...
- Program accreditation: to attest the qualifications and effectiveness of educational/vocational institutions and programs.
- Program evaluation and assessment: to assess programs relative to educational objectives; moreover, students/employees can use the BoK to self-assess their mastery of the GI S&T domain and plan their professional development strategies.
- Curriculum revision: to support faculties in their strategic planning to make their curricula more representative of the evolving GI S&T field.
- Program articulation: institutions of the education infrastructure that use the BoK can easily execute articulation agreements ensuring that credits earned in one institution will be valid at another institution and hence facilitate the mobility and advancement of the GI S&T workforce.
- Professional certification: the BoK provides a basis to support the portfolio-based, competence-based and curriculum-based professional certification programs.
- Employee screening: the BoK can help recruiting and screening applicants for GI S&T positions by defining the knowledge and skills that well-educated professionals should possess.

The BoK needs a major review, it should be more dynamic, and it should integrate a European perspective. This is exactly the aim of the Erasmus Network “Geographic Information - Need to Know (GI-N2K)”, namely to make the geospatial workforce training system more demand-driven and flexible by producing an advanced European-authentic and dynamic GI S&T BoK.

GI-N2K aims to answer the question on how the education and vocational training in the domain of GI S&T can match with the actual job requirements in the job market.
The project analyses the current market demands with regard to the knowledge and skills and compare them with the current training offer in the GI S&T sector. The existing GI S&T Body of Knowledge is being used as a starting point, updated and brought in line with new technological developments, and with the European perspective in mind.

The renewed BoK will apply an ontological approach and will take the form of a dynamic e-platform (wiki-based format) including tools to use, explore the BoK, to define curricula, training opportunities and courses and to define job profiles, with related competence requirements.

**Assessment of training needs in the water sector**

In this section we refer in particular to the main outcomes of the Leonardo da Vinci Transfer of Innovation project “eLeanor - e-Learning and innovation in vocational training for water industries”.

The project aimed at improving the training for professionals of the EU water industry and services in private and public sectors through the optimisation and standardisation of the learning processes and learning paths, also with the help of e-learning facilities and transfer of Good Practices. Its main focus was on (reflecting the main demands of skills by EU Directives): waste water treatment, water supply and storm water management. Among the main outcomes there was the assessment of vocational training needs and curricula design.

In particular, within the assessment of vocational training needs, a mapping of competences in the water sector was performed, identifying the skills needed for each job profile in the framework of different business processes. The results are summarized in a matrix taking into account 52 job profiles and 29 business processes.

Validation of training needs by water industries was carried out in the first project phase to help the identification of the eLEANOR training subjects. The assessment of training needs was
useful to validate and further investigate existing training needs of water companies.

The vocational training needs assessment covered following steps:

- creation of a lists of Business Processes (BPs) and Job Profiles (JPs),
- validation of the lists by water professionals,
- assessment of a level of knowledge for each Job Profile,
- validation of the levels by water professionals,
- creation of a matrix mapping the training needs in relation with JPs and BPs

Here a Business Process (BP) is defined as a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers. A process is thus a specific ordering of work activities across time and place, with a beginning, an end, and clearly defined inputs and outputs: a structure for action.

A classification of urban water uses was done by identifying the existing water business processes and jobs profiles. A Job Profile (JP) is defined as the outline of the duties and tasks required of and performed by a person for a specific title/job.

Business processes and jobs profiles of the water industry can be related to each other by assessing the importance of each BP in every JP.

In order to reflect this relation, the matrix was filled in with a scale from 0 to 3, indicating:

- 0 [not important]: No specific knowledge requested about this BP
- 1 [intermediate]: Minimal knowledge of the BP (general overview about the BP), but the JP requires a shallow knowledge about this BP
- 2 [important]: Knowledge of the global BP and activity in parts of the BP
- 3 [very important]: In depth knowledge of the BP core activity of the JP and management of the BP
Figure 43: Matrix matching Business Processes and Job Profiles in the water sector

CURRICULA DEVELOPMENT

As mentioned above, 54 Job Profiles and 29 Business Processes were identified. Upon this analysis, Curricula were produced based on the Job Profiles description and on the Matrix with the level of knowledge. The Job Profile description provides information on the general requirements, on the required knowledge and expertise; it also describes the outlook of the daily work.

The figure below (Figure 44) shows the Curricula evolution. The first steps (Figure 44 - 1) led to a construction of an idea of the Curriculum design and its structure. Next steps (Figure 44 - 2) were aimed at creating the Curricula for the 54 Job Profiles in the unified, visually understandable design. The final steps (Figure 44 - 3) were dedicated for verifying and validation of the Final Curricula. Each version of the Curricula was verified and discussed among the industrial and academic partners.
Figure 44: Curricula evolution

1. Distribution Manager (could identify a Qualification)

Who can be a distribution manager?
- Civil engineer
- Industrial engineer
- Chemical engineer
- Mechanical engineer

Specialization in water industry required
- Rate estimation model
- Managing pumped system
- Water quality within networks
- Applied hydraulics for networks and simple projects
- Analysis and modeling of networks

Level of education
5 years of education + specialization (at work) = level 6 of EQF
3 years of education + 2 more years + specialization

2. Distribution Manager

Education Level and Requirements
- Basic education level: (3 years) or work experience
- Intermediate education level: (5 years) or work experience
- Higher education level: (6 years) or work experience

3. Distribution Manager

Education Level and Requirements
- Higher education level: (5 years) or work experience
- Intermediate education level: (4 years) or work experience
- Basic education level + work experience
Within the final Curricula, each Curriculum is structured into 5 sections (see Figure 45):

- Business Process: the information on the importance of the Business Process for the particular job,
- Background and requirements in the water sector: tied to the qualification,
- Education Level and Requirements: education level associated to the European Qualification Framework (EQF),
- Specialization needed in the water industry required,
- EU Water Legislation.

The Business Process (1) section covers a list of Business Processes which are sorted according to their importance assessed and validated by the water industries (part of the Matrix in Figure 41). Four colours were selected to define this categorization. Dark blue define the most important process and light blue the less important.

The Background and requirements in the water sector (2) section indicates the knowledge previously acquired, meaning the experience or studies by the job candidate (Background, in Blue) and indicates the knowledge to be acquired in the water sector for the job candidate to fill the role (To be acquired, in Red). This is expressed for a list of job candidates (Who can do this job?) proposed to carry out the job.

The section Education Level and Requirements (3) visualizes the education level in a figure, designed as a bar featuring 3 levels of specialization. It goes from light blue to dark blue. Each of the 3 colours indicates the grade of specialization of the job candidate required for the particular Job Profile. In case that the candidate has got just a basic level of education, the lower part of the rectangle bar will show the light blue square coloured. As long as the level of education increases the following rectangles are filled:

- Higher education level (MSc_2 years)
- Intermediate education level (BSc_3 years) or work experience
- Basic education level + experience (might jump to the next level: BSc or experience)

The European Qualifications Framework (EQF) acts as a translation device to make national qualifications more readable across Europe, promoting job candidates' and learners' mobility between countries and facilitating their lifelong learning.

The section “Specialization in water industry required” (4) describes the specialization required in the water industry, which will be tackled by the job and the worker. This section served as a base for the Learning Path development.

The EU Water Legislation (5) section shows the European Water Directives that are involved in this job profile and/or business process.

Figure 45: Final Curricula
**CONNECTION TO THE EUROPEAN QUALIFICATION FRAMEWORK**

The e-LEANOR curricula have been developed having in mind also the EQF system. As well known, the European Union establishes the European Qualifications Framework (EQF) for lifelong learning following the recommendations in the Parliament and the Council document 2008/C 111/01.

The EQF was chosen as a reference system in order to express the qualification level equalized across Europe. The connection to the EQF is done through the Education Level expressed in the Curricula.

Table 9: EQF Level Explanation

[http://ec.europa.eu/eqf/compare/eqf_en.htm#comparison]

<table>
<thead>
<tr>
<th>EQF 2</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic factual knowledge of a field of work or study</td>
<td>Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools</td>
<td>Work or study under supervision with some autonomy</td>
<td></td>
</tr>
</tbody>
</table>

| EQF 3 | Knowledge of facts, principles, processes and general concepts, in a field of work or study | A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information | Take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems |

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8 In the context of EQF, knowledge is described as theoretical and/or factual.

9 In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).

10 In the context of EQF, competence is described in terms of responsibility and autonomy.
<table>
<thead>
<tr>
<th>EQF 4</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factual and theoretical knowledge in broad contexts within a field of work or study</td>
<td>A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study</td>
<td>Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EQF 5</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge</td>
<td>A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems</td>
<td>Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EQF 6</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles</td>
<td>Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study</td>
<td>Manage complex technical or professional activities or projects, taking responsibility for decision making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups</td>
</tr>
</tbody>
</table>
The Figure 46 below provides the Education Level bar appearing in the eLEANOR Curricula, connected to the EQF levels 2, 3, 4, 5, 6, and 7.

According to the project findings from the training needs assessment and from the Curricula creation, within the water industry Job Profiles (in the scope of the project) there are 7 Job Profiles with the EQF Level 2, 3 Job Profiles with the EQF Level
3, 14 Job Profiles with the EQF Level 4, 1 Job Profile with the EQF Level 5, 24 Job Profiles with the EQF Level 6, and 5 Job Profiles with the EQF Level 7 (see table below).

Table 10: EQF Levels and the correspondent Job Profiles

<table>
<thead>
<tr>
<th>EQF Level</th>
<th>Job Profiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQF 7</td>
<td>Production manager, Distribution manager, Sewerage manager, Customer manager, Finance manager</td>
</tr>
<tr>
<td>EQF 6</td>
<td>HR Manager, Logistic manager, Commercial Manager, Contract Manager, Quality Prevention Env. &amp; Processes, Asset Manager, Technical Manager, Innovation manager, Research manager, Communication manager, Health &amp; safety manager, Crisis manager, Marketing manager, DW plant manager, Meter park manager, WWTP manager, Head of the lab, Project engineer, Resource &amp; Envt TSE, DW Quality TSE, DW Network TSE, WW treatment TSE, WW network TSE, SW TSE</td>
</tr>
<tr>
<td>EQF 5</td>
<td>Automation engineer</td>
</tr>
<tr>
<td>EQF 4</td>
<td>Leak detection technician and/or operator, WWTP supervisor, Dispatcher / Control Room Technician, Electro-mechanic Technician, Head of maintenance team, Instrumentalist, Water quality lab technician, Works foreman, Field work planner / coordinator / scheduler, GIS technician, Head of GIS team, Samples collectors, Remote sensors technician, Project technician</td>
</tr>
<tr>
<td>EQF 3</td>
<td>WWTP technician and/or operator, Network inspection technician, Cleaning operator</td>
</tr>
<tr>
<td>EQF 2</td>
<td>Network operators, DW plant technician and/or operator, DW plant supervisor, MMR and AMR fitters, Meter readers, Meter bench specialist, Camera operator</td>
</tr>
</tbody>
</table>

The Curricula provide section “Specialization in water industry required”, which any target user may use as a base for the Learning Path development. In fact, 2 Learning paths were developed for Distribution Manager and Leak Detection Technician in 3 variations suited for the 3 participating water utility companies. In such fashion, other learning paths can be derived, using the Curricula, for the rest of the 52 Job Profiles.
Moreover, a job candidate may consult the Curricula to learn about the required knowledge. As well as, potential students may refer to the Curricula to view the requirements demanded for the particular Job Profile.
In the recent years the Geographic Information (GI) community is promoting several initiatives aimed at identifying the job market needs in terms of knowledge and skills for the new professional profiles arising from new regulatory as well as technological developments in the GI-related fields.

This chapter analysed three projects at the European level. LINKVIT is a Leonardo da Vinci - Transfer of Innovation project built on the results of various GI & INSPIRE European initiatives with some important training results, now exploited to transfer the achievements to support improved GI skills in a wider audience of national users, and the creation of knowledge to support the implementation of the INSPIRE Directive. As part of LINKVIT key INSPIRE Business Processes were defined along with potential job profiles and the required learning paths needed to cover all the knowledge areas and skills for INSPIRE activities.

The second project is the ‘Geographic Information Need to Know’ project aiming to develop a more demand-driven geospatial
workforce education/training system based on an ontology based curriculum development platform. The project develops a new, dynamic version of a Body of Knowledge for the GI Science & Technology domain that can be maintained and explored by a series of tools, and from which academic and other curricula, learning paths, as well as job profiles can be defined.

The third project, eLeanor, is also a Leonardo da Vinci - Transfer of Innovation project, an initiative dealing with vocational training for professionals of EU water industry and services in private and public sectors. eLEANOR contributed with the assessment of training needs in the water sector providing a matrix mapping the training needs in relation with Job Profiles and Business Processes, with Curricula design for professionals in the water sector, and with learning paths integrated into eLEANOR Training Framework.

All those efforts will hopefully result in university-industry shared definition of competencies in specific professional domain, helping education and vocational training offer to match the actual job
requirements, help the recognition of results achieved during PIs in terms of acquired skills and knowledge and, in general terms, providing tools for competence certification and validation at EU level.
References


SECTION 3

INTERNSHIPS AND PROJECT WORK
CHAPTER 11

VIRTUAL MOBILITY IN INTERNATIONAL INTERNSHIPS

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In this chapter we look at the opportunities virtual mobility - or ICT supported activities that facilitate international, collaborative experiences in a context of teaching and/or learning - can offer when used to support international internships. The main reasons for exploring the possibility of virtual or blended internships are the chances it creates for the physically less mobile student, but the concept can also hold an added value for higher education institutions and companies. Nevertheless, the integration of virtual mobility in international internships is not self-evident. There are some important conditions for success to take into consideration: selecting the “right” students, establishing a communication protocol, choosing suitable tasks, integrating the “human” factor etc. This chapter is based on the findings of the European project “Enterprise - University Virtual Placements” (EU-VIP) and also introduces the outcomes of the follow-up project “Promoting Virtual Placements” (PROVIP).
International internships are becoming more and more important in our globalized world. Due to an increased economic connectivity and integration we experience a constant mobility of people, goods, capital and ideas in the world around us. It is of paramount importance that the future work force possesses the right intercultural and digital skills to deal with the opportunities of this global economy.

Internships are an important way of exposing students to complex work problems that require analytical, technical and soft skills. They play an essential role in helping graduates obtain the competencies and skills that are required in our current professional world. The European 2020 strategy\(^\text{11}\) considers stronger links between universities and businesses to be essential for Europe to be able to evolve into a true knowledge based economy.

For financial, geographical or social reasons it is however not possible for all students to undertake an international internship. Introducing virtual mobility in international internships can be one way to address this issue.

**Definitions**

We define virtual mobility as a set of ICT supported activities that realize or facilitate international, collaborative experiences in a context of teaching and/or learning. We introduce it here as an additional way of teaching and/or learning in an international context, not as a substitute for physical mobility. Both types of learning mobility have their own merits and disadvantages that should be taken into account.

Internships do exist in many different shapes and sizes. In the context of this chapter we focus on those internships that are offered and undertaken within the framework of formal tertiary education, as part of a curriculum. This type of internship involves three stakeholders: the higher education institution, the

\(^{11}\) See Reference [1]
student and the receiving company or organization. During an internship these three stakeholders ideally interact with each other on a regular basis, although the main line of interaction will of course be between the student and the company or organization. Virtual mobility can be implemented to facilitate this interaction at a distance. This way it is possible for a student to undertake an internship while not (always) being at the company’s premises. We can make a distinction between a “blended” internship where the student is present at the company from time to time and a fully “virtual” internship where all interaction and collaboration between student and company happens at a distance.

Finally, when we talk about an internship, we always take into consideration three different phases: the “before” phase when all necessary arrangements are made to ensure a successful internship, the “during” phase when the focus will be on the development of skills and knowledge through practical and authentic tasks and the “after” phase when the three parties involved evaluate the internship.

Why: the benefits of virtual or blended internships

As can be deducted from our introduction the concept of blended or virtual internships has initially been explored from the perspective of the (less physically mobile) student and the advantages it can bring for this target group. It allows them to develop cross-border professional experience and intercultural competencies while staying (partly) at home. Moreover, it fits perfectly into the current economic reality where online collaboration and telework are becoming more and more important.

But also for higher education institutions the introduction of blended and virtual internships can have significant advantages. It can support and broaden the implementation of existing internationalisation strategies and enlarge the attraction of study programmes. Next to this, it can stimulate the knowledge exchange with the international professional field.
For companies virtual or blended internships can mean a cost-effective access to new specialized knowledge, foreign markets and native speakers. It also allows them to explore the trend of telework further.

**Conditions for success**

However, a successful implementation of virtual mobility in international internships is not self-evident. Especially in case of fully virtual internships there are a lot of aspects and conditions to consider\(^\text{12}\).

**STUDENT CHARACTERISTICS AND MOTIVATION**

Not every student will be able to undertake a blended or virtual internship. The student involved will need to have good meta-cognitive skills, i.e. he or she needs to be able to take control of and plan their own learning process. A virtual internship is therefore more suitable for students with a higher level of prior education (e.g. master students). A target group that is prominently suitable for virtual internships are adult learners, who would also benefit most from this flexible opportunity to undertake an international internship.

Students preferably already possess the necessary ICT skills and have previous experience with virtual mobility activities.

In general, motivation seems to be one of the major reasons why internships succeed or fail in their learning objectives\(^\text{13}\). A high intrinsic motivation of the student is even more important when it comes to bringing a virtual placement to a successful end. But a high student motivation at the start of the internship will not suffice.

Motivation will need to be fed and stimulated throughout the entire enterprise. One very important factor here is the quality of the tasks that are assigned to the student: even though

\(^{12}\) Based on the manual published in the framework of the EU-VIP project. See reference \([2]\)

\(^{13}\) See reference \([3]\)
the student is not physically present, the tasks need to be authentic and must be part of real projects addressed to satisfy real needs of the enterprise.

COMMUNICATION PROTOCOL

To ensure a smooth ICT-supported interaction between student and company or organisation, it is necessary to draw up a communication protocol. Such a protocol can state: when the different parties are available for synchronous communication, how much time can pass before an asynchronous message needs to be answered, which technologies will be used for which ends, when reporting is required, how the coaching process will be organized etc. A good protocol will help to establish a feeling of availability and help to avoid feelings of isolation.

THE INTERNSHIP MODEL

Internships exist in many shapes and sizes. Not all types of internships are equally suitable for the integration of virtual mobility activities in the interaction between student and company/organization. Internships can differ in length: there are very short “work experiences” mainly aimed at immersing the student in the basic concepts of a professional function and there are long-term internships in which the student really becomes an employee for several months. Virtual internships work better on a long term basis. In this way there will be sufficient time to build up trust via virtual communication and to get familiar with this “new” way of working.

Internships can also differ as far as the general goal is concerned. They can be aimed mainly at discovery (short work experiences), specialization and recruitment or assisting in a specific company project. For the latter type of internship it will most likely be less necessary to be involved in all day-to-day activities of the company. Therefore this type will also be more suitable to be performed at a distance.
THE “HUMAN” FACTOR

Face-to-face contact between the company and the student at some point in time (e.g. at the start) is almost always beneficial to the success of the internship. If this is not an option though, it is possible to reduce the risk of feelings of isolation or distrust by choosing technology that creates the possibility to interact synchronously in a setting that is as close as possible to a face-to-face setting (e.g. video or web conferencing) and by creating space for non-task-related communication. (E.g. talk about other projects of the company, the news, social events, etc.).

ORGANIZATIONAL SOCIALIZATION

The overall design of the internship plays an important role in realizing “organizational socialization”, i.e. exposing the student to an organization’s social and cultural aspects and making him/her feel part of the organization/company. Organizational socialization is what makes the difference between conducting an isolated student project and undertaking a work placement. If we want to make the work placement a social learning experience we need to pay attention to this point. The degree in which organizational socialization can be realized is related to the length of the internship, to the degree in which interns are able to collaborate with different members of company staff, to the degree in which interns are allowed to work on tasks that are of real value to the company, etc. In a virtual internship, organizational socialization is even more difficult to realize. What is important here is to try to avoid a strict one-on-one setting. Concrete strategies here are:

- Inform the student elaborately about his or her virtual co-workers and provide information about how and when everybody can be reached (e.g. through the creation of an online environment with pictures and contact information).
• Also make sure all company staff members involved are informed of their temporary virtual colleague and of what is expected from them as far as collaboration is concerned. The first time around this will probably ask for some adaptation and guidance.

• Opt to work with electronic collaboration tools which allow group interaction, such as Skype (group audio conferencing) or Adobe Connect (group video conferencing and document sharing).

• Let the trainee participate in staff (or other) meetings via video conferencing.

INTERCULTURAL SKILLS DEVELOPMENT

The main goal of internationalization is to develop intercultural competencies: to enable students to tolerate and embrace differences without feeling threatened in their own identity. An international internship of course provides an excellent opportunity to work on these skills in a professional environment. However, the development of these types of skills is not self-evident just because a student is exposed to another cultural environment. Even in traditional physical international internships, intercultural competencies are only really acquired when explicit attention is paid to the development of these competencies. From before the internship the student should be aware of what “intercultural competencies” are and that it is an explicit learning goal to work on these competencies. During the placement, students need to be stimulated to reflect upon this on a regular basis. Essential here are formative assessment and feedback, also from peers in similar situations.

Gaining intercultural competencies in a virtual setting is of course still an entirely different matter. There is no “immersion” in the other culture as will be the case during a stay abroad. Body language and intonation will also be less on the forefront.

14 According to the INCA project, there are six components of intercultural competence: tolerance of ambiguity, behavioral flexibility, communicate awareness, knowledge discovery, respect for otherness and empathy. See reference [4]
during virtual interaction. Nevertheless it is possible to at least develop a sense of dealing with cultural differences through virtual mobility activities if the following points are taken into consideration:

- As for traditional internships: explain beforehand, give feedback and stimulate reflection. This is always of key importance.
- Focus on differences in written communication, negotiation styles, business cultures, decision making processes (e.g.: formal vs. informal communication, importance of hierarchy etc.)
- Do not limit the interaction to a one-on-one situation. In this case personality traits will be more determining for the experience than cultural identities.

**Project background: research and consolidation of findings**

The findings above are the result of the EU-VIP project (http://www.euvip.eu). EU-VIP stands for Enterprise-University Virtual Placements. The project looked into the possibilities virtual mobility can offer in the area of international internships. EU-VIP ran from October 2009 until September 2011. The project brought together 16 partners from 8 different countries.

Firstly, the project established a state-of-the-art report regarding virtual and blended internships. Starting from this document and additional research, the partnership put together a scenario for organizing virtual and blended internships. This scenario served as a general framework to design and implement 19 pilot projects.

Before executing the pilots, pilot participants (students, teaching staff, administrative staff, company mentors...) received local training adapted to their specific needs (development of technology skills, help while implementing the general scenario, how to undertake e-coaching). After pilot execution, all participants contributed to the evaluation of the pilot, via surveys and/or interviews. The feedback from the pilot
participants was used to further expand and fine-tune the framework and to identify critical success factors for the integration of virtual mobility in internships.

In October 2012 the EU-VIP project was followed up by a new European project, called PROVIP (www.provip.eu). PROVIP stands for Promoting Virtual Placements and runs until October 2014. The project joins 14 European partners.

On the one hand, PROVIP aims at disseminating the results of EU-VIP further. On the other hand, the project looks at the possibility of consolidating these findings through the development of an ICT-tool. The project started from the assumption that some of the most important success factors for virtual or blended internships could be realized more easily if they were supported through an online environment:

- making clear agreements beforehand about goals and roles,
- establishing a communication protocol,
- avoiding a strict one-on-one setting,
- good student follow-up in order to avoid isolation.

This was the basis for the development of the Pathway platform. Pathway is an innovative tool for supporting and facilitating international internships at-a-distance. It aims to support the virtual internship process during the three different phases (before, during and after) and involves the three different stakeholder groups during this entire process. The main features of the platform are:

- it supports matchmaking between students and companies,
- it supports the creation of an internship charter (including a communication protocol),
- it enables a close follow-up of interns from a distance,
- it supports online communication and collaboration,
- it provides just-in-time guidelines and advice about the organization of virtual internships.

The tool was tested through a pilot project by students, study programmes and companies in the field of marketing and ICT. It is available online and can be used free of charge. There is also a possibility to download and use the open source software.
This way it can be customized and hosted on other servers. The tool and more information are available via the PROVIP website.
In conclusion we can state that blended and virtual international internships are a valid addition to “traditional” international internships. The concept does open up new possibilities for students who are not able to travel abroad. There are nevertheless some important conditions for success that need to be fulfilled and that require a lot of planning and preparation. Therefore virtual and blended internships are preferably not organised as one-shot-initiatives, but should be part of a sustainable internship programme. Such a structural implementation of virtual and blended internships, as part of a sustainable internship programme, will also help to gain general acknowledgement of and support for this type of internship. Another way to realize a consolidation of the ideas about virtual mobility in international internships is a structural support for internships from a distance, provided by online tools such as the Pathway tool which was introduced in this chapter.
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CHAPTER 12

ESTABLISHING STUDENT INTERNET RADIO AND TELEVISION STATION ON A LIMITED BUDGET

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Traditional radio and television stations are limited in providing students the opportunity to practice their skills and gain experience. Broadcast media have to maintain their program without major interference. Occasional short term internships are not optimal since existing staff and resources are diverted to introduce students to the many processes and equipment before they can even go on air. If indeed the students are present long enough to come that far and experience the pressures of live on-air work. On the other hand, students have many obligations and it is hard to include full time media internship into regular studying process.
To circumvent these limitations student run media can be established, through which students have more possibilities to get the necessary know-how to work in varied media environment. Student media can be very open to new students in (extra) curricular settings either as a study requirement or voluntary obligation. The main problem such media might have is availability of start-up resources. Traditional media demand substantial investments in specialized equipment, broadcasting frequencies and financial resources to ensure broadcasting. It makes little sense then, to set up such media for student practice purposes. Some of these issues can be avoided via internet media where many traditionally prerequisite resources are irrelevant or financially tolerable.
Through this paper we will make an overview of different stages in establishing internet radio and television station with limited resources, both in technological aspect and human resources. The overview will consist of existing student media, perception of student media station from members of university staff, attempts to establish internet television for the first time, redefinition of study programme with stronger emphasis on practical media experience and last but not least, establishing internet radio and television station with their current issues.

Keywords: television, radio, production, internet, student media

Evolution of television

As MacGregor described, television program started as an illegitimate child of movies and radio informative program (MacGregor, 1997, p 118). But there is a major difference between motion picture and television. For motion pictures, chemically based photographic processes were used in order to preserve a picture. For television, electronics and recorded images were used, which were transmitted instantly to a receiving tube (Vivian, 2006, p 175).

In 1997 FCC decided to leapfrog the Europeans and Japanese by converting US television to digital technology. In analogue technology, picture came to the screen as pulsing, continuous signals. With digitalization all images are
computerized data. By doing so, picture becomes sharper, but wider broadband space is needed for transition. Existing television networks had to be improved and even though digitalization has many advantages, the cost for improving networks is very high. Lack of financial resources was the main reason why digital system was implemented at a slower pace than the commission predicted. In the meantime, other important players adopted digital technology (Vivian, 2006, p 176-177).

Another big change is digitalization. Digital cameras computerized editing and the Internet television created visual exhibition out of television news. Television news became highly complex media features and similar to highly developed computer games (Caldwell, 1995, p 352). Digital television offers a possibility to the audience to be more active, since they can influence the flow of the content. Viewers can stop the program, fast forward or have access to additional information about the program (Chalaby, Segell, 1999, p 365).

With digitalization the Internet become an important player in mass media. Internet was developed incredibly fast. Its first 50 million users were online in only three years after World Wide Web was established. In comparison, radio took nearly 40 years to attract 50 million listeners and television needed 15 years (Naughton, 2000).

The main task of media is to publish/broadcast news. In modern world, news is spreading through media with incredible speed in both formal (through traditional media) and informal ways (like blogs or social networks at the time of the tsunami in 2004). News is just the final product of complex processes of evaluation and framing (Branston, Stafford, 2006, p 194-197). News is not floating around and waiting for reporters to catch them. The whole process of gathering news is a systematic construct, where reporters aspire to the ideal of objective reporting. While reporters are dealing with news selection, construction, and presentation, they have to follow professional codes (O’Sullivan, Dutton, Rayner, 1994).

With the mass media we get new opinion leaders. Modern opinion leaders are publicists which are creating a public opinion
through media. Formal political leaders or important persons can be widely known only through mass media communication. Journalists and other publicists are having the power to create a person’s reputation as positive or negative. With the development of communication services a social interaction between people is changed as well. People start following different sources and they change their habits of receiving messages (Nastran Ule, 2000, p 447).

**University television**

University television was established in 1995. The television was well equipped and offered professional facilities for creating television program. Around the same time the idea of a Media Communication study program surfaced. University television would be a perfect opportunity for students of Media Communication to be easily involved in the entire process of creating television program through various aspects: (1) searching for news as journalists and cameramen, (2) creating the program, (3) preparing graphic design for various television shows, (4) providing support as technicians, (5) setting sound and light for television shows etc. As such the University television could provide a safe place for learning because (1) it is relatively small, (2) not subject to commercial laws, (3) not responsible to public demands as it is not a public television, (4) a more forgiving audience bearing in mind students are preparing television shows and they still have to learn and last but not least (5) university program has all the possibilities to achieve the quality of other professional products at commercial or public televisions.

Media Communication study program was established in 2001 and welcomed the first generation of students a year later. The program itself lasted four years. The first two years were common for all students and the last two years were divided into media production and graphic design. Students of Media Communication started to work at the university television from their first year already, but mostly on their own initiative.

Before first students reached the third year, university television closed its door in 2004. Suddenly students lost the best
possibility for learning and part of the learning process at the study program had to be changed drastically. Students were left equipped with only two cameras, where just one was a professional piece of kit, and a set of professional lights in a small room. The rest of the equipment remained at the facilities of university television and eventually divided among local television stations and studios. After several years, in 2008, another professional camera, few lights, screens and other smaller pieces of equipment were recovered and assigned to Media Communication department, but at that time the equipment was quite old and mostly not suitable for further use.

**Practice at the television station**

To solve the problem responsible persons for the program searched for alternative solutions since there were no facilities for television production at the faculty itself and there was no possibility to re-establish university television. In 2006, with the second generation of students, cooperation with the regional subsidiary of national radio and television broadcaster was established.

The main idea behind this cooperation was offering students an inside view of daily working processes at real-life television production. One day is not enough to learn how extensive the whole process is. According to many journalists, work in media is different day to day and not a single day is the same as the previous. Dealing with various situations should be helpful for students, but only if they would really be a part of the whole process.

Television production is a live process and live broadcasting does not allow any mistakes. As such, students had many difficulties to become part of production process since broadcasting cannot be interrupted for the learning process. Among other problems was the fact students were too often only observing the production process or assigned meaningless jobs, which demotivated them more than giving them useful knowledge.
Such cooperation lasted for two years. After that cooperation was shortened and revised on a much smaller scale. Partly because students got better possibilities at the faculty itself, partly because of problems Polutnik (Polutnik et. all, 2013, p160-162) described and explained. The cooperation was fair and both sides agreed it was useful, but the outcomes did not meet the expectations. There have to be better ways to establish a long term solution for larger number of students giving them a basic knowledge of television production and broadcasting. A large number of students simply cannot be introduced into live broadcasting process without too many interruptions for television station.

**Perception about university television**

After the cooperation with regional subsidiary of national public radio and television broadcaster ceased, study program moved away from television production and focused more on basic video production with documentary film as a final result. This step was necessary since there were no long term possibility in term of facilities and equipment needed for television production. This change was taken approximately at the same time remodelling of the study program. In 2007 all study programs were redefined following the Bologna system.

Nevertheless, part of television production remained in the program. In 2007 Media Communication department got new facilities, which were slowly transformed into television studio from 2008 on. The amount of financial resources allocated to the project was approximately 6.000,00€, including adaptation of electrical connections, internet network and other basic infrastructure, but excluding any equipment in terms of devices, software etc. The formative years of the studio were full of improvisations and ad-hoc solutions just to enable students a fragment of real life television production. Students had to prepare pre-recorded television shows, combined with some news from local environment and footage made in the studio. Such working process was far from real television production, but
at the same time technical resources and facilities did not enable anything more complex.

In 2011 a major step forward was made. Basic equipment for live broadcasting was given to students. Even though there was still a substantial lack of technical equipment (cameras, lights, prompters etc.), the first steps towards live broadcasting was made. With some ingenuity we managed to connect existing equipment into a working network and students were able to broadcast their shows live on Internet. Financial costs for all necessary equipment was approximately 5.000,00€.

All financial resources were part of other projects. After projects finished, we reused all materials and equipment as much as possible. Even so, the total amount of dedicated financial resources was very low or almost nothing for establishing a television studio compared to professional standards. But the system worked and students were really eager to participate in the broadcasting process. After several years this was the first time students could practice basic broadcasting principles on their own and the first time ever they were not only observers, but the creators. Facilities and equipment were finally good enough to provide a decent output.

With these attempts of making live broadcasting there were many ideas among university staff to start a new university television again. The idea itself was not wrong, neither new. The main question was connected to financial resources. Not so much in terms of technical questions but more in human resources. The main idea was students would work at the university television for free, earning only experience for further career. At the same time the scope of university television station should be quite big, close to what university already had.

Through conversations we tried to expose that such model cannot work in long term and there have to be dedicated financial resources for staff and updating technical equipment. At the same time a group of students working at the television station has to be big enough for regular undisturbed working process since students have many other obligations as well. Exposing such issues marked us as counterproductive, incapable and unserious. Broadcasting process was perceived as taken for
granted and easy to do since everyone can do it without any knowledge. Based on this experience further cooperation was not possible.

**Establishing faculty television**

Even so similar ideas were coming from our own students as well, but in much smaller scale. While students had to make obligatory exercises, they enjoyed preparing live broadcasting and after exercises were completed, they wanted to continue preparing television shows. Even though students wanted to do it on their behalf, many unpredicted problems occurred.

**THE FIRST ATTEMPT**

After the first time students had to deal with live broadcasting over internet at exercises in the end of 2011, they wanted to start their own show. The first attempt to start the shows was in the beginning of second semester 2012 after they finished obligatory exercises.

While the main initiators were students who went through the live broadcasting exercises, we did not want to limit the experience only to them. Informing all students went mostly through emails and the response was very encouraging. More than 20 students applied for different tasks and they covered all necessary fields of television production. Nevertheless the first meeting for television production was poorly visited, only a few students showed up. The second attempt was even worse. The number of students who remained was not enough to do anything with television production so the project was put on hold.

Even so the same students had an idea to start a radio show. All facilities were prepared for radio broadcasting as well so this idea could happen. Again students couldn’t really agree with each other how they should approach creating a radio show. At the same time no one had enough courage to start a show on their own.

Result of this unsuccessful attempt was not just a disappointment for students, but a long term disbelief such radio or television station can be started. Students had the same idea
about radio and television production one year afterwards, but at the same time they argue that it is pointless to start something since nothing really changed from a year before. In one year some equipment was bought and some possibilities for live broadcasting were improved, but what was still problematic was the students’ attitude. They were not prepared to start working on a project only for experience. The main argument was they can do better things for reference only in industry directly, but at the same time they have to pay their bills.

THE SECOND ATEMPT

In 2014 circumstances allowed us to offer live broadcasting to higher number of students. Many of these students signed in to the study program from other backgrounds and as such live broadcasting process was much more intense for them. At the same time it was for the first time students dealt with radio program during obligatory exercises. Since the group of students was big enough again, we decided to try establishing both a radio and a television program.

As before, we didn’t want to exclude other students from this project, so again information about the project went to all students via email. The main difference from the first time was the warning, what students can expect from the project and how large the team of students has to be to create the program.

At the first meeting more than 30 students appeared with strong wish and ideas what to do. The most encouraging aspect was that students from the first grade showed up with high motivation to learn something new. Based on students’ wishes we set the television program mainly with studio program and three pre-recorded news pieces from the field. Television shows should be aired every two weeks for approximately half an hour. For the first television broadcasting students were really eager to participate and there were too many students so some of them could not be part of the process. Nevertheless the fourth and last television show was barely put together since students had other obligations and they wanted to get some payment for it. More
than three quarters of the production team in the final show was assembled from first year students.

Similar story happened with radio broadcasting. At the beginning there were more than ten students interested in radio broadcasting. Soon after the meeting only three students remained and one of them had to leave the team because of work outside the city. Even so the remaining two girls said they will try to continue. Every week they prepared a half hour show and they never considered quitting.

The second attempt at initiating both radio and television live broadcasting was successful, but we cannot talk about great success. Even the technological part of broadcasting is still not very professional, yet it offers enough possibilities for realization. The main problem was keeping motivation high over a longer period of time without any kind of reward. It is easy to start something since it is new and interesting, but through time the interest fades and without additional reasons students simply quit.
As we tried to present through this paper, it is relatively easy to establish an environment for live broadcasting. A bigger challenge is the necessary equipment, which is costly and demands regular updates. Nevertheless, equipment is getting cheaper and more accessible all the time. The biggest problem remains the human factor.

Even though radio broadcasting does not demand a big team of program creators, serious and consistent program is not easy to create and requires enough people to back up all roles in a broadcasting process. In television production such problems are just multiplied. Over a longer period of time all involved persons have to remain motivated and we cannot expect they will be the foundation of such a big project without some kind of reward.

Our case clearly showed that even such a small production based on students own initiative, requires much more than just enthusiasm of everyone involved. Live broadcasting is not an easy task as many would like to think. It involves many different professions to be synchronised at the same time to successfully send a picture
out of the studio. At the same time students have other obligations as well and as such we cannot make any comparisons to professional broadcasting since students are not always available and they are searching for new challenges and opportunities for both earning something and make some steps for further career.
References

CHAPTER 13

INTERNSHIP IMPLEMENTATION MODELS AND STUDENT CHOICES

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There is a strong trend for internationalization of education and increase of learning mobility. PRAXIS project has a strong vision to support these trends. The project aims to create and develop the European Centre for Excellence in the field of Project/Internship (PI) initiatives maximizing students’ chances to find a project and/or internship course matching their needs.

A questionnaire was developed within the PRAXIS network project as a form to collect information from Higher Education Institutions (HEIs) and companies on Projects/Internships they propose, and students were asked to present their wishes on what kind of Project/Internship format they would like to participate in the most. Around 70 responses were collected from HEIs and the companies, as well as 1,800 responses from the students. All this forms the database which is used in this chapter.

In this chapter the analysis of the data collected via PRAXIS project questionnaires is performed. Typical Project/Internship implementation models are identified and analysed.
PRAXIS questionnaires for HEIs, companies and students are described. The results of statistical and qualitative analysis revealed that in many aspects Project/Internship offer and student choices match, but there are also gaps. The Project/Internship course implementation models presented in the questionnaires give an overall picture of model solutions, as well as some examples of good practice to follow.

**Keywords:** Internship models, database, statistical and qualitative analysis.
Project and internship courses are typical in professional study programmes and are particularly relevant to engineering studies enabling students to apply knowledge and technical skills acquired during the studies in practice. Besides special professional skills, it is important to develop such soft skills as team work, communication, innovation, etc.

There is a strong trend for internationalization of education. The Council of the European Union published guidelines and benchmarks on mobility in education [1] stating that “By 2020, an EU average of at least 20% of higher education graduates should have had a period of higher education-related study or training (including work placements) abroad, representing a minimum of 15 ECTS credits or lasting a minimum of three months”.

PRAXIS project has a strong vision to support these trends and benchmarks. The project aims to create and develop the European Centre for Excellence in the field of Project/Internship (PI) initiatives maximizing students’ chances to find a project course matching their needs [2].

It is very important to investigate changing demands from industry regarding workforce knowledge and skills, match educational provision with these requirements and take into account diverse interests of students. It is essential to establish information exchange among parties and find innovative solutions for efficient collaboration.

The PRAXIS network project developed a questionnaire as a form to collect information from HEIs on how they organize Project/Internship (PI) courses within their study programmes. Companies were asked to fill in another form laying out their offer for Internship/Project, but students were provided with the third kind of questionnaire to present their wishes on what kind of PI format they would like to participate in the most. Around 70 responses were collected from HEIs and the companies, a lot more (over 1,800 responses) were received from the students.

The aim of this chapter is to perform the analysis of the data collected via questionnaires, identify typical Project/Internship implementation models and compare the offer
of internship opportunities with the choices made by the students.

The questionnaires for HEIs, companies and students are presented and their aims are described in detail. Internship models and typical stages are analysed. Statistical and qualitative analyses are performed on how internship offer and student choices match.

**PRAXIS Project Questionnaires for Students, Companies and Higher Education Institutions**

It was important from the very beginning of the project to get the knowledge of the field of Project and Internship courses in Europe and agree on common understanding of the concepts. Following the methodology designed for the PRAXIS project, a preliminary review was performed and the core data used to characterize PI course units were outlined. Then these data were used to design a questionnaire and implement it to perform the survey. At first, the questionnaire was tested involving the consortium members only and then it was posted to a broader group of HEIs, students and companies. After the first stage, the questionnaire has been revised and updated eliminating the deficiencies revealed.

The questionnaire starts with defining the concept of “Project” and “Internship” used in this survey:

- A Project in general is a project course which gives students the opportunity to explore a problem of particular personal or professional interest and to address it through focused study and applied research under the supervision of a faculty member. The project should demonstrate the student’s ability to synthesize and apply the knowledge and skills acquired in his/her study program.

- An Internship is a system of on-the-job training, similar to an apprenticeship. Interns are usually undergraduate students but they can also be post graduate adults seeking skills for a new career. A project course is developed as a student internship
when students work in the real workplace by selecting a project proposal submitted by a company.

It should be mentioned here that depending on tradition in different countries, institutions and projects, there are different terms used instead of “internship”, such as, for example, “work placement”, “industrial placement”, “practical placement”, “practice” and many more.

The main stakeholders of the PI field are HEIs, Students and Employers (Companies) with their own specific interests; therefore, a different questionnaire for each target group was designed.

The questionnaire for HEIs aimed to collect information on how Projects and Internships are organized in a particular institution. Companies were asked to present their offer in the field of Projects and Internship. The main questions to students were - What are your wishes and what would you like to achieve from PI?

The questionnaires were developed in compliance with the stated aims. Multiple choice questions are combined with open questions requiring more detailed comments. The first part of the questionnaires contained questions extracting general information, such as country, city, name and size of institution, main areas of study, age and gender of the student, level of the study programme, year of study, business sector, size and economic sector of the company etc. Then followed more specific questions related to the stated aim of the questionnaire and general comments were asked at the end. The questionnaires for the students and the companies contained just 20 questions, whereas HEI questionnaires consisted of 30 questions. HEIs were asked to characterize their PI courses in more detail.

Specific questions related to PI course options are:

- Project or internship or both, part-time or full-time, remuneration, governance;
- Individual or team based. For the Team: national, international, real or virtual, small team (<4), medium (4-8), large (more than 8);
- Location: home institution, national company, abroad (international team), real or virtual;
• Project/Internship option: Project, Practice (internship), Project in Practice, Design Project, etc.;
• Duration (in months), ECTS and timing (semester, included in the study program before or after graduation).

Students are asked which option of PI course they would prefer, what the most important selection criteria are for them (company, brand, topic, salary, teamwork, abroad, etc.) and what they expect to gain from the PI course.

**Statistical and Qualitative Analysis of the Data**

The questionnaires were made available at the PRAXIS project webpage [2] and survey was active from September 2012 till October 2013. 77 responses were collected from HEIs, 68 responses from the Companies and 1,804 responses from the Students. We have to recognize that the collected data cover European countries, business areas and PI examples from particular HEIs unevenly, therefore, the data are not statistically representative, but it was not the main aim of this survey. Still it is possible to extract some valuable information from these data, therefore, statistical and qualitative analyses were performed and the results are presented below.

**HIGHER EDUCATION INSTITUTIONS**

The data representing HEIs are from 19 countries and 34 institutions, the majority of which are PRAXIS Network partner organizations. Most HEIs are presented in the survey by 1-2 examples of PI courses, but FH Joanneum - University of Applied Sciences from Graz, Austria, has 13 examples and Turku University of Applied Sciences, Finland - 10 examples. This may cause bias in statistics. Small size HEIs with less than 10,000 students and medium size HEIs with 10,000-20,000 students are represented in almost equal number and there are just few HEIs with over 20,000 students, which participated in the survey.
Most popular study areas presented in PI course examples are Engineering (38%), Computing and IT (34%) and Business (12%). These courses are mainly organized at the national level - 77%. In most of the responses, PI course is as a compulsory part of curricula (65%) and 14% are capstone/diploma projects or Thesis. PI course in the form of teamwork and individual work are equally popular, but in 22% cases both are combined. From pure projects just 23% are individual and 55% are projects in team, but 23% allow both versions (individual work or team).

Teamwork is organized mainly in small teams with less than 4 participants (61%) or in teams with 4-8 participants (33%) and just in one case a virtual team is mentioned.

In some cases it is difficult to distinguish pure projects and internships in the body of the data, because these forms may be combined. In the survey sample, pure internships altogether constitute just 20%, of which 87% within bachelor programs and all are individual, but in 20% of cases it also may be teamwork.

A large part of responses given within the survey of HEIs is related to the project courses (54%) or projects combined with the internship (26%), amounting to 80%. Considering projects, 70% are mid-stage or capstone/diploma projects done at “home institution”, which can be translated as HEI. In 16% of cases place of the work is a research laboratory and just in 12% of cases location abroad is mentioned.

Duration of a typical PI course is 1-3 months (51%), but there are also 3-6 month courses (34%) and longer (8%). Typical duration of the internship course can vary from 1 to 6 months or even more and workload is evaluated with 6 to 10 ECTS or even more. Full-time PI courses constitute 53% and part-time - 42%.

Most HEIs (73%) report that they are governing/supervising PI courses, but, as it follows from a more detailed description, company staff is also involved if work is done in the company. In 65% of cases a student does not receive any payment for the work done (20% may be paid). From pure project courses, 95% are unpaid, but from pure internship courses just 30% are reported as unpaid. There is a large variety of different PI course options, as shown in figure below.
Almost all HEIs responded that Internship is done during the study program and there are very few exceptions when PI course is done before starting the study program.

**COMPANIES**

Altogether 68 companies from 18 countries filled in the questionnaire. From these, 72% are private companies, 22% - public and 4% belong to social/voluntary sector. Size of the company varies from less than 10 employees (25%) to over 250 employees (28%).

Main business areas of the companies represented in the survey are Computing and IT (44%) and Engineering (37%). The majority of internship places and projects are offered in these study areas. Internship places and projects for bachelor level students are offered by 60 companies (88%) and for master level students - by 45 companies (66%). Internship and projects for doctoral students are offered in 23 companies (34%). Altogether, internships are offered by 85% of the companies and projects - by 60% of the companies.
Work can be organized individually or in a team. Smaller teams with less than 4 students are preferred (62% of the companies). Virtual team is a possible option in 9 companies (19%).

The duration of internship in the company offer vary from 1-3 months (38%) to 3-6 months (37%) and 19% of the companies offer even longer duration of internship. Full-time internship places constitute 55%. Companies are ready to supervise internship in 75% of cases.

Companies comment that the main added-value of the cooperation with HEI within PI courses is the opportunity of knowledge and innovation transfer, exchange of experience, building up better understanding and attraction of perspective employees.

STUDENTS

Over 1,800 responses from the students from 21 countries were received within the student survey. The countries represented by a larger number of students are Spain (433 students), Slovenia (291), Cyprus (183), Portugal (126), Belgium (113) and Finland (91). The main study areas represented are Engineering (41%) and Computing and IT (37%). Most students are bachelor students (67%) in the age group of 20-24 years (60%); 69% are male.

Students prefer internship organized in a team (75%) and in particular - international team (58%), but 5% would like to participate in a virtual teamwork. Work in international team is offered by HEIs just in 23% cases and companies would like to have an international team in 33% offers. Student wishes well fit with the EU benchmark for student mobility [1].

Students also prefer small (less than 4) and medium size (4-8 students) teams, which fits well with the existing offer.

Home institutions are chosen by 43% of students, a national company - by 52% and a research laboratory - by 39% as a preferable place for a work, while only 38% of students want to go abroad. Combining this with the previous answer, where 58% of students prefer work in an international team, we can
conclude that some students expect to join an international team at the home institution or in a national company or in a local research laboratory or work in a virtual team.

If asked about the form of the course, 53% of students prefer a project combined with internship, 29% - project and 18% - internship. The duration of the PI course preferred by the students is 1-3 months (36%) or 3-6 months (38%). 57% of respondents prefer full-time engagement, while part time work is preferred by 41% of students. These preferences quite well fit with PI course options offered by HEIs and companies.

Students were also asked to rank several factors, which they find important in choosing the company for the internship and/or project. The question was, “Choose the most relevant characteristics for you when selecting your project/Internship: 1 - least important, 5 - most important”. The factors were: company, brand, salary/scholarship, subject/topic, being abroad, working in a team.

“Subject/ topic” of the PI course was recognized as the most important factor, getting an average rank 4.3; 50% of students identified it as “the most important”. The next in rank are “company” - 3.8 and “salary/scholarship” - 3.7. Just slightly behind in rank are such factors as “being abroad” and “working in a team” with rank 3.5. Brand, as a factor, received the lowest rank - 3.3. For the sake of comparison, evaluation graphs for factors “subject/ topic” and “being abroad” are presented in figure below.
Compared to other factors, the opinions on the opportunity to be abroad vary significantly. Some students (8%) ranked it as the least important factor, while 17% of students chose it as the most important and 30% assigned rank 4 to this option. It shows that the average rank does not always show the real picture.

Another question regarded the benefits, „What are the main benefits of Project/Internship for you?” The answers ranked in order of popularity are the following:

- 71% Getting experience in the field of my own interest
- 65% Working in a professional setting
- 64% Chance to be employed by the company/institution offering P/I
- 59% Working on a real-world non-academic assignment
- 50% Getting to know real working conditions
- 40% Working in team
- 22% Autonomy
PROJECT AND INTERNSHIP IMPLEMENTATION MODELS

One of the aims of the survey was to review PI course implementation models and to extract the cases of good practice which could be shared. There were several open questions to HEIs referring the implementation models:

- Describe the general/most common procedure for PI course management.
- Describe best practices, tools, differentiation factors among your internship programs and project courses.
- In your opinion, what is the main added-value of PI courses regarding your institution?

MODELS FOR INTERNSHIP

Internship or work placement is an opportunity for student to experience real working life and try to apply in practice knowledge and skills acquired at HEI. 3 common stages can be distinguished in the internship courses presented in the survey:

- finding the internship place and official arrangements;
- supervision of the internship;
- reporting and evaluation.

There are several options how a place for internship is found. Students may find the place for internship in the company by themselves or companies send their offer, then these internship places are evaluated and approved by a particular HEI. Students can present themselves to companies by publishing their CV. In some HEIs, virtual tools are used for this procedure. Internship can be done not only in a company, but also in a research lab and other kind of institution. Such options with regard to internship place as “abroad” and “home institution” were also mentioned.

When an internship place is found, certain administrative arrangements are made. There is a set of tasks defined for the student to complete during internship. The supervisors from the HEI and the host company must be assigned. This can be arranged as a tripartite agreement (HEI, company, student).
Supervision of the internship may be organized in different ways. For example, the student is asked to contact the supervisor via e-mail within 14 days from the start of the internship and report on the situation. Alternatively, reports are requested from the student once a week. In another HEI just a mid-term report is requested. There is an option that students have a set of tasks for the internship and every 10 working days students report on their activities in relation to these tasks. Supervisors visit the companies to inspect the process of internship at least once during the internship.

At the final stage of the internship, students have to prepare a report, present and defend it. In some cases, students should keep a diary or log of activities performed during the internship. The company is asked to file the report with the evaluation of the student’s performance during the internship. Students are also asked to reflect on what they have achieved during the internship.

Very similar stages of internship implementation process could be found in [3], but in [4, 5] the first stage of finding the internship place and related official arrangements is divided into 6 and 9 steps, accordingly.

**MODELS FOR THE PROJECTS**

A large number of responses within the survey of HEIs is related to the project courses (or combined with internship). 3 common implementation stages can be distinguished in these responses:

- selection of the project topic and project planning;
- work on the project, project management and supervision;
- project results, reporting and evaluation.

There are different options reported regarding how to offer project topics and how students choose the topic. Project topics could be offered by HEI staff or the company or the student can find her/his own project idea during the internship. Project proposals are analysed and only the appropriate ones are
approved. It is important that the complexity and scale of the project is appropriate to student abilities, time and resources assigned. The project topic may be interdisciplinary and then multi-disciplinary project team is composed.

Most projects are planned for teamwork. It means that a team of 4-5 students (may be an international team) is created and project tasks are assigned to the team members. Teambuilding and project management is very important, therefore at some HEIs there are Project Management courses or just few lectures in parallel to the project course. Students apply in practice not only the knowledge and skills obtained during the special professional courses, but also planning, management, teamwork and communication skills. Sometimes students work on several projects in parallel in the course of one semester, thus experiencing work in different teams.

Work on the project for students is a learning process; therefore, they need assistance from academic staff. Sometimes doctoral students are assigned as assistants. Within the projects offered by companies, advisors are also provided. Regularity of assistance and supervision differs from once a week to 2-4 times a semester.

At the end of the project, students have to prepare a report and/or present a working device, software, etc. There are definite rules established for the content and documentation to be presented in the report. The project should be publicly presented and in some cases project presentation is organized as an oral examination.

Grading of the student work is done not only by the academic staff; it may be also partly assigned to other student team members.

The analysis of the Project/Internship course implementation models presented in the questionnaires gave an overall picture of model solutions, as well as provided some examples of good practice to follow. Unfortunately, it should be recognized that multiple choice questions and even short answers to open questions did not allow presenting PI course implementation models in sufficient detail. Some of the Project/Internship courses were presented at the PRAXIS project.
Conference in 2012 and could be found in the conference proceedings [6-8]
A questionnaire as a form to collect information from HEIs, companies and students was developed within the PRAXIS network project to map the field of Project/Internship courses.

Having performed statistical analysis, we can conclude that in general Project/Internship course offers by HEIs and companies comply with student wishes, however, some gaps have been recognized. For example, companies offer more internship places and fewer projects than students want. Students prefer teamwork, but it is not fully supported by companies and HEIs. The data differ even more in relation to such option as an international team. Willingness to work in an international team is expressed by 58% of students, companies are ready to accept an international team in 43% of cases, but HEIs allow international team just in 17% of PI courses. The demand is not covered by offer in the field of virtual teamwork either, mainly by HEIs.

The subject/topic of the course was recognized by the students as the most important criteria for choosing
Project/Internship course. Answering the questions regarding the benefits students expect from the Project/Internship course, 71% of students recognize experience gained in the field of their interest.
References

CHAPTER 14

GAINING PRACTICAL EXPERIENCE THROUGH REAL-LIFE ICT PROJECT INVOLVEMENT

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Education in the field of ICT is very popular as the ICT industry requires more and more qualified personnel. Students of Computer Science programmes and other ICT-related programmes are often directly or indirectly obliged to acquire practical experience during their education. Often parts of the study programmes include practical parts or even a whole semester of practical work. Another possibility for students to gain practical experience is through real-life project involvement. In this chapter we present preliminary findings regarding student involvement in real-life project during their education in the sense of a part-time employment. The inclusion of students is voluntarily and their work is evaluated also through payment as well as through evaluation from the educational institution. We discuss the impacts, advantages and drawbacks of this ongoing project. Additionally, we attempt to draw conclusions and predict such ways of enriching the educational process.

Keywords: practical experience, ICT, project, students
Universities are one of the pillars for long-term development of the society. In ICT higher education it is very much desired for students to gain additional practical experience through their studies. Therefore, different types of project work in cooperation with industry and internships are very common in the process of study. Sometimes they are requirements of the study programme, sometimes students are eager to gain additional practical knowledge also without formal requirements.

Universities are oriented towards long-term research. On the other hand, companies often seek to apply research in short-term for the purpose of product development. Thus the collaboration between those two worlds must seek to achieve a common point where both partners benefit from. Several policies, strategies of universities and government bodies aim to facilitate good collaboration between universities and industry. Consequently, the research results can be used in the mid-term. Lee proposes four models of university-industry collaboration regarding research and development [1]:

1. The ideal lab which is based on the Open Innovation principle - companies fund short-term applied research work with a clearly formulated problem state. Universities can publish their results and companies have a right to use the results.

2. The grand challenge model - It is also based on the Open Science and Open Innovation principles. In this scenario companies sponsor long-term fundamental research, where the aim is to acquire a new knowledge base which is shared in the public domain and is used to develop new products by the companies. The transfer procedure of intellectual property rights from universities to companies is easier.

3. The extended workbench - a collaboration model in which companies work with universities on proprietary problems and solutions.
4. Deep exploration - a collaboration model in which companies and universities establish a rich and long-lasting relationship.

Experiences in industry-university collaboration are differently handled from country to country and are dependent on the specific environment. However, good practices can be shared. In a study which compared industry-university collaboration in Sweden and Tunisia, differences were determined - Swedish companies had greater interest in collaborative research than Tunisian companies [2]. In Sweden, where the number of collaboration is high, it was determined that the ability of actors to engage in heterogeneous collaborative partnerships plays a very important role in raising collaborative efforts between universities and companies. Another good example shows that raising awareness on and developing a “triple helix” relationship between universities, governments and industry is vital for developing economies [3]. However, there are still concerns, mostly among academic staff, that university-industry cooperation in profit-oriented research may interfere with long-term, disinterested, fundamental research [4].

On the other hand, the collaboration between universities and industry is also beneficial in the study process, particularly for students. Companies, students, but also the university have interest in the collaboration and practical experience acquisition during the study process. Therefore, students are often formally or informally stimulated to gain practical experiences during their study years.

In this chapter we describe experiences gained through an approach where students are engaged in real-life projects of companies. This not only widens their perspective, experiences and knowledge, but in our case it also gives them some financial benefits.
Students’ involvement on real-life ICT projects

The University of Maribor facilitates the involvement of students in projects, where they can gain practical experiences through a project called “The creative path to knowledge” which is partially funded by several Slovenian government agencies and the European Commission [5]. The aim was to promote direct collaboration between the industry and students on both Bologna levels (Bachelor and Master students). The University of Maribor has applied for several projects. The project described in this chapter was applied for by the Faculty of Organizational Sciences and the Faculty of Electrical Engineering and Computer Science of the University of Maribor and the company Arctur d.o.o. [6]. Students were selected through a public call issued by both faculties. In the end 10 students were chosen to participate in the project. The particular project was titled “Management of multi-project organizations with the support of a cloud-based information system” (“Upravljanje večprojektnih organizacij s podporo spletnega informacijskega sistema v oblaku”). The aim of the project was to perform a case study and research on the deployment of the 4PM software in multi-project organizations. The students were divided into groups of which every group was investigating the deployment and case study for a different company or organization. The projects started with a kick-off meeting during which the roles and obligations were explained to the students. Additionally, administrative tasks were elaborated and students were given introductions on the content of the projects. Four groups were formed and students were informed that there will be regular meeting, but most of their work can be done remotely. The four groups of the students were assigned three different companies and an organization which will be the dealt with in scope of the projects.

Preliminary findings

The project work is still ongoing, but some conclusions can be already drawn. Until now the feedback of students is very
positive. They were and are still very keen on working for the project. They gain valuable real-life experiences, but also benefit from the financial perspective as they get paid for their work. However, most of them took part in the project because of the experiences and knowledge to be gained rather than money. The company involved in the project is satisfied with work of the students and even has given the students the possibility to become full-time employees if their will perform well. This was another positive stimulus for the students.

As the work is performed in teams, students will also gain experience in teamwork, as today’s project work is mostly teamwork. The company gives the students support for their IT solution 24/7, but also regular meeting of all the stakeholders give the possibility to solve any situation which may arise.

In scope of the projects, students also need to report on their work which compels them to be systematic in their work.

Last but not least, the technical part is also very important because gives them the possibility to work with the newest technology and trends. However, most skills they acquire are of non-technical nature. This also indicated that such project involvement is very beneficial as the university often does not or cannot give all this spectrum of non-technical skills, but usually focuses on the technical part.

As the project is coming to it final phase, the current status indicates that the outcomes will be positive for all shareholders. Students gained and are still gaining much additional knowledge and skills and the company the results they need. The fear that the project work would influence the students’ performance was not an issue, as the students were last-years students and were not anymore actively involved in courses.

The university can also benefit of this collaboration, maybe not directly but surely indirectly. Such project work tightens or in some cases brings up new partnerships between the university and the industry. In the mentioned projects, two teachers are involved and therefore also have insight into the project development. Their role is a coordinating role, but still they are able to acquire information about students’ skills. In this sense
the curricula can be modified if the findings of the project indicate that the students lack in some skills. Additionally, such collaboration facilitates future collaboration between the company and the university. Last but not least, positive feedback could also promote additional projects of this kind and other project between both partners.
In this paper we presented the preliminary finding regarding students gaining practical experiences through real-life ICT-project involvement. The overall feedback was very positive both from the student and well as from the company’s side. Such practices and the inclusion of practical work in a study programmes in a form a project work should be part of a modern study curriculum. The experiences show that such projects not only facilitate collaboration of universities and the industry, but also give students an opportunity to gain additional, not only technical, knowledge. As the EU would like to facilitate university-industry collaboration, such an approach is surely adequate.
References


SECTION 4

INNOVATION IN PI TEACHING
CHAPTER 15

INNOVATION IN TEACHING AND LEARNING IN HIGHER EDUCATION WITH 3D VIRTUAL TECHNOLOGIES

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The increasing availability of information and communication technology (ICT) compels innovation in teaching and learning in higher education as it provides the design of new pedagogies beyond the fields of the traditional classroom. Students must be prepared in a way that engages them to promote the practice of skills, the construction of knowledge and not just assimilating facts. It is therefore necessary to develop educational activities both for the classroom and for virtual world learning environments designed to carry those changes. 3D virtual world technologies provide platforms for different levels of online interaction and the development of a new online role that gives a deeper level of engagement in the discussion and learning environment. 3D virtual worlds provide levels of testing simulated practice, moving learning from discussing ideas to testing and practicing behaviours. Such possibilities challenge instructors to consider a renovated pedagogy, moving to an online form of what was previously limited to the experience in classrooms. Virtual learning does not seek the gathering of facts so much as the construction of new meanings. Virtual worlds
provide almost unlimited opportunities to test and practice behaviours in a safe environment. Activities which facilitate interaction can be done in a short time span with a following critical analysis. Very rich exercises can be carried out in virtual worlds and experimental learning in these contexts holds exciting scenarios for the educational field. This paper discusses a research project where aspects of learning circuit theory were understood within the context of a unit of study for engineering students as part of the Bachelor of Electrical Engineering degree. This study illustrates the use of the 3D virtual world in teaching and highlights some of the possibilities and limitations that were considered in the research study.

Keywords: E-learning, interactive application, software packages, virtual reality, 3D lab internet
Technological innovation motivated by new discoveries and the demands of the labour market stimulate all technical areas. The labour market needs a continuous supply of suitably qualified engineers and technicians to support the changes. This requisite is present in all the major technical challenge areas identified in forward-looking strategic plans such as those identified in Europe’s Horizon 2020 initiative [1].

It is the role of Higher Education to produce qualified individuals to meet these technical challenges. This is achieved through appropriate curricula, teaching and learning environments and methods.

The quick developments and growth of information and communication technology had a profound influence on Higher Education. The preparation of an expert involves the acquisition of theoretical knowledge and the practice of skills. Simulation has been implemented as a learning-by-doing training method that can enhance education in many professional and engineering courses.

It is through a learning period with experimental work that a student learns how theory applies to practice. A simulation-based training system in a virtual world can provide students with a safe and realistic environment in which to practice, and also demands a smaller amount of resources than with real-life techniques [2].

Students need to use continuing education opportunities throughout their studies since their progress can depend upon their understanding of the latest technology.

In Higher Education students depend on computers to do the work. Many of these institutions are aware that using network technology can stimulate and promote learning, and increase students’ experience and knowledge.

E-learning allows students to perform their tasks through the internet, with advantages on their learning outcomes as it provides the design of new pedagogies beyond the fields of the traditional classroom. The traditional classrooms will continue to
offer benefits that cannot entirely be obtained in any other way, but the difference in the engagement is completely different.

**Educational Context - Virtual Simulation**

One of the key aims of Higher Education in today’s information technology is to actively involve students in the learning process [3].

Engagement has been considered a research priority due to the involvement in learning and academic tasks, and participation in school-related activities [4]. It is also determined by the interactions between the environment and the individuals so that social and academic changes in class modify students’ perceptions and engagement [5].

The constructivist theory includes support, experimentation and collaboration, which are also incorporated in virtual simulations. Another important component of the constructivist theory is reflection. Although this may not be a part of a virtual simulation in itself, it is a crucial classroom activity that is utilized in combination with simulations [6]. Reflection reinforces the learning experience by having students look back on their simulated experience to reflect on what they have learned and how they would do things differently.

Students enjoy working in virtual environments because they are allowed to interact with digital objects. Through this interaction, students can make observations, gather data and suggest experiments. Through the use of simulations, they are able to practice, increase their information and gain confidence in their technical skills [7].

Education can be achieved in a traditional classroom and through e-learning. In a traditional classroom, it is typically based on the teaching system, often with emphasis on the material itself rather than the students, and the differences between competencies and learning skills. The teacher assumes the main role and students often take notes and focus on something the teacher is saying. Their learning is mostly passive. The traditional classroom does not stimulate the senses or the mind, merely memorization.
Teaching in Higher Education has become more student-centred, and that is why e-learning has been promoted as an alternative or an assistant to traditional lectures [3], [8].

E-learning can help in conveying information and interaction. The transformation from the traditional classroom to e-learning really means the change in the learning environment.

Nowadays the paradigm is student-centred learning, and students need to participate in topics, and pay more attention to learning skills besides listening, writing and thinking. They have to be prepared to answer and ask questions, cooperate with classmates to complete some tasks on a certain topic. These are active and cooperative learning behaviours that proved to be more effective for students’ learning outcomes. The aim is to lead the students to take on responsibility for their own learning by acquiring the tools and the skills [9]. Technology allows this learning to take place virtually. As a teaching method, e-learning ensures that students can be more active and involved than in a traditional classroom.

Students’ engagement has advantages over the traditional classroom by promoting critical thinking [10].

Virtual worlds have become valued in educational institutions [3]. Several challenges are involved in the development of a virtual training system framework. It is necessary to ensure that system requirements are well understood, develop supporting components to meet these needs, and create an environment that is appropriately realistic to provide the students with the necessary sense of immersion. It is therefore necessary to develop educational activities both for the classroom and for virtual world learning environments designed to convey those changes and teachers must be able to engage a variety of students [11].

**Virtual simulations in the classroom**

Knowledge is not a set of abstract concepts to be acquired by the student and it depends on the context in which it is used.

Learning needs to occur in an embedded manner within the relevant context. Instruction should involve an authentic activity with dynamic, practical learning. There are three activities
involved in the cognitive-learning model: modelling, framework and reflection. Modelling refers to student observation of an expert enacting an authentic and relevant situation in the early stages of learning. Framework involves providing support in the form of expert feedback on students’ strategies as well as their results. Reflection requires students to review their own strategies and discuss alternatives. This model is effective within a technologically rich learning environment [12-13].

There are necessary costs associated with the setting up of virtual labs. Teachers and software programmers are essential for their development, to provide an effective learning experience. Once the virtual labs are developed, they need to be appropriately put into practice in the classroom. It is also necessary to include support, collaborative and reflection activities to assist it so that the learning results and behavioural engagement in learning can be effective. Abrami et al. highlight the importance of the three types of interaction: among students, between the teacher and students, and between students and course contents [14].

Virtual simulations are environments that have been digitally created to allow users to interact with that digital scenery [15]. In these settings, knowledge and perception are distributed across objects, individuals, items, and tools and students can interact with those various objects. Virtual scenarios provide a deeper learning experience as students become completely absorbed in them.

Virtual simulations also aim at giving a deeper understanding of a complex subject by going through concrete experience, reflective observation, abstract conceptualization and active experimentation. Virtual simulations can provide safe environments where students can experiment situations often only achieved through internships.

Virtual labs can be used to teach complex subjects that are traditionally taught through role-playing, apprenticeships and internships.

While they may offer an innovative learning experience for students, there are many issues to consider when implementing it into a classroom [16].
There are pedagogical challenges intrinsic to distance and online learning that need to be reflected in instructional design and software development [14], [17].

It is important to confirm if the virtual lab adequately meets the learning goals. Teachers need to be aware that extra classroom time might be needed as the students need to be taught on how to appropriately use and interact with the virtual lab.

**Potential of virtual world systems**

Although the projects may vary in terms of the context areas and the related technology, there are several common features that should be mentioned. Each project must consider the students’ educational needs to be met by the virtual world-based projects, either for high school students, undergraduates or professionals. This type of system is effective in a wide range of contexts, and with a broad range of students.

A virtual world-based training tool can offer advantages in several key areas. For one, a workflow-based system with independent objects enables flexible scenarios. Thus, the students doesnot just learn a rigid sequence of steps; actually, he/she can interact with active objects in any order, determine his or her path through the scenario, and thus engage in self-directed learning.

A virtual world-based system solves many practical problems as the number of students who can use the system simultaneously is not limited by technical factors.

Representing an action in a virtual world can pose a variety of challenges, depending on the accessibility and capabilities provided by the virtual world. Nevertheless, this method does not replace the traditional ones.

Less time is spent in critical assessment at the end of the course, since the learning process and measurement instruments are interactive and observable.

Virtual labs add information on how projects will be delivered, how class discussions will be evaluated, and how students can benefit from feedback to improve the quality of their work throughout the course.
Virtual lab learning experiences blend the features of exploration, moving around the world; communication, by sharing information with others; navigation, by looking at 3D content; and interaction, by using 3D objects.

Learning in a virtual lab can be designed to offer contents to students who for some reason are absent from classes or who need more time to study and reflect.

The students interacts with an object and seeing 3D simulations of contents come to life is quite powerful. Offering information in a variety of ways allows students to use that information to solve problems and create solutions for their assignments. Their attitude shifts from being passive listeners to become engaged in interactions and activities, demonstrating that they understood the course contents via the completion of projects and case studies.

Some students learn better by listening to the course contents, others by observing and visualizing contents in context, and the rest by using a proactive approach to demonstrate course competencies.

In virtual labs, there can be a balance of a mix of contents and activities to support all learners: auditory, visual, and kinaesthetic. Virtual labs support these different learning styles and give students opportunities to explore, discover, and express their understanding of the subject.

**VEMA (Virtual Electrical MAnual)**

Learning through constructivism is an active process of constructing, rather than acquiring knowledge [18]. Learning occurs from experiences of interacting with the environment rather than the learner as a passive recipient of information. Thus, each learner’s understandings or schemes of the world are unique. Instruction within a constructivist context focuses on supporting that construction, rather than handing over knowledge [19].

These theories support the value of simulation-based training, presenting students with knowledge and teaching skills in a context similar to that they will encounter in real life.
Experimenting in a lab is an important component of the learning process in engineering education. The regular use of laboratories leads to the improvement of students’ skills and the development of inventive solutions: the virtual labs [20].

Virtual class experiments require a number of elements: technology, tools, contents, course structure, training, feedback, commitment, and a good guidance to use the tool. For most users it is intuitive to move, look around, and/or interact with others. Students need to know that it is admissible to make mistakes and explore the limits, and that they are required to be active participants. They learn from their mistakes and do not need to be restricted to a traditional class setting and, instead, it is possible to move within the learning environment.

In virtual environments students are no longer involved in one way interactions, but rather in complex interactions as they engage themselves in virtual reality spaces. Virtual environments have allowed them to be highly absorbed in spaces that produce constructivist learning, interactive problem solving, and new types of experiences.

A new virtual laboratory for electrical engineering courses was developed - VEMA (Virtual Electrical MAnual) [21]. The 3ds Max, VizUp and Wirefusion were the software tools used both for the device handling (control and configuration) and Dreamweaver, a web design and development application that provides a visual WYSIWYG (“What You See Is What You Get”) editor.

With this innovative teaching/learning tool, the students should be able to recognize the electrical circuits and the acquisition methods in an easy and intuitive way, and improve their knowledge.

VEMA provides a new and effective learning delivery platform. Specifically, 3D environments can be used in a variety of ways to include:

• Discovery learning by clicking on objects with associated information;
• Reinforcement learning by offering a repository of aids, tools, etc., again associated with objects in 3D;
- Traditional instructor-led learning through a distance delivery method;
- Simulated learning by modelling a process or interaction that closely resembles the real world in terms of fidelity and outcomes.

The relevant equipment and actions were identified when a setting in a virtual world representing a real world scenario was created for each scene.

The intention behind designing training scenarios in VEMA is to provide students with open-ended situations in which they have to decide what to do, based on their background knowledge.

A significant amount of effort was put into developing the virtual space in which the students would be working. The idea was to make this space realistic enough so that students would feel immersed in the context, and thus have a more realistic, educational experience (see Figure 49).

Figure 49: Rendering of lab environment developed in 3ds Max for VEMA

A menu for one scene is shown in the Figure 50 (Equipment - Resistance). The figure shows the image and description of the resistances. The objects and actions produced are shown in the centre of the display.
Several problems came up. The most significant one was the size of the objects which were too large to handle. The solution was to use VizUp to achieve a 3D model optimization, reducing model size and increasing rendering speed (see Figure 51).

Figure 51: 390,924 polygons model reduced to 30,091 polygons (90%) and exported to VRML97

It was also necessary to use Xrefs, external files that can be attached to the archive in use of any three-dimensional design, frequently used as background scene over which supplementary information can be added (Figure 52).
In developing the training scenario, a series of prototypes objects were designed to be used in creating the system (Figure 53).

Some objects went through numerous adjustments, and there were some requirements that were not easily created in the development of the system. On the whole, using a well-defined process for identifying and clarifying needs, and defining actions and objects based on those needs was helpful in developing clear requirements and effectively designing and implementing a system based on these requirements.

It is important to develop the appropriate virtual world tools to teach the required skills (see Figure 54). These tools included interactive objects connected to procedures and allowed the students to practice the experiments.
An important benefit of VEMA was to provide the common virtual space for students to meet, overcoming difficulties [22]. Another challenge was to ensure that the course contents would be general enough to be appropriate to all students, and yet would still be meaningful and useful. By focusing on interactive objects, rather than electrical circuit domain-specific knowledge, this requirement was addressed.
E-learning assists high level learning in advanced and critical thinking.

Students were intensely absorbed in the learning activity because they felt in control during the learning activity. They were able to anticipate what would happen next in response to the actions that were performed.

VEMA allows the students to examine closely the objects in use in the environment. They were able to examine objects they needed to form multiple viewpoints in the environment, making the learning activity more interesting.

VEMA also provides an environment that immerses the students in a specific role and task. This higher level of engagement with the VEMA prototype not only maintains the students’ interest, but also encourages each one to become an explorer. Through this engagement, they move beyond the confined learning offered by many textbook activities and into a wide realm of learning where they are free to explore, innovate and experiment.

This project explored the ways in which students interacted within the virtual
environment, and the overall educational effectiveness.

A virtual tool was used to create simulation-based training scenarios to acquire basic skills, and learn electrical circuit theory. It is possible to surf within a virtual environment and interact with some electrical components.

While these training scenarios offer life-like experiences for the students, there is no limitation on how many students can participate at any one time. Furthermore, distance education students are completely included in this type of training.

It was found that the students expressed a higher level of satisfaction with the environment and level of instruction in the virtual world, as compared with other online learning systems.

VEMA is a project built using a VR desktop system devised to improve training and practical performance in a laboratory environment.

No browser plug-in is required to display presentations.

WireFusion Web is a Java applet that, using the http protocol, is downloaded to
the user's browser the same way as other files on the web server.

VEMA offers flexible, adaptable and innovative solutions to help students grow and succeed in their training.
References


CHAPTER 16

VIRTUAL WORLDS IN SUPPORTING THE COMMUNITIES OF PRACTICES

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Community of practice are a group of individuals that aim to share knowledge and practices in a particular subject. Sometimes, these communities are geographically dispersed, making difficult to handle communication and collaboration. In order to minimize these setbacks, we believe that virtual worlds can be used as tool to support communities of practice because they have peculiar characteristics: shared space, immersion, interactivity, persistence, immediacy and socialization. These environments offer one avenue of communication with a rich choice in methods for communication and share of knowledge. Use of these virtual worlds is already occurring in diverse areas, for example, companies are using virtual worlds to exchange information and ideas. In addition, virtual worlds are being used for technical support and business improvements; provide teamwork and training simulations that would not have otherwise been as accessible. Thus, the paper will describe a model for knowledge sharing in virtual communities of practice in virtual worlds, addressing some potential advantages when used to supporting communities of practice.
Throughout the years, we have verified that technologies are increasingly rooted in the daily lives of people. These have enabled the sharing and exchange of knowledge between different individuals.

Tools to facilitate this sharing of information, communication and interaction between people, are available on the web. Can be used by companies and educational institutions to define their knowledge management strategies and can improve intelligence, agility and efficiency of organizations. Face of this context, it is assumed that virtual communities, that use collaborative web tools and are represented in virtual worlds, may constitute communities of practice providing the exchange and creation of knowledge, where participation and collaboration are voluntary, and whose main purpose is to create and share the acquired knowledge through situated learning.

To check how virtual worlds provide effective collaboration of the CoP in the context of Praxis Project, we present the terms CoP, Virtual Worlds, and its main features. Also, we explain how to build a community of practice in order to facilitate the improvement of services between the project partners and finally, we draw some conclusions. Suggestions for future studies based on the effective collaboration of Virtual Communities of Practice in Virtual Worlds are presented.

**COMMUNITIES OF PRACTICE**

“Community of Practice” are groups of people who share interests, problem sets by a particular topic, deepening their knowledge and expertise in specific areas, through interactions each other. These people usually do not work together every day, but meet several times to share their knowledge, acquire new information through their interactions. These people they should create tools, standards, manuals and other documents - or simply develop a tacit understanding of what they want to split.

The Communities of practice (CoP) take a range of forms: they may be small or large, long-term or short-term, disclosed or hidden, at work or at school, spontaneous or intentional, co-
located or distributed, personal or entrepreneurial, private or open to the public, active or peripheral participation, among others [11]. Some communities of practice, meet regularly face-to-face, others are mainly connected via digital channels provided by new technologies like the internet, i.e. the interaction methods are not limited to any particular means to be an interaction between participants. However they are distinguished from other structures because they have three dimensions: domain, community and practice, as shown in Figure 55, which allows analysing and classifying groups such as CoPs.

Figure 55: Structural elements of CoPs Source: Wenger [14].

It is through the development and combination of these elements it is possible organization "cultivate" community practice [12]. These three key elements are described as follows:[12]-[14].

- **Domain** - A community of practice has an identity defined by a shared domain of interest. Membership therefore implies a commitment to the domain, and therefore a shared competence that distinguishes members from other people.

- **Community** - In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other. Having the same job or
the same title does not make for a community of practice unless members interact and learn together.

- **Practice:** A community of practice is not merely a community of interest—people who like certain kinds of books, for instance. Members of a community of practice are practitioners. They develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems—in short a shared practice. This takes time and sustained interaction.

It is the combination of these three elements that constitutes a community of practice. And it is by developing these three elements in parallel that one cultivates such a community[11].

**VIRTUAL WORLDS**

A virtual world is a simulated persistent space based on the interaction by computer, inhabited by several users, who are represented by iconic images called avatars, who can communicate with each other’s and the world in a synchronized way [6].

This definition allows us to demonstrate that a virtual world is more than a simple virtual environment. The term "virtual world" usually brings us to mind a space similar to the real world where we can live, with details and action of gravity, the surface topography of the different ways to move the objects, passage of time and finally, the possibility of active communication between the various objects created by the users. This world must not be interrupted; however it should continue to exist if the user does not connect. The persistence means that the participant is a member of a dynamic community and so, they communicate and interact with each other and with the environment. Ensure that participants have the feeling of sharing time, should be able to see the behaviour of each other and, for communication between users. Although the view is the basis for an actual virtual world, you should allow some kind of communication, mediated by the computer, occur among the participants. Such as the interactivity tends to be dynamic, the
communication is in real time. Moreover, the sense of presence, which is related to the individual and collective, allows when we got in a shared space, each participant becomes a “virtual person”, known as avatars, i.e., is a digital representation (graphic or text) in the virtual world.

Based on this definition, we can identify characteristics of the virtual world:

- **Shared space**: The world allows many users to participate at once. All the users have the feeling of being in the same place, room, land. The shared space is a common location where interactions may be occurring. The place can be real or fictional, and this space must have the same characteristics for all participants.

- **Immersion and Interactivity**: The idea of virtual world allows the users in the interaction with the environment, to alter, develop, build or submit contents. The user must feel immersed in the environment and fully engaged with the activities being undertaken. This is normally achieved through representation of the user and environment in-world.

- **Persistence**: The world’s existence continues regardless of whether individual users are logged in. The persistence of the world leads us to the immediacy feedback and synchronous use of the actions that take place in the word

- **Immediacy**: An immediate virtual world allows real-time interaction between the user and the world. Interaction between users is also real time. It is a definitional quality of virtual worlds.

- **Socialization**: The world allows and encourages the formation of in-world social groups or communities

These characteristics have contributed to represent in virtual world the different categories of information by means of three-dimensional objects, and thus, it is possible to develop a world similar to the real life. For this chapter, we solely focus on social virtual worlds which are oriented by socialization and
haven’t pre-defined rules. The objectives of members shall live and prosper by using the social practices that they can find in off-line environments, allowing its experiences being more realistic. The users do not necessarily win or play a game, but socialize with others users. These applications have several technologies into a single platform: audio, video, webcam, text and voice chat (VOIP), graphical tools, scripting, web browser and of course, avatars - the user’s projection in the world. Combining these tools and the social aspects, it opens up the way for new perspectives, new ideas that will gradually allow new applications to be used more or less related to real economics.

From the wide range of tools available in the market, we can found the Second Life, Active worlds, OpenSim, Croquet, so on. These worlds give users the ability to develop the experiences that could be difficult in real world; Have a great potential for integrating different technologies, allowing presenting e-learning materials and e-content, narratives based on social interactions, sharing documents and files, hold meetings and events, and provide forums for sharing research findings and meetings with international colleagues; Are safe places for people (students) to learn by doing and they can work in collaborate teams. The ability to interact with one another simultaneously provides students the opportunity to learn concepts not easily learned from a textbook.

VIRTUAL WORLDS IN SUPPORTING TO COMMUNITIES OF PRACTICE

From an organizational learning perspective, a communities of practice supported by information systems have long been an object of interest [1]-[15].The growth in popularity and functionality of virtual worlds suggests that they, like the wikis and blogs that preceded them, might provide a powerful new platform for learning and supporting virtual communities. Thus, the relentless technological advances are fuelling the increased interest in virtual worlds, because:

- allow to support the collaboration and cooperation between the individuals of practice community; the community
of practice can to communicate in a synchronous and immersive medium, as users are able to work on boundary objects simultaneously and finally through crowdsourcing, they can to reach out to a global audience for individuals with similar interests. For example, a group of people interested in the design of a new car can meet in Second Life and collectively work on a virtual version of the car by modifying it in real time to incorporate evolving ideas.

- the community members can collaborate not only in terms of the joint written document (which happens, for example, tools such as Google Docs or Wiki), but also in the construction of objects together performing simulations or participating in them in order to obtain an education through digital experiences.

- immersion allows the development of digital interactions between community members, they can construct objects of knowledge can make a digital representation of abstract concepts and can share experiences and practices in an environment that allows many actions

- the presence of different technologies (audio, text, video, 3D) allows the people belonging to different cultural systems can develop relationships;

Thus, in our perspective, the virtual worlds can allow develop CoP informally; [9,10] argues that virtual tools can be used to develop characteristics of communities, such as emotion, the meaning of membership, collaboration and cooperation.

Based on this ideas, we defining a virtual community of practice (CVAP) as a digital CoP developed in 3D virtual environments; this type of community can be critical to the development of productive organizations because the elements underlying the organizations are people [2]-[5]-[6].
A MODEL FOR IMPLEMENTING A COP UNDER VIRTUAL WORLD PLATFORMS

The model is composed by several phases, as shown in Figure 56.

Figure 56: Phases of model for implementation a CoPs in virtual worlds

Planning - In this step we need to identify the domain of community of practice and specify the type of community, i.e. it is private or public. An important feature is the allocation of roles to participants in a community of practice. Among these papers are considered some fundamental [7]: coordinator, facilitator/mediator, technical support, and professional (expert) or other paper. In figure below, we can see the several task of planning.

Figure 57: Tasks of planning

In this phase it is important to develop the concept of community, i.e. what is the subject, the activities that will be developed, the members and their roles in the community, what are benefits, financing, among others.
**Design** - This step was designed to describe the structure of the community of practice. We suggest divide the space in three subspaces: knowledge space, discussion space and activities space. The knowledge space must present the CoP, describe the domain and activities of community of practice; describe about the speciality area of members. The discussion space is a space where members get together and discuss the problems. In this space the members must participate in discussions, events sponsor and launch questions, give suggestions and advice, propose solutions and suggest new ideas. Finally the activities space, where we can expose the experiences, problems resolution and access the repository of shared resources. However, it is necessary the members ensure that activities are enabling the creation and sharing of knowledge. In this sense, the team support communities of practice identified some of these activities: activities presentation and promotion of events and conferences, publishing articles; establish and maintain infrastructures of information technology and eventually monitor their own development costs and objectives at the same time improving and adapting the parameters of the community.

**Development** - Design of Community of practice is based on the scenarios. To describe the scenarios, we propose the use the storyboards. The storyboards creation is a complement of the interface objects description. Its aim is to provide a global view of the CoP giving a clear idea of the speech, plot and other instructional questions. Here, the members of CoP share a continuous flow of assessments (corrections and/or suggestions) by sending and receiving versions of the storyboard. The organization of the storyboard is an important feature since it provides a clear view of what will be the CoP.

The platforms used in their implementation are the virtual worlds. With these platforms the design is easy to implement in anytime; it is possible to create content targeted to different areas, such as simulations, problems resolution, computer programming and so on; the members, by means of their avatars, can explore, interact with each others and modify the world.
CASE STUDY: A COMMUNITY OF PRACTICE PRAXIS

The members of Praxis project, mainly the Portugal Partner, decided to develop a practice community using OpenSim platform. This CoP has as objective to support work of the group of Paradigms of Cooperation between the Worlds of Education and Labour and to centralize discussions and resources. Our aim is to observe if the Communities of Practices developed under virtual worlds platforms can contribute to facilitate collaboration, learning, or knowledge generation.

Based on the model described above, our environment must allow members interact with the CoP, create contents; realize meetings and events in space virtual.

So the goals here is to have a narrowly defined thematic, identify the audience, purpose, goals, vision for the community, plan activities to help grow and sustain the community, group process and roles that will support the community’s goals. Every community is indeed unique, with distinct goals, member characteristics and needs, and purpose. Purposes should be defined in terms of the benefits to the community’s stakeholders and the specific needs that the community will be organized to meet.

For generating ideas, we held regular brainstorming sessions for collecting ideas. At the end a design document was delivered. The content of the document reflected the work done by development team, including the tasks shown in figure.
In next step, the environment was implemented in OpenSim platform. We divided the space into three distinct areas (see the figure). We decided to separate our space into different areas because an effective approach to community facilitation involves creating a predictable “rhythm” that sets an expectation around how and when to participate in the community. A “sense of place” is created in the minds of community members through an integrated, thoughtful combination of face-to-face meetings, live online events, and collaboration over time within a persistent virtual environment.
The structure of our Cop in OpenSim was developed according to certain key principles:

- Provide a shared context to communicate and share information, stories, and personal experiences in a way that builds understanding and insight.

- Enable dialogue between members to explore new possibilities, solve challenging problems, and create new, mutually beneficial opportunities.

- Introduce collaborative processes to encourage the free flow of ideas and exchange of information.
To overcome distances and develop collaborative work, we resort sometimes to insulated tools and not integrated environments that enhance the productivity and satisfaction of its members.

The emails and Skype typically are resources used successfully, but also, are exploited simple tools of collaboration, dialogue and video conferencing. However, if we are to develop environments where users CoP can feel the sense of place and presence of other individuals, facilitate communication beyond chat, voice, and automatic synchronization of documents to the supporting the community concerned, we can take advantage of virtual worlds. Was in this sense, that we was wrote this paper and wanted to create the community of CoP Praxis, because we agree with Figueredo [4], when he states that “the communities we create must leave the space to stimulate the imagination because "who participates without dreaming hardly will be creative".
REFERENCES

CHAPTER 17

WHY DO WE HAVE A SHORTAGE OF QUALIFIED ENGINEERS?

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This chapter looks at engineering from the viewpoint of the education process that creates professionally qualified graduates. A simple model of the education process is presented and, using statistics from a number of UK sources, analyses the loss at each transition point. The model is a simplistic one in that it does not include losses within each stage due to withdrawals or failures on the part of individual students. In this respect the model is slightly optimistic in its results. On the downside, the data is taken from a number of different sources and, due to differing availability of data, in some cases from different years. To mitigate this last point longitudinal data is considered that shows some statistics are fairly constant so misusing data in this way does not completely invalidate the findings. What emerges from the analysis is that approximately 1 percent of male and only 0.1% of female students who take A-level mathematics will find themselves in Engineering as their first job after graduation. The chapter shows that we cannot rely on the conventional education pipeline to provide more graduates to fill a shortage by 2020. Other methods
to fill such a short term (5-7 years in the future) shortfall will be needed.

Keywords: engineering education, qualification, educational system.

In 1975 an Electrical and Electronic Engineering graduate with a lower second-class Honours degree applied to 10 companies for their first employment after study. They received 11 job offers, one company had passed the application around different divisions and two decided to make an offer. This was not an exceptional situation. There was nothing special about that period in the history of the electronics industry although it was around the time when digital communications and microwave systems were on the cusp and rising sharply as technologies of the time.

What of the graduate electrical and electronic engineer of today? Graduates frequently need to make applications to 10 companies to receive one job offer. Why is this the case when “the UK needs to increase by as much as 50% the number of Science, Technology, Engineering and Maths (STEM) graduates it is creating.” “We need 100,000 STEM graduates per year just to maintain the status quo.”

2014 is not the only time since 1975 where there has been a declared shortage of STEM graduates. The Career-Space project was formed at the end of the 1990s to address the significant skills gap and shortage of qualified ICT engineers across Europe. [1]

Shortages in qualified engineers result not only from changes in the supply side but also when the demand side of the first employment transition changes. As technologies change, for example as new green energy technologies become more mainstream, the need for different technical skills emerge. The fundamentals of engineering generally remain constant but the ‘flavour’ of the study programmes need to evolve in line with
current industry demand. If a mis-match of knowledge and skills being developed on the supply side and what industry needs on the demand side, a reported skills shortage follows.

This paper considers the supply of qualified engineers through the fluid pipeline metaphor first introduced by Professor Perkins [2]. It explores this from a quantitative point of view using a range of different data sources. Quantification of the extent of the losses is, in itself, of potential interest to some, but of more importance are the levers it exposes to allow higher education institutions and, more importantly, others to influence the whole system involved in the creation of these ‘skills gaps’. The overall objective is therefore to consider the lossy pipeline with the objective of exploring what can be done to increase the number of qualified engineers available to meet our future demand side needs. The paper ends with some conclusions and recommendations.

The “lossy pipeline” metaphor

The supply of qualified, graduate engineers is the output of the education process. This process is considered similar to a complex arrangement of pipes, junctions and leaks that ‘fluid’ from its source to its discharge, the output of the pipeline system. To explain the terminology of the metaphor, the “discharge” is the flow of qualified graduate engineers; the “source” is the pool of all individuals that enter the education system; “junctions” are points where the fluid (the student) is faced with a choice of which route they take through the pipeline system; the “pipeline system” covers the entirety of educational options open to the student from their entry age. This entire system covers all the STEM subjects and all the Arts and Humanities subjects and all the vocational education subjects. “Leaks” in the pipeline system result when any unit of fluid, a student, either leaves the entire system or, as of interest in this argument, leaves the pipeline pathway that leads to the engineering output.

In the UK students enter the education system approximately at the age of 5 years, they enter at what is referred to as year 1. The first stage of the education process,
“primary education” ends when the student is aged approximately 11, or year 6. From year 6 to year 11 students are in first part of “secondary education”. At the end of the first part of the secondary education stage, at the age of 16, they reach the end of compulsory education, level 2 in the European Qualifications Framework (EQF). Those who wish to, and who meet the progression requirements to the second part of their secondary education enter years 11 to 13 where, typically they take A-level or equivalent qualifications, level 3 in the EQF. A comparison of these levels is shown in Figure 60.

Figure 60: Comparison of UK qualifications levels [3].

After secondary education students can enter tertiary education at, typically, higher education institutions where they undertake a 3 or 4 year First Cycle Degree (FCD), and undergraduate degree in UK parlance. The 3-year degree would be a Bachelor of Engineering or Bachelor of Science in the engineering field and the 4-year degree an integrated Masters programme. The 3-year degrees typically meet the academic requirements for Incorporated Engineer status and the 4-year programmes for Chartered Engineer status. At the end of the tertiary education stage the majority of graduates enter the world of employment through the First Employment Transition [4].
Figure 61 shows the complete education system as described above.

Considering the education system through the lens of the pipeline metaphor we can see that the first “junction” occurs in the first part of the secondary education stage. In this time period, years 6 to 11, students tend to have a study bias towards or away from the STEM subjects. Engineering, at the professional level, relies heavily on fundamental mathematics so, any diversion of the fluid away from the section of the pipeline system in the future that requires maths, is a loss to the qualified graduate engineer output. Students that choose a non-STEM bias go on to have good educations but few, in later life will find it easy to transfer back into the STEM fluid flow.

Students entering the second part of the secondary education section of the pipeline to take level 3 A levels are also exposed to junctions. To progress to the Electrical or Information Engineering (EIE) graduate discharge point, students need to take Mathematics at A-level plus subjects from a limited STEM list including Physics, Technology, IT, Computer Science. Those taking the Chemistry, Biology, Biochemistry and so on pipeline routes are also likely to be lost to the engineering graduate discharge point.

Students who, after A-levels progress to Higher Education also make a choice and hence face another pipeline junction. With an A-level in Mathematics plus other relevant STEM A-levels can progress to Engineering degrees, but they can also, with the right set of A-levels, go on to study Mathematics, Physics for example. Not all study Engineering and even fewer EIE subjects.
Figure 61 shows the full picture of the conventional education system with the subject choice junctions. It should be noted that this is the ‘conventional’ education system in that it is the system a student goes through if they continue in education without any break, such as a gap year, year in industry, absence due to illness, or, as would be the case in some countries but not the UK, a gap for military service.
Students with a STEM bias

To understand how the lossy pipeline works the number of individuals at each stage of the education system will be considered and, using available data, the overall loss figures will be derived. Data will be considered for the total loss but also the losses by gender where this can be derived. Gender is considered to test the magnitude of the imbalance that exists in engineering in the UK. Data is drawn from a number of difference sources and there is a lack of consistency in numbers, this weakness in the analysis is further explained in the following analysis. Further some data is shown with absolute numbers of individuals and others with percentages without indication of the absolute number for a consistency check.

To start this analysis some assumptions must be made. The first, and most important is that it is assumed that we are talking about students who take STEM subjects during part 2 of their secondary education. This is based on the further assumption that students require A-level standard Mathematics as a minimum to enter an Engineering programme at the tertiary level. This is
certainly true of engineering students who aspire to be Incorporated (Chartered) Engineers in later life.

According to the Guardian newspaper’s statistics for 2014 a total of 833,807 individuals took A level examinations, of these 379,823 (45.6%) were male and 453,984 (54.5%) female. Of these 88,816 (10.65% of the total number of individuals who took A levels) took mathematics, of these 54,442 (61.3%) were male and 34,374 (38.7%) female [5]. These percentages show the ‘loss’ that occurs in the pipeline at the second part of the secondary education to tertiary education process transition is 10.65% overall, 6.53% in the male, and 4.12% in the female populations.

“Statistics published by the Department for Business, Innovation and Skills show that 49.3% of young people in England entered higher education in the last academic year, the highest rate on record and just a shade below the 50% mark that successive governments have vowed to reach.” [6]. Of importance here is the percentage of students who go into Engineering. To answer this question a different data source is required, that published by UCAS, the UK central system through which all students make their application to tertiary level education [7]. UCAS data is for all individuals applying for a University place and hence is not restricted to the ‘conventional’ education process modelled in
Figure 61. Herein lies the first source of divergence of available data sets consistency in underlying assumptions and hence loss of accuracy in the actual losses in the pipeline. There is also differing delays in the time taken to publish data from the different sources. To offset this potential source of error longitudinal data is presented where available. This provides an indication of the temporal stability of the data as well as the magnitudes.

Figure 62 shows the percentage of students who were accepted applications to Engineering programmes at UK Universities.
Figure 62: Percentage of students accepted to tertiary Engineering Programmes.

![Percentage of Accepted Students]

Source [7]

Figure 62 shows that the number of students accepting places is relatively stable over time.

The figure also shows two different engineering lines, one for JASC Engineering, the other for Engineering Plus. These lines indicate another potential problem in the analysis of the overall lossy pipeline, that of defining what is and what is not Engineering. According to UCAS ‘JASC Engineering’ comprises the main engineering subjects of Aeronautical, Chemical, Civil, Electrical and Electronic, Mechanical, etc. and ‘Engineering Plus’ comprises these subjects plus Physical Sciences, Mathematical Sciences, Computer Sciences, Technologies and Combined Sciences programmes.

UCAS provides detailed information about applications that allows an analysis by engineering sub-discipline. Figure 63 shows the breakdown of accepted students by Engineering sub-discipline for 2013 and Figure 64 how these numbers vary with time.
Figure 63: Accepted students across the Engineering sub-disciplines in 2013

Figure 64: Time variability of accepted students across the Engineering sub-disciplines.

Figure 64 is interesting in that it shows the popularity of engineering sub-disciplines over time, of particular note is the monotonic rise in popularity of Mechanical Engineering. The number of students accepted onto Electrical and Electronic Engineering programmes is relatively stable over time.

Table 11 shows the number and percentage of female students entering University. The assumption is made that all
students accepting a university place actually enter that programme - in reality there is a further loss between the accepted and started transition because not all students meet their offer grades and hence ‘fail’ to enter.

Pulling the above data together as it relates to the transition between the second part of secondary education and engineering at the tertiary level. 49.3% of the students who exited the second secondary stage entered the tertiary stage. Of the number of students who entered the tertiary stage, the average percentage of accepted students entering Engineering as a subject (JASC definition) was 25,584 or 5.33%. Therefore only 5.33% of the 49.3%, or 2.63% entered engineering. If the extended Engineering subject group is used this figure rises to a maximum of 8.48%. If we take the number of students who entered A level mathematics as being 88,816 and the number of these entering Engineering degrees to be 25,584 we can see the loss of students at this transition as being 28.8%. This is an approximate figure since the year of the data differs. However the temporal stability of the percentage accepted is constant which in part suggests a similar result might occur with consistent year data.

The average percentage of females in Engineering varies with sub-discipline as shown in Table 11. Electrical and Electronic Engineering has the lowest percentage at 7.0% and Chemical, Process and Energy Engineering having the highest at 23.2% as at 2012.

Table 11: Percentage Female Engineering Entrants in 2012 by Sub-discipline.

<table>
<thead>
<tr>
<th>Sub-discipline</th>
<th>Total</th>
<th>UK %</th>
<th>Non EU %</th>
<th>EU (exc UK) %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 - General Engineering</td>
<td>3379</td>
<td>15.9</td>
<td>24.5</td>
<td>14.5</td>
<td>16.9</td>
</tr>
<tr>
<td>H2 - Civil Engineering</td>
<td>4231</td>
<td>13.5</td>
<td>21.1</td>
<td>26.3</td>
<td>16.0</td>
</tr>
<tr>
<td>H3 - Mechanical Engineering</td>
<td>6855</td>
<td>7.6</td>
<td>9.8</td>
<td>8.2</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### Project Work and Internship Improving the Cooperation between Employers and Universities

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>UK</th>
<th>Non EU</th>
<th>EU (exc UK)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>H4 - Aerospace Engineering</td>
<td>2394</td>
<td>9.6%</td>
<td>13.2%</td>
<td>18.4%</td>
<td>10.7%</td>
</tr>
<tr>
<td>H5 - Naval Architecture</td>
<td>130</td>
<td>11.3%</td>
<td>13.6%</td>
<td>13.5%</td>
<td>12.3%</td>
</tr>
<tr>
<td>H6 - Electronic and Electrical Engineering</td>
<td>4645</td>
<td>7.0%</td>
<td>19.9%</td>
<td>8.8%</td>
<td>10.1%</td>
</tr>
<tr>
<td>H7 - Production and Manufacturing Engineering</td>
<td>648</td>
<td>23.0%</td>
<td>25.0%</td>
<td>20.4%</td>
<td>22.8%</td>
</tr>
<tr>
<td>H8 - Chemical, Process and Energy Engineering</td>
<td>2221</td>
<td>23.2%</td>
<td>36.3%</td>
<td>41.3%</td>
<td>27.1%</td>
</tr>
<tr>
<td>H9 - Others in Engineering</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>63.6%</td>
</tr>
<tr>
<td>HH - Combinations within Engineering</td>
<td>785</td>
<td>11.1%</td>
<td>13.2%</td>
<td>10.7%</td>
<td>11.3%</td>
</tr>
</tbody>
</table>

Considering all nationalities of entrants the overall average percentage female is 13.4% of the 88,816 students who entered A level maths, 25% of the male and only 3.9% of the female population entered engineering at the tertiary level.

The last stage of the pipeline is graduation and where Engineering graduates as their first employment. To obtain this information we turn to the Destination of Leavers from Higher Education, DLHE, statistics [8]. These statistics, gathered through surveys post graduation. Of the 25,584 students taking engineering where they go as their first employment is called their graduate destination. Figure 65 shows the graduate destination for the 2011/12 academic year, that is those who graduated in the summer of 2012.
Figure 65 shows that 61% of engineering graduates go into full time employment. There is no gender data at this point so the assumption is made that the same percentage applies to both.

Summary and Discussion

The above analysis has considered three transition stages in the education pipeline shown in
Figure 61, one between Parts 1 and 2 of the secondary education stages, the second between the end of Part 2 of the secondary education (A level) and entry to Higher Education, the tertiary education level and the third between the end of tertiary education and into engineering employment. These transitions are labeled as x1, x2 and x3 respectively in Figure 66.
The three x’s when expressed as numeric values representing the number of students progressing in ratio to the total number that could, these coefficients can be multiplied to give the overall output to input ratio. From the above analysis these ratios are summarized in Table 12.

Table 12: Education process stage losses to Engineering.

<table>
<thead>
<tr>
<th></th>
<th>Total %</th>
<th>Male %</th>
<th>Female %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input (to A level Maths)</td>
<td>10.6%</td>
<td>6.5%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Into HE Engineering</td>
<td>28.8%</td>
<td>25.0%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Into Engineering Employment</td>
<td>61%</td>
<td>61%</td>
<td></td>
</tr>
<tr>
<td>Overall ratio</td>
<td>1%</td>
<td>0.1%</td>
<td></td>
</tr>
</tbody>
</table>

Table 12 shows that approximately 1% of male and only 0.1% of female students who take A level mathematics actually have engineering employment as their first job. An immediate word of caution is needed with these figures, they are taken from a mix of years and data sets. The data sets are not completely consistent because terms vary in definition, such as what constitutes engineering, and also in who is counted - in that UCAS data includes overseas students not only domestic UK students - the figures used in the A level statistics. So the reliability of these numbers is suspect.
Knowing the numbers is one thing, understanding the impact of the lossy pipeline and knowing what can be done to mitigate it are another. Consider a current European problem, the shortage of Engineers stated at the beginning of this Chapter. Will the shortfall be solved simply by the pipeline itself? Let us, for the sake of argument, say that the shortfall occurs in 2020. Assuming students graduate as engineers at the age of 21 and assuming tertiary level education is 3 years (the first stage of higher education as per the 3-5-8 Bologna model), the students who will emerge as graduate engineers are currently, taking 2013 as the current year, 14 years old. Referring to
Figure 61 or Figure 66 these students are close to the end of Part 1 of their secondary education. They have almost certainly decided what A levels they will take and most importantly whether they will be taking a Mathematics A level because to take A level maths requires preparation, and this starts at around the age of 14. So, what impact can be have on the number of engineering graduates that emerge from our conventional education pipeline in 2020? In short we can have no impact on the input to the pipeline, it is already too late to influence students. Might the number of students entering the pipeline be greater because of population expansion? Figure 67 shows the UK population by age as of mid-2013.
Figure 67 shows that the relevant population, that is the population aged 14 now (the students who will exit the tertiary stage of the education pipeline in the year 2020) is lower than it currently is. Assuming a proportionate impact, the number of graduating engineers will be lower in 2020 than it is last year or the year before.
To conclude, engineering has a problem in that the conventional education pipeline cannot fill a shortage in any short to medium term (5-7 year) timescale. The impact will only come through the influence of students aged 14 or below and preferably considerably below so that the pool of students who take mathematics at A level is significantly increased, this is the most significant loss to the overall pipeline for both males and females.

Females in particular are clearly not seeing Engineering as a good career as they study A level mathematics as only 3.9% of those with A level maths on average progress into an Engineering degree.

Initiatives such as the Faraday Challenge [9], Schools Outreach [10], Lego League [11], Big Bank UK [12], and Makey Makey [13] to name a few are great initiatives designed to encourage more students into Engineering. The encouragement and nurturing of students as they progress from the very start of their education into a STEM (and in particular mathematics) subject bias to A level and then into Engineering as a
career is essential if we are to have a significant impact on numbers.
References


8. www.hesa.ac.uk/stats-dlhe.


CHAPTER 18

UNPRECEDENTED GROWTH IN FEMALE ENTREPRENEURIAL PROGRAMS - AN EXAMPLE FROM POLAND

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The steady economic growth in Poland over the last 25 years, since the collapse of the communist regime in 1989, with the gross domestic product per capita (GDP/C) increasing over 80% only from the beginning of millennium (Eurostat, 2014) and with its peak in terms of GDP growth reaching almost 7% in 2007, and 4,5% in the middle of the global crisis (2011), can be explained by an outstanding expansion in entrepreneurial activity with unprecedented variety of programmes in support of start-ups.
Female entrepreneurship in Poland

Entrepreneurial and innovative activities of Polish women, recognised as one of the most enterprising in Europe (GEM, 2013), contributed to the spectacular economic progress in Poland to a great extent. Poland belongs to one of few European countries where women are more likely to perceive opportunities to start up a business than men. They also launch their companies out of necessity less frequently than men (PARP, 2012).

Challenges female entrepreneurs facing in Poland

Psychological constrains represent one of the main problems confronted by women when it comes to launching a company. Even if women perceive business opportunities, fear of failure and low self-perception of entrepreneurial competences constrain them significantly (PARP, 2012). Furthermore, women usually start their businesses as solo-initiatives and their growth aspirations are usually low.\(^\text{15}\)

Advantages of starting up by female entrepreneurs in Poland

There are several advantages to launching a company in Poland: an expanding economy with growing internal demand and limited exposure to global economic “turbulences”, supportive entrepreneurial climate, localisation in the middle of Europe giving an easy access to the market of Central-European countries. Yet, in terms of female entrepreneurship, one of the

greatest incentives to set up a company in Poland is an outstanding variety of entrepreneurial programs designed especially for women. The number of programmes, projects and other initiatives is remarkable in comparison with other European countries. For example, the research by the international consortium WINGS (www.wings-network.eu) found the existence of 17 projects supporting female entrepreneurship across all Scandinavian countries and 8 in Turkey (WINGS Working Papers, 2014). At the same time, just in one Polish region (voivodeship) – in Lower Silesia – 27 projects offered financial support for female start-ups, and almost 100 workshops on entrepreneurial skills development addressing exclusively women. As a result of these projects, over 600 SMEs were launched by women in years 2007-2013 (author’s research results). Similar projects were organised in all other 15 voivodeships multiplying their effects on the national labour market.

Examples of programmes addressing female start-up activity in Poland

Some of those programs are coordinated by the Ministry of Labour and Social Policy with projects such as “Youth in the Labour Market” and “First Business”. There are also numerous initiatives addressing female entrepreneurship focusing mainly on networking and usually coordinated by business clubs, universities, chambers of commerce and various associations. However, in the years between 2007 and 2013 the decisive majority of programmes were supervised by the Ministry of Infrastructure and Development and financed by EU funds. Polish young entrepreneurs got support for their businesses from the Operational Program Human Capital, mainly from sub-programmes „Regional Human Resources of the Economy” (RHRE, Priority VIII) and „Labour Market Open for All” (LMOA, Priority VI).

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17 Data includes only EU funded projects and workshops in years 2007-2013.
The RHRE aimed at improving and adapting qualifications and skills of labour force to meet the needs of the regional economy. Programmes for participants covered:

- general and specialized training and consultancy services related to management, ICT etc.,
- implementation of environmentally friendly production technologies,
- skills development,
- advisory services for SMEs.

The LMOA was the biggest among all the programmes supporting female entrepreneurship in Poland in terms of participants and awarded grants. Its goal was to raise women entrepreneurial awareness, build positive attitudes towards self-employment, prepare them to start and efficiently run their own businesses.

The support offered within the programme LMOA included both training on establishing, maintaining and growing a business, and financing the initial costs of company launching (amounting to 7,000 - 10,000 euro) as well as covering the basic operational costs (250 - 300 euro monthly) for a period from 6 up to 12 months.

Lessen for Central European economies (CEE)

Contrary to other Central European countries, since 2007 there have been numerous opportunities in Poland to finance female entrepreneurs and cultivate their entrepreneurial skills and knowledge. During the same period, no programme of this type was recorded in Hungary, and only very few in Slovakia and Czech Republic. Based on an extensive Polish experience, it is recommended that the labour markets in other Central European countries can be strengthened by more support for female entrepreneurship. Launching programmes to finance business ideas, especially those with high growth potential, is reasonable and advisable. Programmes for female entrepreneurs should focus on:
• Teambuilding for people with complementary skills, competences and personalities - because diversity greatly supports entrepreneurship, innovativeness and problem-solving,
• development of entrepreneurial spirit finding opportunities where others see problems, and willing to take calculated risk,
• social networks to spot business opportunities and broaden the horizons,
• business coaching and mentoring - helpful for overcoming the limitations,
• development of business knowledge and entrepreneurial skills.