KEYNOTE PLENARY
THE TRAINING OF MORE PROFESSIONAL ENGINEERS: AN ONGOING CHALLENGE

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ABSTRACT

In 1996, our completely renewed mechanical engineering undergraduate program was launched. The aim of this educational reform was to train engineers that are more competent and more professional. For this purpose, two guiding principles were followed. The first one is known as 'knowledge integration'. It consists of offering to students many opportunities to mobilize their knowledge in problem solving. The second one, which is necessary to the first one, is known as the 'less is more' principle. It consists of identifying and focusing on the most important theoretical and practical knowledge required to develop the engineering's competencies. Ten years later, these two principles are still the major guidelines used to address new challenges that are constantly identified. Among them, two are of greater concern: developing a strong competency in occupational health and safety; improving the individual and collective performance in teamwork. After a brief overview of the program reform, this paper will address these two challenges.

INTRODUCTION

Training of more professional engineers is an ongoing challenge. At the Mechanical Engineering Department of Université de Sherbrooke, it looks like a never-ending story! For example, in 1992, a pilot project was launched to integrate a major design project during the last three sessions. In 1996, a completely renewed program began. In 2002, a bioengineering concen-tration started. In 2007, a reformed master degree program will be launched. Beside these major changes, many other improvement projects had been realised.

This paper presents two of them. The first one aims to improve the occupational health and safety competency of our students. Indeed, it is an important part of engineers' work and some studies suggest weaknesses in this field. The second one concerns teamwork skills. Although a good training is already offered to the students, various observations lead us to believe that it can be improved again. But first of all, an overview of the program reform is given.

MECHANICAL ENGINEERING PROGRAM REFORM

In 1992, the Mechanical Engineering Department set up a task force to evaluate the existing undergraduate program and make recommendations. Simultaneously, a pilot project was undertaken, whose prime objective was to improve engineering design components. The inclusion of a major design project was the centrepiece of the approach. It aims to allow students to live a real design experience, from the definition of their project to the validation and exhibition of their prototype. Forty students took part to this pilot project(1).

During winter of 1993, the task force spent a week in the United States to study current and ongoing programs at three universities (Cornell, M.I.T. and Toledo). Another professor visited a French university (Toulouse). In spring of 1994, the task force submitted its major recommen-dation: to undertake a complete program reform, which aims to improve the professionalism and the competencies of our students. Encouraged by the success of the pilot project, the departmental assembly approved it. In spring of 1996, an outside advisory committee of international experts and industry representatives gave an extremely favourable review of the proposed program. In fall of 1996, the program was launched and in 2000, our first students graduated(2).

Overview of the New Program

In Canada, most engineering programs comprise eight sessions of four months. Usually, students graduate at 23 years old. Our program has this structure, and it also comprises four work terms, distributed between the fourth and the eighth session. Its duration is nearly four and a half years. Another distinction is our major design project, which starts during the fifth session and finishes at the end of the program. It counts for 10% of the diploma's credits.

The principal difference in our new program is the teaching philosophy: it entirely lies on a competency-based approach. For us, a competency is defined as '*a set of cognitive skills (knowledge), psychological/sensory/motor skills (know-how) and socio-affective behaviours (attitudes) that enable the individual to acceptably carry out a function, activity or task at the entry-level of the job market'*(2).

In this philosophy, a shift from the '*teaching paradigm*' to the '*apprenticeship paradigm*' is required. In the former, the teacher acts as an expert and his main role is to transfer knowledge. Apprenticeship is conceived as knowledge accumulation. In the latter, the teacher acts as a coach, a facilitator. His main role is to challenge students with real and complex problems. Apprenticeship is conceived as knowledge construction and integration(3). To make this paradigm shift successful, two principles shall be respected: knowledge integration and 'less is more'.

Knowledge Integration

This principle refers to the idea that real-life problems are complex and to solve them, one has to mobilize different knowledge. Thus, students have to work on complex problems, for which they need to integrate notions, concepts and theories learned in different courses. Design projects are used to carry out the overall integration of competencies along two axes:

- Vertical integration with specific semester-based projects for the first four sessions of the program;
- Horizontal integration with projects in mechatronics and a major design project over the last four sessions(1,4).

All those projects are complex. For example, a semester-based project could be the design of a mouse computer for blind people, the design of more effective bus wipers or a water treatment system for mountainous villages. Concerning the major design project, a three-wheel car, an electrical submarine and a multi-modal locomotion robotic platform are three examples among a hundred or so projects carried out since 1992.

'Less Is More'

With a competency-based approach, the teacher has to be very selective about the theoretical notions he will address. Two main reasons sustain this idea. Firstly, with the 'apprenticeship paradigm', what is important is not the amount of knowledge memorized by a student, but his ability to mobilize it when solving real and complex problems. Secondly, it is more important to give them enough time to do so, than to fill their head with notions that are interesting, but not absolutely necessary.

All things considered, according to this principle, the bet which is taken is that the students will learn how to learn and if specific knowledge is necessary to solve a problem in their future job, they will acquire it by themselves, as they did during their training. By doing so, they develop an important professional competency: to recognize their own competencies' limits.

Results of these innovations

Are the results of this reform worth all the invested time and effort? Since no national engineering exam exists in Canada, it is hard to answer precisely this important question. To do so, we should undertake a longitudinal study, comparing the professionalism of our graduate students to that of others. Nevertheless, according to a recent survey answered by 56 of our graduate students and 29 of their employers, the answer to this question is undoubtedly *yes*(5). For example, both students and employers recognize that competencies developed in engineering

design, creativity, problem solving and teamwork are useful in their jobs and that these provide them an advantage in comparison with graduates of other universities. Another example is that 69% of the employers recognize that our graduates are more autonomous and resourceful than their colleagues coming from a more classical engineering program.

However, in spite of the time and the effort invested in the program reform, the training of competent and professional engineers is an ongoing challenge. Many improvements are necessary; some are little details, some are more important. The author identified two great challenges in his field of interest: improving the occupational health and safety competency and developing a high level of teamwork skills.

IMPROVING THE OCCUPATIONAL HEALTH AND SAFETY COMPETENCY

According to the Canadian Engineering Accreditation Board, '*each program must ensure that students are made aware of the role and responsibilities of the professional engineer in society. Appropriate exposure to ethics, equity, public and worker safety* (. . .) *must be an integral component of the engineering curriculum*'(6). It is not thus surprising that all engineering programs in Canada offer courses covering the occupational health and safety aspects.

The identified problem

The occupational health and safety domain is very vast, and the related knowledge is diversified: laws and regulations; engineers professional obligations; industrial safety devices; methods of risk assessment; accident statistics; etc. Moreover, our occupational health and safety course constituted a very limited activity (15 hours) in the program. Thus, students have only a few hours to acquire the new knowledge, and a lot of time to lose it.

Consequently, it is reasonable to assume that newly-graduate engineers transfer very little knowledge acquired in the occupational health and safety course to their professional practice (e.g. for designing a safe machine). Moreover, interventions in some industrial plants support this assumption(7).

The implemented solution

From 1996 to 2002, the *Institut de Recherche en Santé et Sécurité du Travail* (IRSST, the Quebec occupational health and safety research institute) developed a safety management training program. Because it is practical and supported by efficient teaching methods, it should produce a greater knowledge transfer in professional practice. Our department picked up the opportunity offered by IRSST to integrate its training program into our mechanical engineering curriculum(8).

Keeping in mind the importance of knowledge integration, it was decided to divide the training program into two major themes (risk assessment and safety devices) and fit its different components into seven existing compulsory courses(9).

Risk assessment training component

The risk assessment theme is tackled in the fifth session, in the design methodology course. Keeping in mind the 'less is more' principle, instead of presenting some of the hundred or so risk analysis methods, only one approach is discussed. It results from an adaptation of international standards, made by the IRSST(10). By focussing only on this approach, students develop a greater mastery of the overall process and, more importantly, become aware of its weaknesses and limits.

Also, as already discussed, it is important that students work on real and complex problems. In an ideal world, they should have the opportunity to visit a plant, observe a machine, ask some questions to the operator, look for past accidents, and then assess the risks. Due to evident logistical constraints involved in bringing fifty students in a plant, it has been decided that the plant will be virtually brought in the class. A multimedia support (composed of pictures, sketches, videos, all linked together in a Web environment) allows

students to do a risk assessment as if they were in the plant. In fact, after a three-minute introductory video, this one stops on a picture with hidden sensitive zones: a left click of the mouse on these gives access to some complementary information. Exactly as in a real risk assessment, if one does not have the reflex of asking information, one cannot do a complete job(9).

Horizontal integration of this theme is mainly done through the major design project, where students have to consider health and safety aspects. Of course, the risk assessment scope varies according to the nature of the project: safety review of a machine is more alarming than it is for a bike, for example. What is important here is that students develop the reflex of caring about safety aspects.

Safety and protective devices training component

The first basic notions of this theme are introduced during the fourth session, in the first mechatronics course.

To stimulate students' interest, an expert (from the IRSST) gives a three-hour course, assisted by the teacher. In the first hour, a special effort is put to contextualize the subject: past accident examples, pictures, and statistics. Then, the expert proceeds to a generalization by presenting the following notions: guards; lock and interlock concepts; protective devices; positive mechanical action of safety limit switches; forced-opening contact switches; magnetic and inductive switches; the safety of command systems. Again, a lot of pictures, sketches and samples are used to improve the apprenticeship(9,10).

After this short course, they have to analyse eight laboratory modules, conceived by the IRSST (see **figure 1**). The goal of this activity is the application of the previous theoretical concepts.

A very interesting particularity of these modules is their voluntary imperfections: some limit switches do not respect the positive mechanical action principle, some switches do not possess forced-opening contacts, the proper use of locking and interlocking devices

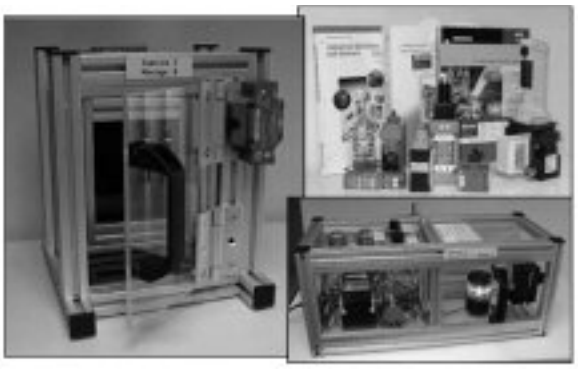

Figure 1: Laboratory modules

is not always respected, some protective devices can be easily bypassed. From a general safety and protective devices questionnaire, students have to identify the strengths and weaknesses of the modules.

Horizontal integration of this theme is ensured by two main approaches. Firstly, in the mechatronics project (sixth session), students have to take into account safety aspects by designing a protective device for their mechatronics platform. Secondly, during the major design project, if any protective devices can increase the safety of the product or the machine, students have to design it properly.

Lastly, in the eighth session, another exercise is proposed: investigation into a fatal accident. From an official report made by occupational health and safety inspectors, a Web montage has been developed. Through it, students have to collect many facts (related to technological, organisational and human aspects). By analysing them, they have to reconstitute the chain of events that lead to the fatal accident. To succeed in this exercise, *risk management* and *safety and protective devices* notions have to be mobilized.

The next step

Although occupational health and safety is now part of seven courses, the horizontal integration can be improved. Indeed, this topic relates to not only engineering design nor mechatronics. It concerns many other topics: safety factor calculus for any kind of structure, dimensioning of hydraulic circuit components, experiment planning, reliability of materials and so on. A project that has started in spring

of 2006, with other mechanical engineering departments, consists of creating a bank of educational objects (case study, anecdotes, accidents, tricky problems) that will be introduced in several other courses. What it aims to do in long term is to develop a reflex, a state of mind, regarding engineering health and safety aspects.

Another planned activity is to integrate advanced notions in risk management and safety protective devices into an elective course on 'Design for X' (DFX).

DEVELOPING A HIGH LEVEL OF TEAMWORK SKILLS

Since 1992 with the advent of the pilot project, teamwork training is offered to our students. Since 1996, it is an integral part of the program. As early as the second session, students are exposed to some important aspects of teamwork, such as:

- Efficient individual and group time management;
- Myers-Briggs' types indicator (MBTI);
- Planning, leading, and documenting a meeting.

Next, at the fourth session, the following topics are addressed in a second course:

- Characteristics of efficient teams;
- Leadership styles;
- Efficient communication (active listening, constructive feedback);
- Conflict management.

However, teamwork is not always a positive and constructive experience for some students, especially in the major design project.

The identified problem

An analysis of several teamwork difficulties encountered by students reveals that unequal individual contribution to the team project is an important cause of conflicts(11). If this difficulty has few consequences for a short team work session (e.g. a lab report), it affects considerably the cohesion of a major design project team, in which serious conflicts arise every year. If most of them manage to find appropriate solutions, others know important difficulties (e.g. team break-up and psychological discomfort, going from disillusionment to burn-out). If nothing is done to help them, those future engineers can become bad team members in their careers.

The implemented solution

A three-component solution is being developed since 1997 to improve teamwork relations in the major design project(11).

Firstly, the establishment of a team contract is now strongly encouraged by the teacher responsible of the activity. In this one, team members write down what is important for all of them (e.g. punctuality, equal contribution, respect, honesty, etc.). Some foresee a penalty system in case of fault: '*if you are five minutes late, take five more minutes to bring muffins and coffee for all team members*'(11). By signing the team contract, all members show their engagement towards it.

Secondly, an efficient self-and-peer evaluation process has been developed. It consists of calculating a '*contribution factor*' (varying from 90% to 110%) that will be multiplied by the collective mark. Moreover, since a student who receives an evaluation of 90% should conclude that his fellows are not satisfied with his contribution, he should improve himself. Thus, by applying this process several times during a session, each student should reach a satisfying level of contribution. Presently, this evaluation process is applied three times during the session. All three contribution factors are multiplied at the end by the collective mark. Thus, a lazy student which receives three times 90% will get only 73% of the collective mark. Of course, this process allows teacher to induce variation in his notation, but the most important is lived within the team: students perceive this process as a feedback period's opportunity. They can recall the team contract to update it or to ask their colleagues different behavioural changes.

Thirdly, a coaching approach for relational difficulties is offered to students or teams that need help to get over a major conflict. In this

approach, the teacher acts as a facilitator. He helps students to listen to each other, to express their frustration in a non-violent and constructive way, to ask for concrete behavioural changes. Of course, the teacher can not improvise himself as a relational coach; that requires training.

The next step

This three-component solution contributes to a better climate during the major design projects. However, teamwork skills are not useful only for this educational activity; they are fundamental skills for engineers. According to the survey related earlier, both students and employers accorded the higher score for relational skills, in regards to their usefulness(5). Do our graduate students distinguish themselves from the other students as per to their relational skills? Both students and employers said *yes*> (64.3% and 65.5%, respectively). However, a higher level of teamwork skills can still be achieved.

To do so, a strong horizontal integration is necessary. However, in the current program, teamwork training sessions are punctual events. Moreover, the second course, which introduces conflict management tools and concepts, was at the fourth session, in which no major conflicts arose. Keeping in mind the importance of proposing real and complex problems to develop competencies, students are not able to really put into practice the learned notions. Fortunately, a reorganisation of other courses of the program gave the opportunity to move this second course during the most profitable session for conflicts arising: the last one. Now, students can put into practice the conflict management tools and concepts to solve their own problems.

So, the next step envisaged to develop a high level of teamwork skills is to make a close follow-up of students from the second to the eighth and last session. A portfolio approach, in which students accumulate different realizations in regards to their apprenticeship, could be used. This idea is still at an embryonic state, because it implies many important considerations:

- How to make a good follow-up of four hundred students on this specific topic?
- Which competencies are necessary for teachers? Do they possess them?
- Is this activity official in the program? If yes, how do we evaluate it in the program and how do we avoid cheating? If not, how to sustain a student motivation throughout four years?

CONCLUSION

This paper presented educational innovations that aim to train more professional engineers. In the overview of the mechanical engineering program reform, the necessity to favour the 'apprenticeship paradigm' has been underlined. Within this training philosophy, two important guidelines were introduced: knowledge integration, which ensures a great knowledge transfer from training to practice; 'less is more' principle, which allows students to spend enough time on solving real and complex problems, as well as learning how to learn and recognizing their competencies' limits.

Then, the focus has been oriented on two other challenges of particular interest to the author: to improve the integration of occupational health and safety aspects into design projects; to sustain the development of high level teamwork skills. Although a lot of work has been done up to today, it arises that other improvements are still necessary, for example to increase horizontal integration of these notions all along the program.

In conclusion, to train more professional engineers is truly an ongoing challenge!

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THE PRACTICE ORIENTATED EDUCATION NEXUS: 'IVORY TOWER' MEETS PRACTITIONERS IN 'MUDDY TRENCHES' – MENTORING INDUSTRY PRACTITIONERS IN DEVELOPING ASSESSMENT FOR POSTGRADUATE PROGRAMS

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ABSTRACT

The Postgraduate Maintenance Management Programs at Central Queensland University are offered in a flexible mode of delivery to domestic and international students. Almost all of our lecturers are active practitioners in the Maintenance Management field and bring an experienced and cutting edge profile to the delivery of our programs to our students. The introduction of the Blackboard 6.2™ software platform has required the lecturers, who are not qualified educators, to achieve a greater understanding of the complexities of educational delivery and the necessities to map assessment criteria to learning objectives to delivery practices. Industry based students are being provided with the experience of learning in a range of environments such as studying in a virtual mode as individuals, in virtual groups and through residential schools and using paper-based materials. Lecturers are mentored through face-to-face and teleconferenced meetings to equip them with the necessary skills to meet these requirements. The success of the strategy has been that students are being provided with a more interactive and interesting learning environment which has been achieved in a virtual group dynamic and involves their critiquing and being more active in sharing their experiences and participating in their learning.

POSTGRADUATE MAINTENANCE MANAGEMENT PROGRAMS

Structure

The postgraduate Maintenance Management (MM) Programs were developed in 1995 as a result of community interests in the Gladstone region. The Gladstone campus, located 120 kilometres from the Rockhampton campus of Central Queensland University, (CQU) serves a city with a port and much industry development.

First introduced were the Graduate Certificate and Graduate Diploma in Maintenance Management, followed by the Master of Maintenance Management by coursework in 1998. These programs were initially driven by the need of the region to up-skill employees of industries in the area of MM. Now, after a period of about ten years, these programs have a more national focus.

While the programs are managed by academics (often perceived as from the Ivory Tower) of CQU, the development and the delivery of the courses involve mainly practitioners (often perceived as from the Muddy Trenches) in the area of MM. Regular consultation with industries and their practitioners ensures that the materials delivered within the courses are current and relevant to the need of the industries. While the Faculty, and therefore the academics, is responsible for the quality, development and management of the programs the practitioner lecturers are part of a team responsible for the courses. The practitioner's role includes delivery of the course and a contribution to the development and upgrade with major reliance on them to ensure that content is industry relevant and current.

The method of delivery of these programs is through distance-learning or flexible mode delivery to allow greater access for people working in industries. Telford (1995 as cited in[2]) describes flexible learning to be 'another cover-all term [similar to open learning], inclusive of all forms of learning which, though institution-based, do not follow a laid-down pattern but are adaptable (in terms of times, place, method, etc.) to individuals or particular groups'.

CURRENT DELIVERY MODE AND LEARNING/TEACHING ENVIRONMENT

When the programs were first developed, they were delivered by sending paper-based study materials to students and students submitted assessment items using surface mail. Later, the more widespread use of electronic mailing has resulted in the submission of assessment items being mainly as attachments to emails. Support for learning is mainly through the use of emails and telephones.

Progressively, the positive development of the electronic delivery medium has resulted in the introduction of electronic delivery software systems. CQU has adopted the Blackboard 6.2™ Learning Management System that allows for electronic medium delivery of courses and assessments. The development of a web-based environment has required that we teach the lecturer practitioners the capabilities of the system and engage with them and upskill them so that they develop a skills-base appropriate to developing relevant and meaningful web-based assessment items.

As a staged developmental process we have adopted the strategy that a very basic web-presence should be the achievable goal for the first year of implementation (which we achieved), then incorporated more interactive features before designing assessment items that operate within that virtual framework. We find ourselves currently in a transitional stage between what Roberts *et al*(3) would term the naïve and standard modes of a hierarchical development phase comprising naïve, standard, evolutionary, radical model. The naïve model is the most widely used and may be characterised by 'putting the lecture notes on the web'. The standard model involves introducing the added feature of the use of a range of inactive communication processes to facilitate learning. The evolutionary model introduces the ability to use animations, audio prerecord in order to provide 'live' lectures. The radical model includes minimal discourse from the academic staff and a greater need for students to operate autonomously.

Lecturer profile

Most of the casual lecturers are not academics but practitioners in MM with either undergraduate or graduate diploma level qualifications and extensive experience in the maintenance, systems engineering or related area. While having knowledge of a field of MM is valuable to the delivery of courses, they are limited in their ability to write assessment for courses as they have had no previous training or exposure to educational practices. Therefore, the academics of the University act as mentors to these practitioner lecturers to train and inform them of good practices in teaching delivery and the development of assessment items.

In the majority of cases we as academics need to challenge their ideas and perception of what happens in a university environment as their knowledge of educational practices is based upon their own learning experiences. Advances in teaching and learning strategies have broadened the manner in which we offer flexible and on-campus courses and so it is our responsibility to ensure these practitioner lecturers are informed of the latest developments in these areas. This is important so that students are provided with a stimulating and supportive learning environment attuned to their educational and work-life balance.

Student Profile

Entry Requirements

For the Graduate Certificate and Graduate Diploma Programs the entry requirement is either

- an associate diploma or degree in engineering, technology, science, or business

or

- a trade background, but have significant experience and demonstrated competence in the field of maintenance engineering.

For the Masters program it is a Graduate Diploma in MM, or its equivalence.

Student Demography

All are mature aged students. These programs have attracted people from a broad range of industry sectors; mining, manufacturing, energy, processing and regulatory bodies. Since students are returning to a learning environment that differs from what they have experienced in the past, we provide supportive re-orientation into this new learning environment by

- providing clear information, well-defined structures and processes and include residential schools, and
- promoting team building and networking opportunities, more recently through the development of web-based study communities.

LEARNING/TEACHING ENVIRONMENT

To facilitate life-long learning through continuous acquisition of skills and knowledge the student is exposed to a range of educational environments.

This is achieved by students working individually (in a virtual setting), in groups (virtually and face-to-face (through residential schools) and using traditional distance learning paper-based materials.

Current Practices

It is expected that the Blackboard platform will be used increasingly to develop and enhance the teamwork skills of students, and to promote collaborative learning. While synchronous interaction amongst students is suitable for full-time students, it is not for students in these programs as most students have both family and job commitments. Asynchronous mode of interaction is more suitable for these students. It allows students to choose when they engage with other team members. Students will have to work out basic working schedules such as how regularly they contribute to group discussions, and how regularly they communicate with team members. The ability to place students into a working team with the means to facilitate discussions among the team members makes Blackboard an ideal platform for promoting asynchronous teamwork activities.

As students have increasing access to Broadband connections, the use of video scripts for delivery of material becomes feasible. This allows lectures to be pre-recorded as video scripts for delivery to students. Case studies become more realistic as students can see a video presentation of cases. These features are yet to form part of our repertoire of learning strategies but are planned to be incorporated in the next phase of development. The change of use of study resource material over time can broadly be represented by **figure 1**.

Assessment

When we are collaborating with the practitioner lecturers to develop assessment items we want them to think beyond simple textbook exercises. As part of a student's learning experience and in order to broaden their professional skill and knowledge base we want assessment to challenge the students to think critically of their own individual, their employer's and their industry's practices. Also it is important that they do not simply 'regurgitate' delivered content but demonstrate that they are capable of interrogating and critiquing the current body of knowledge. The challenge for both the academics and the practitioner lecturers is to develop assessment strategies which allow students to explore methods that could be used in other applications or for them to determine what alternative strategies are adopted beyond sites within their company and their industry but focus on strategies and practices adopted by other industries. It is in this professional dialogue of practice that we are challenging and broadening student's perspective with the expectation that ultimately this will positively influence the practices within their own profession.

Indeed we concur with Palmer(2) in the importance of providing relevant and meaningful learning experiences and enact this by drawing upon the experience of the lecturer practitioners and in so doing we adopt an approach to ensure we are 'contextualizing the content of the course . . . to include assessable assignment tasks that require the student to use their own workplace as a case study for the analysis and application of the course content'.

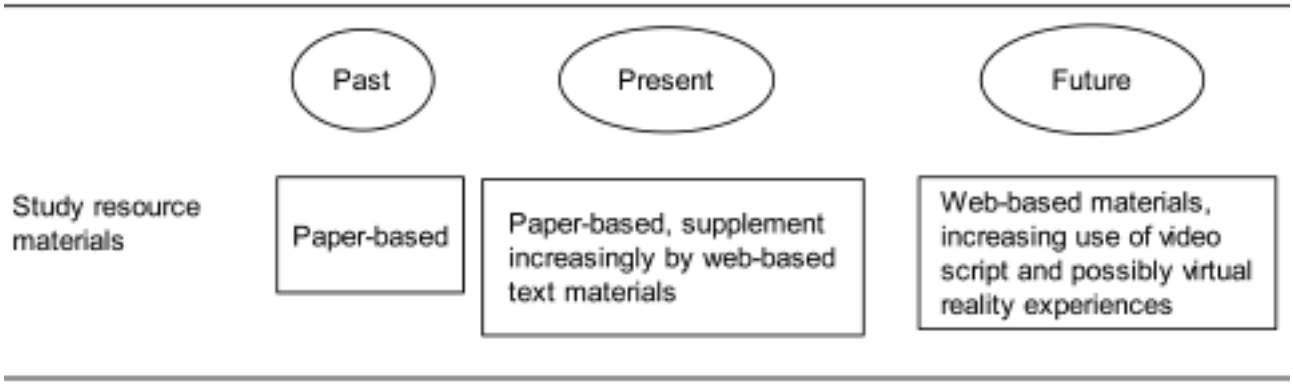

Figure 1: Progress of study material provision

Electronic marking allows feedback to occur in a much shorter time frame. The limiting factor is the student and staff internet access capability. In the case of multiple markers geographically isolated from each other this mechanism also enables moderation of marking and feedback turnaround to occur in a timely fashion.

The purpose of the assessment we wish to see implemented is the demonstration of the development of both generic professional skills and technical knowledge and skills. As academics we oversee the academic credibility and consequently we need to ensure that students gain a learning experience that challenges and develops them as professionals. Such an approach emphasises the distinction between training and professional development because training up-skills a person in a content or technical area whereas professional development encapsulates the acquisition of generic profession skills as well as technical knowledge and skills. Power (1999, as cited in[1]) reports that 'students participating in a traditional educational course have shown that the students who had access to supplemental multimedia materials (egg video, audio and animation) and simulation environment did significantly better than the students who did not have access to such material'.

MENTORING OF PRACTITIONER LECTURERS

Assessment practices

Since these programs depend on practitioner lecturers for the delivery of courses, these lecturers need to be mentored to improve their understanding of educational philosophy including appropriate assessment practices.

In the process of up-skilling the industry practitioners, who are not experienced educators, the major focus has been on mentoring by the university academics. The academics involved in the mentoring have been attempting to model the educational process the Faculty wants the industry practitioners to adopt. In this process, the industry practitioners are learning through a range of media – by paper-based correspondence, email, phone calls, face to face as an individual, as teams through video conferencing, and more recently through the use of Blackboard. It is in our modelling of the strategies with the practitioner lecturers that an action research process is invoked so that they as learners of these assessment techniques are exposed to the same learning experiences that they as the lecturers, will be facilitating with the students of our courses.

In the same way that individual courses are run by a team of academics, (academic course coordinator, industry practitioner lecturer, and industry practitioner marker) the mentoring is run by a team. While one academic is the main contact and has responsibility for mentoring a practitioner, there is a team of academics who participate in the process and each adds their own particular area of experience. A team approach is adopted when having students undertake assessment items and we also incorporate such an approach in the mentoring of the practitioner lecturers. Again exposing the practitioner lecturers to the same learning

experiences as their students highlights important aspects that are not evident unless understood from the perspective of a student.

The mentoring process started with addressing administrative and general educational issues, and the general operation of Blackboard with all industry practitioners. Now the practitioners are receiving individual mentoring to assist them with development of specific educational issues. This has involved defining learning objectives and understanding the purpose and appropriateness of different modes of assessment (including electronic media aspects).

As most practitioners have only their own educational experiences to call upon in developing these areas, the mentoring process involves reflective discussions where the practitioner is able to verbalise what they really require the students to understand, and how students might be able to demonstrate their understanding. During the mentoring process, an outcome is that practitioners come to understand that assessment is not simply a tool that tests knowledge, but a means for students to demonstrate their understanding and application of the delivered material. The innovative assessment items that have been developed through the team mentoring process have been exciting, and more industrially focused than the assessment previously developed by the practitioners.

The practitioners not only have to develop an understanding of the concept of assessment, but they also have to understand assessment criteria. For most of the practitioners, the idea of giving the students the assessment criteria with the assessment item is a new concept. While it is recognised as good educational practice, the process has also proven to be an excellent method of having the practitioners understand what they are asking the students to do and why. It ensures that they are asking the right questions in the assessment items. This process also ensures that the assessment items are addressing the learning outcomes for the course and not just merely asking the students to do a particular exercise.

The mentoring process also provides a forum for reflecting on the previous offering of a course. This reflective practice is an opportunity to identify any issues that arose from that offering and the suitability, pros and cons of particular assessment items and strategies. Until the mentoring process, courses had been offered in subsequent years with little or no change to assessment items. At this point, there has been general mentoring with a number of practitioners in a group environment as a preliminary step. This has been done using email and video conferencing.

As a case in point, one practitioner has received intense mentoring from the academic staff in addition to group mentoring in 2005. This has involved face-to-face meetings with individual academics and with the academic team, with follow-up by email and telephone. The process used for this course was to conduct a reflective review of the previous offering of the course, and to have the practitioner identify the issues that arose during that offering. The practitioner then identified what he would have liked to have seen the students do, and using brainstorming techniques, a new assessment process was developed. The number and type of assessment items were changed. The new assessment required the students to critique the work of another student. This introduced privacy issues. We have found from previous practices that allowing a student to critique the work of another student improves the student's learning. The student can compare and contrast the work carried out by them and the work of another student. The student's reflection from this activity is submitted for assessment. Compliance with privacy policy necessitates the removal of the name of the student of the assessment item used. Students have also been asked not to identify name of company and individuals in the initial submission.

One of the outcomes from this mentoring process is the recognition that there are academic and non-academic facets that relate to the actual conduction of the assessment item. The academic team as well as the practitioner lecturers need to be conscious of these issues and to comply with them.

Using Blackboard

The introduction of Blackboard to practitioner lecturers takes place in phases. First a playpen is created in the development server for the

course. The lecturer of the course is mentored by an academic of the Faculty on the basics of using Blackboard. These include the use of announcements, discussion lists and the internal email system within blackboard. They are also introduced by the mentor, to uploading teaching materials onto Blackboard. The advantage of multiplicities of communication is a powerful ally in providing differing ways in which to develop assessment items. As Palmer(2) highlights 'one-to-one communication with remote students can be time consuming; but creating a one-to-many (i.e. a bulletin board) or many-to-many (i.e. computer conferencing system) enhanced communication environment is an even greater undertaking' but in doing so it opens up the opportunity to develop assessment items which take advantage of such an electronic media component of the system. By way of example, virtual groups are able to be assigned and they are able to operate as students in one-to-many communication mode and so the learner is engaged and developing a range of communication and technical skills.

CONCLUSIONS

The practical delivery of MM courses requires the use of practitioner lecturers from 'muddy trenches'. Working with them and assisting them in acquiring sound teaching philosophies while complying with university policies are the academics, usually perceived as from the 'ivory tower'. Much emphasis has been given in the MM postgraduate programs at CQU to bridge the gap between these two groups of people as only by successfully doing this can the quality and the robustness of the programs be maintained.

This paper has presented the useful preliminary work of mentoring practitioner lecturers, by academics, in the development of appropriate and innovative assessment materials. This was made possible through the use of the Blackboard delivery system, a new course delivery system also introduced to the practitioners by the academics.

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THE UNIVERSITY ALUMNI – A FORCE FOR MAKING A DIFFERENCE TO LIFELONG LEARNING THROUGH THE WORKPLACE

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INTRODUCTION

Universities are increasingly being judged, not only on their research output but equally importantly by both potential recruits and employers, on their ability to demonstrate that their learning programmes are work relevant and lead to successful careers. Consequently, the ability to track and continuously professionally develop sufficient Alumni members to demonstrate the effectiveness of the University to provide for successful ongoing career progression is becoming of increasing importance. To do this the Alumni must feel that it is able to continue to benefit not only from the Alumni organisation, but also relevant continuing University provision. Forsyth(1). In the UK, vocational education is increasingly expected to provide up to date work ready graduates DfEE(2); Lambert(3); Little *et al*(4). Additionally the Universities are increasingly asked to: 'Prove to us that your awards are relevant to our industry or my business' Forsyth and Goodwin(5), Goodwin and Forsyth(6,7,8), HM Treasury(9).

The role of this paper is not to define the philosophy, nature and scope of a University education, but rather to indicate an option a University might use when responding to the above pressures.

PROPOSAL

The overall aim should be to provide for and continuously update a workforce capable of sustaining not only the long-term viability of industry but also the local and national economies. Consequently workplace learning frameworks, which support the development of employability attributes and emotional competencies within the individual, is pivotal to increasing their ability to adapt to challenges and seize opportunities. Significant added value is provided by incorporating the practitioner experiences of the Alumni in the form of an Alumni Mentoring Scheme. For the purposes of this paper the role of the mentor is to help the mentee fulfil his/her potential and is essentially a longer term activity compared to coaching which tends to be more skills based than mentoring and concerned with identified academic subject deficiencies. The role of the coach may be provided by identified university courses. Workplace learning should combine and apply the theoretical with the vocational practical and also develop 'employability skills'. It should also excite both the employer and learner by the relevance, academic and industry credibility of the learning on offer.

The concentration by Universities and employers on the 'need to know' activities of core knowledge and skills can be enhanced by mentors who contribute to the value added aspects of the 'ought to know' knowledge and skills which frequently affect the perception of a person's capability by employers. Forsyth(10,11), Forsyth and Goodwin(5,12), Goodwin and Forsyth(13). Workplace learning frameworks tend to place a greater emphasis on the participant to provide and evidence the learning activities and outcomes undertaken. Gray(14), Goodwin and Forsyth(15) and therefore provide the opportunity to recognise 'ought to know' activities.

In successful workplace learning frameworks participants need to learn to question, to innovate and to interact with others in order to create the knowledge and skills that will carry them forward. This is also recognised by enlightened employers, universities plus current government policies. DfEE (2,16), Taylor(17,3,4,5,7,8,12). However the expectation of the learner to question, explore and critically evaluate workplace activities related to the learning undertaken may be considered threatening by both employers and learners

and so inhibit learning. The mentor can provide a safe learning environment by being outside of the workplace, employer and University assessor and so act as a supportive sounding board not only to widen the nature and scope of learning but also to sustain the learner's motivation and retention on learning programmes.

In workplace learning the reflective process is key to successful progressive learning. Barnet(18), Chernis and Goleman(19), Smith and Hughes(20), Goodwin and Forsyth(21). The mentor can have a significant role in supporting the learner to:

- identify, evaluate, reflect upon both the planned and unplanned components of learning and relate these to the work place;
- gain overall learning reinforcement and a widening of thought processes from the experiences and approach provided by the mentor.

Reflection upon the attainment and application of technical skills is more readily undertaken as they are more easily measured in the work place and denote technical expertise. Reflection upon the proficiency and attainment of soft transferable skills is more difficult, but of major importance as they significantly affect the ability of the learner to reach their learning and career potential within the work place. Evers *et al*(22), Harvey *et al*(23,12,21). A mentor experienced in the workings of the workplace can, in a non-competitive environment, aid reflection by providing a form of on going constructive peer review of the learners' incremental gain and application of emotional competencies.

Workplace learning should bring about a knowledge community, bridging the worlds of education and work, Boud and Solomon(24), and considerably reduce the significant differences between the academic and employment environments which militate against learning transfer, Candy and Crebert(25), Chalkley and Harwood(26), and satisfy the need to build skills through subsequent practice via a range of contexts(19). This approach is compatible with the notion that motivation and interest are particularly important in learning transfer and sustained transfer of interpersonal skills to the work place, Axtell *et al*(27), Alexander and Murphy(28). The experienced practitioner acting as mentor can significantly support these concepts by helping to bridge the world of education and work, reduce the perceived differences between academic and learning in the workplace, widen the range of contexts through which learning occurs as well as encouraging interest and motivation. This encourages the formation of a 'can do' attitude to learning aimed at growing the talent of the mentee. Forsyth(5,11,29,30,31,32)

It is proposed(1) that a crucial element in attaining the full potential from the Alumni mentors and each succeeding generation is to maintain close two-way contact with the University. This process should become self-generating by achieving and sustaining a critical mass of pro-active Alumni members at all stages of career development and progression. This will provide mentors for all stages of a mentee's career. A mentee may also act as a mentor to someone at an earlier stage of their career so sustaining the contribution Alumni members can make as their own careers progress. The ideal(1) would be for both mentor and mentee to carry out the roles given below.

The mentor is **NOT** there to tell the mentee what to do, but rather to help the mentee to learn how to learn, in a wider context, through research, reasoned articulation of arguments and courses of action with post activity reflection. This will ensure that the mentee has ownership of what he or she does. The discipline for the mentee to provide topics for discussion will force the mentee to reflect upon his/her activities and bring these forward for discussion in a safe, supportive and exploratory learning environment.

The success of the mentor will depend upon his or her willingness to:

- Listen, draw upon and share experiences in a supportive and constructive manner
- Play devils advocate in order to encourage the mentee to fully examine their intentions, alternatives, their consequences and appropriateness
- Help the mentee reflect and gain confidence

- Help the mentee to successfully develop their own unique way of learning and attain goals.
- Help the mentee to develop their emotional intelligence and competences
- Recognise his/her own limitations and encourage the mentee to consult other sources and give feedback

The mentee should:

- Be honest with the mentor, in regular contact, and build a pro-active relationship;
- Be prepared to discuss openly the workplace learning undertaken;
- Implement the reflective cycle and give honest feedback(21);
- Look ahead and discuss how to prepare for future learning;
- Proactively embrace the continuous improvement cycle(21);
- Accept questioning and alternatives raised by the mentor and respond constructively.

Such University Alumni collaboration also supports the formation of well informed learning brokerages, which have also been identified as a need elsewhere(9), not only at strategic levels, to identify gaps in available continuous professional development, but also to support the content and delivery of learning. This can be further enhanced by the integration of strategic alliances with employers(3,4,5,7,17).

The Alumni mentors should proactively champion workplace learning within their own and other organisations and also encourage mentees and employers to consider the University the first port of call for continuous professional development, technology transfer, consultancy and research. This will increase the range of and the updating of, the curriculum, modus operandi and relevance of workplace learning. They should also act as ambassadors for workplace learning developing the credibility of and increasing the demand for workplace learning not only from within the Alumni but also from those of other backgrounds from within their own organisation, industry sector and community. The establishment by the university of a collaborative Alumni mentors Forum identifying and disseminating best mentoring practice, informing on gaps in up to date knowledge, skills and learning provision both in content and mode of study, would raise the reputation profiles of both the university and Alumni members. A high reputation profile supports the development, marketing and perception of a University Brand for learning, research and consultancy.

CONCLUSION

A formal sustainable mentoring service provided through the Alumni can provide significant added value to, and encouragement for, lifelong workplace learning through aiding the development of emotional competencies, the constant dissemination of best practice, curriculum updating, widening the nature and scope of the learning and providing a safe questioning and exploratory learning environment. The learning brokerage, ambassadorial roles of the Alumni mentors and mentees can also raise the profile of workplace learning with both employers and employees and so stimulate its demand by those from other backgrounds. Such an Alumni service could also be a powerful recruiting tool not only to workplace life long learning but also to full time undergraduate programmes where such a formal after graduation career mentoring service is provided. A University Brand can be supported and marketed.

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IMPROVEMENTS TO AN INDUSTRIAL PROJECT SCHEME: FINDING PARTNERS, OPPORTUNITIES TO ENHANCE EMPLOYABILITY, EQUITABLE ASSESSMENT AND FACING CULTURAL CHALLENGES

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ABSTRACT

This paper describes enhancements to an industrial project scheme that has run for all second year undergraduates in an Electronic Engineering department for more than 30 years. Students, working in groups, tackle real industrially inspired problems with complex and difficult constraints, whilst also reinforcing soft-skills including teamwork, ideas generation, oral and written reporting. Also described are recent improvements including: a four-part assessment scheme incorporating tutor, peer and even industrialist marking plus encouraging reflection by the use of Work Experience Portfolios to highlight the acquisition of skills and experience likely to enhance employability. The difficulty of finding sufficient industrial partners with suitable problems to tackle is discussed and the particular success of promoting the scheme as an opportunity to raise a company's profile among potential recruits is described. The increasing in-take of overseas students onto engineering courses leads to some difficulties for schemes such as this; the challenge of integrating students from abroad who have different educational backgrounds is highlighted.

BACKGROUND

The Department of Electronic and Electrical Engineering at the University of Sheffield, U.K. first ran its short duration industrial project scheme in 1969, see Chambers and Brown(1), quickly entitled the Sheffield Industrial Projects Scheme (SHIPS).

The aims of the scheme were as follows: to give students an opportunity to develop problem solving skills by exposing them to a challenging real industrially inspired technical problem with real technical, financial and environmental constraints. In so doing it was hoped that students would not only get an opportunity to develop their creative and criticism skills but would also gain exposure to industrial practice and so bridge the gap between theory and practice. As a spin-off it was hoped that staff too would gain by increasing their exposure to current industrial activity.

The Scheme operated as an intensive full-time 'Think-Tank' activity over a five to seven day period outside of term time. Teams, randomly selected, were made up of six or seven second year undergraduates. Projects came mostly from (often heavy) industry within 150 mile radius of Sheffield, from companies where some existing link with the University could be exploited.

Problems needed to be tangible to second year undergraduates so no in-depth fore-knowledge could be presumed. Similarly projects where a broad knowledge was required but at a low level were favoured. Multi-disciplinary problems (the stock in trade of most professional engineers) that also invited use of lateral thinking were welcomed. To encourage more projects to be offered, the University chose to waive any rights it might have to any inventions that might arise.

Beginning with an on-site part-day visit to the host company, groups (accompanied by their lectures) would receive briefings from engineers on the nature of the problem set, followed by a site tour where the issues would be examined in-context. This site visit was seen as key in giving the students exposure to current industrial practice. After this all further work took place at the University. Day two would be spent brainstorming (now referred to as 'ideas showers') this being an important technique for collective ideas generation, new to most students. The following days would be

spent consolidating ideas, selecting those most worthy of further investigation, researching and occasionally performing first order experiments to verify feasibility. The final days would be spent constructing a formal group technical written report of findings and preparing a stand-up presentation to be delivered to visitors from the host company who would attend to hear the outcomes. This presentation day was valuable as it not only gave an opportunity for the students to experience delivery of a technical presentation to real professional engineers but also allowed them to be exposed to healthy critical dialogue. The intensity of this short course was emphasised by all group members and supporting staff being encouraged to meet together for tea, coffee and lunch breaks to stimulate continued dialogue. Made compulsory, it was positioned outside of normal teaching (often during the Easter vacation).

It was not felt necessary to assess the SHIPS experience formally. Diprose *et al*(2) explain: 'SHIPS has been regarded by the department as principally for the enhancement of personal skills and experience and this is of value in itself'. A process of on-going formative self-appraisal was informally encouraged in the interests of improving group performance.

Changes and adjustments

Throughout the late '60s, '70s and early '80's the SHIPS scheme remained relatively unchanged. Although hard work for staff, they believed the benefits accrued by students outweighed the loss of staff time. Both the government's Finneston report(3) and the Engineering Council's SARTOR (Standards And Routes TO Registration) document, Levy(4), called for a greater component of engineering applications activity in the education of professional engineers. The department saw SHIPS as providing valuable opportunities to meet these demands and so satisfy the relevant professional institution, the IEE (Institution of Electrical Engineers), for the purposes of course accreditation.

Assessment: Student course evaluation questionnaires of the time revealed contradictory calls: that students wished to receive a mark for SHIPS but did not want that mark to contribute towards their second year overall average. Feelings among staff tended to favour the status quo; assessing individuals working in group activities is notoriously difficult plus the added complication of diverse project topics ranging from detecting the depth of molten steel in a furnace ladle to determining whether a chicken is dead. As a consequence the department first attempted a peer assessment based system, designed externally, with marks used for feedback purposes only(2). Students found this scheme onerous, involving the completion of many forms concerning the performance of peers and it proved unpopular. Peer assessment was new to many of the students; they strongly disliked the feeling that they were being asked to 'tell tales'(2) on colleagues. As a consequence the department devised its own peer assessment scheme with just a few forms, requiring groups to evaluate their performance as a group(2), hence avoiding the singling out of individuals. This formative assessment scheme was promoted as helping groups reflect and improve performance as they went along. Although better received it still did not contribute towards overall marks.

Changing sources for projects: Economic pressures of the '80s, especially on heavy industry, were severe. By the '90s it had became increasingly difficult to find sufficient good quality SHIPS projects. As a consequence the field of possible project sources was widened to include such less obvious sources as museums (e.g. detecting corrosion inside metal box sections within aircraft exhibits) and agricultural businesses.

Spreading out the scheme: It proved increasingly difficult to keep the scheme as one intense block of activity outside of term time: accommodation and subsistence costs for students to remain at university during vacations where prohibitive; pressures on staff to do more research made devoting vacation time to the scheme unpopular. The department therefore made the scheme a part-time term-time activity. This had quite a serious effect on outcomes. The intense 'Think Tank' nature of the earlier format had kept momentum and enthusiasm high and avoided the time waste of context switching from one activity to another. As a consequence staff

noted that the amount of progress and success achieved had declined.

Group make-up also changed. In order to distribute a range of academic ability to each team, it was decided to assemble groups with reference to performance in year one examinations such that each team would consist of academic high flyers, middle performers and weaker candidates. Exam performance is by no means a reliable predictor of performance in SHIPS, sometimes apparently weak candidates come into their own, particularly those with prior work experience. Also students from abroad where distributed between groups rather than being kept together. It was hoped that, as a consequence, individuals would be forced to develop their teamwork skills.

Support Lectures: In the early years only a brainstorming lecture was given, a topic new to most. With the move to a part-time scheme and given the increasing external pressure to include more professional-skills teaching, more one-hour support lectures were offered.

THE PRESENT SCHEME

At the end of the last century a major review of SHIPS was performed. The changes recommended are discussed next. However the principles, aims of the scheme and sequence of events remain essentially unchanged.

Time allocation

SHIPS now takes place over the twelve week Autumn semester with the visits day occurring on Monday of week 4 and oral presentations to companies on Monday of week 11. Two brainstorming/consolidation and two general purpose working afternoons are timetabled to ensure that all group members are free to meet together. Five one-hour support lectures are given: introduction to the scheme; ideas shower (brainstorming); project planning; oral presentations; technical report writing. Eight one-hour tutorial slots are also scheduled where further guidance is offered from the scheme coordinator and groups can meet to exchange information and plan.

Make up of Groups

Personal tutor groups now act as SHIPS groups. That students already know each other and have established a working relationship with their personal tutor is seen as an advantage. Although groups no-longer have a range of academic ability, this is not seen as a disadvantage as previous exam performance does not necessarily imply comparable SHIPS performance.

Significant numbers of overseas students now enter this department, some directly into the second year. For administrative reasons such students tend to be allocated together meaning tutor groups consisting solely of overseas students can result. Two westerners reflecting on their experiences of teaching in Hong-Kong in an article entitled ‘Teaching Abroad: lessons learned about inter-cultural understanding for teachers in higher education’, observed that by placing students in culturally mixed groups: ‘. . . students were forced out of their comfort zone and into the realm of inter-cultural understanding.’ Bodycott and Walker(5). Also Leon(7) interviewing Yvonne Turner about her research into culture shocks experienced by Chinese student studying in the U.K. reports ‘Group work presents students with their biggest cultural challenge. Interviewees saw it as “just playing, not learning” and found the experience intimidating.’(7). It is therefore regrettable that such groups cannot be split.

Tutees meet together formerly with their tutor once a fortnight and tutors meet their groups informally at other times to give encouragement.

Assessment

Pressure from the IEE and external teaching quality assessors has persuaded the department of the importance of SHIPS marks contributing towards students’ overall marks. Therefore the department revised its assessment scheme as follows:

Initial Visit Report (15%): assessment of a short pro-forma report prepared by each student after attending their visit, performed by the tutor. The marking criteria are: General Company Information (5 marks). The description of the

Project Problem and Related Issues (5 marks). Overall Construction of the Report (5 marks).

Final group written report (40%): each student's contribution to their group's report is assessed by the tutor (students indicate who wrote each section). The marking criteria are: Organisation, Structure and Layout (10 marks). Technical content, Clarity of Discussion and any Conclusions or Recommendations made (10 marks). Quality of Language and Quality of Figures, Tables, Graphs, References etc. (20 marks).

Oral Presentation (15%): each student is assessed on their performance at the presentations. All staff and company visitors in attendance are invited to mark using the same criteria and their marks are summed and averaged. The criteria are as follows: Presentation Quality (out of 10). Technical Content (out of 10). (Total scaled out of 15).

Peer and Tutor assessment (30%): each student assigns marks to each of his/her group peers. Individuals then receive the summed average of all their peers' marks. The criteria are as follows: Generation of Ideas (out of 5). Effort and Motivation (out of 5). Reliability and Timekeeping (out of 5).

This simple peer marking scheme is easy to understand. It is promoted to students on the basis that tutors, with their limited contact, are unlikely to be able to form a complete picture of how each individual performs: peers are able to fill in the gaps. Also, in the working world, they are likely to have to assess the abilities and contributions of others in order to pick teams or appraise performance, so good experience!

Tutors similarly allocate a mark for each group member against identical criteria. This tutor mark is combined with the averaged peer mark at a ratio of 1:1 to give a final mark.

These four stages of assessment offer opportunities for a number of assessors (including a student's peers) to contribute, hence increasing the chances of a 'true' picture being formed. The multi-part nature of the assessment irons out individual anomalies that occur.

These four marks are then summed to produce the final SHIPS mark out of 100% contributing 1/24th of a student's year two mark.

Attracting companies

SHIPS projects most often come via three main routes: those sourced via existing relationships between departmental staff and engineers working in industry (usually collaborating on research); organisations seeking to recruit more graduate engineers approaching the university looking for opportunities to raise their profile; approaches from industry seeking help with specific technical problems. Of these the last is most problematic. Students, because of the intensive researching done, often discover alternative existing solutions to problems, new to the company. However the likelihood of them coming up with a truly novel viable solution is remote. It would be unwise to use such a project where certainty of outcome is required as it would put inexperienced students under undue pressure. Universities are increasingly conscious of the commercial potential of intellectual property (IP) arising out of all university activity, not just research. Consequently universities are no longer willing to simply waive all rights should IP be created. This raises serious obstacles for those seeking realistic projects for engineering students. The author has lost good project opportunities when potential partners' commercial lawyers insist on IP agreements with restrictive clauses assigning all IP, however it should arise, to the company. Unsurprisingly university lawyers will not accept such clauses, also one cannot simply assign away any rights students might have so easily either. That IP issues are not a serious impediment to the scheme at present is shown by the results of a recently conducted anonyms reply survey among current SHIPS partners, where of the five respondents (out of a possible seven current partners) only one indicated that the lack of an IP agreement restricted the range of projects they felt able to offer.

A recent University project known as 'Business in the Curriculum', funded by a successful University bid to the Higher Education Innovation Fund (HIEF) round 2, has recently

allowed us to create a generic IP agreement for SHIPS to better deal with such situations in future. This agreement makes it clear that all IP conceived at the University will remain the property of the University but the University will grant to the Company on fair and reasonable terms a non-exclusive royalty bearing licence on University Intellectual Property.

Projects arising from existing relationships with industry have traditionally been the most common, good personal relationships bearing most fruit. Contact at practicing engineer level, where the same individual is the one that will dream up and organise the project, proving best.

Companies seeking to raise their profile (or that of their industry sector) among potential future recruits is another profitable area. For example, an engineering consultancy working in the building construction industry approached the University seeking ways to highlight their often forgotten industry sector as a worthwhile future destination for electrical and electronic engineering graduates. SHIPS has proved a highly successful vehicle for their purposes, they having recruited a number of graduates since becoming involved. Indeed in the same survey referred to earlier, three of the five organisations that replied indicated that they viewed involvement in SHIPS as an opportunity to enhance recruitment and two of those indicated that they had indeed recruited as a consequence of their involvement.

The presence of a significant proportion of non-U.K. students might be thought a disadvantage when attempting to attract companies seeking to boost recruitment, however some see it as a positive advantage. In the same survey referred to earlier, one respondent considered the presence of overseas students as an advantage, two neither an advantage nor a disadvantage and only two saw it as a disadvantage.

The University's HIEF funded Business in the Curriculum project has funded the production of a high-quality colour brochure to advertise opportunities for industry and commerce to become involved in teaching activities in our Department. This brochure will allow staff to cross-sell a variety of opportunities for industrial interaction in one go.

In the survey of participating companies mentioned earlier, respondents were asked to score various possible motivating factors for involvement on a scale of one (representing 'not a motivator') to five (representing 'Major motivator'). Averaging the results shows 'Benevolent gesture towards the education of young engineers' rated highest at 4.8; 'To help build a relationship with the University' next highest at 4.4; 'To get fresh ideas' next at 4.0; 'To raise your companies profile among potential recruits' fourth at 3.2 and 'To have a problem solved was the least motivating at 3.2.

Project problems

Instrumentation and measurement problems (e.g. how to detect failure in the water cooling system within an induction heating transformer or detecting under-carpet leakage from office air-conditioning plant) have proved the most fruitful over the years, students finding it easy to grasp the nature of such problems and the issues involved. They offer scope for exploitation of students' basic grounding in physics.

In the beginning each SHIPS group had a unique project to tackle. In order to reduce the pressure to source sufficient projects, as many as three groups now tackle the same project and are encouraged to compete to present the best solution. Initial fears that groups would collaborate extensively and offer the same solutions have proved unfounded, the sense of competition adding an extra stimulus.

Searching for information

In the early years students' only sources of information where books and journals in the University library. Recently the internet has become the dominant resource for SHIPS researchers, its apparent ease of use and wealth of information proving tempting. However students display a disappointingly high level of trust of such sources, being reluctant to use the library hence missing other sources. Information on the internet is often unreliable, rarely peer reviewed and volatile. There are examples among recent SHIPS reports of students relying on un-trustworthy internet information sources that have proved

to contained serious errors invalidating conclusions drawn. It has become necessary to educate students to be much more critical of such sources and to seek reliable confirmation.

Human Resources Management

A management school half-module on how groups from, function (or don't function) and the personality types need for effective groups has been introduced as a partner to SHIPS, where such theory can be observed in practice.

Work Experience Portfolio

The University's Careers Service have devised a general purpose 'Work Experience Portfolio' for use by undergraduates across the University: to encourage students to reflect on any work experience they may accumulate and so recognize and record skills acquired or developed. This portfolio pack has been modified for use by SHIPS students. They are encouraged to reflect and record how they have developed such employer friendly attributes as leadership, team working, self-management, communication skills etc. and to consider what evidence they might offer to support such claims. Guidance accompanying the portfolios usefully points out the similarity of this activity with the acquisition of competencies and collecting of evidence expected of those seeking to become Chartered Engineers under the 'UK Standard for Professional Engineering Competence', Engineering Council UK(6).

As the intention is to have students acknowledge skills acquired and developed, assessment is on a satisfactory/unsatisfactory basis determined by checking that sensible claims have been made. Also an opportunity for Personal Development Planning exists as students can plan how skills might be developed further.

Student course evaluation survey

Evaluation of all courses is conducted by questionnaire circulated among all students each semester. The most recent such evaluation of SHIPS resulted in the following feedback. Questionnaire return rate was 79% of all second year students. For the SHIPS part of this questionnaire, students are asked to respond to a series of questions answered by selecting one from a set of five possible answer options.

When asked whether they thought their allocated project was interesting: 9% chose 'Very interesting', 36% 'Interesting', 31% 'Reasonably interesting', 13% 'Fairly Tedious' and 11% 'Very tedious'.

When asked to assess the benefits gained from SHIPS: 23% chose 'Very worthwhile, learnt a lot', 41% 'Worthwhile, learnt a fair bit', 22% 'Reasonably useful. Learnt a few things', 11% 'Not particularly worthwhile' and 3% 'Complete waste of time'.

When asked about the oral presentation experience, students responded thus: 16% 'Extremely useful', 67% 'Useful', 13% 'Reasonably useful' 4% 'Not particularly useful' and no-one chose 'Not at all useful'.

This general course evaluation survey obviously gives only a coarse impression of student view, more detailed surveying, perhaps including interviewing, will be considered in future.

CONCLUDING COMMENTS

After forty years SHIPS is still highly valued by staff and (as the survey shows) by students for the educational opportunities it continues to provide despite its high cost in student/staff time.

The move away from an intensive full-time activity has certainly resulted in a weakening of the experience and less being achieved but practical constraints mean it is unlikely to revert to the old format.

The current assessment scheme is seen as a success, with its multi-part multi-assessor format, it tackles most of the unfairness consequent upon some other methods of assessing group work and is accepted by both students and staff.

Some students find the multi-disciplinary and sometimes non-electronics nature of the problems

set off-putting at times and more needs to be done to emphasise the relevance of tackling problems outside of ones present expertise.

Over the years hundreds of companies, from small local enterprises to international blue-chip, have taken part in SHIPS. Companies continue to be willing participants, some for five or six years continuously. It is pleasing to note that, despite competitive times, their main motivation remains benevolence. And so the scheme continues to have a healthy future.

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ENHANCING GRADUATE EMPLOYABILITY: ANSWERING TO THE REQUIREMENTS OF INDUSTRY

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INTRODUCTION

As the routine production is moving to cheaper countries, we have to concentrate on more creative work that is based on high know-how(1). Our education system should educate creative, tolerant and critically thinking people who see the world full of opportunities(2). The possibility of Finnish economy is know-how and creativeness(1). A lot of hopes are put on our higher education system that is made up of two parallel sectors: universities and universities of applied sciences.

Traditional universities rely on the connection between research and teaching. Their basic purpose is to perform scientific research and to provide higher education connected with it(3).

Universities of Applied Sciences are typically regional higher education institutions which emphasize a connection with working life. In addition to theoretical studies, these degrees also require practical training in the workplace and a thesis(3).

The law for Finnish Universities of Applied Sciences defines our three tasks clearly. In addition to providing higher education we must serve the region we operate in and we must involve in applied research and development. Applied R&D has been one of our activities for a long time, but only in 2003 it was included in the law. This is the playground we must place our operations in. This guides us to develop our education to the way where students really have the right set of skills for the local industry and other organizations.

In addition, there is and has been lively discussion about the needed future developments of higher education. Many reports have been published and several new requirements have been presented for the engineering education as well as for the higher education altogether. Most of the reports we refer in this paper are Finnish, but similar topics are also processed elsewhere for example in the white paper of British Department for education and skills(4). Typically multi-disciplinary education, internationalization and entrepreneurship are topics that are emphasized in these reports. These development challenges should be answered in our curriculums.

In this paper we describe the solutions we have developed for answering these challenges and at the same time enhance employability of engineering graduates as well as graduates from other disciplines. The presentation is based on activities in Telecommunication and e-Business unit (faculty) of Turku University of Applied Sciences (TUAS) that is the biggest University of Applied Sciences in Finland offering education in 37 different degree programs in different disciplines.

This paper uses qualitative approach and presents a descriptive study of a development process in the unit of Telecommunication and e-Business in TUAS. We start describing research setting and general requirements for the curriculum. We then continue with industry requirements for the education. After that we describe how we have answered to the requirements. Finally we give concluding remarks.

RESEARCH SETTING

The unit of Telecommunication and e-Business offers education for Bachelor of Engineering and Bachelor of Business Administration. It operates in two cities (Turku and Salo) and in this presentation we concentrate on the process carried out to develop curricula of five degree programs that operate in Salo campus (**table 1**). Industry requirements were one of

Degree Programme	Specialization	Credits ECTS	Discipline
Business and Administration	e-Commerce and Marketing	210	Business
International Business (in English)	Technology Marketing	210	Business
Business Information Technology	Database Systems	210	Information Systems
Business Information Technology (in English)	Business Information Systems Management	210	Information Systems
Information Technology	Embedded Systems	240	Information Technology

Table 1: Degree programs and specializations

the main reasons for this development process. However, there were also other reasons like financial pressures, staff workload, curriculum constraints and enablement of multidisciplinary learning.

The financing of the small degree programmes was not enough to offer anything else other than a basic setting of courses. In the curriculum only 15 ECTS (optional studies) was not predefined and fixed rather student could include here for example additional foreign language courses. More coordination was also needed because there were similar topics in every degree program, but typically under different course names that also had slightly different content and credits.

The curricula were filled with a large number of small (3 ECTS) courses, which made the management of these degree programs challenging. Maybe, the biggest problem relating to these small courses was that the professional competence students were aiming at was hidden or was at least a little fuzzy. This was also a question of teachers' resources: instead of concentrating on couple of large courses, every teacher had a mixture of small courses. This meant that a teacher had to master many subject areas without actually being a master in all of them. Constant changing from topic to topic also reduced the time to really develop the courses.

GENERAL REQUIREMENTS FOR THE CURRICULUM

The basis of our curricula is defined in the law for Finnish Universities of Applied Sciences. However, it gives only general guidelines for the curricula defining for example the structure of the curricula. It also defines the length of the study that for example in engineering is four years (240 ECTS).

The goal of the basic studies is to give broad view of the discipline in society, in working life and internationally. Basic studies should also familiarize students to common theoretical principles of the discipline. In addition students should learn basic communication and language skills.

Professional studies focus on essential applications and problems of the profession in question. The goal of the professional studies is to provide such education that students are able to work in expert positions or as entrepreneurs after graduation.

In addition to basic and professional studies the curriculum contains practical training in the workplace and a thesis. Practical training provides experience of the future work in practice and gives a possibility to test the skills and knowledge acquired in studies. With the thesis students show their readiness for applying the skills and knowledge in solving a practical research problem or task.

Next document that guides our curricula is the pedagogical strategy of TUAS. We can condense the message of that into a sentence.

The competence qualifications of the working life instruct what students should learn. The goal is a learning process in which student matures to working life expert and developer as well as life-long learner.

The main ideas of the pedagogical strategy and the above mentioned law of universities of applied sciences are opened into a format of a workbook that helps the development of the curriculum. This workbook emphasizes pragmatic topics like

- Utilization of multi-disciplinary environment
- Real possibilities of elective courses
- European co-operation
- Language skills
- Communication skills
- Critical thinking
- Ability to solve problems
- Ability to find and read information

REQUIREMENTS FROM THE INDUSTRY

We receive information about working life requirements through many channels. One of the most important channels is our advisory boards. These boards are made of important representatives of the industry and public organisations. The purpose of these boards is to show the direction of our development actions. Another important channel is the feedback during and after students' industry placements. Also every project and development task with the working life gives us valuable feedback about the requirements.

During last few years many different reports have been published about Finland and the challenges Finland is facing. Many of them see education as one important driver for future success. At the same time these reports pose requirements towards education in order to be able to answer these future challenges. Also Ministry of Education in Finland has described development challenges for Universities of applied sciences in their Education and Research 2003-2008 report(5). Degrees in Universities of applied sciences emphasize working life competencies and development requirements. Degree Programmes should also provide possibilities for individual curriculum i.e. individual study plans. One challenge is also to have such a tutoring organization that supports and guides students in their studies and decreases number of drop-out students(6). Development actions should focus primarily on speeding graduation and making quality of teaching better(7).

It is essential that the know-how that is generated in Universities of Applied Sciences transfers to working life. Especially important is that the know-how is relevant for the working life and for the positions they offer. Know-how is actually a sum of education, research, development and innovations. Universities of Applied Sciences should focus on practical skills and competences and forget the role as theoretical knowledge producers.(2) Employers want graduates whose skills are better fitted for work(4). The reports also write that teaching should be organized in larger modules that are based on working-life competence requirements(8). To summarize interaction between education institutes and working life should be widen. For example teachers' know-how of companies and working life should be improved and updated by arranging individual and field-specific placement periods for teachers too(7,8). Universities should ensure that staff are engaged in continuing professional development to maintain, develop and update their skills(4). Altogether, Universities of Applied Sciences are expected to provide peculiar education meeting the requirements of working life and education that graduates students in production as well as in design and superior tasks(7).

Enhancing entrepreneurship is another requirement that is constantly mentioned when the responsibilities of Universities of Applied Sciences are discussed. For example The European Commission's Green Paper 'Entrepreneurship in Europe' stated that education should contribute to encouraging entrepreneurship, by fostering the right mindset, awareness of career opportunities as an entrepreneur and skills(9). Changes are required in the higher-education system to place more emphasis on advanced entrepreneurship education(10). A report says that for a small country like Finland R&D, exploitation and business skills belong together. Improvement of business skills is a supposition for success in global markets.

However, there is lack of entrepreneurs and a need for entrepreneurship!(2) Another report emphasizes business and management as well as project management skills in general. Overall the integration of different working life skills, like interaction, project, superior and business skills, is important(7). Employers have actually concern about the skills of graduates, particularly in terms of communication and other soft skills(4). A major challenge is however enhancing knowledge in business operations and entrepreneurship(2,6).

Internationalization is also a big challenge especially for a small country like Finland. Education should prepare and educate students for international operations for example by arranging work placements abroad. Exchange periods lasting several months should became a rule for students but also for teachers(7). If our aim is to be a global actor, we need to send our students early enough to exchange periods so that they learn how different cultures operate(2). Altogether we need to strengthen our efforts in internationalization(2,11). Universities of Applied Sciences should encourage student exchange and make sure that this will not introduce any problems for the progress of studies in students own institute(7). There should also be reasonable modules that are taught in foreign language(7).

Another requirement that is quite often named is that graduates should have multi-disciplinary skills. A challenge is to get different disciplines work together(11). Actually, students should be able to acquire knowledge and skills from many disciplines during education(2). Future education should offer chances for multi disciplinary learning. Education system motivates and supports learning of multi disciplinary skills and knowledge as well as language skills and co-operative skills. Altogether the message is that the possibilities to combine different disciplines should be increased(8).

HOW WE ANSWERED TO THE REQUIREMENTS?

A simple answer is that we developed our study process and curriculum structures. Our development had different phases:

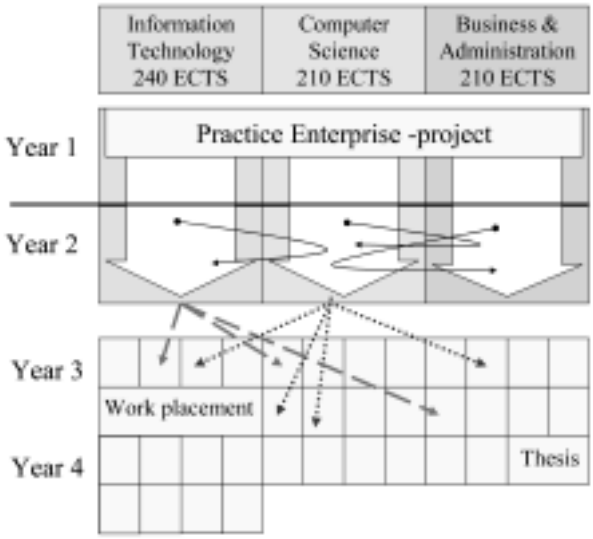

Figure 1: Structure of the curricula

- Defining the structure of the curriculum
- Defining the competences
- Add entrepreneurship
- Add internationalization
- Discuss with the working life representatives
- Refresh lecturers working life experience.

In first phase we had to define a curriculum structure that allows answering to the requirements. The basic principle was of course to have a structure like defined in the law, but also a structure that gives us a possibility to support multi-disciplinary education. We ended up to a version where a student can build his/her personal curriculum within the constraints (see **figure 1**).

A major change that has been implemented is the possibility to study courses from another degree program and discipline. This change required a flexible curriculum structure and major changes in the study process itself. For example we had to develop our time schedule system in order to guarantee the possibility to follow some course without getting into a conflict with some other course.

In next phase we defined a basic set of skills and competences a student should acquire in minimum when studying in certain degree program (basically first two years in **figure 1**). After definition of these basic competences we created a set of competences that a student

can select and build his/her own expertise. The competences were defined as study paths consisting different amount of courses. We tried to define these competences so that they have relevance in the working life. There are competence areas like Web application programming, Information systems development, Programming and Databases.

One of the basic and mandatory competences is entrepreneurship. Now every student in Salo campus learns basics of business operations during this first year project. This one-year practice entrepreneurship project is also a multi-disciplinary way of working since there are students from 4 to 5 different disciplines and it connects our students with the University students as well. The students start up companies in groups of around 12 students. These companies operate in international practise enterpise network and simulate operations of real-life partner companies: everything else is like in real life but money and goods are not moving. The project uses Problem Based Learning and Learning by Doing as pedagogical means. **Figure 2** shows how the number of participating students and number of started companies have grown from the beginning. Engineering students in Salo campus joined this project autumn 2003.

Besides learning basics of business operations and entrepreneurship the aims of the project are

- Students' networking: they recognize strengths of each other
- How to work in a team
- How to tolerate uncertainty
- How to plan my own work
- Creation of new contacts with region's companies and organizations.

Basically this project strengthens also general skills like communication skills that are constantly needed at work.

Internationalization has always been a natural part of our unit because three out of six English-taught degree programs of TAUS have been our programs. However, we still had to seriously think how internationalization could be promoted. An obvious solution is to increase courses that are taught in English.

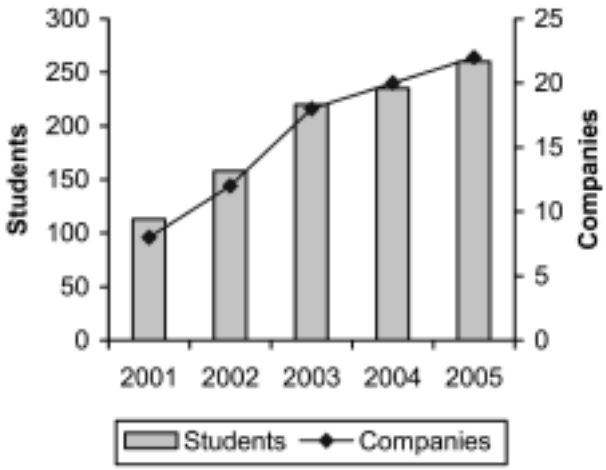

Figure 2: Statistics of the Practice Enterprise project

Within last 2 years the instruction language has been changed in many courses and we currently have a quite large collection of English courses. Earlier English was an option and only used if some non-Finnish joined the course. Now the situation is much clearer when the language is settled beforehand. Another action that we have taken is active marketing of exchange places among students. It has been especially difficult to get engineering students interested in an exchange period. Fortunately, the marketing has succeeded and the exchange figures are going up. We are also starting to analyze our partner network to make it more efficient. Furthermore, we have activated in R&D-sector and have started international projects to activate our teachers too in international relations.

The requirements emphasized that education should be relevant for the working life. We have done many improvements to our curricula and study processes. Our advisory boards have acted as commentators for our curricula. We have presented our curricula in advisory board meetings and have received encouraging feedback. The introduced solutions are seen reasonable. They also emphasized the practically oriented relevancy of the education. In addition, they recommend long exchange periods abroad.

Applied R&D has provided our teachers a natural way to update working life contacts and know-how. When a teacher is guiding a real-life project he updates his know-how and

receives valuable information what's going on in industry. An example where both students and teachers update their know-how and be in contact with the working life is our co-operation with Microsoft in establishing Education Support Center in Finland (ESCfi). ESCfi provides support for Microsoft operating systems and server products for schools and universities by solving real problem cases. The personnel working in ESCfi must be Microsoft certified professionals of the supported product areas.

CONCLUDING REMARKS

We have taken the requirements very seriously and a lot has been done within last years. We have answered to most of the requirements that have been presented. Our students have now a real possibility to study courses over the degree programs; they can truly build an individual study plan. This open system has required more tutoring, development of our information systems, more accuracy in our planning and better communications. However, we see this support for multi-disciplinary arrangements very valuable.

Our solutions in learning entrepreneurship are recognized. We have had many questions about our solutions from our Finnish colleagues and at the same time they have thanked our operations. We are also starting together with Tallinn University of Technology's faculty of Economics and Business Administration a R&D-project that is funded by EU's Interreg III A program. The name of the project is 'From SEM to SME' (From Student Entrepreneurship Model to Small and Medium sized Enterprise). The goal of the project is to intensify the entrepreneurship training know-how in participating universities. The idea is to develop the Student Entrepreneurship Model further as a co-operation between Finnish and Estonian trainers. The goal for the long run is to turn the concept into an international certificated training product for export.

The competences we first defined have changed couple of times already. However, the basic idea to define competences has proven to be correct. Now students know better what they study and how they set their goals. Nationally a project has been started where common competences are defined for every degree program. It is quite interesting how similar or different the national competences are compared to our current competences.

As the requirements defined teachers' know-how of companies and working life should be improved and updated by arranging individual and field-specific placement periods for them. Typically, funding this kind of activities is the key issue. Fortunately, we have managed to create a two-year project (ICT Pro) around this placement idea and we have funding for altogether 12 teachers for three months placement with full salary. The funding comes from EU and it is locally coordinated by State Provincial Office of Western Finland. At the moment the 12 teachers are selected and they are arranging the placement periods with different companies. In addition to updating the working life knowledge the teachers should actively look for possible R&D-actions together with the company and our university.

One of the challenges we still have to work on is teacher-exchange abroad. Our people do travel a lot, but these trips are mostly for conferences and meetings. True teacher exchange has been insignificant. This promotion of teacher-exchanges is one of the tasks for this year.

Finally, we believe that our efforts in developing the education towards industry requirements will give better possibilities for our graduates when they enter into labour market. We are sure that our choices have enhanced employability of our graduates.

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