

COURSE MATERIAL

COMMENTS

REPORTS

**RESEARCH REPORTS 17**

Jerker Björkqvist, Mikko-Jussi Laakso, Janne Roslöf,  
Raija Tuohi & Seppo Virtanen (eds.)

# INTERNATIONAL CONFERENCE ON ENGINEERING EDUCATION 2012

Abstract Book

Turku, Finland  
July 30 – August 3, 2012



TURUN AMMATTIKORKEAKOULU  
TURKU UNIVERSITY OF APPLIED SCIENCES

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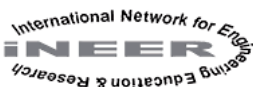
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Turun yliopisto  
University of Turku



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## FROM THE EDITORS

The International Conference on Engineering Education 2012 (ICEE 2012) takes place in Turku, Finland, July 30<sup>th</sup> – August 3<sup>rd</sup>, 2012. The event is the 2012 edition of the popular ICEE conference series sponsored around the world by the International Network for Engineering Education and Research (iNEER) with 38 000 members in 98 countries. The ICEE 2012 conference is hosted by Turku University of Applied Sciences together with University of Turku and Åbo Akademi University. All the organizers together with the City of Turku welcome you to the event!

The main theme of the conference is Contributing to Success through Innovations in Engineering Education. This theme is visible in the keynote presentations, topical sessions and workshops. The rich topical program will surely facilitate lively discussions and contribute to further development of engineering education. The event will be devoted to studying various aspects on how to enable the students, future engineering professionals, to utilize their full potential to meet the global challenges. The topical areas contain, for example, categories like Sharing Global Perspectives in Engineering Education, Facilitating Innovation Competences, and Promoting University-Industry Collaboration & Commercialization of New Innovations.

Originally, 260 abstracts were submitted to ICEE 2012. 241 of these abstracts were accepted. The authors of accepted abstracts submitted 174 full papers to the blind peer review process. During the review, 433 review reports were filed by 112 members of the ICEE 2012 International Program Committee. The acceptance decisions were made based on these reviews. Moreover, the reviewers' remarks served as valuable support to the authors of the 160 accepted full papers when they prepared the final versions of their submissions. We want to address our warmest thanks to all the colleagues who participated in the review process.

This publication, ICEE 2012 Abstract Book, finally presents the abstracts of the 149 accepted full papers that will be presented in the conference. These papers are written by 356 authors representing 34 different countries. The abstracts are published in the form they were accepted in the first submission phase in February 2012. This book is available both as a traditional printed book and an electronic publication. The full papers are published in the ICEE 2012 Proceedings publication that is available in electronic format only.

The ICEE 2012 Abstract Book will serve as a general manual to the papers of ICEE 2012 both during and after to the conference. We hope that it will help you to find the contributions that are most valuable in developing your own research, practice and profession further.

Take the opportunity to discuss and network with your colleagues during the conference. Global co-operation and partnership is of major importance when meeting the challenges in engineering education.

We hope that you will have a fruitful ICEE 2012 experience!

*Turku, June 22<sup>nd</sup>, 2012*

*Jerker Björkqvist*

*Mikko-Jussi Laakso*

*Janne Roslöf*

*Raija Tuohi*

*Seppo Virtanen*



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## 9 ON MOVING FROM STRUCTURED ORAL ASSESSMENTS TO COMPUTER-AIDED ASSESSMENTS FOR VOCATIONAL TRAINING

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Included in methods commonly used for assessing knowledge and skills associated with vocational training are oral assessments (OAs) since, with a careful line of questioning, they can be used to assess knowledge and skills to a depth rarely achieved in other forms of testing. However, OAs require considerable preparation by the assessors, they can be restricted by time and assessor allocation, it is difficult to fully cover the course fairly and they can put undue stress on the examinees, hence hindering a true expression of their skills and knowledge.

The present work develops and tests computer-aided assessment methods for mechanical engineering workshop practice and compares their use with that of OAs. It is recognized that computer-aided tests have merits and problems. They are efficient and straightforward to run, and they give an assessment environment which is less stressful than OAs, but, they have a major disadvantage in that students will on occasions guess answers when multiple-choice questions (MCQs) are used. This disadvantage will be addressed here.

Two electronic assessment methods are developed, one using a scoring method designed to eliminate the effect of guessing and the other using a set of pairs of MCQs also designed to counteract examinee guessing. This is followed by a comparison of the four assessment results for three cohorts of students, namely, the results from an OA, the results of the electronic assessment method using the “scoring method”, the results of the electronic assessment method using the “set-of-pairs” method and the results of an electronic assessment method using the traditional “positive-grades-only” scoring rules.

It was found that the scoring method was the best of the electronic assessment methods to replace the oral assessment method.

# II A STUDENT'S PERCEPTION OF ETHICS DURING HIS FINAL YEAR PROJECT "ETHICS ON A CONSTRUCTION PROJECT" IN THE MIDDLE EAST

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The construction industry is known for low ethical performance, and business ethics are rarely taught and emphasised in Middle East academic institutions. The purpose of this study is to show how and why an engineering student's perception of ethics changed during his undergraduate final year project.

The study is based on a case study approach and it analyzes the change of the student's perception of ethics throughout his project, measured by emergence and continuation of ethics concepts. In addition to the qualitative analysis, NVivo9 [1] has been utilized to analyze ethics concepts and conceptual relationships within the student's submitted thesis.

It was found that the student's ethics perception changed throughout his final year project. At the beginning he considered the topic unimportant, but gradually became aware of its significance without a clear conceptual understanding. His final perceptions were, that personal misbehaviour is the core issue, and that clear expectations, a role model, applying the Golden Rule and trust between project participants are the primary solutions for a variety of ethics issues on a construction project.

The study clarified causes of a student's shift of his perception of ethics. Interaction with an ethically minded project manager and a workshop with high ranking project participants had a greater impact than the student's interviews with the same project participants or literature review. This should be considered when preparing engineering students for ethical dilemmas in the workplace through final year projects and other assignments.

## REFERENCES

[1] QSR, "NVivo9 user guide", QSR International, viewed on 15 November 2011, <http://download.qsrinternational.com/Document/NVivo9/NVivo9-Getting-Started-Guide.pdf>, 2011.

# 15 INNOVATION PEDAGOGY – A NEW CULTURE FOR EDUCATION

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According to Hall “culture is learned and shared behavior”, there are great differences among the ways people behave in different cultures. Culture can also be defined as “the entirety of societal knowledge, norms and values” Culture sets the norms which are rules of conduct for particular circumstances and values, which mean sense of what should be maintained or achieved. Culture is not a one thing but a complex series of activities interrelated in many ways. There are various approaches for comparing and classifying cultures which usually refer to cultures between nations. However there are different cultures between different occupations, social classes, subcultures etc. Culture is transferred from older to younger generations by different agents in a socialization process. It is obvious that this kind of socialization happens also when a new student arrives into a study program. The norms, values and well-regarded behavior is different among engineering students and sustainable development students or business students and design students.

Traditionally, the role of education has been to give knowledge-based readiness, which later would be applied in practice to various innovation processes in working life. Innovation pedagogy introduces how the development of students’ innovation skills from the very beginning of their studies can become possible. Innovation pedagogy contributes to the development of new generation of professionals. It provides a new starting point for all the different study programs. It is a prevailing culture for the new university.

According to Senge a learning organization is “an organization that is continually expanding its capacity to create its future”. It has been argued that the rate at which organizations learn may become the only sustainable source of competitive advantage for them. Organizations are made up by people so it is essential that the people are capable of being innovative and producing something new, the learning of the organization is directly related to the learning of its employees. It has also been presented that organizational learning is a requirement for achieving sustainable competitive advantage. So it is vitally important that an organization, when wanting to continuously maintain its competitive advantage, also makes sure that the conditions for organizational learning exist.

In this paper we present the concept of innovation pedagogy and show that it can form a new culture for the universities and thus provide a cornerstone for the creation of individuals who are innovative and capable of contributing to the success of future learning organizations of working life.

## 16 PROFILES OF ENGINEERING STUDENTS IN MATHEMATICS

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For some time mathematics teachers in Finnish UAS engineering have been talking about students struggling in passing the courses. It is quite usual that last courses before graduating are the first year mathematics, physics or statics. Amount of these students is growing at the same time when resources are diminishing. It is easy to point the finger at students coming from technical colleges because of their lesser education in mathematics. Analyzing grades of the first mathematics course in 2010 at Saimaa UAS showed that grades were diverging despite the previous education. The same kind of diverging could also be found when grades were classified according to the results in the proficiency test, which was hold at the beginning of their studies.

We asked the students to fill in questionnaires about motivation and self-regulation towards mathematical studies. Answers were classified according to the grades with background information like previous education, mathematics studied in a high school and result in the proficiency test. Classification was done with IBM SPSS® Decision Tree. It could be found that the same motivational and self-regulating factors were either lowering or raising the grades despite the previous education or results in the proficiency test.

These factors were used to get profiles of different kinds of students. In the autumn 2011, freshmen were asked to select the profile best describing them. The selection was done during the proficiency test. The same students also filled in the motivation and self-regulation questionnaires. In this paper, it is analysed how well students' selection from profiles and their actual mathematical profile according to the questionnaires matched and how, if necessary, the profiles should be improved. When profiles are selected correctly enough by students, their mathematical studies could be supported from the beginning. It would lower frustrating felt by students and the diminishing resources could be used efficiently.



# 19 IMPROVING HANDS-ON EDUCATION BY INTRODUCING A MECHANICAL COMPONENTS MODEL SUITCASE

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Engineering students start their bachelor degree course with little or none understanding of mechanical components. As part of the education program the Institute of Product Engineering developed a mechanical design course to improve the students understanding [1]. In addition to the theoretical lectures the students are participating in hands-on workshops starting from the first through to the fourth semester. The objective of the workshops is to close the gap between theory and praxis. The student teams are working on engineering problems with increasing complexity [2]. It has been shown in the past that students understand a mechanical system faster when presented a working model.

This paper presents an education approach using a “mechanical components model suitcase” to improve the students understanding of mechanical components and their functions. The content of this suitcase ranges from bearings to a gear box. By using real objects it becomes much easier to point out complex relationships such as working surfaces (WS), the relevance of surface roughness and tolerances.

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## 21 RESIDENCY PROGRAMS FOR ENTREPRENEURIAL UNDERGRADUATE ENGINEERING STUDENTS

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An important component of any entrepreneurial endeavor is diversity of the founders. This fact leads to a process of incorporating engineering students with those majoring in business and all other fields. A second important aspect of entrepreneurship education is experiential learning; i.e., trying entrepreneurial endeavors in a supportive environment. A third important element is being closely associated with other students with strong entrepreneurial spirits.

In 2000, the Clark School of Engineering started a program for entrepreneurial junior and senior students which incorporated these three elements into a unique program called the Hinman CEOs Program. Each year about 50 entrepreneurial junior students are selected to join with about 50 senior students to live together in a residence hall where they form teams, start and operate companies while pursuing their chosen fields of study. The Hinman CEOs student body is very diverse, typically with about a third engineering and science majors, a third business majors and the remaining third made up of students majoring in arts and humanities. At any given time, 25 percent of the students are operating companies that are generating revenues, and upon graduation 10% of the students choose to run their companies full-time.

The program has been so successful, that 23 other U.S. universities have replicated the model. Also, the Clark School has started a similar program for freshman and sophomore students, with about 150 total students, and this program is drawing entrepreneurial students to the University of Maryland who in some cases would otherwise have selected other, more prestigious, universities. Details of these programs will be discussed in the paper.

## 25 OUTSTANDING FEMALE HIGH SCHOOL PUPILS' PERCEPTION OF ELECTRICAL ENGINEERING – WHAT HAS CHANGED?

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The underrepresentation of women studying Electrical Engineering (EE) is a well-known phenomenon in many countries, including Israel [1-2]. Attracting young women to this field is a challenge since females have a more negative attitude towards engineering than do males [3]. Thus, universities throughout the world hold exposure days for female high school pupils aimed at encouraging them to consider taking up engineering studies [1-2].

The Department of EE at the Technion – Israel Institute of Technology is the largest of the Technion's departments, with 1800 undergraduate students and 400 graduate students. It is ranked among the top EE departments in the world. This paper describes an annual one-day conference for outstanding female high school pupils held by the Department in 2011. Analysis of data collected before and after the day reveals a notable increase in pupils' willingness to consider studying EE, accompanied by a substantial increase in intrinsic motivation factors (e.g. interest and enjoyment) at the expense of extrinsic factors (e.g. high salary, fringe benefits, and status). Moreover, this one-day conference sharpens the vague picture the pupils have of EE and creates the impression that EE is an appropriate field of occupation for both genders. The conference, however, also creates the impression that EE is an exceedingly challenging discipline. A comparison with findings from the 2005 conference indicates that initial awareness to EE and initial willingness to consider studying EE has increased notably over the past six years. This finding is in accordance with the increase in the representation of women among the undergraduate population of the Department, from 13% in 2005 to 16% in 2011.

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### 33 DIGITAL TANGIBLES INTERFACES AS AN ALTERNATIVE OF TANGIBLE MODELS FOR ITS USE IN A VIRTUAL LEARNING ENVIRONMENT IN ENGINEERING

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At the University of La Laguna it has been developed a 3D modelling workshop in order to improve the spatial skills of engineering students. The first exercise of this workshop used a tangible painted aluminium models. Students should manipulate them with their own hands to create a normalized representation drawing in paper. [1].

In order to implement the workshop in a Virtual Learning Environment, the problem arises that these pieces (aluminium models) are only available for students in the classroom setting for the subject. The aim of the Virtual Learning Environment is to allow students to make the workshop both, in the University and in their own home. Because of this, is intended to replace aluminium models for digital files that remain the need for handling touch.

To this end, we propose two different solutions: the use of augmented reality files and 3d virtual models manipulated using digital tablets. These two technologies are called digital tangible interfaces, since there is a need to manipulate digital representations of objects with the hands [2]. In the case of augmented reality moving a printed mark and in the case of digital tablets, by moving the fingers on a touch screen. This article describes the exercise of 3D modelling workshop using aluminium models and its implementation with these tangible interfaces in a Virtual Learning Environment.

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## 34 ASSESSMENT OF SHORT-TERM POST-IMPACT OF STUDENTS' LEARNING EXPERIENCE IN AN ORAL COMMUNICATION COURSE AT MIT FOR EECS MAJORS

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Electrical Engineering and Computer Science (EECS) majors at MIT are required to take a communication-intensive course called "6.UAT"[1]. An assessment of the oral presentation skills component of this course was performed during the Spring 2009[2] and Fall 2009[3] semesters. This paper describes a follow-up study in which a retrospective survey was designed and administered to assess the impact of the course on these same cohorts, eight months after their completion of the course. The response rates were 56% and 52% respectively, and the findings were consistent and positive: students clearly feel they now give more effective presentations and do so with more confidence. They also understand that their presentation skills can continue to be improved and 90% say they continue to strengthen their oral presentation skills.

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## **35** LECTURERS' PERSPECTIVES ON THE EDUCATIONAL BACKGROUND OF ENGINEERING STUDENTS

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One of the rich flavors but also central challenges present in engineering education deals with the high level of heterogeneity among the incoming engineering students. Students enter Bachelor's level engineering education with many different educational backgrounds. For example, the new students of the Degree Program in Information Technology at Turku University of Applied Sciences (TUAS) typically represent three main categories. Usually approximately 1/3 of them have a vocational qualification, 1/3 have completed the upper secondary school with the so called "short" course in Mathematics, and the remaining 1/3 enter the program with upper secondary school certificate with a "long" course in Mathematics. In addition, the students with vocational degrees often represent many different fields of education (usually technical or business-oriented, but also others).

The goal is to provide such a learning environment that the admitted students have equal possibilities to learn and, finally, reach the same core learning objectives regardless of their educational background. However, there are rather limited possibilities to tailor the teaching and learning processes so that they fit the different needs of individual students or even the different student categories. Furthermore, there are different opinions between the lecturers whether the educational background affects students' risk to drop out, or their possibilities to reach the learning objectives in the first place.

In this paper, the results of a small-scale survey to the lecturers of the Degree Program in Information Technology at TUAS are presented and discussed. The goal of the survey was to study how the lecturers consider the possible differences between the students with different educational backgrounds. How do the lecturers describe the differences?

Do the lecturers consider different students in their teaching? How could the learning of different students be supported better than they currently are? The survey was implemented as a web-based questionnaire, and the lecturers answered the questionnaire anonymously.

## 37 A MODERN COURSE IN VIBRATION OF RODS AND BEAMS

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This work shows how dynamics of rods and beams can be taught in a modern way. The authors develop the theory based on variational principles and set the focus on linear rods [1,2] and Euler-Bernoulli beams [1,2]. From their teaching experience the authors know that certain mathematical problems for the students appear in the topic especially during the solution procedure of the partial differential equations of motion. This work shows how these challenging problems could be mastered by two different solution techniques. The first one is the classical separation of variables method in conjunction with Fourier series, and the second one is the Green's function method [3,4]. Today it is necessary for engineering students to get familiar with modern computational tools. This work gives several examples how a computer algebra system (CAS), in this case MAPLE [5], can be used by instructors and students to shorten lengthy calculations during lessons or self studies. Additionally the visualization capabilities that a CAS offers are used extensively e.g. the motion of a beam or time-dependent variables can be animated in an easy manner. Further one it is an easy task to study the influence of different boundary conditions or change material properties to make case studies.

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## 39 NEW CHALLENGES FOR ENGINEERS: DESIGN AND IMPLEMENTATION OF A MOBILE SYSTEM DEDICATED TO IMPROVE ORAL HEALTH CONDITIONS

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The aim of this paper is to address how engineering students can face real problems through interdisciplinary approach in social relevant problems. Quite often, engineering and computer science students just deal in their academic processes with toy problems, simulations and black box models. It is well known that there is a shortage of engineering students in many countries, which it is the case in Brazil. Nevertheless, the situation has become a little better in the last few years due to the rates of increasing economic growth. Some of the attractiveness for the engineering careers is strongly related to the vision that society has about the importance and role of professionals. In this sense, through a research and extension project of the Federal University of Rio Grande do Sul, students of Computer Engineering and Computer Science undergraduate courses are facing real and relevant problems through their insertion in knowing the health situation of a deprived city in the state of Rio Grande do Sul, in the south of Brazil, in which capital city, Porto Alegre, the University leis. But their insertion is done through the conception and design of how new Information and Communication Technologies (ICT) can collect and process data much more efficiently than the usual methods used by the public health agents. In Brazil, there is a special program of the Health Ministry known as Family Health Program in which agents visit homes of citizens in order to acquire some specific data as social indicators and health indicators, as blood pressure, weight and many other ones. More recently, we have added a new and very important service to this population through the analysis of oral health conditions. In this sense, a research team of students of both courses was created for this project in order to develop a computer system that can collect data through mobile phones (smart phones), including the treatment of complex data, as mouth images. It is important to emphasize that this project will be entirely developed in PBL. In this paper, we will discuss the main issues involved in this project and how it is being developed.

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## 40 TEACHING STRATEGY AS A MODULAR SERVICE PRODUCT IN COMPREHENSIVE COURSE DEVELOPMENT

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Teachers in engineering education continuously develop the courses to reach better learning outcomes which also fit with the competence needs of the industry. This work is in nature the same as the very important product development (PD) work in every company which wants to be competitive in the markets. This comparison suggests the use of PD methodologies also in this course development work in the universities.

A lot of research has been made on the different teaching and learning methods as well as on the assessment methods. However, few papers deal with the development of the whole teaching and learning process. This paper proposes the use of the modular product concept in a comprehensive course development. The product under development is the teaching strategy of a course. This service product includes several modules from the targets for learning outcomes to the learning and teaching assessment. The technical documentation of a physical product consists of the module list, components of these modules as well as the drawings and other possible descriptions of the components. Module list and components of the modules form the bill of materials (BOM) of the product. The BOM of the teaching strategy of a course and its component descriptions are established.

Modularization of the teaching strategy product offers many benefits for its development. For example the product development work of a modular product can also be split into the module level. Also the use of well-proven industrial PD tools and methods can be efficiently applied on a course development. In this paper these benefits, tools and methods are introduced for a teaching strategy product in the environment of the engineering education.

## **43** ANALYSIS OF THE IMPACT OF PLACING ENGINEERING, MATHEMATICS, AND COMPUTER SCIENCE GRADUATE STUDENTS IN THE K-12 CLASSROOM

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As we approach the end of a nine-year project, K-12 Learning Partnerships: Creating Problem-Centered, Interdisciplinary Learning Environments (NSF – DGE-0638719 and 0231611 ), we reflect on the impact of the program on the various users: the university, the university faculty, the university graduate students, the K-12 school district, the K-12 teachers, and the K-12 students. This paper examines the impact of the program on the graduate student participants, specifically. One goal of the Learning Partnerships project was to increase K-12 student knowledge of mathematics and science through engineering examples. The middle school level (grades 6 – 8 was targeted). Summer workshops were held to increase K-12 mathematics/science teacher knowledge and to provide training in the K-12 classroom environment for graduate students. During the summer workshop, graduate students were paired with teachers. In the academic year, the graduate students visited the middle school classrooms for 10 to 15 hours per week. While in the classrooms, the graduate students were mentors, content experts, and extra set of hands to aid the teachers. Often the graduate students would prepare a hands-on activity, help students who had fallen behind, or challenge the students who were ahead in the classroom. The graduate students were NOT student teacher, substitute teachers, or graders. These graduate students were also participating in either a Masters or Doctoral program in their engineering, mathematics, or computer science departments. The advantages for graduate student participation were: gain of a classroom experience, increased publication and presentation experience, improved communication skills, improved team skills, grant writing experience, enhanced thesis opportunities, and financial support. Fifty-five graduate students have participated in the program since 2003. A survey of these students has investigated the impact of the program on these graduate students. The results to date show that 20% of the students are still presently in graduate school, 50% are working in their technical profession in either industry or government employment, and 10 % have entered educational careers. An additional 20% have not yet responded. Those who have chosen a teaching career credit the Learning Partnership with guiding them towards that profession. These former graduate fellows teach at both the high school and college levels. Others credit the project with encouraging them to participate in educational outreach even though they have pursued technical careers.

## 47 ISSUES OF INFRASTRUCTURE AND CAPACITY BUILDING FOR ENHANCING ENGINEERING EDUCATION IN DEVELOPING NATIONS: A FOCUS ON AFRICA

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Education in Africa suffers from issues related to the availability of infrastructure. For example, in Electronics Engineering, there are no facilities for basic practical experience in the production of printed circuit boards (pcb) for micro-processor and other integrated circuit. Similarly in Computer Engineering, it is not unusual for the courses on programming to be carried out as a completely theoretical activity not to mention courses on networking where the students could graduate without ever using or configuring devices such as routers and switches. Fortunately, open source tools exist that allow the above listed practical activities to be carried as highly realistic computer based simulations. For example, SPICE, gEDA, kicad & qcad tools for electronic circuits and gns3, qemu, virtualbox & similar tools can simulate network and computer devices. Computer based simulations involving multiple devices or objects may be enhanced to cover a larger domain (that is more devices) or higher resolution by running them on High Performance Computing (HPC) clusters.

This paper presents a project of the International Centre for Theoretical Physics (ICTP) which was funded by the Italian Government (through UNESCO) to implement computational physics centers in sub-Saharan Africa using low cost Linux based commodity High Performance Computing (HPC) clusters. The project was concerned with matching the right infrastructure to solving immediate scientific needs and also building local (in Africa) capacity for deploying, maintaining and using HPC clusters in a sustainable manner. The paper stresses the importance of investment in development of infrastructure which must be backed with appropriate policy and strategy for both implementation and capacity building in order to achieve enhanced engineering education.

Also presented are the results of the project including lessons learnt from the capacity building component and discusses how the deployed HPC infrastructure is used as a multi-disciplinary tool and how both components have enhance engineering education at the institutions involved. With the plethora of resources available in Africa, the support received from such initiatives as the one reported has the potential to benefit the economy of nations whilst encouraging collaboration of engineering educators in the exchange of ideas and development of projects that are sustainable.

## 48 ENGINEERING STUDENTS' DILEMMA – WORK VS. LOAN

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The present research seeks to understand why Israeli engineering students would choose to finance their education by working rather than by applying for readily available loans. Prospect Theory and Norm Theory may offer some understanding and insight into this behavior: According to Prospect Theory, taking a loan would be perceived by students as a large risk in comparison to their anticipated income on graduation. Norm Theory suggests that students will decide to work during their studies if it seems to them that this is the accepted norm in their social circle.

Research results indicate several prevalent attitudes amongst students:

1. Working during studies is detrimental to their academic achievements.
2. Working during studies does not, in general, constitute an essential social virtue, or part of student life in particular.
3. Investment in studies and academic achievements leads to clear dividends expressed by finding rewarding employment.
4. Taking a loan is a responsible act. This is quite a rational step that supports success in studies, and engineering students will be able to repay the loan upon graduation when employed as engineers.

Nevertheless, despite professing these attitudes, in practice only a very few students in the sample (14 out of 170, approximately 8%) actually took loans. These results are supported by data obtained from the Office of the Dean of Students at Braude College. How can this disparity between students' declared attitudes and their actual behaviour be explained? Why do most of them recognize the advantages of taking a loan, but in practice do not choose to take a loan? And why do most of them prefer the alternative that may harm their studies: going out to work. Consideration of Prospect Theory [1,2] may provide assistance in answering these questions.

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## 49 ENGINEERING STUDENTS – READING HABITS AND FRAGILE KNOWLEDGE

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Special needs and attitudes of today's engineering students are investigated – from a marketing point of view - in this paper. In particular, it examines freshman students' attitudes regarding textbook reading and use of Internet sites as a supportive environment for basic courses. 134 college engineering students and 94 university engineering students participated in research relating to: reading habits before and during academic studies, preferred language for textbooks (English or Hebrew), reading skills and use of on-line learning materials. Findings indicated similar reading habits for college and university students, except for use of on-line learning materials and a significant correlation between pre-academic study reading skills and reading during academic studies [1]. More than 90% of the students clearly prefer textbooks written in their mother language. The students rarely used textbooks to deepen understanding of course subjects, but thought they were very important for success in the courses. They were primarily assisted by textbooks for exercise solution. University students used on-line learning materials more often in comparison with the college students [2].

This study does not leave any doubt regarding the preferred language for studies for the students, without any distinction between university and college students. More than 90% of the questioned students preferred to read books and learning matter in Hebrew. Most of the students claimed that they have a command of English in three areas: speech, reading and writing. Their attitudes with regard to their mastery of the English language are influenced by their reasonable to high functioning in spoken English. However, reading a chapter in an English textbook requires different more complex coping skills and the lecturers' assumption that students' are helped by English textbooks is not realistic for many students.

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## 50 ENHANCING CULTURAL AWARENESS AND MOBILITY BETWEEN JAPAN AND FINLAND

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In the global working life skills, experiences and awareness of different cultures and countries are valuable and essential. There is a need of knowledge of different market areas and their cultures, international business competence and language skills. Actually, global skills will be a natural part of any business in the future [1]. The role and responsibility of higher education institutes is to create international networks and partnerships that enable and strengthen cultural and international competences for the students and staff. One of the key tools to promote these competences is mobility [2].

The importance of international aspects in higher education is recognized in Finland and Japan by the Ministries of Education. Supported by both Finish and Japanese governments, Turku University of Applied Sciences and Sendai National College of Technology started active co-operation in 2008. During 2008-2012 almost 100 staff and student exchanges and visits have been carried out. At the beginning staff exchanges focused on raising general awareness of the education systems in both countries. Later staff exchanges have mainly focused on lecturing and other pedagogical activities. Student exchanges have focused on learning the culture and on research and development activities in laboratory projects.

During these five years a strong trusting and understanding relationship has been built. The needs and special requirements can be openly discussed and solved. Altogether our collaboration has been very fruitful and successful. Based on our positive experiences we have created a larger network of higher education institutes between Finland and Japan. An agreement encompassing eight institutes will be completed by 2012.

In this paper, we will introduce this international collaboration in detail. We will discuss the challenges as well as successes and provide practical experiences of this kind of collaboration.

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## 51 VIRTUAL DEVELOPMENT LAB: CONCEPT, IMPLEMENTATION, EVALUATION

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Virtual Lab (VL) is a computer simulation which enables essential functions of laboratory experiments to be carried out on a computer [1]. In recent years VL have emerged on the internet.

Shortage of young well-trained engineers and a wish to share the industrial experience that the author have accumulated over a decade has led author to teach satellite navigation at a University whilst simultaneously leading an industrial R & D team. Author developed VL to provide students with hands-on experience in satellite navigation. It was reported earlier [2] that VL has only partly bridged the gap between the University training and the needs of industry.

As suggested in [2], only an extension of the VL to the virtual development lab (VDL) allows the requirements of industry to be fully addressed. The paper introduces a concept of VDL. VDL is defined as a web-based platform which assists learning by enabling the whole development cycle (design, development, verification) to be conducted in a controlled environment which is similar to industrial one. VDL combines ease of use with real life task setting, thus allowing a student to focus on the essentials of the engineering task.

The paper provides practical advice for VDL realization and discussed the results of the use of a virtual lab in University. It is shown that reality met the expectations given in [2]. A gap between the university training and the needs of industry is bridged by the hands-on development experience obtained with VDL. Lecturers obtained deeper insights into every student's capacity and motivation. Students gained greater stimulation and psychological engagement through realistic developments.

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## 52 SPATIAL DATA INFRASTRUCTURE AS LEARNING ENVIRONMENTS FOR SPATIAL SKILLS DEVELOPMENT IN ENGINEERING EDUCATION

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The development of teaching methods adapted to the new European Higher Education Area requires a review and updating of content and learning methodologies. In this sense, our work addresses the task of studying a learning environment based on new Information Technology and Communication in the geographic area: the INSPIRE geoportal (Infrastructure for Spatial Information in Europe). It offers to users the chance of free online access to all geographic data and geographic information from the several state members' organizations. According this standard, each state develops their own spatial data infrastructure (SDI) portals, within their territory and all its regions. A spatial data infrastructure is a geographic information system consisting of a set of resources dedicated to management of Geographic Information (maps, orthophotos, satellite images, location names, thematic information...) available on the Internet.

The cartography, maps and street plan are an activity field where spatial orientation abilities are used [1]. Institutions like the National Council of Teachers of Mathematics contemplate among their aims the development of spatial orientation as one of the sources for describing and modeling the physical world.

The aim of this research was determining, using a workshop with engineering students, whether the new geographic information technologies develop spatial abilities (spatial orientation) included as teaching objectives in the new European Space for Higher Education Engineering Degrees and analyze their usability through parameters of efficiency, effectiveness and user satisfaction [2].

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## **53** EXPERIENCES WITH EXCHANGE STUDENTS AT THE COPENHAGEN UNIVERSITY COLLEGE OF ENGINEERING WORKING IN INTERNATIONAL PROJECT TEAMS

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This paper summarizes our experiences at the Copenhagen University College of Engineering (IHK), program in Electronics and Information Technology, with international project teams working with different engineering projects. Globalization makes it necessary to cooperate on an international platform, engineers from different parts of the world work on the same projects and it is necessary to train the engineering students to cooperate and communicate internationally, with the students from different cultures and speaking different languages. A great contributor to globalization is the student mobility program within the EU, like the Socrates-Erasmus program. At the Copenhagen University College of Engineering we have more than 50 active Socrates-Erasmus agreements. Beside that we have bilateral agreements with many non-European countries. Usually the exchange students come to us after 2-3 years of studying in their home countries. Their prerequisites are in most cases the basics of mathematics and physics, but there is very big variety in their practical skills, like electronics and programming. Some of them do not have much experience in working with projects. The challenge of supervising the international teams is to motivate the students with different prerequisites to study the theory and work together with other students from very different cultures with a practical engineering project. In our program, students work in teams four to five students. It is worth to put time and effort at the beginning of the semester to teach students the fundamental skills like students' interaction and cooperation, team training, project management and leadership, communication and presentation skills, conflict management. The project approach helps students to illustrate mathematical and physical problems and increase students' learning potential. This paper describes some of the projects with international and multicultural students' teams. We conclude with describing the benefits and problems we experienced during the last three years of working with international teams and the students' own evaluations of their experiences during their exchange semester at IHK.

## 54 TECHNICAL WRITING COURSE DESIGNED FOR THE REALITIES OF AN ENGINEER

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Engineering students are regularly called upon to produce written communications in project courses and courses requiring technical or laboratory reports. Teachers noted recurring problems in the writing of technical reports for a client: students do not know how to communicate technical solutions in writing. Currently, students receive support to improve their written communication skills as part of CIV3100; however, this course is of a general nature and does not allow students to develop specific skills in writing technical reports, a type of writing that will become part of their regular activities as civil engineers. The goal of the proposed project is to completely redesign CIV3100 so that it is coordinated with all project courses and courses that require technical writing so that students can develop skills in specialized written communication. The new course was created based on the results of a survey conducted among all civil engineering teachers in order to involve all teachers in the process and to create a course that meets shared needs. The results of this study clearly showed that the teachers share a common vision. The course is now mandatory for all students in the first term.

This project has a number of implications. Firstly, by having the course reflect the reality of civil engineers and by providing concrete examples of writing, we will allow students to realize the importance of developing effective technical writing skills in the engineering profession. Secondly, this course will give students the skills they need to write effective reports and perform other technical writing tasks: adopting an appropriate writing style for client reports, employing team-based writing strategies and writing e-mails in a professional setting. These skills will be useful for students throughout the undergraduate program and their future professional activities. Finally, the coordination of this course with all undergraduate civil engineering courses that require technical writing will help students develop and maintain technical writing skills throughout the undergraduate program, as their writing will be evaluated in the same way in all courses. From now on, students will no longer adapt to the requirements of a specific teacher but will instead adhere to best practices in technical writing practices that meet industry requirements and that are employed by all civil engineering teachers who include technical writing in their courses.

## 55 CONTEXTUALIZING FUNDAMENTAL SCIENCES INTO ENGINEERING CURRICULUM

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The scientization of engineering curricula, at Australian universities, from the middle of the twentieth century has had a profound influence on engineering education in Australia. The prevailing culture that embodied scientific method in the engineering curriculum determined the nature of student entrants into engineering schools and faculties in Australia. It has eschewed the human, the artful and conceptual dimensions of professional engineering discourse. Victoria University belongs to a small, but significant, group of Australian universities which provide opportunities to a small pool of students who have not performed well in the final year of secondary education or have completed technical and trade training, and who wish to pursue studies in engineering. A large proportion of students enrolling in engineering at Victoria University have a poor knowledge platform in fundamental sciences and mathematics. Though foundation summer schools assist, to some extent, in bridging the knowledge gap in mathematics and fundamental sciences, there is both documentary and anecdotal evidence showing poor progression rates in these subjects which may also be responsible for high attrition rates. This paper deals with the implementation of a half semester subject (unit) concerning with chemical literacy. The design of this unit departs from the traditional stand alone fundamental science subject by integrating and embedding it to engineering philosophy and practice. In this unit, students enrolled in architectural, building, civil and mechanical engineering are exposed to the scientific method and yet are confronted the instability, doubt and messiness of engineering solutions. The main themes of the syllabus are energy and sustainability where the introduced chemical principles are applied in context to engineering problems. Though the unit was notionally delivered in problem-based learning mode, constructivist tools such as enquiry-based learning and threshold concept pedagogy was used. The dynamic pedagogical component in this subject closely resembled pedagogies found in creative arts and music than in the traditional mode of teaching. This was essential to cover large amount of material. Despite the crowded syllabus and great demands on student time, the progression rates were above average of other subjects and student subject satisfaction was high.

## 58 SKILLED ENGINEERS THROUGH INTERNAL COMBUSTION ENGINE RESEARCH

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The internal combustion engine (ICE) laboratory at Turku University of Applied Sciences (TUAS) has been engaged in applied engine research for more than 15 years. The main targets have been and are to reduce exhaust emissions and to improve the efficiency of various diesel engines. New renewable fuels are also being developed, as well as different exhaust after-treatment systems. Heat transfer analyses have been conducted, and scenarios on energy economy and future fuels have been written.

The main customers and co-operation partners of the R&D work are Finnish engine, exhaust after-treatment and fuel manufacturers, energy consultants, and other universities and research institutes. Commercial agreements account for most of the R&D work but public funding has also been received. Over the years, the R&D work has expanded from one engine test bench to today's four test benches.

Since the first projects, a large number of B.Eng. students have been involved in the ICE R&D work. Primarily, the students produce their theses within the projects. Usually, students work as research assistants under the direction of the senior research engineers of the laboratory since the tasks and customers are demanding and the main responsibility must be taken by the laboratory staff. – In addition to the B.Eng. theses, one Licentiate Thesis and two Master's Theses have been completed within the ICE R&D projects at TUAS. Besides thesis workers, students also act as trainees in the laboratory before starting their thesis project. Furthermore, younger students perform minor projects within the ICE study modules. Students form groups, organize their work by themselves, design and manufacture test components, conduct measurements, analyze the results and present them to the industrial partners.

Until now, the industrial customers have employed several new engineers who have graduated within the ICE R&D projects of the laboratory. Systematic working within the R&D projects, becoming more challenging phase by phase, has brought smart workers for the needs of the engine, fuel, and after-treatment industry. A number of students have also continued their studies at various scientific universities. The present laboratory has expanded to its utmost limits. The four test benches are almost fully-booked and the cooling and air conditioning systems are no longer efficient enough. Therefore, TUAS has decided to rent new premises for the ICE laboratory. Up to six test benches are planned for the new laboratory. Besides increased industrial R&D work, early student projects will be increased in order to get more competent thesis workers for the R&D projects and more skilful graduates for the industry.

## 59 UNIVERSITY-INDUSTRY COLLABORATION IN NETWORK SECURITY EDUCATION FOR ENGINEERING STUDENTS

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Gaining experience in hands-on laboratory work is essential for engineering students to facilitate their development as future professionals in their specialization. In network security, one cannot become an expert professional in administering firewalls and intrusion prevention systems (IPS) just by reading textbooks: proper and adequate laboratory experiments are needed. Unfortunately, building a research and teaching laboratory environment with powerful computing equipment and specialized hardware and software for the target lab works is often extremely costly and a public institution like a university may be reluctant to invest money in an expensive new laboratory. A very beneficial solution to the problem is to find an industrial partner from the research area and start negotiations for university-industry collaboration in building a laboratory. All parties of the collaboration benefit from the co-operation: students have the possibility to perform hands-on laboratory work, the university is better able to include work-life relevant education in its curriculum, and the industrial partner gets visibility among students and is able to contribute to university education planning from the educational needs of professional careers point of view.

Our industry collaboration has resulted in building a network security lab for research and education, where modern powerful computing equipment is used together with specialized firewall and IPS hardware and software from a recognized manufacturer to provide students with hands-on laboratory experience and skills on using and administering state-of-the art network security solutions. The hands-on work is organized into a laboratory course where theory learned in lectures is put to test in lab work. At the end of the course, most successful course participants have an opportunity to attempt the vendor's certification as system administrator, firewall architect and IPS architect. The collaboration has been going on for three years, and the experiences are very positive both from the point of view of the university and the industrial partner. Student feedback is also very positive, leading us to the conclusion that tight co-operation with an industry partner in organizing hands-on network security laboratories to engineering students is extremely fruitful for all parties and reaches the planned student learning outcomes very well.

## 60 CASE STUDY: THE PROGRESSIVE INQUIRY LEARNING METHOD IN COURSE REAL ESTATE BUSINESS AND MANAGEMENT

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The progressive inquiry learning method is a pedagogical model, which is designed to support typical data acquisition by the specialist (Hakkarainen et. al. 2005). It emphasizes student's activity and effort of the co-directing research. The progressive inquiry learning method was tested in the course Real Estate Business and Management at the Tampere University of Technology.

The main purpose of the research was to find new ways to improve students' learning results and make learning more meaningful by connecting studying to the shared research project. First were developed the course plan which based on progressive inquiry learning and then implemented it at the spring 2011. After that, were improved the course plan, based on students' feedback, to support better progressive inquiry learning. The second implementation of the course is in progress.

During the course were collected student feedback and were compared it with the previous years' feedback. According to the feedback, the inquiry learning has helped students' learning process. Students have felt that the tasks and learning events which based on progressive inquiry learning have been the best parts of the course. Students think that the co-operating studying with other students promotes deeper learning and participating in the shared research project makes studying more meaningful.

The research demonstrated that the progressive inquiry learning method is a good way to develop courses and integrate research and education. The results can be used to develop the other courses so that students' learning results increase and they experience learning more meaningful. Also teachers and researchers can benefit from the progressive inquiry learning method. They can get new knowledge and viewpoints to their research by using their own research themes as a starting point of the progressive inquiry learning.

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## **61** VALIDATING SOCIAL COMPETENCIES AS LEARNING OUTCOMES OF INNOVATION PEDAGOGY –EXPERIENCES IN FINLAND AND POLAND

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Students graduating from any European university should possess such kind of knowledge, skills and attitudes that they can contribute to the creation of the best knowledge economy in the world. Organizations aim to create innovations and need employees who possess the competencies essential for enabling them to participate in the different innovation processes of their organization. Significance of social competencies is crucial in order to respond to the needs of the working life but the evaluation and validation of them is challenging and requires co-operation.

The purpose of this study is to discuss the challenges to validate the students' social competencies as learning outcomes of innovation pedagogy in higher education, including engineering education, and stakeholder reactions to the topic as well as to give some ideas for solutions based on Polish and Finnish experiences. The study extends the individual-based learning used in many contexts to include interpersonal and networked learning to develop social competencies and support ability to create innovations. The validation of social competencies is of high relevance for employers, ensuring a student's ability to success in teamwork and thus providing trust and social capital. The validation process has to be shared, referring to the participation of both external and internal stakeholders in the validation process.

The results are useful both for students, lecturers, and employers, and for all those who want to outreach and engage in the validation of learning and increase the impact of the higher education institutions among their stakeholders.

## 62 TOWARDS SELF-STEERED STUDIES BY WORKING IN R&D PROJECTS

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A pilot project as a part of the development of the engineering education in the Faculty of Life Sciences & Business, Turku University of Applied Sciences (TUAS) was conducted by integrating a R&D project and a normative course in the BEng program. Three engineering students specializing in biotechnology were chosen to a group, which performed a course on biochemical engineering in a separate R&D project during their 3rd year of studies. The R&D project, preparation and testing of injectable biomaterials for tissue engineering, requires versatile knowledge on (bio)chemical engineering, (bio)materials science, cell biology and rheology. Lecture-based, theoretical teaching is challenging in this kind of multidisciplinary subject. In addition, self-discovery as a learning method is effective and working in a real R&D project motivating. Working in a multidisciplinary project develops also communication skills. Hence, a long-term goal is to extend this pilot project to cover larger student groups in corresponding courses.

The conduction was based on team work including students' own planning and scheduling, practical laboratory work including testing of biomaterials properties and reporting. The students were also provided a possibility to continue the work in further studies, i.e., to replace a practical training period (12 ECTS), a continuing course on chemical engineering (3 ECTS) and bachelor's thesis (18 ECTS) by working in the R&D project. They were also told that there is a possibility for exchange in partner universities. 2 of the students in the original group of 3 chose to continue the work and they also chose to do a part of their bachelor's theses in the exchange in Austria.

This paper aims at describing how the students advanced their knowledge through self-discovery and found the project work motivating. This high motivation resulted in activities where they on their own initiative extended the project learning to other courses (Basics of Industrial Design, 5 ECTS and Entrepreneurship and Organisations, 3 ECTS) and to company collaboration, i.e., working in the R&D project was also self-steering towards project-based learning.



## **65** PEELING AN ONION: MARKETING ENGINEERING COURSES THROUGH NEW COURSE PEDAGOGY?

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In order to enhance its social and educational capital, Victoria University (VU) decided in 2005 to adopt a different educational paradigm. The new educational paradigm would allow VU to differentiate itself from other universities in Melbourne and the State of Victoria to attract a higher calibre of students to maintain high educational standards and reduce the relatively high attrition rates. The faculty of Health, Engineering and Science (FHES) was the first to take off the rank to introduce problem-based learning (PBL) pedagogy to engineering education in the two engineering schools. This new pedagogical paradigm was followed by an extensive publicity and marketing at secondary schools in Melbourne. Despite a mix of PBL models, by 2007, all first year engineering courses had integrated PBL into their curriculum. This project of monitoring students begun in 2008 with the purpose to evaluate whether marketing engineering courses through distinct pedagogy had any effect in attracting and retaining students, and as such it is still a work-in progress. Simple surveys of second year engineering students over the period 2008-2011 have shown that the proportion of students who chose engineering in high schools as their first choice of study has increased to over 88 percent and the number of students who were considering transferring to other courses or universities has decreased to less than 25 and 34 percent respectively. The survey has also shown that engineering courses at VU have grown in popularity among secondary students. Students have also demonstrated ambiguities concerning the teaching methods of PBL subjects and these ambiguities need to be further explored. Despite the positives of the three year survey outcomes have to be approached with caution. Prior to 2006 the marketing of engineering at VU was largely based on course offerings, whereas in the current period the marketing of engineering at VU is far more complex. It is envisaged that at least 5-7 year study would be able to produce the results in which outcomes can be differentiated between the marketing of engineering and pedagogical influences.

## 66 A CURRICULUM IMPROVEMENT OF MIS COURSE IN COLLEGE

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Most of the social science college graduates nowadays will someday work in a computerized application environment. Although they have studied some computer business applications in college, they do not know how the applications were made; and they only utilize the output in their real world work. This is similar to a black-box situation where users merely believe that the output is correct and appropriate. Most technical engineering students engage in artifact development projects before graduation. Graduation projects aim not only for the students to experience real product design, but also to realize the importance of internal structures.

Although many business decisions depend on work environment factors, routine decision-making nowadays depends on information produced by computer application systems. It is crucial to know how application systems create information. This means to know gathering, storing and processing of original data. This information creating process is a black-box to the users.

Most social science colleges usually teach a computer business application system. The problem is that the course assumes that students already know the real world operations and computer software. Therefore, the course focuses on how the computer system works and the concept of the decision-making without relating to a real world operation. The system concept is difficult to understand, however, without having real world knowledge.

In order to understand real world operations, I have made a virtual company in the class room [1] and have been teaching a business application system design using it. The course consists of roughly four phases: 1) Hands on exercises of business operations using the company; 2) Analysis of the business operations of the company; 3) System design for the business operation; 4) Development of a real computer system.

This paper will discuss the background of the teaching method and details of the four phases and how to conduct the class. It concludes with a discussion on the effectiveness of the method and future research.

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## **67** ENHANCING STUDENT MOTIVATION BY MEANS OF SOFTWARE PROGRAMMING PROJECTS

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Degree Programme in Information Technology in Turku University of Applied Sciences is a 4-year study. We have arranged interesting software projects for the second year students. The aim of the projects has been to improve motivation for programming and real-life business.

Here we present four examples of projects that have helped students to achieve confidence in team working. We discuss the experiences of four students concerning the cooperation between our students and companies during the project and the employment after the project. The analysis is qualitative.

For some students the results have been quite good. The motivation for learning and working has enhanced. Besides, one student, who participated in a project with students of the faculty of Health Care, got an opportunity to represent the project in a conference. The interdisciplinary learning turned out to be encouraging.

## 70 ENTREPRENEURSHIP IN A CURRICULUM REDESIGN OF COMPUTER ENGINEERING

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According to a report from Global Entrepreneurship Monitor [1], Brazilian educational system does not favour entrepreneurship, and is considered focused in educating employees. Particularly, university education does not address entrepreneurship and only 9% of Brazilian population had start-up training, with a much smaller percentage having formal training at universities.

The computer engineering course at the State University of Feira de Santana - UEFS (Bahia, Brazil) have started in 2003 and, among its objectives, it is stated that it should stimulate the start-up of new technology-based business. Nevertheless, instead of starting up new business, most graduated students have become employees or go into public service, mostly in other cities. Reasons for the lack of new entrepreneurs may involve the limited Information Technology market in the city, but also the absence of entrepreneurship training.

Technological innovation and associated themes, such as entrepreneurship and university-industry collaboration, were only recently included as an important topic in Brazilian government agenda. The Innovation Law, approved in 2004, stimulates the transfer of know-how from university to industry. It also allows the creation of the Offices of Technology Innovation (OTI) at public universities, which are in charge for managing the relationship between the academy and the industry, with the start up of new business as a possible path to integrate university with the industry.

The curriculum of the computer engineering course of UEFS was redesigned in 2011, and with support from the university's OTI, two new courses were included to address issues related to entrepreneurship and business start up in order to improve the our students' profile in these areas. The first course deals with identifying opportunities for new business and developing a business plan. The second one addresses product development, like a hardware prototype or an initial version of a software, especially important in an engineering course. As a final goal, we expect deep changes in the local scenario with the start up of new IT business in our region.

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## 71 CHEMICAL ANALYSIS SERVICE: LEARNING IN PROJECTS

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The pedagogical philosophy of the Turku University of Applied Sciences emphasizes fostering innovation through work-based learning, meaning close collaboration with businesses and working life through R&D projects. An example of good practices based on innovation pedagogy is the Chemical Analysis Service learning environment. Chemical Analysis Service first began as a project in the Degree Programme of Laboratory Technology. The need for this project was born out of increasing requests from industry partners for various chemical analyses, analytical methods and quality control. After running for several years the Chemical Analysis Service has expanded into a learning environment, offering students an opportunity to improve their skills in the fields of chemical analyses and quality. The topics have included e.g. testing the natural water field analysers, waste water analyses, antimicrobial active substance analyses, water purification resin testing and heat capacity testing of bioenergy.

Chemical Analysis Service is quite popular among the Laboratory Technology students. It encourages learning by doing and the accumulation of both wider and deeper knowledge on the subject at hand. Students are themselves in contact with the client company in order to fully understand the entire objective in detail. Before testing of the real samples it is essential to investigate a method of analysis, test it, find the limits of the measurements and prove the validity of the method. Most students have been highly motivated and reported having learned much more in a project than in a traditional learning situation arranged in the laboratory. A connection to the “real world” and a deep concentration on the chosen topic has been reported rewarding and the learning results are clearly better. Furthermore, the student experiences the entire project cycle from the first contact with the client to objective definition, reporting and feedback.

Before participating in the Chemical Analysis Service, the students have covered the first year of their studies with basic knowledge on chemistry, analytical methods and laboratory practices. There are several possibilities for participating in the Chemical Analysis Service. The student can cover a part of a course by participating in a project. Some students have completed their practical training in a project. All this requires flexibility and interpretation of the curriculum.

The most challenging projects have been the ones with a challenging schedule and where project partners have not been able to keep their part of the contract. These situations always require extra coordination. A major challenge in Chemical Analysis Service is a need for supervision and control by a lecturer. After all, the individual student requires much more attention while working in projects compared to traditional laboratory lessons.

## 76 THE AGE OF INFORMATION AND DE FACTO ETHICS

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This paper discusses cyber ethics, e.g. how ethic norms are realized in virtual environments [1], and in particular how this happens in the Internet [2]. As such, the discussion concerning cyber ethics is essential for engineering profession, as well as for engineering education. Authors argue, that there exists a conflict between pragmatic, and general justice. The definitions of cyber ethics are discussed through the lenses of pragmatic ethics, while at the same time challenging dominating values in the contemporary society [3]. Authors suggest that prevailing values are pragmatic by nature, following the ideology of de facto ethics, but they also question the legitimacy of this dominant approach. Used research approach in this study is phenomenology, where conceptual analysis on cyber ethics is based on comparison [3,4]. Based on this analysis, new openings on the cyber ethics research will be presented, and discussion about the reasons for present situation takes place. In addition, authors will also discuss what really makes us active members of a reality that is determined by de facto ethics, and what we can, and cannot do about it. While the speed of technological advances is very fast, ethical discussion concerning these issues seems to be lagging in behind [5,6]. It appears that while used technology has already established itself as a part of normal everyday routines, it is still unclear what is right or wrong. Is this a discussion, that engineers should take care of — or is this a general discussion that should take place every time new, ground breaking innovations emerge? Ideological discussion concerning de facto ethics is essential opening for enhancing ethical awareness among those working in the field of information technology.

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## 78 FROM THEORY TO PRACTICE: ADAPTING THE ENGINEERING APPROACH

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The relationship between engineering and cultural practices and worldviews is little studied. Engineering education is largely based on the assumption that engineering sciences are value-neutral, objective sciences. However, technology is always applied in a particular societal setting, depending on the surrounding conditions. Moreover, engineers have their own cultural and educational backgrounds. This paper addresses the encounter of standard educational practices and international students who enter engineering schools in Finland.

The aim of engineering education is to teach how to adapt theoretical knowledge to practical technical problems. The ability to connect theory and practice develops in varied degrees in primary and secondary schools in different parts of the world. Paradoxically, a school system that relies on theoretical instruction, appears to produce concrete thinkers without pragmatic skills.

This paper examines school backgrounds and learning approaches of an international group of engineering students at a Finnish university of applied sciences. It presents an analysis of student writings on their learning experiences, which are compared with earlier observations and surveys [1]. The diversity of the student population that is investigated conveys a variety of previous modes of education, and consequently, a variety of abilities and technical skills.

The effect of culture to adapting technology emerges as an important factor, which is discussed based on Wilson's hypothesis [2] on re-engineering of cognition. The development of engineering expertise in a global context arises as a multifaceted challenge that increasingly calls for attention from educational institutions.

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## 79 INDUSTRIAL DESIGN AS AN INNOVATIVE ELEMENT IN ENGINEERING EDUCATION

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Appointed by the Danish government, the Danish Design 2020 Committee published its report in June 2011 on how design can be strengthened and used in order to contribute to growth, productivity, and innovation. Building on a strong Danish tradition the Committee envisioned that, in 2020, Denmark will be known worldwide as the design society which, at all levels and in a responsible way, has integrated the use of design to improve the quality of people's lives, create economic value for businesses, and make the public sector better and more efficient. A central prerequisite to the realization of this ambitious vision is the further development of design and creative competencies at all levels of education. This paper describes how the Copenhagen University College of Engineering (IHK), in our continuing effort to innovate the engineering study programs, have introduced strong industrial design elements in the 210 ECTS Bachelor of Mechanical Engineering program as well as the 30 ECTS International Design Semester and the 10 ECTS Summer School in International Design and Development. The paper describes how implementation of novel design subject areas challenges the competence profile of the teaching staff and requires the creation of new laboratory and workshop facilities in order to combine traditional engineering design disciplines with creative design as a driver of innovation. With a practical and problem based learning approach at IHK the students are asked to work closely together with companies to come up with engineering solutions that are sustainable from both an engineering and design perspective. Stimulating the students' creative talents through design work is challenging; Engineering students often prefer the exactness and predictable nature of science-based problem solving. It is demonstrated that by encouraging students to leave the classroom and the computer for a while enhances their ability to solve real world problems and some examples are presented. The paper also touches upon the pedagogical challenges that arise since the IHK students are from diverse national and ethnic origins.



## 82 STUDENT ACHIEVEMENTS IN SOLVING PROBLEMS USING MODELS IN ELECTRONICS

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The article presents the results of a two-semester research which examined student achievements in problem solving using engineering models in electronics. The research aimed to investigate the effect of the following variables on student achievements: the course, student maturation, department that the student belongs to, studied model, and the lecturer education. A quantitative research methodology was applied. An achievement test, based on a mixture of Bloom taxonomy [1] and the problem-solving taxonomy [2], was developed for five models of electronic devices: two models of diode, bipolar transistor, an amplifier, the phenomenon of harmonic oscillator, and offered to students as a part of the final test. 451 students, studying mechanical and electronics engineering, and seven lecturers participated in the study. A one-way analysis of variance for the course and maturation variables and two-way analysis of variance for the model, department, and lecturer education variables was performed for 336 participants. The results indicate that the most significant difference exists between the grades of students who were taught by lecturers with academic degree in technology and scientific education in comparison to those who were taught by lecturers without the same academic degree. The grades of students educated by lecturers with academic degree in technology and science education are significantly higher in each taxonomy level of problem solving than the grades of students taught by lecturers without academic degree in the field of education. Additionally, it was obtained for all 451 participants that the mean grade of knowledge level is higher than the mean grade of routine level, and the later is higher than the mean grade of the interpretation level.

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## 83 A STUDY ON HEALTH INFORMATICS EDUCATION IN FINLAND

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Governments and health authorities in many countries have recognized the urgent need for a highly educated and trained workforce in information management in health care. The challenges rise among others from the ageing population, advances in health care and technological developments. This paper presents an overview of health informatics programs and courses in Finnish higher education. In addition, our study focuses on defining what health informatics is and how cooperation between higher education institutes and health informatics experts in working life can be developed. This empirical study is descriptive and data collection contained interviews with health informatics experts.

The results show that health informatics education is quite new in higher education in Finland. Health informatics is an independent degree program in five universities of applied sciences. Furthermore, many other universities and universities of applied sciences provide courses and modules focusing on health informatics. In addition, the results show that different universities and universities of applied sciences have different focus areas.

The interviews raised three main thematic areas of health informatics in focus: the concept of health informatics, higher education in health informatics and knowledge sharing. The results show that the concept of health informatics is well known, but it is also problematic because a general agreed definition is still lacking. Still, the interviewees emphasized many possibilities of health informatics in society.

The importance and need of health informatics education was confirmed in the interviews. Especially, multidisciplinary knowledge and skills were emphasized in order to answer the challenges of modern society. The education should provide comprehensive understanding of today's health care, but also vision of the future health care. Furthermore, the importance of understanding the interfaces between users and systems was emphasized.

The results showed that health informatics experts co-operate through many consortiums, clusters and networks. It is essential that the higher education institutes operate and are active in these organizations as well. Furthermore a suggestion of a common organization for all health informatics educators was recognized in this study.

## 85 THE USE OF STREAMING VIDEO TO SUPPORT ENGINEERING STUDENT'S LEARNING IN ENERGY TOPICS

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Nowadays there is great interest in education about 'streaming media' in all branches of education because the enormous potential of video dissemination through the information and communication technologies (ICT). At present, video can be considered as a powerful medium that, first, can provide narrative visualization, and second, can engage multiple senses of learners simultaneously. With the advent of digital video, video resources can be distributed to students via CD-ROM or DVD, on-line via the Internet, and embedded within Learning Content Management Systems (LCMS). Although, while the technical requirements for digital video production may now be less demanding, the production of quality learning content still requires appropriate expertise [1, 2]. High level technical and/or educational videos are very scarce, and direct use of streaming videos for teaching could be inefficient for the learner if the video resource is not integrated in a comprehensive teaching approach.

This paper presents a review of design criteria for developing streaming video teaching materials for engineering education within the frame of active, deep approaches to learning. The approach taken consists in the consideration of general good teaching practices in higher education. The paper also presents a review on video teaching materials on renewable energy topics, mainly solar energy. The search has been performed on common websites such as YouTube and Vimeo, but mostly in relevant Educational Digital Libraries such as NEEDS, MERLOT or ERIC, where streaming video could be considered within the general category of digital courseware. The review has been performed with the aim of using the founded digital materials in introductory courses on mechanical and electrical engineering at the University of Burgos, but can be also of value for any interested reader of any other Faculty of Engineering.

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## 86 A STUDY ON THE DEVELOPMENT OF PROGRAM OUTCOMES ASSESSMENT TOOL USING REFLECTION JOURNAL

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The main purpose of this study was to develop a program outcomes assessment tool using reflection journal. Reflection journal has recently come to gain more attention from school as an alternative assessment tool.

Although numerous studies reconfirmed the education importance and value of reflection journal as an assessment tool, research on the assessment tool of the engineering accreditation, based on education view is scarce.

After literature review about the case studies on the program outcomes assessment, this study, first, to analyse the current assessment tools, and then, examined the educational implications of reflection journal as a program outcomes assessment tool. Next, pilot study was carried out to validate the assessment tool.

As a result, this study suggested the assessment tool using reflection journal for PO6(teamwork) and PO11(engineering ethics), one of the most important assessment items in engineering accreditation. In this study, we used the performance criteria, assessment criteria, rubrics, and closed the loop to measure the teamwork and engineering ethics.

## 87 A NEW EMBEDDED SYSTEM PROTOTYPING SERVICE FOR TAIWAN ACADEMIA

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For helping researchers in the academia of Taiwan to speedup their implementation and verification of innovative designs, National Chip Implementation Center (CIC) of Taiwan provides a new service program named MorPACK. The MorPACK platform is highly modularized and flexible in contrast to present prototyping systems, by adopting three concepts: substrate-level modularization, three-dimensional module stack, and components reuse. MorPACK helps professors and students to concentrate their efforts on their own functional module(s), and easily reuse existing modules like playing bricks, which greatly reduces the development cycle of an embedded system. CIC also have prepared an operating system based on Linux kernel, a virtual platform simulator, a plenty of user manuals, reference designs, and training courses.

Since 2010, six professors and their research groups have joined the MorPACK program for their own research projects. The research topics consist of DSP algorithms, medical electronics, multimedia, and hardware debugging. By the program schedule, CIC has to provide the MorPACK platform modules and manuals, and also developing environments, instructions, and consultations of the design-flow for building customer IP modules. The steps of design-flow include virtual/rapid prototyping, bus protocol verification, RTL/gate-level simulation and synthesis, P&R, post-layout simulation, DRC checking, tape-out integration, substrate design/fabrication, and system assembly and test. The crew members of the research groups have to attend the CIC training courses, follow the design-flow to accomplish each work, and hand over a report to CIC on each check-point.

In this paper, we will introduce the general situation of the two-year prior run of MorPACK program, including the concurrent engineering model between CIC and research groups from universities, project accomplishment status, and participant feedbacks. For further planning, CIC will revise the design-flow arrangement, hardware/software specification, documentation, and training and consultation services, to provide the MorPACK as a regular prototyping service for Taiwan academia.

## 88 THE LAB OF COURAGE: STUDENT PARTICIPATION IN BUSINESS PROJECTS

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Anna Sulkakoski is a biotechnology engineering student completing her fourth year of studies at the Turku University of Applied Sciences (TUAS). Already in her second year she was recruited in the university's R&D projects as a project assistant. She has completed all her obligatory training periods working in projects and spent her summer holidays in the laboratory.

For a year and a half Anna has been working as a project assistant in a business commissioned project which aims at producing the adiponectin protein in yeast cells. The adiponectin is a protein hormone secreted by fat cells, and is connected to metabolic processes. The lack of adiponectin in humans has been linked to gaining weight, diabetes and cardiovascular diseases. The ACR30 project at TUAS aims at developing a production system for adiponectin in yeast cells, more specifically the *Pichia pastoris* species. The benefit of applying this particular species is that its post-translational modifications are closer to mammalian protein modification than that of e.g. *S. cerevisiae*. Other benefits include its strong inducible promoter and the scarcity of secreted homologous proteins which makes the downstream-processing less intricate.

The project's progress is steered by the commissioning company's needs and timetable. Since the project plan is protected by NDA, the chain of information in the project is highly structured: the R&D Manager is in contact with the company and shares only the information necessary for the execution of the project with the Project Manager and the student assistant.

Although Anna has become an expert both in protein production processes and especially the adiponectin, she claims the true value of project work for her lies in gaining the courage. For Anna, the most significant pedagogical innovation behind project work is learning through trial and error: courage is born out of the realisation that one survives the failure. What is more, projects are a rich environment for developing engineering skills, which are cemented by repetition: the more laboratory work a student can get her hands on, the better.

## 89 SUSBIO – DEVELOPING THE BIOGAS PROCESS FOR FUTURE ENGINEERS

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Energy consumption is growing rapidly throughout the world and increased energy prices are well documented. For example, the U.S. Energy Information Administration (EIA) noted that as of 2008, the spot price for a barrel of crude oil has increased by 53% over the past year. Rising energy costs increase agricultural production input costs as well as transport costs. These costs are passed on to consumers in the form of increased food prices. This is not the only reason for why it is necessary to develop and adopt renewable sources of energy which can reduce the dependence on fossil oil and temper global warming. Used energy is directly related to material produced for everyday life.

Currently in the SUSBIO project we are developing tools for material efficiency combined to food value chain. The aim is to create new methods to utilize waste food material as well as to produce biogas from various low value sources. Recovery of valuable nutrients in waste food is underway in laboratory scale to create guidelines for other users. A pilot-scale biogas production unit in Turku will demonstrate gas production from various feedstock adding to the information about the processes during gas production as well as and provide further guidelines for sustainable energy processes.

We are focusing on optimizing biogas processes in our pilot plant and nutrient recovery processes in laboratory scale by implementing experiments conducted by students in different stages of the process.

Students are learning project-type working and they are producing crucial information to the project at the same time. This type of learning is discussed in more detail by student and project manager (teacher) perspective in paper.

## 90 THE “KNOWS” AND “DOING” IN ENGINEERING EDUCATION

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Engineering practitioners are required to master a large variety of skills to succeed in the workplace. The required skills have been recorded in international agreements, such as the Washington, and subsequent accords, and have become legally required outcomes of accredited engineering degree programmes in many countries [1]. The skills can be divided into four distinct areas: Science, General Knowledge, Communication and Engineering. These diverse requirements make the training of engineers complex, requiring teaching input from different sources. In an engineering degree programme Science subjects (presented by scientists) dominate the early years with Engineering subjects dominating the final two years of study.

The philosophy of the two disciplines is different. Science is inductive [2], starting with an observation, and is normally taught as laws and procedures which the students have to know (“knowings”). Engineering is deductive [2], requiring conceptualisation of the problem before deciding on the “knowledge” required to solve it. This is the “doing” type training required in an engineering education programme and, as the students come from a “knowing” school education, it is important that engineering students are exposed to the “doing” requirements in the early years of study.

In this paper the evolution of a first year Electric Circuits course, designed to develop conceptual thinking and engineering problem solving, is presented. The special measures used to change the students’ mindset, including the requirement to pass all the knowledge areas in the course, to improve their ability to succeed in subsequent years, are discussed and results presented.

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# 91 “MY BEST COURSE IN ENGINEERING” – DEVELOPING A COURSE IN PROJECT PLANNING AND REQUIREMENTS ENGINEERING FOR UNDERGRADUATE STUDENTS

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In any ICT project, proper project planning and careful requirements analysis constitute the basis for a successful project execution and achievement of the set goals. At the Turku University of Applied Sciences (TUAS), fourth-year engineering students specializing in ICT were offered an optional 6-credit course in Project Planning and Requirements Engineering with the focus on the initial phases of ICT projects. The aim of this practitioner’s report is to describe the planning and implementation of the first course in 2010 at the TUAS [1], and its further development on the basis of student experiences in 2011. Problem based learning (PBL) and concurrent case-oriented work on product definition and project planning were the guiding pedagogical principles [2].

One of the challenges in teaching project management is the creation and simulation of a ‘real’ project environment to facilitate genuine project work [3] and management training. The students were encouraged to invent and define an exciting product of their own, to specify the requirements for it, and to plan the development project based on the product definition. In order to simulate the project environment in a product-oriented company, a full-day session was arranged for playing the business simulation game ProDesim developed at the TUAS. Feedback was collected from the students in the middle and at the end of the first course and also at the end of the second course. The collected feedback and observations from students’ course logs will be reported in the congress. The preliminary results indicate that the PBL approach for teaching generic engineering competences will inspire the students and give them a wider view of how to utilize the specific ICT engineering skills in practice.

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## 92 A BRIDGE BETWEEN ENGINEERING AND LANGUAGE LEARNING: AUTOMATION AND GERMAN IN AN ONLINE COURSE

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Germany has one of the strongest economies in Europe and the world and is therefore very attractive as a trading partner for many European countries. Nevertheless, there is a lack of qualified engineers with international experience who have specific German language skills in certain fields such as the field of Automation Technology.

Therefore, universities and companies from four different European Union countries (Tampere UAS, Reutlingen University, Tallinn UAS, VŠB TU Ostrava, T:mi Ulrike Eichstädt, HINTERWAELT Grafikdesign, InPunkto Softwareentwicklung) are working together to develop a curriculum and teaching material for an interdisciplinary online-course which combines the fields of Automation Technology and German as a foreign language. The course is named ADOK (Automatisierung und Deutsch im Online-Kurs/Automation Technology and German as an Online-Course) and will be available free of charge by the end of 2012 on the website [www.adok.projekt.eu](http://www.adok.projekt.eu)

In this course the German language is not functioning as a medium for learning another subject, but is rather a learning target of the same value as the PLC. Thanks to the financial support of the EU within the framework of the Lifelong Learning Project (LLP), an international team is collaborating to produce contemporary teaching material.

The course is meant to train engineers in programming and German language skills. The course material produced is a combination of problem-based instruction in the field of Control Engineering and active learning of the German language. Situations from daily professional life are simulated and this will have a positive effect on the motivation of the students.

Computer modified, animated and interactive learning material for the combined teaching of Control Technology and German language will be produced on the basis of authentic texts and diagrams. These tasks will be embedded in Moodle, a widely-used online learning platform, so they can be used by the students to produce, for example, glossaries together. For language learning purposes, we will adapt an existing reading strategy which clarifies, for example, keywords. This reading strategy could be used for most European languages.

In the springtime the course will be tested with students from the partner institutions. I will present the outcome of the piloting at the conference in Turku.

## 93 DESIGNING A GAME MODE FOR ONLINE LEARNING ENVIRONMENT

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There is an ever increasing buzz about using computer games in educational settings. Games are nowadays played by a very wide audience which provides a substantial potential for using games in learning. However, there are barriers that we need to overcome to design and adapt games in order to use them in a productive way as a part of formal education. Even if the games do teach general skills like foreign languages, problem solving, or communication, there has been only little success in teaching specific skills like mathematics or physical laws in a more resource efficient way than using traditional educational strategies.

ViLLE [1] is a learning environment, which combines several exercise types with collaborative environment for teachers. The motivation to design a game mode into ViLLE was to increase students' engagement in doing the exercises. As shown in [2], students' active engagement in exercise has a substantial effect on learning. To form a basis for design process, we conducted a survey among high school students about their gaming conventions and interest in educational game settings. Our goal was to extend the existing system without compromising the learning effects that have been discovered earlier [3].

The game mode was implemented so that the normal work flow of doing ViLLE-exercises is not disturbed. Instead of doing the exercise alone the students compete against other students. The students receive points similarly to normal mode, but in addition they can collect experience points, higher ranks and awards by succeeding in matches. The winner is based primarily on the score achieved, and only secondarily on the time used to emphasize the point of doing exercises properly.

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## 94 ELECTRONIC EXAMS WITH AUTOMATICALLY ASSESSED EXERCISES

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Electronic exam (or, eExam) is a method of transferring an examination into online environment. The electronic form contains some substantial benefits compared to the traditional exams: scheduling is more flexible, as the students can take the exams when they want to, typing the answers via keyboard makes it easier to write and read the answers, and, presumably, electronic form makes it possible to include question types that are not possible with pen and paper. However, the electronic exams still need to either be manually assessed, or contain only questions which are easy to assess automatically (such as multiple choice questions).

ViLLE [1] is an online learning environment featuring different kinds of exercises ranging from surveys to visualizations. All exercise types feature automatic assessment and immediate feedback to students. ViLLE also provides means to build and utilize courses which combine the exercises into rounds with required minimum scores. ViLLE automatically gathers data on students' actions in the courses; this data can be viewed by course's teacher at any time. Teachers are encouraged to collaboratively share and develop learning materials with other teachers. The effectiveness of ViLLE has been evaluated in various studies [2].

The electronic exams in ViLLE are designed to facilitate ViLLE's automatic assessment capabilities in their full form: any exercise type in ViLLE can be included in the electronic exam as well. This is a substantial improvement to traditional eExams: instead of answering multiple choice questions about programming, the students can (and need to) actually write and test the program code, simulate the execution, order the code lines and so on. The teacher can export the results into an Excel spread sheet at the very minute the exam closes. The eExams in ViLLE have been tested both in Finland and abroad with encouraging results.

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## 95 A ROBOT EXERCISE FOR LEARNING PROGRAMMING CONCEPTS

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Visualization has been perceived as a useful method for teaching programming. However, as the visualizations are commonly seen hard to integrate into teaching, this is commonly discouraging and real world implementations of such exercise types are scarce. To enhance this situation, we should be able to show the benefits of such instructions and visualization tools should be made easily adaptable as well as their content should be made effortless.

Earlier studies conducted with the program visualization tool ViLLE [1] have shown that visualizations can be effectively utilized in the teaching of basic programming concepts. Collaboration, immediate feedback and automatic assessment are highly effective when coupled with visualization exercises [2].

This paper describes a new exercise type deployed in ViLLE, in which the program state visualization aspect has been taken further. Students partaking into this exercise are asked to write a program, which will be then executed by a graphical representation of a robotic arm. The general goal is to have the arm perform various tasks while minimizing the number of moves made. Optimization of the arms' movements aims to encourage students to follow programming best practices, especially when implementing repetition.

The good results reported from a similar exercise implementation by our Australian colleagues and the preliminary positive feedback from teachers is used to further develop the version of the robot exercise discussed in this paper. Additionally, ViLLE's data gathering tools are used to record data about student actions and performance when taking the exercises. Gathered data is then used to assess how well the new robot exercise type supports the goals we try to achieve and especially what are the common miscomprehensions in learning the basic programming concepts. This process of data gathering and analysing will be utilized to further improve visualization exercises.

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## 96 MOLECULAR DIAGNOSTICS LABORATORY (MDL) – COLLABORATION BETWEEN STUDENTS AND SMES

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Molecular diagnostics laboratory (MDL) at the Turku University of Applied Sciences (TUAS) was established in 2009 to provide R&D services, education, and training in state-of-the-art molecular biological methods for students at different stages of their basic and advanced level studies. The idea is to bring students in close collaboration with their potential future employers in the SMEs and other work providers. MDL has provided further education in ‘genome wide analysis’ (30 ECTS) at the level of specialisation studies together with the University of Turku at Bachelor’s/Master’s level.

MDL is equipped with Roche LightCycler 480 II Real-time PCR, Roche 454-Genome Sequencer GS Junior (equipped with the Roche 454 Titanium chemistry), Agilent Bioanalyzer and Agilent Microarray Hybridization Oven. The performance of the laboratory equipment allows e.g. analysis of human whole genome DNA-microarrays (Agilent) for genotyping as well as the high-density DNA oligonucleotide (200K, Agilent) arrays for the transcriptomics analyses using either catalogue or custom-designed oligonucleotide arrays. GS Junior genome sequencer is able to produce ca. 65 Mb of sequenced bases per run with read lengths of approximately 500 bases in median (Phred score Q40) by using the Roche 454-Titanium chemistry. The sequencing plate can occupy flexible amounts of samples through bar-coding procedure of the samples. The laboratory is dedicated for testing, validation, and development of custom-tailored molecular diagnostic methods and services for biodiversity analysis of environmental samples, microbial detection of food and food production industry, fermenting industry, and analysis of animal/human microbiota for various scientific and clinical diagnostics purposes and to the future needs of personalized medicine.

The laboratory performs also bioinformatic mining of high-throughput data from Agilent/Illumina microarray analysis and Illumina-/Roche 454-sequence data. MDL will be providing training for 20-30 students/student assistants annually serving both national and international study programmes such as ‘internship’ training for European students. In addition, the laboratory organizes training for student groups in quality control and quality management. MDL aims to implement ISO 17025 standard for certification and accreditation of the services provided by the laboratory.

## 97 ACTIVE LEARNING THROUGH VIDEO LECTURES

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Active learning [1], which refers to the engagement of the student(s) through activities in the classroom/other places, is widely recognized as being superior to passive learning that occurs when the students merely listen to lectures. On the other hand, multiple modes of information delivery, such as video lectures, web-courses, etc., on-line, are now commonplace in many parts of the world. One of the challenges of the on-line modes of delivery is that the innovations developed to improve learning in a classroom setting, such as active learning, possibly cannot be effectively invoked. This paper demonstrates the possibility of effectively invoking active learning in a video lecture format, to either a single learner or a group of learners, at the other end.

The possibility of invoking active learning calls for a different strategy to structure the video lectures. Such a novel strategy has been employed in developing a course on Thermodynamics (Classical) for Biological Systems and given for the National Program for Technology Enhanced Learning (NPTEL). This paper will present the strategy, and discuss its details.

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## **104** A NOVEL APPROACH TO INTRODUCE RESEARCH IN UNDERGRADUATE ENGINEERING CURRICULUM

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The Department of Electrical and Computer Engineering undergraduate curriculum has design components that involve minimal research. Our approach here is to introduce research to suture graduate students in engineering. The faculty selects students based on their academic capabilities and interest in graduate studies to do research. The department is a member of the Engineering Research Center group based in Reseller Politechnique Instiyute in Troy, New York.. We present here the smart lighting acoustic characterization of power emitting diodes (LEDs) as a case study for the students.

Light emitting diodes(LEDs) are increasingly replacing fluorescent and incandescent lamps (electrically inefficient devices) as ordinary light sources. They already appear in several applications such as automobile illumination. They are more efficient than fluorescent and incandescent lamps. LEDs operate at low dc voltages and take less current (about 20 volts dc and 1.5 Amps compared with conventional light sources that operate at 110 volts, 60 hertz ac, ac and around one (1) amp or more). They are becoming very important in daily use especially at this time of the word's dwindling energy sources. Their luminance depends on high frequency rectangular pulses that can be associated with temperature rise and noise that need to be minimized. This is a case study performed by research undergraduate engineering students' trainees in preparation for graduate studies.

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# 106 DESIGN OF A PICAVET SYSTEM THAT SUPPORTS A REMOTELY CONTROLLED PAN AND TILT DIGITAL CAMERA EQUIPMENT

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This paper introduces the reader to a freshman engineering design project where students were required to design a picavet system that supports a remotely controlled pan and tilt digital camera equipment that can be used for aerial imaging projects. The system requirements defined by the client specified that the platform had to be able to be lifted by client provided kite system. The system previously designed for the client could not house the new payload due to size and freedom of movement issues. Additionally, the client's existing system had a tendency to hang up the strings at the attachment points causing jerky movements that affect the camera's ability to take a clear image. Students utilized planning and teamwork concepts to complete the client's project with fixed time and budget constraints. This project provides a meaningful medium to educate freshman engineering students on both concept and teamwork principles. The goals of the project were (a) to introduce collaboration across disciplines given the students' intended majors, (b) to enhance scientific inquiry, (c) to foster communication among the group as well as enhance communication between the students and the client who provides the project objectives, and (d) the group management structure and its implication as it applies to achieving the overall objectives of the project. As an integrated department with both Engineering and Aviation Science faculty, it was natural for the Aviation Science faculty to serve as clients, who then generate plausible problems that can benefit both the Aviation Science and Engineering students in the program and these problems are then used as the basis for a structured engineering design approach for introducing engineering design fundamentals to the freshman engineering class. The unique nature of the assignment lies in the need for the concept to be low cost and practical. Team leadership styles were evaluated and compared against design outcomes. This paper examines both the engineering aspect of the students' learning as well as their leadership growth and interaction between group members as well as the interaction with the client. With students from various engineering backgrounds involved in the course, this paper also provides the audience the ability to examine the applicability of this approach to other subject areas.

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## **108** INTEGRATING HUMAN FACTORS RESEARCH INTO UNDERGRADUATE COURSEWORK IN AEROSPACE/AVIATION: A CASE STUDY IN PILOT COCKPIT DISTRACTION BY A PORTABLE ELECTRONIC DEVICE (PED)

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This paper introduces the reader to an upper level aerospace/aviation psychology course design project where students were required to design a methodology to measure the affects of cockpit distractions on pilot performance. Students conducted a replication study of a driver (automobile) distraction study but changed the mode of transportation and distraction metrics. Students utilized eye (gaze) tracking hardware and software to begin to study the general aviation pilot distraction phenomena introduced by emerging hand held devices known in the aviation industry as Portable Electronic Devices (PED). The aim of this study is introduce students to basic research methods and how to begin to ask questions about distraction in a novel setting. Initial findings on pilot distraction as well as the processes encountered by students in setting up the experiment will be discussed. This project provides a meaningful medium to educate aviation students on both concept and teamwork principles. The goals of the project were (a) to enhance scientific inquiry basics by attempting to address emerging issues in the field of transportation, (b) to foster communication among student groups, and (c) understanding the challenges of meeting the overall objectives of the project. The unique nature of the assignment is the distraction study as it applies to general aviation (GA) in coordination with engineering faculty.

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# 110 METACOGNITIVE KNOWING AND SOLVING PROBLEM: CASE STUDY ON SOLVING-PROBLEM IN ENGINEERING THERMODYNAMICS

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The metacognitive ability is one key of successful learning. This metacognitive ability is the skill that allows the student to be aware of what, why and how to know. Along this process we can differentiate two aspects. First, the self-knowledge of the process itself [1]. Second, the capacity to self-regulate the process [2]. Nowadays these processes are especially relevant in Higher Education, as well as the relation between the competences of Know-What and Know-How, respectively. The recent metacognitive research points out that some students can be aware of their metacognitive skills but they do not know to use them in the learning context. From this point of view the learning is a dynamic process and it involves the planning and assessment of the performances. Therefore, the design of the teacher in the presentation of the student-solving tasks is essential to obtain good results by the students.

This paper presents a case study of structuring and solving an Engineering Thermodynamics problem in the second year of an Electronic Engineering graduate program at the University of Burgos during 2011/12. An energy analysis of a coupled steam turbine-air compressor problem is posed to students at the beginning of the module. Small groups of students work on a cooperative learning project for fourteen weeks, while the teacher act as the coach and the facilitator of knowledge acquisition. A metacognitive, problem-solving approach has been developed to help the teacher and the students to face up the learning of thermodynamic principles and fluid behaviour. Results obtained from teacher-student interviews and from one student's survey questionnaire are presented. Results could be helpful for interested readers in any other engineering topic.

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## III ANALYZES OF COMPETENCE BASED APPROACH TO LEARNING

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This paper describes competence based approach and its features to measure students' learning results. Instead of summative grading, every aspect of the student's answer is analysed. By mimicking the student's answering process the exact nature of student's mistake can be determined. Also, for some tasks the answer depends on previous results that would carry mistakes over, but with the competence based approach this can be overcome by using data available at the current point to evaluate the correctness of the student's input. The competence based approach enables one to give appropriate and individual feedback on the student's submission automatically and recommend study materials according to the mistakes made.

Since 2010, when the competence based approach was introduced in ISC e-learning environment in Tallinn University of Technology in Department of Computer Control, a lot of information about the students' behaviours is being collected and it can be analysed to restructure the learning process to fit with nowadays rapidly changing learner.

In the last two years almost 400 different competences have been identified in tasks which can now be individually marked overcoming summative grading shortcomings, allowing student results for some competences to rise at the same time as some may fall. Also, algorithms used to evaluate student answers were analysed to see if there is any connection between the structure of the algorithm and the students' result. Algorithms were simplified to structural elements. They were then compared showing that for more than 1100 algorithms used to evaluate answers, in simplified form, they were reduced to 155 distinct structural types. Results showed that having a more complex answer evaluation has tendency to help students receive better results after a few tries because they can learn from their mistakes, but there was not any specific algorithm structure that stood out.

Also students' pattern of using different kinds of help-materials, hints, and choosing tasks were analysed and some surprising results were found.

# 113 MATHEMATICAL MODELING AND ENGINEERING MAJORS

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Many courses and materials designed for the mathematical education of engineers have two drawbacks: (1) providing introduction to the “fundamentals” without comparable attention to developing facility with using mathematics to solve complex problems, and (2) assuming perfect knowledge of prerequisite mathematics courses. Differential equations (DEs) is one such course. In a recent trend, mathematical modeling is used as a venue to address these shortcomings by revitalizing the curricula in light of the changing role of school mathematics in two ways: (1) mathematical modeling and applications as a means for learning mathematics and (2) to build competence in using mathematics to solve real and lifelike problems [1].

This project is part of a broader design research program [2] that addresses a shortcoming in both the mathematics and the engineering education literatures. In mathematics education, theoretical conceptualizations of how individuals engage in mathematical modeling have not duly considered engineering students. In engineering education, studies of and recommendations for enhancing engineering students’ mathematical modeling skills have not emphasized the continuity of conceptual development of mathematical ideas. This project is a study of engineering students’ mathematical thinking as they learn to work with mathematical models.

In this talk, I will present a theoretical model [3] of the mathematical modeling cycle and the findings from my study of engineering students enrolled in a DE course who were asked to solve mathematical modeling tasks. Findings are expected to extend knowledge of the development of mathematical thinking in engineering students. Instructional implications for creating a learning environment will be presented and discussed.

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## 115 ECOLOGICAL ASPECTS OF RUSSIAN AGRICULTURAL ENGINEERING EDUCATION

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Russian agriculture has now become sufficiently effective (especially in Leningrad region). Agricultural enterprises use modern technologies, purchase new power-saturated agricultural equipment, including imported one. Therefore, the complex of measures of transition to environmentally safe agriculture must take account of the problems of technical ecology in the agribusiness industry.

Application of agricultural equipment presupposes professional use operation materials, including lubricants. The most environmentally hazardous materials as applied to agricultural are lubricants, especially waste oils (WO). Due to liquidation of the Russian system of waste oils collection and medium consumers have to solve the problem of WO management themselves. Small consumers confine themselves to WO disposal in landfills, sewer or by discharge in stowaways in violation of environmental standards. Ecologists have found out that WO make at least 50% of total contamination with oil products. Having a low biodegradability rate (10-30%) and accumulating in the environment WO hydrocarbons appear in food products, get into human foodchains, deposit in fat tissues causing diseases and failures of the immune system.

One of the directions of solving of this problem is increase in awareness and efficiency of engineering personnel and improvement of technical facilities of the enterprises and organizations in combination with detailed legislative regulations. Today Russian educational standard 110300 "Agro-engineering" includes specialization 110308 "Fuel-supply complexes and oil storages" that trains engineers for operation of oil storage and fuel-supply equipment in agricultural production, engineers for fuel and oil application during agricultural equipment operation, engineers for management of fuel-supply complexes. However IHE practically do not provide training for this specialization that leads to the lack of specialized knowledge in the sphere of fuel and oils with the specialists of engineering service.

Acquiring of necessary additional skills and knowledge is feasible through completing off periodic postgraduate advanced training or retraining for the corresponding courses on the basis of Institutes of Higher education. Institutes of advanced training and for retraining for agroindustrial managers and specialists as a well as for specialized enterprises. It is worth mentioning that some of such programmes can be provided to the interested organizations by St. Petersburg State Agrarian University department "Motor vehicles and tractors", which, if required, can be adjusted and added for the further joint implementation with the Russian and foreign partners. This enables a better interaction between the educational institution and profile companies.

## 116 SEAGEP SCIENCE AND ENGINEERING IN THE GLOBAL CONTEXT PROJECT AND ASSESSMENT OF ITS EFFECTS

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While there has been a widespread recognition of the need for students to gain global experience, white students made up 78.7% of U.S citizens studying abroad in 2009/10, 63.5% were female and most went to European countries [1]. Study abroad has also been a primarily undergraduate activity for students in non-technical disciplines. Obstacles exist for science, technology, engineering and math (STEM) students wanting to pursue an international experience, including fitting it into a generally crowded curriculum [2]. Only 0.6% of U.S. study abroad students in 2009/10 were PhD students, and STEM graduate students face additional obstacles to participate in international experiences such as mentors reluctant to allow time away from the lab and lack of funding [3]. Programs to diversify the average travel abroad student (across student level, race, ethnicity, country visited, and discipline) are needed to ensure that tomorrow's scientists and engineers have the global perspective that is considered of paramount importance. The South East Alliance for Graduate Education and the Professoriate (SEAGEP) is funded by the National Science Foundation to prepare minority students in STEM disciplines for academic careers. In recognition of the need for global experience as well as the limitations of current programs, the University of Florida SEAGEP developed an international project entitled Science and Engineering in the Global Context. The program provided short-duration, STEM-focused trips to Chile, China, South Africa and Brazil for four groups of multidisciplinary PhD students (54 total). The project was part of a research project to determine if short-term but intensive trips can provide students with the desired global awareness. This paper will describe the planning and organization of the trips and results of the research into the effects of the trips on the participants.

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# 117 FRAMEWORK FOR INTEGRATION OF TEACHING AND R&D IN BSC LEVEL EDUCATION – CASE STUDY ON CHALLENGING LONG-TERM R&D EFFORT

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Background: The Finnish law on universities of applied sciences defines following tasks: teaching, R&D, and regional cooperation with industry. At the moment, Finnish government is planning big changes to universities of applied sciences, which will further emphasize industry-driven R&D activities and innovative practices. Meanwhile, governmental resources for university education will be decreasing heavily. The full-cost funding model was introduced in the last part of previous decade. It requires university own funding at some cases to be even 40% of the whole project budget. All these changes has led to the situation, where integration of teaching and R&D activities is the only possible way to fulfil tasks required by the law and to maintain high-quality education when teaching resources are decreasing.

Industry-driven R&D project with also external public funding poses several challenges when considering teaching and R&D integration. Key question is how to guarantee enhanced learning experience for participating students. From the project point-of-view, granted funding is based on research plan document and teaching is not allowable cost for many public organizations. Also, industry wants to see their support invested in producing innovations rather than giving education to students. In addition, challenging research oriented R&D projects tend to be long compared to duration when student can be involved. Changing personnel creates discontinuity points in project implementation, which may cause problems e.g. in industry collaboration. Traditional way to involve students in R&D projects has been through BSc and MSc theses, but this approach alone is not sufficient in the current situation.

The full paper offers practical solution for the challenges presented above by presenting widely applicable framework for integrating research and education in BSc level education. Teaching is partly implemented as university-industry collaboration. Framework involves curriculum design, course implementation planning, and student mentoring. The framework is illustrated with case study project funded by public funding agency involving large-scale industry collaboration.

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# 119 STUDENTS' PERSPECTIVES ON TEAMWORK LEARNING IN ENGINEERING EDUCATION IN CHINA

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Cooperative Learning (CL) was firstly introduced to engineering education by Smith in 1981. There were about 60% American college teachers adopted CL in their course in 2008. Professional skills or transferable skills had been defined as one of the important learning outcomes for engineering graduates by professional accreditation organizations in many countries, such as America, United Kingdom, Europe and Australia. Teamwork skills are one of the main objectives to be evaluated.

China started professional engineering accreditation in 2006 in a few pilot universities, and it included teamwork skills as one evaluation criteria. However, teamwork skills have not been taken into consideration in curriculum design and assessment nationally, and cooperative learning has not been widely adopted by instructors in engineering education. Students might study collaboratively in learning communities, but not in structured cooperative groups.

Prospective engineers of China are expected to work together with engineers from other countries and cultures in the economic globalization, but the college engineering education on teamwork skills lags behind the whole world. Team working spirit has often been fostered in after class activities, while technical teamwork is overlooked in academic setting. This is a big challenge to the Chinese engineering education.

This work is conducted on the Joint Bachelor Degree Programme (JP) between Beijing University of Posts and Telecommunications (BUPT) and Queen Mary, University of London (QMUL). The programme aims to mix the best of teaching approaches from China and the UK, and it includes more emphasis on professional skills than is usual in Chinese degree programmes. One of the important skills that need to be studied is team working.

About 100 questionnaires were collected from Year-3 and Year-1 students. Year-1 students took a Personal Development Plan (PDP) module that takes team working as one of its key teaching objectives; Year-3 students had participated a lot in group projects in technical module coursework.

This paper attempts to find out students' perspective on team working and the way they want to learn it. Cultural appropriateness, mobility and generalization of cooperative learning in China are studied. Culturally inherent notions and barriers will be identified. Comparisons between students from different years, and between experiment student groups and non-experiment students groups, will also be conducted.

## 120 ESTABLISHING A TRADITION OF MENTORING

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The Biomimetic MicroElectronic Systems Engineering Research Center (BMES ERC) is an NSF-sponsored Center of Excellence at the University of Southern California (USC). The strategic research goal of the BMES ERC is to develop implantable prostheses for a growing number of patients with profound, incurable disabilities. Understanding the importance of educating the next generation of engineers and leveraging its resources and human capital, the BMES ERC has developed an extensive K-12 outreach program. Mentoring is a key component of the outreach initiative. It is interwoven throughout the program and it facilitates the establishment of a culture of connectivity in which mentors pass acquired knowledge and skills onto successively younger generations of students. This integrated mentoring conduit begins with senior USC faculty researchers and proceeds to students at the university, high school, middle school and elementary school levels. Mentoring is particularly important in the Engineering for Health Academy (EHA) Research Experience class. This capstone class places high school students in USC biomedical engineering laboratories. The high school students spend a minimum of 2 hours every school day working under the guidance of a university mentor. USC mentors help the high school students navigate the challenging transition from a structured high school classroom into a university research environment. In partnership with their mentors the EHA students develop and execute an appropriate yearlong research project. Mentors guide the EHA students in the formulation of scientific hypotheses and experimental designs to test those hypotheses. They train the students in scientific protocols and methodologies, help them collect and analyze data, and draw defensible conclusions. Mentors also offer advice on study habits, give tips on time management, and make suggestions related to the college application and financial aid processes. Mentors play a significant role in the EHA students' attainment of knowledge, mastery of technical acumen and development of life skills.

The high school students in the EHA Research Experience capstone class become mentors themselves and work with elementary students as part of the Science for Life outreach program. They guide the elementary students through a series of hands-on activities that relate research conducted at the BMES ERC to California state science standards. The interest and enthusiasm the high school students exhibit towards science and engineering is authentic and contagious. It exposes the elementary students to the excitement of scientific discovery and helps them understand the relevance of their science classes.

Through their example, mentors pass on their knowledge and skill sets onto younger generations of students. Mentoring helps create and sustain a culture of connectivity and inculcates the idea of lifelong community service.

## **123** EFFECTIVE TEACHING METHODS FOR CAPSTONE DESIGN COURSES : CASE STUDY

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This study analyzes the effectiveness of current Capstone Design teaching methods and makes suggestions based on its findings. To reach these conclusions, a university program was chosen and based on course evaluations, an adequate representative case subject was selected. The sample was analyzed based on the course syllabi, topics of study and course content, teaching methods, course evaluations and learning outcomes.

Beginning in March 2005, “A” University began to seek accreditation for its Engineering Education programs, based on the 2005 KEC standards for ABEEK accreditation. In December 2008, the Engineering Education programs met KEC standards and all of the programs received accreditation. Further, students who graduated in February of 2009 were considered a part of the accredited program. In 2010, the programs were evaluated based on KEC standards and again received accreditation.

Engineering Design is the application of various techniques and principles in order to correctly identify appropriate equipment, processes and systems [1]. By doing so, students can raise their abilities through participation in various levels of design courses, which will enable them to be more effective in the field. Further, as creativity increases in importance in the field of engineering design, it is also increasing in importance in the classroom [2].

In particular, students need to integrate everything they have learned from the curriculum in a Capstone Design Course. For this, students can enhance their design skills. Therefore, to implement Capstone Design Course, teachers have to develop optimal teaching methods to support their students.

In this study, we intend to propose how to teach effectively in a Capstone Design Course for implementation.

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## 124 LOW-COST REMOTE SEMICONDUCTOR DEVICES LABORATORY WITH NI SWITCH

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In engineering education, hands-on laboratory experimentation is essential. This paper describes the design and implementation of a low-cost device characterization laboratory using computer-controlled instrumentation and Internet. National Instruments (NI) PXI-1042 hardware combined with NI PXI 4130 power SMU and NI PXI 4110 programmable DC power supply, NI TB 2636 and LabVIEW software are used to implement the laboratory. In teaching semiconductor devices, characterization of transistors and other active devices are essential to enhance the hands-on experience. Traditionally, microelectronics device courses lack a laboratory component. This is largely due to the high cost and complicated logistics involved in implementing such a laboratory for classes with a large number of students. Over the last few years, development of an online laboratory at IIT Kharagpur makes microelectronics device characterization over the Internet possible [1]. Low-cost solutions for laboratory experiments offer more flexibility and thus the virtual tools and laboratories in engineering education are increasingly gaining attention. The important components of the device characterization laboratory are: (a) a web interface handling user authentication, resource scheduling and other administrative jobs, such as maintaining students' records, experiments performed etc., (b) an equipment server hosting instrument hardware for experiments, plus a switching matrix. The server software is written in LabVIEW and the instrument drivers are VI compatible, and (c) a measurement server handles the requests from the students. The server checks the desired device before they are passed on to the equipment server. After measurements are complete, the experimental data are passed to the users.

The NI Switch TB 2636 contains a set of rows and columns. Using LabVIEW it is possible to configure connection to a certain pair of row and column i.e., to make a new path for connectivity. VI file may be configured to specify particular row and column to connect a particular device. Also, one can select connection to desired power supply for different types of biasing necessary for different transistors. Individual VI file is needed for each device based on its operating condition for optimal performance. Each VI file contains information on a particular combination of the row/column. There is also a redirector VI file that basically transfers the request from web to a particular device's VI file based on a request parameter.

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# 126 RADAR ENGINEERING AND RADAR METEOROLOGY EDUCATION PARTNERSHIP BETWEEN COLORADO STATE UNIVERSITY, AALTO UNIVERSITY, AND UNIVERSITY OF HELSINKI: AN EXPERIMENT IN CONTENT DELIVERY AND PEDAGOGY

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The three universities namely, Colorado State University (CSU), University of Helsinki (UH) and Aalto University have formed partnership in electromagnetics and radar programs to support innovative research in remote sensing. A key element of any program is education. All these three universities have strong programs in the respective areas such as radar engineering (CSU), electromagnetics (Aalto), and radar meteorology (CSU, UH). The goal of the collaborative program is to bring together the strength of these programs. The traditional paradigms of exchange visits and seminars were good, but lacked the fully immersed three way interaction of the students who are the critical part of these programs. This paper presents an innovative implementation of global competence integration.

In order to facilitate an environment to stimulate 3-way interactions, an advanced course offering was made jointly between CSU and Aalto using the research facilities of University of Helsinki. Live class instruction was offered (simultaneously) to all three university students through online tools, and they were fully interacting over a semester. Students were paired between Helsinki and Colorado and assigned projects. This was perhaps one of the most important contribution of this course, where the students learned to collaborate with their counterparts throughout the semester, just as they do in industry or advanced scientific organizations. The joint project idea was very unique where they had to prepare a joint report. The level of stimulation and interaction was exemplary and three of these student projects turned into papers at research conferences. The instructor for the course shared the time between the campuses over the semester, and therefore the students saw the professor both live and virtually. We are extremely pleased with the success of this experimental course that we are thinking of making it a regular course offering. In addition to the pedagogy, instruction tools for collaboration will also be discussed such as Adobe Connect, and Skype conferences.

## 128 ENHANCING STUDENT PARTICIPATION IN ENGINEERING EDUCATION: AN ALTERNATIVE APPROACH TO PRACTICAL WORK SESSIONS

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A new approach to student practical work sessions was applied to the automotive engineering and logistics engineering laboratory exercises in line with the innovation pedagogy as applied by the Turku University of Applied Science. (Kairisto-Mertanen, Penttilä & Putkonen 2011)<sup>1</sup>. Innovation pedagogy notes that constantly improving your know-how in turn leads to further know-how, new ideas and practices. Group work at is best can provide students with tools for working live team work, enhance the learning of a subject matter, motivate and create group dynamics and ideas more innovative and numerous than when undertaking the work on an individual basis.

Group participation and group dynamics were examined within the automotive and logistics department, in particular in the automotive laboratory group assignments. Of particular interest was if the two fold objective of simultaneously teaching a subject matter and team work was clear to all participants. Another aim of this study was to determine the optimal size of the teams within the practical group sessions, optimal size in terms of learning the subject matter as well as group cohesion and equal participation of all group members. All the aforementioned aim to increase student involvement, in particular by paying emphasis on the student fraction with a lesser degree of involvement.

In conclusion this approach aims to provide teaching staff with new hands on tools how to enhance group work within in the syllabus. Students benefit of this approach by understanding the two fold objective of group work as well as increased cooperation and group cohesion. This study also highlights issues to be addressed in further studies.

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# 130 ENERGY ENGINEERS THROUGH DISTANCE LEARNING – COOPERATIVE TEACHING AND LEARNING APPROACHES

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Corporate communication and many training courses are already web-based. A wide variety of communication is possible without direct face-to-face contacts. Social media has become very popular. Distance teaching and learning methods provide extensive opportunities. Web-based learning is independent of time and space. However, contact learning has its advantages. It is rather difficult to organize practical hands-on training in the web. This article deals with cooperative teaching and learning in energy engineering education aiming at degrees and introduces some successful practices.

Adult education aiming at degrees poses a significant challenge to most universities. While teaching and learning should be appealing, time is very limited, both for teachers and students. Adaptable learning conditions should be arranged with reasonable efforts and costs. In 2009, KyUAS started a B.Sc. degree programme in energy engineering, based on distance learning. The schedule consisted of 20 contact learning days at the university and 50 contact evenings online per year. This kind of new scheduling required new practices. Moodle was chosen for organizing course contents, and for offline communication, and Acrobat Connect for online communication. The proper preparation of electronic teaching materials became increasingly important. Colleagues exchanged experiences and supported one another. Students learned to deal with download links and recordings. Gradually also peer groups were formed.

In most cases the learning of novel contents is very motivating for students but may be frustrating for teachers. Information overflow may spoil efforts of both sides. Co-operative teaching can be an efficient way to organize education. Together with Lappeenranta University of Technology, KyUAS started a course on wind energy technology in 2011. The pilot course ran with 4 lecturers from Lappeenranta and 3 from Kotka using Moodle and Acrobat Connect. Exercises were organized locally. The versatility of the pilot course was appreciated by students. KyUAS Energy Engineering as an ERASMUS Intensive Program partner has been cooperating for years with FH Stralsund, UAS, in courses on renewable energy supply. Both students and teachers are co-operatively involved, and the learning outcomes are encouraging [1].

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## **131** DISCOVERING THE LEARNING STYLES OF ENGINEERING AND NON-ENGINEERING STUDENTS

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Students learn in different ways. Some prefer learning alone whilst others learn better by discussing with other students. Some students remember best those things which they have seen or heard. It is important for students to know their learning styles.[1] Without this knowledge it is difficult to improve learning habits. It is as important for teachers to know their students' learning styles. Research has shown that students perform better if teachers adjust their teaching methods to suit students' learning styles.[2]

The objective of this study is to discover and compare the learning styles of undergraduates in different parts of the world; Malaysia, Finland and England. Four universities are involved in the study; Universiti Teknologi PETRONAS (Malaysia), Turku University of Applied Sciences (Finland), Brunel University (UK) and University of Manchester (UK), with more than four hundred first year engineering and business students as participants. The instrument used for data collection is the Memletics Styles Quiz containing seventy items. Microsoft Excel and Statistical Package for Social Sciences are used for the analysis of results and graphical representation of the findings. This research seeks to answer the question: "Are there differences in learning styles between engineering students who study in different parts of the world, between engineering and business students and between male and female students?"

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# **133** FACILITATING & ENHANCING INNOVATION COMPETENCES AND STUDENT INVOLVEMENT: AN EXAMPLE OF INTRODUCING REAL LIFE PROBLEM SOLVING AS WELL AS TECHNOLOGIES TO TEACHING PRODUCT DEVELOPMENT AND PLANNING

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Turku University of Applied Science (TUAS) innovation pedagogy in its teaching practices, which on a practical level refers to an approach to learning and teaching that emphasises working life skills. It moves from the traditional theoretical learning to the application of learned skill to practical development challenges. Putkonen, Kairisto-Mertanen & Penttilä 2011) 1. At the TUAS the automotive engineering and logistics degree programme offers a course called Product development and planning. Since 2008 the course structure has changed to include real life case studies.

The Product development and planning course was originally structured in three parts: firstly students were taught the theoretical background, followed by a real life development project putting into practice the theoretical knowhow. The course was then concluded by a final seminar where all projects are presented. In 2011 the course was altered to include teaching technology, a virtual environment where the product development skills obtained throughout the course are put into practice providing the student an insight as to the importance of the R&D activities in relation to profitability. The simulations are undertaken before the final presentations. Student feedback after the inclusion of the simulation aspect greatly supported the inclusion of the technology.

In conclusion, the inclusion real life case studies increased the number of students taking the course and also had a direct impact on student feedback. The teaching technology has further improved student feedback. Furthermore, by including real life case studies this course also provides students with hands on experience of R&D project work. Most students complete their thesis on product or service development for which this course provides a good basis.

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## **134** THE COSMOS PROJECT – AN ATTEMPT TO INCREASE THE EMPLOYABILITY OF FOREIGN STUDENTS

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During the past 10 years many universities of applied science started engineering degree programs with English as tuition language. The primary reason for this was the internationalisation strategy given by the Ministry of Education [1]. Turku University of Applied Sciences followed the strategy and started the Degree programme in Information Technology 2001.

This paper stems from the Cosmos Project (2010 – 2012) which focus on engineering education in a multicultural environment at Turku University of Applied Sciences. The purpose of the project is to improve the employability of foreign students so that they would stay in Finland and give their contributions for the business in Finland.

The programme has Internet Technology as specialization and is strongly focused on network technology. Cisco Networking Academy courses form the backbone of the curriculum. All students are supposed to do two periods of practical training outside the university. The majority of the students at the programme are from countries outside Europe and the major challenge for these students is to find a suitable job for the training period. They also face problems when they look for jobs after graduation.

The problem has been studied by interviewing students, employers and staff members. Furthermore, benchmarking of other programmes has been done. According to this study there are many obstacles for the foreign students to integrate into the Finnish labour market. It seems that they first need to adapt to the Finnish culture. It would include both the language skills, the rules of the working life and the most importantly everyday habits. This has also been shown by the previous studies [2]. The aim of this case study has been to apply the results of these researches in developing the curriculum of our degree programme.

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## 135 INFORMATION SYSTEMS PROFICIENCY AREA

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The integration of BBA(IT) and BEng(IT) studies at Kajaani UAS started with the establishment of the CEMIS joint centre [1] 2010. The first steps in autumn 2010 included the integration of programming lesson of first year students and the transfer of staff from the School of Business to the School of Engineering.

In December 2010 meetings of different subject groups were held, aiming for more integrated studies in the curricula of students starting their studies in autumn 2011. As a result of such meetings and curricula work, BBA(IT) and BEng(IT) student groups starting their studies in autumn 2011, have integrated studies in maths, physics, ADP, programming, English and Swedish, in all 30.5 credits of 210/240.

From the beginning in 2009, Kajaani UAS' BBA(IT) game studies have included a large amount of project studies. The idea was that the students also learn independently by creating games in teams, as well as through normal classroom teaching. This idea has evolved and taken shape and next autumn BBA(IT) students will have 38 credits and BEng(IT) student 45 credits of project studies.

This model also supports Kajaani UAS strategic aim to be Finland's most proactive university in 2020. One step towards this has been the teachers' "learning by doing activator" –training. During this course of training a considerable amount of discussion between teachers from different fields has arisen. Some of this discussion has already led to cooperation in creating student projects.

One difficult challenge in integrating different fields and in learning by doing is that the teacher's role has to change. The teacher has to set aside traditional individual work and encourage the growth of students' expertise in close cooperation with colleagues. This means that different roles have to be clear and there must be commitment to decisions made. The importance of a creating good and positive learning atmosphere is particularly emphasized in new types of learning environments. [2]

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## **137** TEAM EDUCATION SUPPORT OF THE TECHNICAL SUBJECTS AT THE FACULTY OF MECHANICAL ENGINEERING

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The current development of modern machinery and equipment requires the cooperation of a wide range of experts. Practically, this means that today's research and development carried out almost exclusively by a team. Working in teams, but has its own specifics. It requires not only good organization, methodology, rules, etc., but also the ability to work as a team member. Unfortunately, the standard conception of teaching not only at technical universities does not reflect this fact. Students during their studies almost don't meet with teamwork approach. Graduates coming into practice without the necessary knowledge and experience that often gets up in the form of learning from mistakes.

Research team of the project "Training of human resources for advancement of teams in the development and research" undertaken in the Faculty of Mechanical Engineering VSB-TU Ostrava is acting to modify unflattering fact. The result is a range of innovative courses, student team competitions and a range of support equipment and systems. This paper describes partial results and experience with the newly introduced teamwork methods in technical subjects and students' team competitions.

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# 138 A STRATEGIC PARTNERSHIP: DEVELOPING A NEW APPROACH TO UNIVERSITY-INDUSTRY COLLABORATION

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Innovation pedagogy is applied in the teaching of the Turku University of Applied Science (TUAS). On a practical level, innovation pedagogy refers to an approach to learning and teaching that emphasises working life skills. It moves from the tradition theoretical learning to the application of learned skill to practical development challenges. (Putkonen, Kairisto-Mertanen & Penttilä 2011)<sup>1</sup>. Innovative teaching methods improve both the quality of teaching and the students' awareness of the innovation process. The automotive engineering and logistics study line has included as part of the studies of the car inspection intake group work practice carried out at one on Finland's largest car inspection companies.

Car inspection graduates are by law required to undertake 60 car inspections during a two week work practice period. Traditionally the car inspections were carried out within the facilities of the TUAS. A qualified teacher supervised these car inspections included in the syllabus. In 2005 a strategic partnership began between a car inspection company and TUAS, whereby students undertake their two week practice period/carry out 60 car inspections at a jointly determined location of the inspection company in Finland. The agreement furthermore states that TUAS is compensated for each inspection undertaken by a student. Students gain hands on work experience and an understanding of how the systems of the particular employer. For the company this is a way to assess and obtain possible employee candidates and to familiarise future prospective employees with the organisational structures and technical systems in place.

In conclusion, the strategic industry collaboration has numerous advantages for university of applied science and business. Students gain hands on experience, teaching staff stay up to with industry developments and companies obtain a contact with possible future employees.

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## 139 EMPLOYMENT OF OPENFOAM IN TEACHING AND RESEARCH

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In research areas on universities as well as in companies the employment of the Open Source CFD (Computational Fluid Dynamics) program OpenFOAM® is of growing importance. The reasons are mainly the increasing license fees of commercial CFD programs and their inflexibility towards developing new solvers.

Hence it is of high advantage for students to already know the usage of OpenFOAM® when starting their diploma or PHD thesis. Moreover it is a very appropriate tool to give students an understanding of the numerical implementation of the finite volume method as it is possible to view the whole underlying programming code at each point of interest. This is not possible in commercial programs.

In OpenFOAM®, there is no graphical user interface available. Therefore, all of the input data and simulation controls are regulated over text files. In this paper, the author is going to show how the usage of OpenFOAM® can be taught to students by an easy step by step method in order to ease the student's handling with text files and working with terminal commands.

Further on, in this context, a closer look at the numerical implementation of the finite volume method will be taken, where firstly few theoretical explanations are made, followed by the numerical realization in OpenFOAM®. In order to display the simulation results, the visualisation program "Paraview" is shown.

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# 140 AN ACADEMIC'S TOOLKIT FOR INNOVATIVE PROJECT REPORTING USING AUDIO VISUAL MEDIA

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The video documentary is a very widely used and effective medium through which investigative journalism is disseminated on all kinds of topics. Such works present information in a way that is easily accessible and entertaining. Video reporting has proven to be a surprisingly useful innovation in engineering education where it has been successfully adopted by two UK universities as part of a programme to enhance student engagement and reduce wastage; an issue that is currently of great interest in the sector.

There is already a large body of knowledge about student engagement but, according to Tinto[1], most institutions are yet to translate what we know into forms of action that improve persistence and retention. Innovators, looking for ways to improve motivation, tend to focus on self-directed learning through the use of projects, competitions and teamwork, drawing upon constructivist theories of learning, particularly experiential learning[2] and also the central idea of a learner-led curriculum that is increasingly made possible through the appropriate use of technology.

In this paradigm, student teams, engaged in a research project prepare and edit a short video documentary as a direct replacement for the more conventional written or oral report and in doing so, help to build their own autonomy as effective learners and develop valuable employability skills. The authors provide evidence that this medium generates much needed engagement, help teams to bond and promotes a deeper understanding of the subject matter. An additional benefit is that the assessment process is considerably less tiresome for the academics.

The potential for transferability is vast but for many lecturers, though the idea may sound attractive, it is a leap into the unknown. Having recently completed a 12-month Royal Academy of Engineering (HE-STEM) project to prepare an easily accessible 'toolkit' for lecturers that addresses the issues faced by a new adopter, the authors are now in a position to describe their own case studies and provide help and advice to others who may wish to adopt the idea.

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# 141 INNOVATIONS IN THE CIVIL ENGINEERING CURRICULUM AT UNIVERSITY COLLEGE DUBLIN, IRELAND

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The proposed paper will describe some examples of innovative developments in the 4-year undergraduate Civil Engineering curriculum at UCD. The developments described were undertaken to stimulate active learning and higher order thinking, as described by Felder [1]. The following examples of innovative teaching strategies will be described in the paper:

1. The introduction of a problem-based learning introductory session to the discipline of Civil Engineering for second level students. The purpose of this exercise, in which these students participate in a bridge-building contest, is to interest second level students in engineering as a career.
2. The introduction of a 'Creativity in Design' module for first year engineering students (across all engineering disciplines). This module provides an active-learning engineering experience through which students develop their observation skills, problem solving skills and lateral thinking abilities.
3. The use of digital technology to create virtual laboratories can be used to supplement or even, in some instances, replace physical laboratories. The rationale for introducing virtual laboratories, where appropriate, is that, in a time of diminishing resources, virtual laboratories can go some way to bridging the gap between the demand and capacity to deliver laboratory-based practicals.
4. A review of the literature shows the use of disasters and incidents in engineering education enables students to appreciate the roles, responsibilities and work practices of engineers in a way that would not be possible in a conventional lecture room setting [2]. This mode of learning has been incorporated into a final year module.
5. One technique for managing large classes and promoting active learning is to sub-divide the class into more manageable groups, using peer-assisted mentoring, i.e. the use of students more advanced (e.g. post-graduate students) to mentor undergraduate students. Peer-assisted mentoring should not be confused with 'normal' tutoring of undergraduates, in which the tutors are financially compensated. In peer-assisted learning, there is an educational gain for both the mentoring students and the mentees and both groups of students are awarded modular credit for their respective roles in the educational arrangement.

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## 142 PARZIVAL MEETS MODERN ARCHITECTURE

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Parzival meets modern architecture is the title of an Erasmus Intensive Program. Six universities are cooperating in this international student program. Coordinator of the program is the Fachhochschule Joanneum from Graz, Austria. The Dresden University of Applied Sciences, the INHolland University of Applied Sciences from Haag, the Chalmers University of Technology from Goteborg, the Liverpool John Moores University and the University of Pécs are project partners. Altogether 50-60 students from six countries are trying to find a solution for the revitalisation of the Castle of Borl in Slovenia.

The Castle of Borl was originally built in the 11-12th century. Its other name is the Castle of Ankenstein. It is located on a cliff over the river Drava. The history of the castle of Borl is somehow related to the legend of the Holy Grail and to Parzival. Some parts of the castle are today in a deteriorate state but other parts are still housing concerts or other cultural events. As the castle is situated in a beautiful landscape it is really important for the Slovenian government to find a solution for the function and for the future of Borl.

The international cooperation of the above mentioned six universities can help local and national authorities to decide how the Castle of Borl should be developed.

## **I44** DOUBLE MASTER DEGREE PROGRAMME: ENHANCING MULTICULTURAL ENGINEERING AND MOBILITY BETWEEN FRANCE AND FINLAND

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Mobility and multiculturalism among engineering students in Europe is mainly accomplished through the ERASMUS student mobility programme. This programme contributes to the development of an integrated European labour market and increases the chance for participating students to work abroad later on [1]. However through the ERASMUS programme the length of the study period abroad cannot be more than twelve months and students only “collect” credits in the host institution to be recognized and transferred in their home institution.

The European labour market is driven by a knowledge-based economy and motivated students seeking to increase their assets on such labour market aspired for more than exchange periods abroad. Setting up double master degree programme between trusted institutions is the foremost move institutions can have towards these students. A double Master Degree Programme is a framework promoting multiculturalism where students get the opportunity to gain additional skills and competencies. Such programme can help them to stand out from the crowd and to position them in the international labour market.

This paper presents a double master degree programme in Embedded Systems between a Finnish university and a French school of engineering. It shows how the Finnish three plus two years education system (three years of bachelor followed by two years of master studies) can be couple to the French engineering system of two plus three years of studies (two years of preparation followed by three years of engineering studies). Students are pre-selected by their home institution before being accepted by the host institution on the basis of their applications and study merits. The programme languages of instruction are English, French and Swedish. Through this 6 semesters programme, including two mandatory placements, students will be able to gain two Master level degrees: the Diplôme d’ingénieur from the French school of engineering and the Diplomingenjör from the Finnish university.

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# 145 ENHANCING ENGINEERING EDUCATION AND UNIVERSITY-INDUSTRY COLLABORATION BY SIMULATION TOOLS

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There are endless possibilities to utilize simulation tools in order to enhance Engineering Education and University-Industry collaboration. The spectrum varies from the simulation of a single electric circuit to the intelligent simulation models of production lines and machines in industry. With the simulation tools, practical hands-on learning activities can be carried out and accelerated in a cost effective and safe manner. In industrial enterprises the “bottlenecks” of the production systems can be detected and commissioning processes speeded up.

The basic 3D models can be converted into “intelligent” simulation models by modern simulation tools (3D Create by Visual Components). These simulation models emulate the real machine with high accuracy: the robot model can for example give feedback data (position, speed, current etc.) to the control system. PLC programming tools (Beckhoff, Siemens) can communicate with the simulation models almost in real time. PLC programming exercises can be done using simulation models instead of real machines. The same idea can be applied to almost every study course. Practical learning becomes more controllable (larger groups), more effective (less dead time), more economic and safer.

Customer driven manufacturing requires shorter delivery times and a more efficient commissioning process. The planning, manufacturing and commissioning process can be rationalized by the simulation tools. Raute Corporation is one of the leading pioneers to make the most of the benefits of simulation tools in Finland. In this paper they will present their case how it is done.

LUAS has managed a simulation project in collaboration with Raute Corporation and other companies. During this project the state-of-the-art technology of the simulation tools owned by the companies was transferred in engineering education (LUAS). The simulation tools are also significant from the “Cleantech” point of view: the use of simulation models improves material and energy efficiency as well as logistics. Clean technology (CleanTech) means all products, processes, systems and services, which harms environment less than their alternatives. Clean technology brings added value to the customer and at the same time either directly or through the value chain reduces the harmful environmental effects.

## **146** ROCKETING PROFESSIONAL COMPETENCE OF ENGINEERING STUDENTS AT TUAS (TURKU UNIVERSITY OF APPLIED SCIENCES)

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Flexibility and ability to smoothly adapt oneself to the constantly changing operation environment are among the most essential abilities needed in global business today. New requirements are set for the curriculum and learning environment as well; how can the future engineering and business competence best be studied and learned today? In this paper, the requirements related to learning environment innovations, as well as the development of professional competencies within the curriculum of engineering studies are discussed.

In the ROCKET [1] project at TUAS (in the Faculty of Technology, Environment, and Business), the network structure for the cooperation between universities and machine technology companies has been developed to support the global business competence development of engineering students. Transfer of tacit knowledge related to global production and business operations in different cultures is of special interest here. To make the cooperation function between the university, the companies and individual engineering students, a supporting model consisting of official operators in both domestic and foreign country has been developed, together with a creation of a mentoring procedure covering the training period.

As a result of the ROCKET project, the model has been created where the students will learn and train some essential professional competencies needed in global engineering business today. Operating within a strange culture, and learning production and supply chain management activities also abroad are among these valuable competences. The university-industry cooperation has also improved during the project. The needs of global industry are carefully considered in all the actions taken during the project. In this conference paper, the model building and the best practises created at TUAS will be discussed and shared.

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[1] The goal of the ROCKET project is twofold; on one hand, the innovative learning environment has been created for the real R&D assignments coming from companies. On the other hand, the basic infrastructure for the practical training periods abroad has been created in cooperation with globally operating companies, as well as with foreign universities. Here, in this paper, the latter aspect is in focus.

# 149 LEARNING ADVANCED TELEMETRY AND TELECONTROL SYSTEMS IN THE LABORATORY

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Driven by the rapid growth of the telemetry and telecontrol systems and also the necessity for young engineers to master aspects of this advanced technology, this work describes an innovative scheme that has been designed and implemented for teaching telemetry and telecontrol systems in the laboratory. The scheme gives students the choice to create and test their own scenarios to an entirely parameterized telemetry and telecontrol system that has been installed in a special controlled environment, specifically set up for the purposes of the laboratory exercises. The core of the telemetry system is a wireless sensor network (WSN), which monitors the environmental condition of the controlled environment. In particular, the telemetry system collects the measurements of several basic environmental measurements, such as temperature, humidity, vibrations (acceleration) and light intensity within the controlled environment, which are being visualized and processed on a central control station. The purpose of this WSN is to provide data for the successful automatic management of various devices and subsystems, such as a heating and a cooling subsystem, a humidification and a dehumidification subsystem, along with a lighting subsystem, which have been installed in the controlled environment to regulate the environmental conditions. The control system is complemented by an override subsystem that uses an advanced user interface to help users override the automatic processes. This includes a data glove (a technology taken from virtual reality), which provides the user with the ability to feed override commands using finger gestures.

Under normal (fully automated) operation, the environmental conditions are regulated automatically according to user scenarios. With the use of the override subsystem, the user overrides the automatic control of all subsystems having the possibility to stop the operation of any preferred subsystem online (in real-time), as long as the user interacts with the override subsystem. Specific laboratory exercises have been designed to be tested in this system. The main scenario requests students to monitor measurements from all sensing devices and to control the environmental conditions according to a certain scenario (setting a specific temperature, setting a specific light intensity, setting the humidity, etc), until they decide to interfere and change the balance of the system. To evaluate this work, a group of 50 undergraduate students in electrical and computer engineering were asked to perform the laboratory exercises and respond to a questionnaire about the basic aspects of their experience, which showed a great percentage of acceptance to the system and the concept itself, as it enhanced the learning process with a more engaging approach.

## **150** EVOLUTIONARY APPROACH TO MODERN CREATIVE ENGINEERING STUDIES IN TURKU UNIVERSITY OF APPLIED SCIENCES

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This abstract is a preliminary work on defining and understanding the evolutionary approach to analysis of creative training of engineers. In modern, continuously changing world, competencies for students and experts in engineering branches are in constant pressure for re-evaluation and development. Special skills and competencies that are founded even few years ago are in threat to be obsolete. Another challenge that especially universities of applied sciences (UAS) are facing is that companies, where most graduates are going to work, have to adapt themselves to more rapidly changing business environment. Competencies which are needed in future situations are hard to foresee. This is challenging for UASs which are trying to answer these requests for new skills in their curriculums. We argue that evolutionary reasoning or approach can be a future framework of creative training in engineering or other natural sciences.

Evolutionary, concrete cooperation between UAS, research and technology centers (RTC) and companies is answering to this challenge. This cooperation should be divided at least to two different levels. For distant future needs there should be permanent processes to evaluate where the evolution of technologies and businesses is going. These processes are verifying that strategies are re-evaluated and changed in time. Requests for different type of experts which are needed now or in near future should also be answered. For this, UASs will need more flexible and more industry integrated curriculums, resources and facilities. Answering to these near future needs is where evolutionary approach can be implemented in teaching with fruitful way. Main idea is to integrate every day processes between UASs, RTCs and companies in e.g. joint product development cases. With this combination there can be achieved huge benefits for all partners and answer for real need is guaranteed.

The basis of the evolutionary approach is on the classic theoretical analysis of evolutionary economics where focus is on markets, routines of firms, path dependence and bounded rationality. Evolutionary theories are comprehensive, but what is common to evolutionary approach as we define it is that theories have to be dynamic, they deal with irreversible processes and they cover the impact of novelty as the ultimate source of self-transformation. Learning as well as economic interaction are social and dynamic processes. The individual's process of learning and creative work is often characterized by significant degrees of cumulateness, disequilibrium situations and path dependence but they may also be determined by the exogenous factors (e.g. curriculums). The processes of change occurring in a context of industry and UAS are non-deterministic, non-linear and open-ended.

# 151 MAPPING OUT GLOBAL COMPETENCES: A COMPARATIVE CASE STUDY

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Globalization has undeniably affected educational policy. Curricula, pedagogy, evaluation are dynamically reshaped to form human capital capable of competing beyond the borders of nation-states[1]. More than ever before, a country's wealth is measured in terms of its human capital and it is, therefore, of utmost importance that education provides its recipients with skills that will enable them to compete globally. Information Communication and Technology (ICT) has been at the forefront of the technological developments that have contributed to the world becoming more interconnected and interdependent, in other words, globalization.

As a field itself, ICT is fast developing and has applications in many disciplines, which can make it increasingly complex and specialized. As a result, those who study in this field have to keep up with the latest developments if they would like to maintain their competitive advantage. Subject knowledge constitutes only one set of skills that education recipients are required to master. In addition, labor market nowadays demands graduates who can think creatively, solve problems, have an entrepreneurial mindset[2], learn quickly, communicate effectively, utilize organizational and networking skills as well as have the right values and attitudes[3].

This paper aims to map out the skills that Information Technology students in a Finnish University of Applied Sciences perceive they have in their first year of studies. Three groups will be compared: a Finnish and an international group of first year students and a mixed nationality group of older students who have completed their Work Placement. The competences will be assessed with a ranked scale questionnaire of "can do" statements based on the Evans[3] "starfish" model of competences. The findings of this study will be used for recommendations for curriculum development.

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## 152 CREATION OF QUALITY ASSURANCE IN LIFELONG LEARNING IN THE SLOVAK REPUBLIC

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The article deals with current situation in the Slovak Republic in the field of quality assurance of lifelong learning. Despite the fact that within the European Union is proclaimed the intention to find a common understanding of quality and its ensuring, there is still no clear definition of the quality associated with the social system. In the article, there are defined steps that describe the direction of the Slovak Republic in solving this problem and barriers that limit this process. Slovakia is aware of the positive aspects of quality assurance of lifelong learning and therefore pays great attention to creation of detailed analysis of lifelong learning and its quality in the Slovak Republic. These analyses should clearly and distinctly point out the strengths and weaknesses resulting from the internal environment, as well as opportunities and threats that come from external environment. For a proper understanding and start of this process, Slovakia has become initiator and participator in several major projects. The results provide very good basis for internal quality assurance practices in lifelong learning. In 2010, Mikolaj, as the Minister of Education stated, that the quality management system of formal education is set in legislation relating to formal education at all levels. [1] Proposed solution expects that quality management in informal education system will be provided by national authority. National authority, following the prepared law about lifelong learning, will perform tasks like certification of educational institutions, accreditation of non-formal education programs in modular form, certification of trainers and consultants of non-formal education and thus will guarantee state control over the quality of lifelong education and lifelong guidance.

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# **154** OPEN-SOURCE AS ENABLER OF ENTREPRENEURSHIP AMBITIONS AMONG ENGINEERING STUDENTS – A STUDY INVOLVING 20 FINNISH STARTUPS

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This exploratory study assesses the role of the open-source software phenomenon on the entrepreneurship initiatives of engineering students. Furthermore, this study seeks to provide guidance for managers within higher-education structures on how to stimulate the entrepreneurship ambitions and initiatives of engineering students and graduates.

By taking a qualitative case-study approach, the authors interviewed 20 start-up organizations present at one of the biggest start-up events in Europe. Complementary quantitative data was gathered from the Linked-in social network where many entrepreneurs were screened together with their academic background.

Findings suggest that open-source software plays an important role in everyday life for almost all the studied start-up organizations. More importantly, the authors suggest that educators, seeking an increase of entrepreneurship initiatives from their students, should increase the exposition of their students to open-source technologies and promote the creation of independent and multi-disciplinary entrepreneurship societies.

This research complements existing literature on entrepreneurship and engineering educations with a novel study on the open-source software implications for student's entrepreneurship. It also complements exiting governance models on how responsible for higher-education can better steer student-entrepreneurship societies.

## **155** PROMOTING PEDAGOGICAL SKILLS AND A MORE HOLISTIC VIEW OF ENERGY ENGINEERING EDUCATION

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High-level university education is typically identified with broad overall expertise of lecturers and use of modern pedagogical methods and skills. This was also reflected in the Aalto University Teaching and Evaluation report published in 2011, which identified a more holistic view in teaching energy engineering and supplementary pedagogical education as a required development. The aim of this paper is to respond to these needs, to discuss the importance of energy issues in teaching energy engineering, and to explore educational models that could improve the learning outcomes and the quality of teaching. As a case study, a PBL assignment will be prepared for an energy course and the process will be described in this paper.

The chosen teaching methods should make the pedagogical principles and learning outcomes more concrete to students and increase collaboration between students and enterprises in energy problems to create sustainable solutions. The learning activities in energy issues should emphasize experimental and communal aspects of learning and the importance of explicating thoughts and ideas through brainstorming, assessment, and reflection. The energy issues are important to all sectors of industry for many local and global reasons. The main global challenge is to reduce the greenhouse gases as the Kyoto Protocol went into effect in 2005. The fossil fuels cause global warming and the increasing demand for energy pushes the energy producers and users to choose more sustainable energy alternatives in order to save the non-renewable energy resources.

It is important in education to address also other environmental risks and impacts of the energy choices than the global warming. This paper focuses mainly on designing a holistic view into the teaching of energy engineering. Further discussions will be provided about the role of life cycle assessment (LCA) and the suitability of PBL, particularly for energy engineering education.

# 156 FACILITATING INNOVATION COMPETENCES: INTEGRATING BUSINESS AND ENGINEERING

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Turku University of Applied Science (TUAS) applies innovation pedagogy, which refers to an approach to learning and teaching that emphasises working life skills. It moves from the tradition theoretical learning to the application of learned skill to practical development challenges providing students with a variety of skills in addition to theoretical knowledge. (Korhonen-Yrjänheikki, 2011)<sup>1</sup>.

In Finland industry feedback with reference to required graduate skills has been twofold. On one hand a solid technical knowledge basis is required of students and on the other the technological knowhow is secondary to project management and networking skills. By implementing innovation pedagogy, where new teaching approaches are combined with teaching the theoretical know how, both these industry requirements are addressed.

In conclusion, by teaching the theoretical subjects throughout the entire degree programme and simultaneously applying innovative teaching methods, students are better equipped with the requirements of their future employees furthermore each student's individual strengths and knowledge profile are emphasised. Employees are provided with pool of graduates with the technical knowhow, project and social skills required in the changing business environment.

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## **157** ENTREPRENEURSHIP IN HIGHER EDUCATION – A SUCCESSFUL PROGRAM AT TELEMAR UNIVERSITY COLLEGE

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The main objective of the entrepreneurship program at Telemark University College, Faculty of Technology (TUC-FC) is to educate and mentor our students to develop business ideas, establish private limited companies, develop business plan including partnerships, economy, and manufacturing. In two subjects the students learn how to use innovative tools and more practical view on how to write a realistic business plan. In the freshman year the students will be trained for two intensive days on writing a sketch of a business plan, while in the senior year the students will gain 20 ECTS. Another objective is to teach our students how to create new enterprises for the future work place.

TUC-FC commenced this program in 2004 and the results of the senior year students have been most successful. In seven years TUC-FC has examined 28 Student enterprises and the signals from both students and industry have been very good. TUC-FC has been the most-winning faculty in Norway in national competitions. Our students have participated in the competition Junior Achievement-Young Enterprise, Europe six out of seven times.

The introduction of entrepreneurship at TUC-FC has shown that our students have a much higher potential in gaining innovative and entrepreneurial competence, and are mostly appreciated in the market. The students are working in groups of 3-6 members and they have to invent and develop their own business ideas. The subject has no curriculum but a recommended book. Very few but critical milestones are a pedagogical idea when teaching this subject. The students will have more responsibility and are supposed to seek knowledge and competence from mentors and other network in the industry.

The entrepreneurship program is continuous developed and improved due to good interaction with students, former students, mentors, and industrial partners.

# 160 CONCEPT-BASED TUTORING SYSTEM FOR ON-LINE PROBLEM CENTERED LEARNING

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Among different theories of learning, Roediger's ideas[1] concerning the importance of retrieval are appealing for teaching and learning in core engineering subjects. A recent paper[2] suggests a model for the time-spacing needed when doing repeated retrievals. These ideas are relevant for on-line systems that are being developed and marketed for tutoring, testing and homework in core science, math and engineering subjects.

We have been developing a web-based Intelligent Tutoring System (ITS) [3] for an introductory signal processing (SP) course taught in ECE. The system is built around the concepts needed in this SP foundation course. ITS features two databases: one holding all the questions tagged by concepts, the second containing measurements of student interactions. The student interface is minimalist with a question mode and a review mode. The instructor interface has tools for monitoring the total scores of an entire class and reviewing the answers of individual students on each question. The designer interface provides capability for creating and editing questions, as well as making assignments by grouping sets of related questions. Two modes are available: a self-guided self-paced practice mode where all questions are presented by concept name, and a scoring mode where question sets are presented usually with a deadline due date. ITS has been used for four semesters in the sophomore-level SP course at Georgia Tech. During each of the past two semesters, more than 50,000 questions have been answered by 200 students. We have typically created assignments that amount to quiz-review to offer a new dimension to studying, i.e., multiple retrieval. Student feedback has been generally positive because ITS provides an easy-to-use platform for practicing and enhancing basic skills. A system such as ITS will become more effective when the questions delivered can be tailored to an individual student's "user state" in the system. Quantitative models of students and questions derived from statistical data mining offer a way to develop such an effective tutoring engine for ITS.

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## 161 BRIDGING THEORY AND PRACTICE: AN INQUIRY-BASED COURSE IN MATHEMATICAL MODELLING

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Engineering students often fail to connect and apply what they have learned in introductory mathematics courses to other subjects [1], sometimes leading to the belief that mathematics is not relevant for them. To bridge this gap, we have designed a course in mathematical modelling and structured problem solving, targeting the generic skills needed to deal with real-world problems in science and technology. The course covers a broad range of mathematical models as well as systematic problem solving approaches, such as that of Pólya.

The course is based on the same inductive philosophy as inquiry-based learning (IBL) and problem-based learning (PBL) [2]. The course, offered to software engineering students at Chalmers, is centred around 35 small and reasonably realistic problems. The problems are used as a starting point for the learning process and are solved in pairs. It is often not clear how to tackle the problems, so an important part of the task is to find a model to describe the problem more precisely. An advantage of using several smaller problems (in contrast to one big problem/project stretching over a whole course) is that the students get to practice and get feedback on the different stages of the problem solving process several times during the course. The teacher is more of a “guide on the side” than a “sage on the stage” and mainly facilitates the learning process by asking the right question at the right time. In accepting all reasonable problem-solving attempts, the assessment is well aligned with the objective of the course to encourage creativity.

The course was evaluated through a questionnaire containing both closed and open-ended questions. In 2011, the students gave the course an average overall grade of 4.8 out of 5, and the following comment was representative for many of the students: “For the first time during my studies I was able to connect the course both with previous courses as well as with the kind of problems I can expect in my profession as an engineer”. The small problems have been very effective in revealing conceptual hurdles in relation to mathematical modelling and problem solving, and it is striking to see how the course has helped students to overcome many of the difficulties that have previously crippled them. The course was recently awarded the Chalmers Pedagogical Prize.

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## 162 BEST PRACTICES FOR EFFICIENT STUDENT TUTORING

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Students in master program executed in international cooperation need different tutoring compared to students in our national master programs. Tutoring is needed in studies, in thesis work, as well as all in practical matters taking into account that studying in this program leads into double degree. With individual tutoring and progress follow-up excellent results have been reached, and students have completed master's degree in two years' time.

What makes this kind of individual tutoring possible? Program staff's efficient and informal team oriented attitude with possibility to react in short time and solve problems when appearing. Sufficient resources for tutoring mean not only human resources but also integrating students into research community, and keeping information and services available. For coordinators of the program this means continuous communicating with each other.

The program in-built mobility forces students to adapt to several academic cultures within the two-year program. Because of the tight program time-frame tutoring needs to have active role especially when beginning the thesis work. Thesis topic is selected in cooperation with the thesis supervisor respecting student's own interests and his/her academic background. During the thesis work supervising, individual tutoring and practical support is given, while students are obliged to report their thesis work progress.

Feed-back from students is collected regularly for evaluating the needs of students facing the quality of tutoring. Detailed year planning helps both students and staff in gaining the goals.

## 165 DIFFERING CONCEPTS OF BIOMEDICAL ENGINEERING EDUCATION

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Biomedical engineering (BME) is a very wide, so far not precisely defined area of university study. International discussions are running on this topic aiming at formulation of the main features and requirements of the teaching process and also of the qualification requirements to the respective graduates, both at the BSc and MSc levels. Several international concerted initiatives are trying to provide such definitions and also promote them into the legislation of individual states; on the European scale, probably the most important is the BIOMEDEA initiative (see <http://www.biomedea.org/> [1], [2], [4]). This initiative is based on the new three-stage university teaching scheme (three years Bc + two years MSc, + possibly PhD) according to Bologna declaration principles (1999) accepted into legislation of most European countries. Although it gradually turns out that this system has not only positive features, the curriculae have to comply with the separate two stages – BSc and MSc when considering the BME tuition concepts. There are some discussions in the BME forum on whether the three year BSc stage is sufficient for basic clinical engineers or if it should be prolonged to four years, or if only MSc level is sufficient for the responsible clinical engineer.

The biomedical engineering is a very wide concept, encompassing many different areas from the technological as well as health-care points of view. As a single expert cannot cover the whole range, some established specialisations appear, as e.g. medical electronics, or IT and diagnostic support, or biomaterials, biomechanics, etc. In the contribution, we shall concentrate to the first two of them, where the electrical / electronic and computer technology tuition forms the technological background, while the multidisciplinary must be reflected by a reasonable component of biomedical education. The contribution will discuss the presently promoted concepts of BME education in Europe, namely from the aspect of differences in the rate between biomedical components and theoretical / technological parts of education, with the influence on the depth of theoretical / practical background in both areas. Advantages and drawbacks of differing approaches will be discussed.

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# 166 NORTHANTS ENGINEERING TRAINING PARTNERSHIP (NETP), A MODEL FOR SUSTAINABLE, INDUSTRY – UNIVERSITY ENGAGEMENT

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Twenty-three years ago the University of Northampton along with a number of local engineering companies including British Timkin, Cosworth, Cummins, Express Lifts and KAB Seating formed a partnership to provide industry experience for undergraduate students. The founding aim of the NETP was: “to create a pool of ‘industry ready’ Engineers to support the Northamptonshire area”.

The NETP set up a paid placement scheme where students would spend a year split between three companies, attending University one day per week to continue with their academic studies. It is estimated that the NETP has offered over 500 placement opportunities since its inception.

In recent years the NETP has developed to meet the changing needs of both industry and Higher Education (HE). Changes have included the expansion in the level and range of methods of engagement with the University and other stakeholders, including; schools, colleges, local government and support organisations. To reflect this wider remit new mission and vision statements were recently formulated.

**Mission:** To create a pool of industry ready engineers of the highest calibre and position the NETP as a unique example of good practice and collaboration between Academia and Industry adding value to all stakeholders.

**Vision:** Aspire to increase membership and diversity by providing a platform for full student placements, formal and informal networking, sharing of good practice and inspiring students and Partners alike.

This paper will evaluate why the NETP has been sustainable and how it has developed to meet the changing needs of educators, employers and students. Particular areas of focus will be; how the NETP has input into skills and knowledge and course / curriculum development; how it has supported graduate recruitment, enterprise and professional skills development; and how the NETP has supported research and local economic development.

## **167** ANALYSIS OF SIMULTANEOUS EEG/fMRI DATA – TEACHING OF DOCTORAL STUDENTS VIA RESEARCH

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Electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) are two most common techniques used in neuroscience research [1]. Currently, there is a growing interest to analyze simultaneously measured data from both modalities. The main motivation is to achieve the best temporal (by EEG) and spatial (by fMRI) resolution for the analyzed data. This paper describes the consecutive steps used in analyses of simultaneously measured EEG/fMRI data.

All used EEG/fMRI data were collected during the experiment which was focused on attention monitoring (oddball with distractor paradigm). There were three stimuli types which were presented in random order to the subject. Each stimulus consisted of a single capital letter. Subjects were instructed to press a button whenever the target letter appeared and not to respond to any other letters.

EEG preprocessing contains suppression of gradient (caused by MR scanner) and biological (caused by heart, eyes etc.) artifacts. The data are downsampled to 250 Hz, filtered with bandpass filter 0.5-30 Hz, epoched and averaged. The fMRI preprocessing is comprised of realignment (rotation, translation), coregistration to reference anatomical image, spatial normalization to standard stereotactic space and smoothing the dataset.

Source neural signal from the region of interest (ROI) is obtained by 3D source reconstruction. The source neural electrical signal is modified and included into the model for fMRI statistical analysis [2]. This way we can perform fMRI analysis using general linear model (GLM) [1]. Model signals in classical fMRI analysis are comprised of information about stimulation function. We expand the GLM model by adding the adjusted source neural signal to the above model signals. The experimental analysis shows that this approach allows us to be more specific about spatial localization in the brain (considering ROI). The contribution will show the concept of the interdisciplinary research as a substantial part of doctoral study, enabling the student to work with realistic clinical data and at the same time to utilize the deeply theoretical technological frame.

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# 168 NETWORKED SMART EDUCATIONAL DEVICES FOR ONLINE LABORATORIES

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The advantages of online labs, which also include remote laboratories for educational institutions and research and industry, are well known [1]-[2]. Their use leads us to propose, either in addition or instead, the concept of home laboratories or labs at home [3]. In terms of infrastructure and equipment, the miniaturization of measuring instruments, the new standards that allow to easily network with speeds and quality of service higher and higher as well as their acquisition costs no longer prohibitive. On the online learning environment side, the new situation is that of Cloud computing that enable educational institutions to use open source or of the social web or software, to create a network of learners and their equipment available at their home or made accessible to other classmate our instructors from anywhere . In this article we present the concept of laboratories at home as we see it in the light of Cloud computing era, the existing norms and standards to take into account [4] as well as to develop to achieve educational goals required for electrical engineering laboratories with what we can already call Networked Smart Educational Devices.

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## **171** LEARNING STRATEGIC MANAGEMENT SKILLS WITH BUSINESS SIMULATION GAME

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Strategic management is seen as a proactive management to set company's goals further ahead and to prepare the functions for the future challenges. In Turku University of Applied Sciences (TUAS), attention is paid to students business skills needed in today's working life environment. However, strategic management techniques are challenging to practice and learn in university without a present living business environment.

Traditionally, the basics of the strategic management are learned in courses that include lectures and case studies. The contents of the courses are based on scientific literature of strategic management theories. Nowadays, students at TUAS apply their knowledge about the strategic management in internships within companies, training enterprises, research hatcheries and to some degree also by business simulation games.

This study contributes to the discussion about the needs of improving students management skills by offering new methods to learn management competencies in a more exciting fashion. The aim of this paper is to describe a model how the strategic management training can be enhanced during a collaborative business simulation gaming.

A learning module of the strategic management was designed and integrated with an existing business simulation game (ProDesim). The content of the module was constructed as a combination of the different business scenarios and the potential strategic management techniques to apply. The functioning of the new module was tested in a simulation session, where students apply their theoretical knowledge in simulated business environment.

Based on the collected feedback from the students, we can anticipate that by combining the traditional way of learning in class and business simulation gaming, students are given a possibility for a quicker adaptation of the strategic management techniques and methods.

## 173 THE FUTURE OF ENGINEERING EDUCATION?

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This paper is outlining the future of engineering education, based on background study about future working life requirements and theme-interviews and surveys about current state of engineering education in two different universities. The objective is to find out how well CDIO approach [1] would fit to serve the education development needs of these institutions.

There is need for change and development in engineering education to fulfil the requirements of future working life as well as offer engineering as an attractive career opportunity for new students. For example in Finland engineering students get excellent problem solving capacity based on in depth knowledge of technology and science meanwhile interpersonal, communication, teamwork, business and entrepreneurial skills are not emphases enough [2,3]. Also the dropout rate during engineering education is too high [3]. There is raised a question that could CDIO be a useful tool for improving the curriculum and syllabus in order to produce enhanced and more engaging learning?

This research is based on background information gathered in Finland about the future working life requirements for engineers [2,3], and from semi-structured theme interviews [4] made in the University of Turku, Department of Information Technology and in Aalto University, School of Chemical Technology focusing in faculty. Also a survey [4] was done for the students in both institutions. These findings and results are then reflected to CDIO standards and CDIO Syllabus 2.0 and finally the conclusion is made how well CDIO approach fits to the needs of the Higher Education Institutions is question. Possibilities of adapting and implementing CDIO in those institutions are estimated using success factors presented in book Rethinking engineering education [1].

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## **174** INTRODUCTION OF STUDENT INITIATED AND THEMED MULTI-STUDENT PROJECTS

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We present the background to a change in the delivery and supervision of third year projects for students majoring in electrical and electronic engineering at Manchester University and an evaluation of our experience with this new system. One of the recent changes in the delivery of projects has been to task a smaller number of staff dedicated to the supervision of third year projects. Balancing the increased demand on staff supervising third year individual projects with increasing the quality of supervision has prompted us to change the delivery mode of third year projects. One of the main initiatives is to group individual projects under a 'theme' that will offer places for approximately six to ten students working under supervision of an academic member of staff usually with assistance of a research group member. Although students still perform an individual piece of work they benefit from joint training on (for example) software tools, the use of equipment, key techniques and higher levels of peer support.

We will reflect on the organization of the themed projects, project allocation, their delivery, supervision and support structures that we have put in place. An evaluation of demands on staff time, student experience and preparation overhead will also be presented.

## **175** TEACHING BY DESIGN: PREPARING K-12 TEACHERS TO USE ENGINEERING DESIGN ACROSS THE CURRICULUM

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Engaging and motivating students to learn is enhanced when they are actively involved in problem solving activities and project based learning. Further, the ability to rely on and apply prior knowledge is more likely to happen when learners are not constrained to find a single right answer, but are provided with contexts that inspire them to explore and find working solutions. The context afforded by engineering design engages learners in ways that readily capitalize on and promote activation of the elements that have been identified as essential to learning.

Combining what we know about how people learn (National Research Council, 1999), best instructional practices (Mayer, 2011) and cognitive psychology (Sternberg & Williams, 2010) with the elements and process of engineering design, provides a context rich with opportunities and likelihood for high levels of student learning. However, most K-12 teachers have had little or no exposure to the engineering design process, which hinders their ability to use engineering design as an instructional context and integrate design based activities into the curriculum.

In recognition of the instructional and curricular ties to engineering design, the potential for positive influences on students learning, and the likely lack of K-12 teacher preparation in design we developed and implemented a 4 day residential professional development summer institutes for K-12 teachers focused on engineering design. Our i-STEM summer institute used a combination of keynote presentations, group activities, content strands, and field trips to enhance the 250 attending educators' knowledge, awareness, and comfort with design and STEM education.

To research the effectiveness of our summer institute we assessed an array of associated variables. Salient to our focus on teacher knowledge and applications of engineering design were measures of comfort teaching STEM, knowledge of the design process, and understanding of the similarities and differences between inquiry and design. Our research has revealed significant increases in comfort ( $p < .01$ ) and knowledge of the design process ( $p < .01$ ) and substantially deeper communication of the understanding of the similarities and differences between design and inquiry.

In our full paper we will detail the summer institute, the assessment, the results, and the follow-up professional learning community conversations regarding teacher implementation of design with their students.

## 176 PEDAGOGICAL APPROACH FOR THE STRUCTURAL STABILITY

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Nowadays the materials used in buildings are becoming more resistant, thus the spans of the structures are getting bigger. This has been used by architects to satisfy the wishes of their customers, and everybody becomes happy because of the large areas without columns. Thus, all the structure that supports the building becomes slender. Consequently, the structural elements in compression are more subject to large lateral deflections, being susceptible to loss of stability, requiring second-order analysis. This article first presents a conceptual approach with regard to the theory of elastic stability, including the terminology involved as a bifurcation, critical load, limit points, jump dynamics and post-critical path. In a second step, this paper presents a didactic computer-numerical procedure for stability analysis of nonlinear systems with one and two degrees of freedom, without loss of generality involved in complex systems that need the finite element method for the solution. This approach will be of great value not only for teaching the theory of elastic stability at the undergraduate level, but also for teaching at graduate level, once it introduces details of computational implementation, concepts of stability, analytical solution of systems geometrically nonlinear, as well as incremental-iterative solution based on Newton-Raphson method, using simple mechanical models consisting in rigid bars and rotational and linear springs.



# 177 COMPARISON OF GRADUATE COURSES IN TEACHER TRAINING SCHOOLS OF ENGINEERING

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The aim of this paper is to present and compare some graduate courses in teacher training schools of engineering that exist mainly in the USA.

The existence of such courses arises from the need for further training of teachers in most engineering courses. Usually they are engineers, many with graduate (masters or PHD levels), but without adequate training for the educational field.

For this reason, classes are predominantly expositive, where the teacher is the center of the process. In this model the teacher is one who concentrates the information, passing it to his students, who have a passive participation, which may culminate in a process of teaching and learning that do not reach their goals.

The paper presents a total of 15 graduate (Master and PHD) from the USA., a course of education support and a course that is in preparation, which belongs to the University of Brasilia from Brazil. We did an analysis and a comparison between the courses looking their main features. The courses are divided into 6 of master degree, 7 of PHD degree, and 2 master's / PHD degree.

The creation of graduate courses to training engineering teachers is based on the idea that the actual approaches to educate engineers, using mainly non-participative techniques are not the most appropriate. Thus, the main goal of these programs is to transform the way students are educated in schools of engineering and applied sciences, especially during the first years.

Training researcher teachers using new teaching and learning methodologies with multidisciplinary and constructivist focus, able to develop not only knowledge goals, but attitude and behavioural goals, able to prepare students to be critical leaders. In general, this is the main goal of the graduate programs in engineering education.

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## **178** WORKFORCE DEVELOPMENT IN NANOSCALE SCIENCE AND ENGINEERING – TRAINING TEACHERS TO EDUCATE FUTURE NANOSCALE SCIENTISTS AND ENGINEERS

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Nanoscale science and engineering (NSE) is a truly interdisciplinary endeavor in that it combines engineering, chemistry, physics, physical science, and biology. This rapidly developing field is expected to impact almost every facet of human life and thus has been termed the “next” technical revolution. Workforce needs of NSE are estimated to be 2 million worldwide by 2015 with another 5 million in support positions. The NSF estimates that by 2015 nanoscale science and engineering will be a \$2.0 trillion industry of the U.S. To meet the need of an educated populace that can work in the field as well as support its safe development, it is critical to provide high-quality nano-education programs for K-12 teachers. Teachers will play an important role in this workforce development issue not only in the US but in countries around the globe. The Georgia Institute of Technology’s National Nanotechnology Infrastructure Network (NNIN) site has been developing and implementing a professional development program in nanoscale science and engineering education for secondary science teachers (grades 7 -12). The NNIN is an integrated geographically-diverse partnership of 14 university-based laboratories supported by the National Science Foundation. It is our belief that we must provide teachers with the tools and resources needed to educate the future workforce in science and engineering as well as nanotechnology. In addition, we have found that nanoscale concepts excite students about science and engineering. We have been refining our approach over the past several years and are now focusing our professional development on the Big Ideas in Nanoscale Science and Engineering (Stevens et. al, 2009). The primary focus of our program has been to help teachers understand how nanotechnology can fit into a standards-based science curriculum that they are already teaching in middle and high school classrooms (physical science, physics, chemistry, and biology). Additional components of the program include why students should learn about nanotechnology (workforce development) and how nanotechnology in an interdisciplinary field which helps students understand the interconnections between the sciences and engineering. Our work with secondary science teachers through our workshops, Research Experience for Teachers program, and our work with the NanoTeach program (a five year professional development program for teachers) has led to insights into what is needed to incorporate nanoscale science and engineering topics into the classroom. We will share what we have learned as well as the results of several years’ worth of evaluation results from our assessments of numerous workshops held across the US.

# 179 DEVELOPING GLOBALLY AWARE SCIENTISTS AND ENGINEERS IN NANOSCALE SCIENCE AND ENGINEERING

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The National Nanotechnology Infrastructure Network (NNIN) is a NSF-funded program which supports nanoscience researchers by providing state-of-the-art facilities, support, and resources. The NNIN is an integrated partnership of 14 universities across the US (<http://www.nnin.org>). The NNIN has a large and integrated education and outreach program. One of our goals is to encourage and develop talented students (undergraduate and graduate students) to become future leaders in nanoscale science and engineering (NSE). We have developed and implemented three programs that we hope will lead to globally aware scientists. In 2007, we established the NNIN international Research Experience for Undergraduates program (iREU) to further the NSE experience of exceptional undergraduates who participated in the NNIN REU program. NNIN established this program because we believe that globally aware scientists and engineers should be a priority in the 21st century. This program is only open to our prior year REU students – we are effectively using our REU program as a “filter” to select only the very best students for this enhanced research experience. Our partners for this international program: the National Institute of Materials Science (NIMS) in Tsukuba, Japan, the Forschungszentrum Jülich (FZJ) (a Helmholtz Research Institute) in Jülich, Germany, IMEC in Leuven, Belgium, Delft University in The Netherlands and Ecole Nationale Supérieure des Mines de Saint Etienne in Gardanne, France. The second program is a graduate level program with our Japanese partners at NIMS. As an integral part of our relationship with NIMS for hosting our iREU program, NNIN sites host a number of graduate students from Japan’s Nanonet, which is managed by NIMS. The goal of this summer program is much the same as the iREU, that is, to increase awareness of the global nature of research for both the visiting Japanese and the host NNIN sites. The final “global” program is the international Winter Schools for Graduate Students (iWSG) which are organized jointly by NNIN and institutions in third world countries with the goal of promoting international bridge building and understanding by bringing together students and faculty in an intense teaching and societal experience. Each year, ~10 graduate students and faculty participate in a rigorous course in an emerging and research-intensive interdisciplinary direction that is not part of US graduate curriculum. The course is co-taught by faculty of the host site and includes participation by graduate students from the host country. This lasts six days and is followed by travel to a rural part of the country (~4-5 days) where students spend time observing, experiencing and discussing societal challenges and the part science and technology can play. The presentation will present the components of each of these programs as well as results from our surveys of participants.

## **184 ASSESSMENT OF STUDENTS PROJECT – NUMBERS, LETTERS, WORDS**

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New engineering programs have been developed to meet requirements from society and industry, but are still lacking useful assessment and evaluation methods. Evaluation of engineering programs has been on the agenda for several decades, and the amount of literature dealing with different evaluation approaches shows that there are many useful concepts and methods. The problem we have experienced is lack of assessment methods which can be used when assessing the knowledge, skills and competences developed in projects using PBL pedagogical approaches (problem based and project organized learning). These projects are very complex to assess because each project is unique. This means a huge challenge for the teachers because the content of the different projects many times need different assessment criteria but still have to be within the learning goal of the study regulation. For project work a number of different assessment methods are available which can be used to assess a range of different skills, and be evaluated, either formatively or summatively. In this paper we will present different assessment methods used for assessing projects. Experience of assessing first year projects from the Medialogy education, Aalborg University (AAU), and third year projects from Electrical and Computer Engineering Department at University of Minnesota Duluth (UMD) will be discussed. In the cases from AAU and UMD different assessment methods are used. The AAU assessment purpose is to give a final judgment of the project together with an individual oral exam performance in topics related to the project, and it is based on the 7-point grading scale. The students get feed-back after the individual examination. The UMD assessment is based on formative as well as summative purposes. The UMD assessment purpose is to give a final judgment of the process and the project, and together with an oral presentation the result is given in natural language terms representing categories at a scale. The teachers grading principles are based on the 5-letter grading scale, but the feed-back to the students is explanatory. The two assessment methods are analyzed and discussed in relation to the learning goals. The study shows that several assessing methods from both cases are in use with more or less emphasis on the different aspects in the methods used. Furthermore there is an emphasis on a profound explanation of the assessment results. The results show that teachers are able to assess the project and during the oral individual or group examination to give a total grade for project plus examination result, but different methods assessment methods are used.

# 185 ISSUES SURROUNDING TEACHING CALCULUS TO ENGINEERING FRESHERS

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Modern undergraduates join science and engineering courses with poorer mathematical background than in the past. University tutors spend more and more time delivering remedial teaching classes. When doing so, most rely on traditional methods of delivery. However, such methods presuppose that the learners have a good memory and a considerable time to practice. These suppositions are particularly unrealistic when dealing with large groups of undergraduates who are so-called ordinary learners, that is, have limited mathematics background, limited memory, limited proficiency in explanatory reasoning, limited interest in the subject and on top of that, limited time to cover a large amount of material and limited study skills, all aggravated by a limited contact with teachers. Yet, these disadvantages can be overcome when dealing with adult learners. The talk will elaborate on aspects of a specific approach to teaching elementary calculus to engineering students described in [1], showing how to put to practice a combination of traditional and modern educational theories. We report common student misconceptions and suggest how they can be overcome.

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## 190 IMPROVING FIRST YEAR RETENTION IN COMPUTER SCIENCE BY INTRODUCING PROGRAMMING IN SCHOOLS

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This paper will introduce the ‘Introduction to Programming’ course delivered in a number of local secondary level schools over a period of 3 years. In the project we specifically aimed to address the issue of non-completion by targeting schools that currently have pupils who progress to Computer Science courses. Non-completion is a significant problem within Northern Ireland with a non-completion rate of 14.4% which was significantly higher than the UK benchmark of 9.7%. Within the Faculty of Computing and Engineering, there is quite a high rate of non-completion, mainly due to a high rate of early leavers (who often indicate that the course was not what they had expected) and those who fail first year. We have worked hard to decrease the number of students failing first year over a three year period and in the academic year 08-09 came below the Faculty average. Initiatives such as small group tutorials and extended studies advice and inductions have helped to improve retention figures. However, the non-completion rates for the Faculty leave much room for further improvement. Therefore, by introducing programming to secondary schools, we aim to give the students a feel for the types of things they would be doing when studying STEM subjects in HE. In addition, as there are two programming modules in the first year of single honours programmes, learning the fundamentals prior to admission should be highly beneficial in improving student performance and ultimately decreasing non-completion rates. In the first year of WABIPS we have targeted three local secondary schools with the intention of encouraging pupils to progress to computing and engineering related. We have conducted a follow on study on students that participated in the project and then started first year of a Computer Science related degree. We present results on the student performance in programming modules in comparison to those who had not been exposed to programming prior to university entry.

## 192 TEACHING INNOVATION PROJECTS IN UNIVERSITIES AT TAMPERE

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Project work courses are common at computer science departments all around the world. A standard goal of a traditional course is to familiarize students into the design, implementation and testing of software systems and into working in a managed project. An outcome from a project is a software product.

Global change in societies and work environments has raised a need to ensure that students have capabilities to work in a multicultural and multidisciplinary work community and project teams. Competencies to understand, learn, and apply fast changing technologies are required on daily basis. New crucial competencies are understanding the software product concepts and communicating of the essential features to all stakeholders, thus raising the abstraction level of low level design to product and business issues.

Three universities in collaboration with Demola [1], an open innovation platform located at Tampere, designed a new course concept, Innovation Project, to meet emerging requirements of local companies and university level education.

In the course, project teams are formed from students of different universities. Students' backgrounds vary (arts, computer science, interactive technology, management, pedagogy, etc.). All projects have a real client, and topics are related to new technology or services. It is also required that all projects have a freedom to innovate, the project goal and design process are not completely fixed. The outcome from the project is a demo.

In this work we describe in detail Innovation Project course organisation and give preliminary assessment of its benefits and weak points. We also compare traditional project work course and innovation project.

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## **193** PEDAGOGIC ANALYSIS FROM AALTO UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY AT HIGHLIGHTS OF MOT – INTEGRATIVE EDUCATIONAL METHODOLOGY

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The present paper discusses about integrative view in education following the workshop titled: “Integration in Curriculum Development” [1]. The mentioned workshop has been presented by the School of Chemical Technology from Aalto University, Finland. This workshop represents an opportunity to Engineering Community to discuss together about integration concept in education. This theme inspired the author to present self experience in technological education in Florianopolis at Federal University of Santa Catarina, Brazil.

The author presents the Thematic Oriented Methodology - MOT point of view [2], now concerning the curriculum development focus. At this instance it is possible to influence technological education converting sequential traditional knowledge focus towards integrative focus associated with “real worlds” vision. On this direction, the School of Chemical Technology from Aalto University, Finland proposal seems to be innovative and appropriate to analyzed searching for common points experiences.

The theoretical foundation from MOT comes from Object Oriented Modelling philosophy derived by Emeritus Prof. Krysten Nygaard from Oslo University. He has worked at the end of his life in the COOL Project [3], using Object Oriented tool in education. Conclusion points out integrative curricular development is an important trend in technological education to face XXI century desired professional profile.

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## 194 THE AUTOMATION ENGINEERING STUDENTS' KNOWLEDGE DEVELOPMENT IN A SIMULATED WORK ENVIRONMENT

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The control engineering students shall be up to their assignments at work after finishing their M.Sc. degree. The learning processes during the university education should thus prepare them for demanding real world design cases.

The research questions we answered in this empirical study were:

1. How do the students of control engineering's knowledge develop during their design projects?
2. What is the optimal form of a student group for these kinds of work related assignments?

The evaluation was carried out during a university level course. We utilized observations, interviews, assignment diaries, and exams to collect data for the study. In analyzing the data we utilized content analysis.

The goal of the project assignment was to specify and implement the control system for a pulp production batch process. The assignment was carried out in a student laboratory environment which simulates an industrial pulp process. Small scale pulp process simulation consists of small scale process equipment (i.e. tanks, pumps, magnet and control valves, and several sensors) and a real distributed control system.

Varied group profiles were identified for this exercise. We had three types of groups: master and apprentice group which is well known and widely used method in control engineering, pair programming group which is well known in software engineering, and regular student group which represents the control group. One interest in evaluation was to compare the traditional methods, master and apprentice groups and regular pairs, with pair programming which is rather unfamiliar in the field of control engineering.

We had four perspectives to the learning: the conceptualization and control of a mini pulp process, the use and functioning of a control system, the usefulness of recipes in developing a batch control application, and the use of physical model when designing batch controls. These perspectives gave us a good conception of students' knowledge development and an ideal group type to support various perspectives of the development process.

## **195** ENGINEERING PROFESSIONAL DEVELOPMENT AND ECONOMIC GROWTH: ISSUES OF COLLABORATION BETWEEN ACADEMIC, INDUSTRY AND PROFESSIONAL ORGANISATIONS FOR THE BENEFIT OF EMPLOYMENT AND SUSTAINABILITY

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In the current global economy, the STEM students need to be able to demonstrate to potential employers, that they possess extra competences. In addition to the technical skills covered in traditional degree courses, Opportunities exist to enhance them. Various actions by universities are possible, including closer links with local industries, by visits, visiting lecturers, industrial based projects and placement opportunities. Further action can be taken in conjunction with professional bodies, such as the BCS, the Chartered Institute for IT, by encouraging the students to achieve, in addition to their technical awards, professional qualifications. The industrial/professional qualifications developed in collaboration with industries could be of particular interest to employers who are not directly aware of the particular university courses when they are allocated at a distance or in a different country. Introducing students to these qualifications, external to their universities' assessment process, enables students' development of their confidence to maintain their continuous professional development to an approved level, by taking further external qualifications throughout their working life. Universities and colleges can include, sometimes at the students' own expense, the opportunity to take external professional qualifications, such as those by Cisco and Microsoft. The I/ECDL (International/European Computer Driving Licence) at the initial level of end user computing competences can be offered to students, often in the first year of their degree course. The assessments are normally via the Internet without restrictions of location or country, providing the necessary technology is available.

The paper discusses the practical issues of this approach. The authors have practical experience in integrating professional qualifications with degree courses. We examine the processes involved in engendering useful collaborations for the development of systems and qualifications for attainment of qualifications and competencies useful for employment. The paper report on existing partnerships between organisations with a focus on professional computing qualifications from BCS, the Chartered Institute for IT. This is done in relation to specific roles and initiatives of professional bodies, expectations of industries and the aspirations of learners for a sustainable future.

## 198 SUPPORTING PROGRAMME DEVELOPMENT WITH SELF- AND CROSS-EVALUATIONS – RESULTS FROM AN INTERNATIONAL QUALITY ASSURANCE PROJECT

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This paper introduces the results from an international quality assurance project ‘Quality Assurance in Higher Education II’. This project continued the work done in the first QA project and enlarged the co-operation to two Baltic universities. The main goals of the project were to further develop and disseminate the quality assurance methods and tools defined in the first project. In addition, the project aimed at familiarizing new Baltic partners with the CDIO initiative, which is an innovative educational framework, international collaboration network of engineering educators and it supports the quality assurance in higher education institutions.

The project had universities from five different countries (Finland, Sweden, Denmark, Estonia, and Lithuania) and it was funded by the Norplus. The project started in summer 2011 and continues until autumn 2012. The project has three main phases: workshops, self-evaluation, and cross-evaluation.

The project organized three workshops in pedagogical development and quality assurance. The workshops were defined to provide support for the pedagogical development and quality assurance work.

Four degree programmes joined the self-evaluation process which involved detailed program description and self-evaluation with CDIO tools. The teachers of the programme, student representatives and industry representatives participated the self-evaluation process. In cross-evaluation phase four pair-wise cross-evaluations were done. The cross-evaluations were based on the self-evaluation reports and site visits were included in the process. As result of the project, new tools and methods of quality assurance were adopted in partnering universities. In addition, the international co-operation in the area of quality assurance and curriculum development was deepened. Finally, the programmes defined their near future development actions.

The project, phases and results will be described in detail in this paper.

## **200** DEVELOPMENT OF AN ARTIFICIAL INTELLIGENCE PROGRAMMING COURSE AND UNITY3D BASED FRAMEWORK TO MOTIVATE LEARNING IN ARTISTIC MINDED STUDENTS

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The paper investigates and poses a number of potent solutions to the problem of teaching artificial intelligence programming and other technical topics to students who are neither technically skilled nor aspired to learn these. The research continues and extends a study that has been done over a period of five years and tested on over 500 students at the bachelor part of the relatively new multidisciplinary engineering education Medialogy at Aalborg University Copenhagen. All educations under Aalborg University are following the Aalborg University pedagogical model based on Problem Based Learning (PBL) principles[2][6]. The education was developed to meet new demands from the interactive media industry and have during the last eight years educated hundreds of bachelors and candidates to fill the void between the many creative fields of media, art, design, and the technical engineering disciplines. Since the dawn of Medialogy it has been the goal to attract young creative artistic students with an interest in technology and media. The author has through a five years research [1][14] identified that the education attracted several types of students, including a large group passionate about the artistic/content part of media, art, and design; and with no or little motivation to change their aim and learn technical disciplines to meet the new demands of the industry. The author successfully found a number of pedagogical approaches for teaching technical topics to the challenging diverse students. Results showed that not only did the failing rate of the courses drop by almost half. More importantly, a clear positive change in the attitude towards programming was identified. This paper will present the extensive changes made to the sixth semester artificial intelligence programming course and the development of a framework for effective teaching of artificial intelligence programming. The framework is build on top of the new successful tridimensional engine Unity3d, in order to provide a highly motivating direct visual feedback, and thereby remove the long initial learning curve for artistic minded students. The framework was developed with close dialog to both the game industry and experienced master students, so the contend directly links to the demands of the students future challenges.

## 202 PROJECT-BASED LEARNING: THE SAE AERO DESIGN EXPERIENCE

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This paper describes some ongoing Project-based learning (PBL) experiences under development at the mechanical engineering course at the Federal University of Juiz de Fora, Brazil. Those experiences are related to student's team participation in the SAE Aerodesign competition. The main argument is the great stimulus for the students that this kind of project can achieve. The PBL principles [1] consider the role of the teacher as a facilitator rather than a director of the process. In that sense, the students have to assume some tasks and roles that can bring to them experience and expertise that are not common place in the traditional disciplines and teaching and learning processes. These tasks and roles can be related to team organization and management, self learning, work division, among other with more technical content. The paper will present some theoretical background around PBL concepts and will report how students deal with difficulties and gains from the first experience of the team.

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## 204 DIDACTIC KIT FOR THE STUDY OF INTAKE AIR SYSTEM IN INTERNAL COMBUSTION ENGINE

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With the growth and development of the embedded electronic in automobiles, it was possible to improve performance of the vehicles, conciliating fuel economy and gas emission. The intake air system in internal combustion engine of Otto cycle is one of the most important and fundamental system to the vehicle [1], [2].

The present paper focus on development of a didactic kit in order to familiarize the readers with all the intake air system of an automobile and the embedded electronic used in it, using for this sensors like MAP (Manifold Absolute Pressure), MAF (Mass Air Flow), TPS (Throttle Position Sensor) and the position of the pedal gas. Through of a microcontroller PIC16F877A, was developed all the electronic management software of the system, to control the throttle body actuator and show in the display the parameters generated by the sensors (Pressure, Temperature, Mass Air Flow, TPS, turbine rotation and position of gas pedal). Together with this system there is a vacuum cleaner turbine whose rotation is controlled by other microcontroller with the same nomenclature, generating vacuum almost equal to a real automotive system.

The project was distributed in a decentralized architecture to become the system more didactic, dividing it in two control modules: the turbine rotation and the intake air system management, where between the two microcontrollers there are a SPI (Serial Peripheral Interface) communication.

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## 205 A COMPARATIVE ANALYSIS OF THE PRE-ENGINEERING CURRICULA OF THREE INTERNATIONAL EDUCATIONAL SYSTEMS

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Industrialization at any level requires the availability of a labor force that is well-trained and capable of participating fully in the development of new products or re-engineering old products. In recent times, a number of countries, Ghana, Jamaica and the USA have expressed concern about the availability of a labor force that can maintain their competitiveness and innovation in engineering and science. The technical labor force required ranges from vocational technical graduates as mid-level engineers or technicians, and the production of graduates from tertiary educational institutions with bachelor's and post-graduate degrees. The questions that must be addressed in the area of labor force development include not only the numbers that are produced from year to year but also with regard to the quality of the labor force that is produced. With the aging of the current labor force, a country or a region must plan carefully for the replacement of its labor force in order to sustain growth in its economy for the benefit of its citizens. The quality of the product of any institution that participates in the production of graduates depends on the preparation received by students prior to enrolling in post-secondary institutions.

In this paper, the pre-Engineering curricula of secondary or high schools in three geographical regions of the world, the USA, the English speaking region of West Africa, and the Caribbean are compared in terms of their curricula content to prepare students for entry into college and for them to succeed and become members of the Science, Technology, Engineering and Mathematics (STEM) workforce. A historical perspective is taken in the comparative analysis as it relates particularly to the influence of technology on the delivery, the learning and practice of engineering and science.

The intent of this paper is to describe the commonalities of the three pre-Engineering curricula and to identify areas in which the three regions can improve in order to make their graduates better prepared and desirable for employment not just locally but anywhere in the world. The paper begins with a description of the pre-engineering curricula of the three regions in which commonalities and differences are noted and highlighted. The paper concludes with recommendations for the three regions to implement in making their curricula more diverse in which opportunities exist for students to obtain training that makes them productive citizens of the global village. A final recommendation is for the regions of English speaking West Africa and the English speaking Caribbean and the USA to form collaborative partnerships with other institutions in and outside of their regions in order to share in the best practices required to enhance the educational experiences of their students.

## 207 MATHEMATICAL LITERACY FOR ENGINEERING MAJORS

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The need to enhance undergraduate education in ways that would produce individuals capable of solving real world problems has been of tremendous interest in the United States for six decades [1]. We propose addressing mathematical competencies necessary to encompass mathematical literacy for engineering students. We will report on an interdisciplinary task force, at The Ohio State University, whose aim is to define indicators of mathematical literacy for engineering students as well as on a qualitative survey of professors from different departments.

The Programme for International Student Achievement (PISA) defines mathematical literacy as “an individual’s capacity to identify and understand the role that mathematics play in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen” [2]. While capturing the general case, we believe this definition falls short of describing how engineering students achieve mathematical literacy. We suggest two subtleties are overlooked when using only the traditional metaphor of language: (1) Translation implies that one moves between two languages when mathematical formalism has been used to articulate natural phenomena in both science and in everyday life. (2) Literacy in mathematics entails both the dexterity and the resourcefulness to recognize and employ mathematical principles and structures. Thus, mathematical literacy is closer to multilingualism: an ability to express one’s ideas and perceptions in multiple languages -- in this case, an ability to express one’s ideas using physical and mathematical principles and see how the two connect.

We posit that in the absence of a framework, the current educational outcomes expected of those entering the engineering community remain unfulfilled. Our exploratory study combined with the interdisciplinary task force should produce a baseline for mathematical literacy for engineering students.

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## 214 ROUGHLY RIGHT AND FAST: BACK-OF-THE-ENVELOPE CALCULATIONS FOR ESTIMATION, PROBLEM BOUNDING, AND DESIGN DECISIONS

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Multidisciplinary capstone design project courses provide a rich environment for honing student critical thinking skills. Design projects at the concept development stage require many decisions to be made with a very compressed schedule, often without extensive data fidelity. During the conceptual design phase up to 80% of the end product's life-cycle costs may be locked in [1]. Clearly, the ability to make realistic estimations or so-called "back-of-the-envelope" calculations is an important skill for a practicing engineer. In our global economy, time to market pressures limit time for repeated analyses, necessitating competence with order-of-magnitude estimation to guide initial direction and design decisions. Unfortunately, without practice, engineering graduates may not have the confidence to effectively utilize these methodologies.

Enrico Fermi, a member of the Manhattan Project, famously estimated the magnitude of a nuclear explosion by observing how far little scraps of paper displaced when dropped while the blast wave passed [2]. His estimate of 10 kilotons of TNT was within an order of magnitude of the 20 kiloton result arrived at by weeks worth of detailed data analysis. Dr. Fermi was famous for challenging his students with these so-called "Fermi Problems." Capstone design students can benefit from similar estimations and order-of-magnitude calculations, especially in the early stages of their design projects during problem framing and conceptual design.

This paper provides a brief literature review of efforts to develop the associated critical thinking skills and confidence to apply effective back-of-the-envelope estimation through capstone design courses. The paper then discusses specific exercises and associated teaching strategies from capstone design instructors and practitioners that can be used to foster critical thinking skills in undergraduate students. The authors support this discussion with examples from their own and other capstone design courses across the world, demonstrating the potential impact and benefit of such calculations.

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## 215 IMPLEMENTATION OF A NEW TEACHING-LEARNING SYSTEM IN THE BENG DEGREE IN MECHANICAL ENGINEERING TOWARDS ITS EHEA ADAPTATION

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As a first stage towards the implementation of the new European Higher Education Area (EHEA) degrees [1], the School of Design Engineering (ETSID) at the Polytechnic University of Valencia (Spain) took, during 2009-2010, the development of a pilot experience in the first year of the Bachelor Engineering (BEng) degree in Mechanical Engineering. The guidelines of this innovative experience have been defined in accordance with the EHEA approaches [2].

Positive academic outcomes found in this pilot group encouraged to extend this experience to a group of second year during 2010-2011. Beside the above mentioned action lines, in this second pilot experience, a similar teaching-learning methodology for the classroom activities was designed for all the core subjects with the aim of improving the student performance, so that the acquisition of generic and specific competences could be assured.

Classroom activities were designed, so that cooperative work was promoted. In coordination with these activities, autonomous tasks were also developed. In addition, a formative assessment that took into account both classroom and autonomous activities, were implemented in this pilot group.

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## 216 COMPARATIVE ANALYSIS OF STUDENTS PERFORMANCE IN PRE-EHEA AND EHEA STRUCTURED BENG DEGREES IN INDUSTRIAL DESIGN ENGINEERING

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Over the last years, European Universities have executed several reforms to implement the changes required within the Bologna process [1,2]. The teaching-learning system has changed from a teacher-centered model to a student-centered one. This change has provided the opportunity to create a more active and dynamic teaching-learning process, with more personalized methods and the integration of new technologies.

This paper provides a case analysis of the consequences of such change in the academic results of the Bachelor Engineering (BEng) degree in Industrial Design Engineering of the School of Design Engineering ETSID (Polytechnic University of Valencia, Spain). The study aims to compare various performance and success rates between first grade students of the European Higher Education Area (EHEA) adapted program and those obtained by the first grade students of the corresponding pre-EHEA program at ETSID. The rates used for this comparison have been defined with the aim of having the most objective starting point for this assessment. This study is intended to work therefore as an instrument to monitor the development and effectiveness of different teaching-learning policies, thus contributing to the continuous process of educational improvement at ETSID

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## 218 INNOVATIONS TO PRODUCT, CO-OPERATION BETWEEN INNOTOOLS AND SAIMAA UNIVERSITY OF APPLIED SCIENCES

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Innotools is a small innovative company placed at Imatra. Company has developed and is manufacturing electrostatically charged stickers, which are competing successfully with 3M yellow glue base stickers. Worldwide markets for these kind of products are about 10 000 millions € /year. Markets showed demand for more developed, coated products, which could be printed and used in several marketing and education (e.g. flipchart) purposes.

Innotools take contact with Saimaa University of Applied Sciences to find expertise in coating. Saimaa had this knowledge and research laboratory, so co-operation started. After two years co-operation in research, Innotools developed coated, patented product, which is accepted by global international companies like Cannon. Product will be in the market 2012. Patenting procedure started in the beginning of project.

Three students have made their final thesis work on this subject and one 10 person laboratory course was working to develop Innotools products. Innotools is hiring more employees steadily so this co-operation made it possible to get employer and possible employees to get to know to each other's. A market prospect for new products is huge, so co-operation will continue.

This paper will discuss about how co-operation between small local company and local university has started and what positive possibilities and risks there can be in this kind of co-operation.

## **220** E-LEARNING: CONTRIBUTIONS FROM THE SCHOOL OF DESIGN ENGINEERING ETSID AT VALENCIA (SPAIN)

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Technologies in learning and teaching offer nowadays a great variety of possibilities to facilitate innovation competences in engineering students. The Universitat Politècnica de València (UPV), Spain, has implemented an action plan of E-learning in order to improve the academic performance of its engineering students. The plan consists in making available through the network a wide range of didactic resources, such as online courses, virtual labs, online lectures, student orientation guides and problem guides among others.

The present work presents in detail the contributions from the School of Design Engineering (ETSID) at UPV and their impact in teaching and learning. The main statistics of the resources is shown along with the strategies that the School has been implementing in order to improve its effectiveness.

## 221 FITTING MATHEMATICS TO EHEA IN AEROSPACE ENGINEERING AT THE SCHOOL OF DESIGN ENGINEERING ETSID IN VALENCIA (SPAIN)

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Polytechnic University of Valencia (UPV) is a Spanish university focused on science and technology. Founded in 1968 as the Higher Polytechnic School, UPV became a university in 1971 but some of its schools, like the Design Engineering School (ETSID), are older than 100 years.

During the last year we have been immersed in the modification of all curricula in order to conform to the European Higher Education Area (EHEA). We will approach how we have faced the changes in the Mathematics subject within the first year of Aerospace Engineering, which is one of the degrees delivered at ETSID. Mathematics has suffered a notable reduction in the number of credits despite the fact that the objectives and contents to be reached are very similar. These changes should be carried out to all features of the subject: teaching method, evaluation...

The most important change in teaching methodology is encouraging autonomous work to be taken by the students. This obliges teachers to keep a continuous track of student's performance.

UPV started to build up a platform known as PoliformaT, which includes several tools such as document distribution, live chat, assignment uploads and online testing among others. This platform has been partially used by the authors at ETSID since 2007. Nowadays we are also using PoliformaT in the computer aided classes in order to organize them, settle student's work, make him to make some given tasks and monitor his/her work. On the other hand monitoring the theoretical advances and problems solving by part of the students is requiring weekly evaluations of them.

This effort by teachers and students brings as result an improved performance in the subject. Results obtained are presented in this paper and compared to the ones previously obtained.

## 224 FUNCTIONING AND DEVELOPMENT OF DISTANCE EDUCATION AT SILESIAN UNIVERSITY OF TECHNOLOGY

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This paper presents functioning and development of distance education at Silesian University of Technology based on Distance Learning Platform [1]. Distance Learning Platform is example of a modular object-oriented dynamic learning environment represents LMS (Learning Management Systems) technology, a software package designed to help educators create quality online courses. Currently on Distance Learning Platform at Silesian University of Technology are available over 1600 online courses created for students of thirteen University's faculties. Number of Distance Learning Platform users exceeds 44000. Distance Learning Platform has been working at Silesian University of Technology since September 2005 (<http://platforma.polsl.pl>). About 22 servers are integrated to one e-learning service for thirteen faculties of the University [2,3].

Distance Learning Platform is constantly developed. New interesting features are added as new modules to source code. New Platform modules implements the most modern technology appears in web-based e-learning and Internet services. Example of them is: Web 2.0 technology. Majority elements of Web 2.0 technology are currently implemented to Distance Learning Platform. Platform has great potential to create a successful e-learning experience by providing a plethora of excellent tools that can be used to enhance conventional classroom instruction, in hybrid courses, or any distance learning arrangements and significant contributes to increase efficiency of students' education at Silesian University of Technology.

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## 225 INVENTIONS AS AN ENVIRONMENT FOR LEARNING

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Innovations can be used, in addition to pursuing economic benefits, as learning objectives and learning environments in many ways. At Turku University of Applied Sciences (TUAS), innovation pedagogy has a notable role in the institution's strategic policy<sup>1</sup>.

In this paper, it will be described how innovations generated in the Degree Programme in Civil Engineering at TUAS are used as a support for learning<sup>2</sup>. In addition, the paper will cover description on new financing instruments (Product Track for Universities of Applied Sciences) introduced recently by Foundation for Finnish Inventions.

There are several patented inventions used for learning at TUAS. Related to the patented Timperi frame system, an edge-glued laminated timber beam has been researched in cooperation with students since 2010. The OSD pile is a patented new way of making drilled micropiles. Sealing sheet pile structures with cement is a patented invention for watertight underground walls. The inventions have been a learning environment for Finnish students and, in addition, for many exchange students who have mapped the possibilities for use of inventions in Germany, Spain, France, Italy, Portugal and Brazil.

Various forms of active learning have been used in the Degree Programme of Civil Engineering:

- Junior Project Hatchery
- Projects
- Research Hatcheries<sup>3</sup>
- Planning and building detached houses
- Practical training
- Thesis.

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## 226 STUDY COURSE COOPERATION MODEL FOR ENTERPRISES AND SAMK – CASE OFFSHORE

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SAMK (Satakunta University of Applied Sciences) launched two years ago a 5 credit course simply named "Offshore". The objective is to provide students a detailed overview and understanding of the process of oil production, starting from geological surveys of potential offshore oil fields, developing an oil field and ending with refined oil. The Western Finland coastal region has traditionally been strong in producing rigs and equipment for offshore oil production and related disciplines. I.e. companies such as Technip Offshore Finland Ltd, Wellquip Ltd, Kvaerner Finland Ltd among others are located in proximity of SAMK's Pori unit. One enabling factor in the success of these companies has been strong engineering skills and the availability of young professional engineers. This is where SAMK has played an important role.

Need for qualified young professionals is clear and to answer the industries call for educated engineers, SAMK is constantly adjusting the contents of provided education. Correct adjusting would not be possible without constant and open communication between all parties involved. One of several examples of effective co-operation is how this "Offshore"-course was developed and put together.

The idea of launching such a course was a result of brainstorming between SAMK, Western Finland Offshore Companies and OTC (Offshore Technology Center), an organization giving a wide range of training in the field of Offshore Oil Production.

Topics included are geological surveying, test drilling, planning and developing of offshore oil fields and production platforms, processing of gas and oil, distribution as well as HSE to name a few. All lectures are held by visiting lecturers, from leading Finnish Offshore Companies, who are experts in their discipline. The course has proved to be very successful among students and even if the amount of free spots on the course would be doubled, not all applicants could be accepted. This despite the students will not have a very relaxed time during spring as each week an assignment is distributed for the students to work on. These assigned essays are all returned and evaluated.

It is the third time this course is being held and probably will be held future Springs as well. This course demonstrates how mutual interests and co-operation between the Education providing instance (SAMK) and the industry, can result in a very to-need pinpointed course, which meets its aim in answering the demands of both students and industry.

Today approximately 20-25% of SAMK's thesis's are for closely Offshore related industries. Combining this course with other SAMK Courses e.g. production engineering and machine design will ensure sufficient skills for young engineers. SAMK will keep developing education they are giving to meet the requirements in the dynamic world of engineering in all their core fields.

## **227** MECHANICAL ENGINEERING PRACTICE EDUCATIONAL CENTER OPERATING BY BOTH UNIVERSITY AND INDUSTRY

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To meet the need of industry for qualified engineers, China ministry of education launched the excellent engineer education training program in 2010, which encourage universities and enterprises to have a full cooperation on the engineering education [1]. HuaZhong university is one of the first batches of 22 universities to involve in the program. For School of mechanical engineering of HuaZhong university, we invited some large-scale enterprises, such as Sany Heavy Industry Co Ltd, to take part in the excellent engineer education training program, and three mechanical engineering practice educational centers have been built in participating enterprises. Before the graduation, senior students will service in these centers and enterprises for one or two month. In this enterprise service period, they will learn much useful practical knowledge of engineering that are not included in university's curriculum. These centers have been running for two years, and five groups of students have finished their enterprise service, which show a great success. The paper will introduces the operating procedure of the mechanical engineering practice educational center.

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## 229 ABOUT A SYSTEMATIZATION OF THE DESIGN PROCESS OF ORIGINAL EQUIPMENT

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For the design of machinery and equipment there are various methodologies described in engineering textbooks. To strengthen or add value to these methodologies, it is necessary to systematize as much as possible every step of the design process and integrate the diverse experiences of teachers and engineers in industrial and educational projects.

This article describes a innovative proposal of a design methodology oriented at developing original equipment which can be used for engineering education. The methodology consists of 9 phases: 1) analysis of customer requirements, 2) conceptual design, 3) body design, 4) design detail 5) manufacturing and assembly, 6) testing and validation, 7) industrial transfer, 8) life cycle analysis and 9) industrial upgrading and technological innovation. These stages help students contextualize and locate the different subjects that carry during his career and also serves the industry to systematize the programs and procedures with which are designed and manufactured equipment and machinery.

The methodology includes steps ranging from quotation and the contract of a project through to delivery and startup of equipment designed. Important considerations are made about the conceptual design and testing and validation of equipment. Each phase is described as a program or procedure of the design process and for each phase are given a series steps per follow in the design of a product. Finally, the methodology presented in this article, has applications in teaching and in industrial development of original equipment and machinery.

## 230 STRUCTURED LEARNING JOURNAL BASED METHOD FOR LECTURE COURSES IN ENGINEERING EDUCATION

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We have observed that engineering students in our information technology curriculums are able to allocate less and less time each year for deep thought on the subject matters covered in their courses. The trend is more and more towards spending as little time as possible for coursework, just enough to fulfil course requirements. One possible reason for this could be the good chances our students have in the Turku area of being recruited by companies in the information technology sector already in the early stages of studies. The reduced time spent on coursework has a direct effect on the level at which learning outcomes are reached, especially in courses organized as lecture courses with an examination held at the end of the course. The study effort emphasis seems to be shifting more and more towards the few days before the examination from the more ideal evenly spread effort across the duration of the course.

In this paper we present our learning journal based teaching methodology which directly addresses the problem of uneven study effort division throughout the course. Students return a section of their learning journal each week, and at the end of the course they combine the weekly sections and finalize the entirety into a final learning journal. The learning journal is graded, and there is no examination at the end of the course. By requiring students to write a section of their learning journal each week on given topics throughout the course, the students will have to process each week's course topics more deeply than they would in the case of an examination. This way, the learning process is spread evenly across the entire duration of the course, resulting in better reaching of target learning outcomes and deeper learning of the key topics. At the same time, the weekly sections can be used for receiving instant feedback from students from each week's lectures, exercises and reading material.

We present three different scenarios, or case studies, of applying the methodology on university courses we teach. In each case, the methodology is tuned to fit the exact needs of the course in question and the attending student pool. The results and experiences of these three case studies make it evident that our original assumptions were correct: target learning outcomes are reached better, students obtain a deeper understanding of the key course topics and the weekly sections provide an excellent channel for instant feedback from students.

## 233 WEB 2.0 AND COLLABORATIVE LEARNING: AN APPLICATION ON INDUSTRIAL ENGINEERING COURSE

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The internet represents a paradigm shift because it allowed the use of computer in collaborative work. An example of this phenomenon is the blog, a web 2.0 tool. Web 2.0 tools have changed the way that internet users interact on the network. Accordingly, this paper discusses the question: “How professors can improve collaborative learning through web 2.0 tools inside of engineering education?” To answer it, this paper focus on an experiment developed in a discipline of an industrial engineering course.

The blog was chose for this research, because it represents collaboration, autonomy and authorship, concepts intrinsic to web 2.0 philosophy, according to [1]. The activity proposed claims to develop students’ collaborative abilities in learning process. The students’ attitudes were observed according to these concepts: the four-domain development diagram proposed by [2], the collaborative learning concept and the potential use of blogs in education proposed by [3].

We conclude that is possible to create a motivational space using collaborative strategies in engineering education. This does not means deny the importance of expositive classes, but it shows how the collaborative methodology can be used allied to traditional model, promoting a better learning. This activity fosters a large interaction and participation of students’ in classroom and each work group had the possibility to interact with the others groups and enterprises\professionals engineers outside the University. The major difficulties are the professor’s formation in the pedagogical use of these new technologies and a transformation on his attitude at the classroom in the sense to promote active learning process.

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## 236 TEACHING ULTRASONICS USING SPREADSHEETS

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Whenever an ultrasonic wave encounters a boundary between two media it is partially reflected and refracted, as any acoustic wave would be. Unlike light, the wave also undergoes mode conversion so that in the general case a single incident wave could produce two reflected waves and two refracted waves. The angles which define the path of the wave are determined by Snell's law and are easily calculated. The relative amplitudes, on the other hand, require quite complicated formula when the angle of incidence is anything other than 0 degrees. This problem gets compounded when the angle of the incident wave goes beyond the first critical angle. At this point the angle of the refracted wave becomes imaginary and the equations to calculate the relative amplitudes become complex. This paper describes a tool that has been developed, using a spreadsheet, which performs the calculations for all incident angles. The user selects the media and the type of incident wave and the resulting waves are shown graphically as well as numerically. The tool was developed primarily as part of an undergraduate course on ultrasonic testing, but could be used more widely.

## 237 PROMOTING KNOWLEDGE SHARING AND INNOVATIVENESS IN E-LEARNING ENVIRONMENT

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Special character in ICT-companies is that they are knowledge intensive, operating usually in international markets and they have to be able to utilize and create new knowledge constantly to remain competitive. Technological know-how is not enough. Most ICT-companies do R&D and product development internally. Outsourcing such activities is quite rare. Kuusisto, Kulmala & Päällysaho ([1]) researched small and medium sized knowledge intensive companies in Finland and UK attempting to understand how small companies manage and protect their intellectual property. Half of the interviewed software company managers in both countries emphasized the importance of free information flow and efficient knowledge dissemination in the company. The perceived importance of free information flow in the software sector, may relate to the fact that new software innovations are often born spontaneously on 'ad hoc' basis, incrementally and in co-operation amongst employees, collaborators and the client. This type of process requires efficient information flow within the company. Real life for many companies in 21st century is that clients, collaborators and even employees are not located in the same physical premises. In information exchange, storage, exploitation and even learning companies are using different kind of platforms to secure efficient information flow between parties in multicultural and multinational environment.

The aim of the proposed article is to examine what kind of features and processes in e-learning environment support dynamic co-operation, information flow and innovation creation especially in multicultural and multinational project environment. More specifically, how information flow can be promoted in an e-learning environment? How feel of trust and rapport can be created? The proposed article will present and model findings of selected information rich case studies. The topic is important when knowledge intensive companies are trying to find approaches to improve their companies' performance to remain competitive and when developing different type of e-learning environments for educational and commercial purposes.

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## 238 TEACHING DIGITAL DESIGN IN THE FPGA AGE

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A growing number of digital electronic systems are based on Field Programmable Gate Arrays (FPGA), chips that, after fabrication, can be configured by the designer to implement specific functions and systems. A typical FPGA contains many thousands of simple logic components, and a complex path of interconnections that allows them to be configured to perform all kinds of digital functions. The new technological scenario demands now an earlier familiarity with FPGA: there is a strong trend in education to introduce them in a first course of digital design [1]. The approach that we present in the paper is a new extension of Deeds, the design suite for digital circuits developed in our department for design and simulation of digital systems based on combinational and sequential blocks, finite state machines and microcomputers [2].

The extension of Deeds allows students to compile a project into an FPGA chip starting from Deeds, reducing to a minimum their interaction with the FPGA-specific EDA tool. At the date we are writing, the extension allows to download in a FPGA board a digital system composed of all Deeds' combinational and sequential components, and any number of Finite State Machines.

The FPGA extension is centred around an "expert" module that allows the student to choose a FPGA board and to associate all the input and output of the digital Deeds project to the board devices and resources. The operations are guided by the system and aided by highlighting the selected objects in the Deeds schematic and in the board image. Then a VHDL code generator will produce all the files needed by the specific FPGA CAD, that the student will use to compile and load it in the FPGA Board, ready to be tested. All library components and Finite State Machines are exported in behavioural VHDL, while the top level schematic is compiled in structural VHDL.

Our experience, supported by the data of evaluation questionnaires proposed to a very large number of students, has confirmed the effectiveness of our approach.

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## 239 DIDACTIC KIT FOR THE STUDY OF CAN BUS

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This paper will argue about a development of a didactic kit in order to teach how works the communication CAN (Controller Area Network) deeply used by automotive industry due to its high reliability [1], [2].

The didactic kit developed, which is the main goal of this Project, allows to student at beginning to know and fit in with specific hardware working to this communication composed of CAN controller and transceiver. It still allows the software development so that to create data, messages and send them via SPI (Serial Peripheral Interface) to CAN controller, furthermore it is possible configure the same. At this moment, it is possible simulate basic automotive examples. It has used to make this hardware development the integrated circuits PIC 16F877A, CAN MCP2515 controller and transceiver PCA82C251, all them made by Microchip Technology Inc.

The developed board allows the implementation of a network with at limit three nodes. Each node there are one microcontroller, one CAN controller, one transceiver, four potentiometers and four switches to simulate data, moreover there are a LCD display and three LEDs to viewing. As didactic application example of this kit has been developed an electric hold actuation system, power windows actuation and a windshield wiper allowing to student a large understanding about CAN communication system and helping with automotive electronic teaching.

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## 240 INITIATIVES TO PROMOTE SCIENCE & TECHNOLOGY CAREERS AND THEIR IMPACT ON IT'S SECTOR AND ON DEVELOPING COUNTRIES

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Science and Technology are doubtless important in today's world and also assume an important role concerning its economic aspects. Despite that, courses with those subjects are occasionally not even considered by teenagers as future careers. Regarding this, a US Government initiative, STEM (Science, Technology, Engineering, Math), established in 2006, promotes to students these courses. In this concern, this research shows which fraction of students choose S&T as careers since there is a very high demand on labour markets and what a initiative like STEM can do for developing economies like China and Brazil where the markets are always in need for professionals in these careers. An analysis of current data available showed that S&T promoting programs, like STEM has succeeded and could be applied to developing countries, which would encourage the area's growth. Also, each place has its own culture and peculiarities, which requires the creation of a singular promoting program that correlates with each region. The academic data refer to census that state which portion of students choose engineering courses, the fraction that completes the graduation and the amount of institutions offering an engineering program. Furthermore, this analysis proposes to evaluate in which way a larger number of skilled professionals in this areas could make the Information Technology (IT) grow in the economical and laboured environments since it is very important to the market's development.

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## 241 INFORMATION TECHNOLOGY IN THE COMPUTER ENGINEERING CURRICULUM: AN ANALYSIS AMONG UNDERGRADUATE INSTITUTIONS

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The Information Technology (IT) development has caused the world's boundaries to approach. This advance was responsible for many services without which it is not possible to imagine the modern society. In summary, this analysis suggests that computer-engineering schools over the world differ with regard to the number of undergraduate disciplines in which IT topics are addressed. With this in mind this article seeks to understand the importance of the under graduation, in particular the computer engineering courses, to the development of the IT field. In this sense, the current paper presents how inserted is IT in these courses by comparing quantitative and qualitatively the workload dedicated to this field of knowledge. This article has drawn a comparison among the development of IT field in each of BRICS and the emphasis given to this in the under graduation. The data was collected in the official curriculum and of the best university of each BRICS member and the top five undergraduate institutions, all according to QS World University Rankings® 2011/2012. Furthermore, the supply of skilled IT professionals is heavily conditioned by those differences. As a matter of that fact and concerning its economic impact it is highly recommended to enhance and promote the people's IT interests in some ways like establishing extracurricular courses or even obligatory ones that regard IT knowledge.

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## 244 SELECTION OF APPROPRIATE PROGRAMMING LANGUAGES FOR ENGINEERING APPLICATIONS

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When students enter the University from High School they are usually familiar with at least one Application Program / Programming Language. This is usually Microsoft Excel. It therefore is very appropriate to use that language for First Semester applications and expand the basic knowledge that students have with numerous solutions in all areas of Engineering, Statistics and Mathematics.

To give students greater flexibility and more programming ability, languages like MatLab and C++ are considered in the second semester. Both of these languages have capabilities to solve some of the most intricate Engineering Problems. It will be shown that MatLab is far superior in all Engineering applications and can solve problems with very simple and short programming commands. Especially in Electrical Engineering, solutions for complex mesh and nodal problems can be accomplished with a few keystrokes. Providing students with MatLab capability in Engineering lecture rooms or letting them use laptops with MatLab installations will provide quick solutions to many problems that were quite difficult for students to solve with their calculators.

## 245 TESLA TURBINE AS A STUDENT LEARNING TOOL

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Thermofluids Engineering offers unique challenges to students of Mechanical Engineering because its approach to learning is largely heuristic unlike anything else in their prior experience of the curriculum. Used to the familiar and exact analyses in prior studies of kinetics and kinematics of mechanisms and mechanical vibrations, students are confronted in Thermofluids Engineering with applications of a few key principles in various forms of complexity that are often not immediately obvious to a student. Relating theoretical concepts to a hands on capstone project has proved extremely helpful in promoting keen interest with all the pedagogical benefits that stem from it.

The aim of this paper is to present a synthesis of several such projects dealing with the same topic and dwell on the pedagogical outcomes which we have found extremely satisfying.

The Tesla turbine concept proved to be an interesting challenge to a few generations of senior students because it embodies elements of application and research as well as analytical analyses well within the scope of an undergraduate curriculum. In the hands on part, designing and building the machine involved knowledge gained elsewhere in the course. Experimentation provided a tangible outcome which served as a prompt for analytical analysis.

## 246 INNOVATION COMPETENCES IN GAME TECHNOLOGY EDUCATION

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Structural change in western societies has forced universities to update their curriculums especially in technical faculties. For example in information technology links to future technologies in fields such as renewable energy, wellness and games are and will be sought when designing and updating curriculums. In this paper, challenges and possibilities of ubiquitous computing and 3D virtual models are introduced as a part of the process of updating the curriculum of information technology. Game industry is one of the most rapidly growing sectors. According to Reuters [1] the size of global game market revenue was around 65 billion dollars in 2011 up from 62.7 billion dollars a year earlier. Game industry has needs for experts not only in graphical design, manuscripts, audio-visual design, and programming but in new fields of expertise, namely in ubiquitous computing, and geoinformatics.

Ubiquitous computing and geoinformatics will offer game industry tools for new innovations. Game industry is currently switching over to the eighth generation of video consoles. Motion sensing and mobility will be form the basis but ubiquitous computing and geoinformatics will facilitate innovation competences globally. That is to say ubiquitous computing will enable gaming anywhere, anytime, and to anything. It will be embedded into the objects of everyday life, and it will be invisible to the users or accompanied by new form-fitting solutions (cf. [2]). Geoinformatics, in turn, will offer game industry tools for building bridges between real and virtual world. For example Navteq True system is currently collecting laser scanned information all over the world. Based on this information game industry is able to utilize point clouds not only in traditional game fields but also in augmented reality games, in wellness games, or in serious games.

Technologies introduced above will force universities to update not only the courses. Also human resources and investments will be under consideration. In this paper, these challenges will be analyzed in order to identify the excellence in global competence.

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## 249 NOVEL APPROACH TO ORGANIZE HIGHER EDUCATION IN REGIONAL UNITS

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It is a common tendency in Finland to centralize higher education in large units in order to offer students a possibility to diversified studies and to strengthen RDI operations. This sets heavy pressure to regional units located apart from main campuses. However, especially universities of applied sciences have de jure task to serve regionally the working life in their own area.

We introduce one approach to organize higher education in regional units. The model is based on close co-operation with companies and own local RDI in selected areas. Students start their studies in the main campus. Typically, during the second half of the curriculum considerable part of the studies consists of project-based studies which are realized locally in authentic development projects in companies or in own RDI projects. In either case, teachers define the pedagogic goals for the projects and follow the learning process and the achievement of the goals. A general description of the features of project-based learning is given in [1]. In our approach the strong involvement of potential employers should be added to this description.

The proposed approach is currently put into operation in our branch campus in Raahе. The implementation demands changes in curricula in the main campus in Oulu as well. The major challenge is the new organizational culture that concerns both teachers and students and external associates. We give examples on the curriculum development and on the practical implementation of the learning projects. Preliminary estimates of the potential of the proposed approach and main steps and challenges in the implementation are discussed.

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## 252 EDUCATION TO THE TECHNOLOGY ENTREPRENEURSHIP IN ENGINEERING STUDY PROGRAMS IN SLOVAK REPUBLIC

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The contribution will be orientated on the theoretical and methodological background of the technology entrepreneurship and discussed the ways that are using in the engineering education at the University of Zilina in the Slovak Republic. There are used several ways to technology entrepreneurship education, e.g. the optional courses or trainings, creation of cooperation networks, consulting services, workshops and creative ideas forum etc. It deals with legislation framework of this problem and its gaps in Slovak Republic and at the university. It is necessary for Slovak universities to increase co-operation between universities and business surroundings mainly in relation of innovative processes and in solution of high level of unemployment rate. University becomes active element in business environment, in regional development and it declares the responsibility and its place in modern society. The unemployment rate in the Slovak Republic is quite high and so the entrepreneurial competences of students and graduates have to be developed, improved and increased. The engineering students and graduates are also the potential for innovations and for increasing the rate of high-tech industry in regions.

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## 254 SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION: METHODS TO IMPROVE PSAT SCORES USING A STEM FOCUS

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Having informal education (IE) experiences is important (Sawyer, 2006). Research shows that IE settings such as camps, clubs, museums, zoos, aquariums and environmental centers provide visitors with active learning experiences that engage individuals in inquiry-based exploration (Hofstein & Rosenfeld, 1996). Based on the work of others (Bressler, 2006; Rennie & McClafferty, 1995), this study provides valuable opportunities for student learning, motivation, and engagement, in learning in a nonthreatening context (Ramey-Gassert, 1996) while fostering positive learning outcomes. The Aggie STEM summer camp design at Texas A&M shows great promise for fostering inclusive learning across settings (cf. National Research Council, 2009).

Research has shown that learning experiences in IE settings provide significant benefits to 12-15 year old children (Hofstein & Rosenfeld, 1996; Rennie & McClafferty, 1995) in two general areas: cognitive and affective domains (Hofstein & Rosenfeld, 1996). In this regard, IEs can yield significant cognitive benefits for children by enhancing their rate of learning and their breadth of conceptual knowledge while also improving their attitudes toward STEM learning (Falk & Dierking, 1997; Jarvis & Pell, 2005).

In Texas, Science, Technology, Engineering and Mathematics (T-STEM) initiatives offer a fundamental approach to inspiring students, and advancing the studies in these four fields. A key element within the T-STEM initiative are the 7 T-STEM centers which are tasked with creating new STEM instructional materials and providing research based, high quality, STEM, professional opportunities to teachers.

In an effort to increase the number of students entering into STEM pipeline, Aggie STEM has extended its mission to work with students and provides a 2 week long STEM summer camp for secondary students. These students participate in an intensive STEM focused curriculum for 13 days. Sessions include real world science and math applications through project-based learning (PBL), robotics, university engineering and science lab tours, radio and television communication, museum tours, and PSAT preparation. This study demonstrates the learning successes that can be achieved through inquiry-based experiences of a STEM summer camp at a major Texas university with inner city high school students.

## 255 A COURSE IN INSTRUMENTATION AUTOMATION

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A course in Instrumentation Automation that can be taken by engineering students of all disciplines is described. A programming language called LabVIEW by National Instruments Inc., is used in the course [1]. LabVIEW is currently used in major research and development laboratories around the world, and in teaching laboratories in many universities, especially in the disciplines of electrical and mechanical engineering and physics. The programming language is also used throughout industry for process automation and manufacturing performance testing. Additionally, with the latest internet capabilities LabVIEW applications are being deployed not only physically in many places, but virtually across networked applications.

The paper describes the course offered at the senior level at Wilkes University for engineering majors. The course is open to first-year graduate students in electrical and mechanical engineering. Topics covered and samples of projects assigned in collaboration with local industries are explained in detail. With the flexibility of changing the course content, the paper describes the possibility of offering the course at an undergraduate introductory level through the graduate level. As the programming language LabVIEW is popular worldwide, the paper stresses the importance of such a course for students in US who may be assigned to work in a different country and for international students who plan to return to their home country after graduation, thus breaching the language barrier and providing international collaboration.

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## 256 HOW TO PROMOTE INNOVATIONS THROUGH APPLIED RESEARCH IN COLLABORATION WITH SMES?

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European Union has great challenges to become the Innovation Union until 2020 which has been set as a goal in EU strategies. The gap between visions and current status is worrying especially when considering SMEs. The bureaucratic framework programs are currently forming the basis of European innovation strategies but they are often too complex for SMEs. On the other hand, SMEs have great potential both in regional and global innovation systems. To increase the innovation capability of SMEs, research, development and practice should at equal importance level in collaborative applied research projects. In order to sustain the increased competitive pressure, innovation is considered as being the most valuable sources of growth and competitiveness for the SMEs [1]. However, the strategic knowledge necessary for innovation not only concerns technology but also business intelligence, funding, marketing and other non-technical areas [2]. Technology transfer and SME-oriented applied research should be complemented with collaborative creation of new business opportunities.

In this paper, we present a model how innovations and innovation capability can be promoted through SME-oriented applied research. The CENTRIA model [3] is based on integration of technology expertise, technological capability and business knowledge with co-creation, trust and helping relationship between the SMEs and the applied research group. The model emphasizes to proactively take into account the needs of current and future customers. We will present our experiences gathered in collaborative applied research projects between SMEs and CENTRIA. The research approach has been found beneficial both sides: innovation capability has increased remarkably in both partners. The collaborative applied research projects have produced tens of new business opportunities and many of them have already been used in the SMEs. The academic research activities with field experiments have given the research organization tools for publicity, respect and cooperation possibilities on an international level. The developed model is planned to be extended to wider user in Finland in the future.

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## 261 ENGINEERING THE SCIENCE AND ENGINEERING EDUCATION

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Today's engineering education is facing considerable challenges on how to effectively make use of available information and translate that into usable knowledge for students and professionals. Deficiencies [1] in engineering education have been addressed often in university committees, publications, and proposals to fund suggested solutions. The expectation is normally to teach or learn more about real-world engineering design, cover more and up to date areas of engineering, have better communication skills, be adaptable to future changes, have critical thinking skills, be able to connect between technology and society, and much more. It is often expected to reduce the number of hours in math, science, and engineering courses so the average student can complete an engineering degree in four years time.

Another issue is the fact that the explosion of information technology (IT) provides easy access to answers of most, if not all, engineering questions. This makes it easier to search for a solution of a problem than to think or work the problem through. This is actually true for both students and instructors. In other words, individuals will most often have information but not the true knowledge of a given subject. This may help the aspects of covering more up to date materials but have a negative impact on adaptability and critical thinking parts of engineering education.

To solve an engineering problem, one will go through the process of definition, modeling, design, optimization, implementation, testing, and quality control before the work is actually complete. This process may differ for different fields of science and engineering in each step (and may require more or less steps). However, the process will be engineered and improved by evaluation of the outcome.

This study is to present an engineering approach to science and engineering education. Among many other discussions on challenges in today's engineering education, the pros and cons of using IT in science and engineering will be addressed. An engineering based model is defined to bring a constructive balance in the use of information technology and to address the complex requirements of today's engineering education.

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## 263 ENGINEERING STUDENTS INVOLVED IN ACTIVITIES TO MOTIVATE HIGH SCHOOL STUDENTS FOR ENGINEERING COURSES

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This work refers to the project Lab InCognITA - Laboratory of Innovation in Cognition, Information, Technology and Learning - under development at the Faculty of Engineering of Guaratinguetá, a unit of the São Paulo State University – UNESP. The project has, as its main purpose, to motivate High School Students for the Earth Sciences and Engineering Careers.

To achieve its objectives, the project includes activities for both the Students and Teachers from the High Schools taking part in the project. The activities for the students involve essentially the accomplishment of “Energy Shows” and of “Energy Exhibitions”. The activities for the teachers involve the realization of capacitation courses, having as its main focus “Energy and Environment” and as a pragmatical approach the project-based learning methodology.

The shows, accomplished in the High Schools, are related to the subject of “lecture demonstrations”. In the shows, undergraduate students from the Earth Science and Engineering Courses of the Campus conduct a presentation making use of a number of devices (such as the Van de Graph and the Wimshurst Machine, among others), with the intent of illustrating the Physics Principles, with an emphasis to the concepts related to the topic of Energy. The students also collaborate in the Capacitation courses, helping the teachers with the development of their projects, which have their “driving question” directed to the Energy thematic.

In this article, we plan to present initially a general description of the project. Then, we will describe shortly the project activities, stressing the participation of the Engineering and Earth Science students in its development. We claim that the students, participating in the project activities, not only can help High School students to become (to some extent) more motivated for the Engineering careers, as also contribute to their own formation, as the developed activities help them to fix contents of specific subject matters of their Engineering Courses.

## 269 INTEGRATING INNOVATION ACTIVITIES IN AN MASTER LEVEL CAPSTONE PROJECT COURSE

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The computer engineering and computer science curriculums at Åbo Akademi University have had for more than 10 years a capstone course, called Project Course, where the students in groups implement a larger software or combine software/hardware system. A major change in the environment for the students was in year 2006, when information systems students, a business curriculum, was integrated in the department. At that point, activities for integrating innovation activities as added to the course development. The aim of the innovation activities is to try to make the students aware of their possibilities, as well as encourage them to form start-ups based on either ideas in the project course or further development of their ideas. To this point, year 2012, we have at least two companies based on the basic technical work done during the project course. In parallel, a student entrepreneurship organization has been formed in the university campus area, which today is a major, student based, co-operator to the project course.

This paper will present the development of the Project Course and the supporting activities around it. The way how to cooperation work is explained and how it affects the students in the project work during the course. We analyse how different strategies for innovation have turned out in practice, and provide suggestions and tools for how student innovation can be encouraged and facilitated.

## **270** WORLDWIDE-ACCESSIBLE 1.25 GBPS ADVANCED LASER COMMUNICATION LABORATORY

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The amounts of knowledge expected at the baccalaureate and master's levels show drastic increase. The on-going revolution in information technology results in innovations in university education that can address these requirements. The system of engineering education is especially receptive to evolution of the Internet, global communication systems, computers, etc. However, there is one area in engineering education that is still dominated by classical teaching/learning methodology: the laboratory. This could be easily explained: the purpose of an engineering laboratory course is to teach future engineers to interact with the "real hardware" in all its imperfection. Any attempt to replace the "real hardware" in a student laboratory with the most elaborate simulation software can result in the loss of realism and prevents students from gaining important practical skills and experiences. Unfortunately, modern engineering laboratory equipment is highly expensive, requires expensive maintenance and repair, that along with the floor space requirements often exceed the resources of many universities. This justifies the existence of laboratories utilizing virtual reality techniques: virtual reality is better than no reality at all.

The technology presented in this paper is not a virtual reality laboratory. It is a hardware/software infrastructure providing remote access to advanced instrumentation via the Internet. Developed under the National Research Foundation's funding, it brings real hardware to the fingertips of students, thus facilitating the development of important skills. It features a fully operational laser communication link installed on the Binghamton University campus between two buildings separated by 1-kilometer distance. The link provides a basis for a Worldwide-Accessible High Performance Experimental Laser Communication Laboratory that offers its state-of-the-art instrumentation and educational technology for conducting pre-designed and open-ended experiments in the areas of digital communications, physics and electro-optics to the international community of engineering students. It enables its world-wide users to operate complex laboratory hardware, receive experimental data, and take advantage of advanced visualization and data pre-processing via the Internet. Combined with the Internet-based delivery of theoretical courses, it can fully satisfy requirements of both graduate and undergraduate engineering education, providing high quality education across national and social borders.

# 271 MECATAS – TEACHING AND LEARNING MODEL FOR CONTROL AND AUTOMATION ENGINEERING BASED ON THE MEANINGFUL LEARNING THEORY

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This paper presents a proposal structured as a pedagogical model called MECATAS – a model for improvement of teaching-learning process in the control engineering education. According to members of the National Confederation of Industries of Brazil, one of the possible motives of evasion in engineering degrees is the split between the curriculum of schools and the solution of practical problems imposed by the enterprise reality. To reduce this distance, the model proposed in this thesis has the following elements: 1 - cognitive theories of learning, to provide the basis for model construction and analysis of results; 2 - proposed technological platform, to assist students in developing activities related to experimentation of professional practice; 3 - tools for the development of learning and assessment mechanism. The research developed has as goal to answer the following question: “How the technological platforms, can help develop meaningful learning of students in control engineering?”. The theoretical basis for the model is the meaningful learning theory of Ausubel and concept maps of Novak. The proposed technological platform is used to aid the student in the conception, design, simulation and testing of control systems. This platform integrates the mathematical simulation software MATLAB® to a prototype of a distillation column, allowing the testing of control systems developed directly on a real system. To validate the proposed pedagogical model, an investigation was outlined as a didactic and pedagogical experiment for students of advanced control of three periods in a course in control engineering at the Instituto Federal Fluminense. The results from the research instruments applied are reviewed under the light of the theories involved.

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## **272** OPEN AND DISTANCE LEARNING FOR ENGINEERING; OPPORTUNITIES AND CHALLENGES

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The majority of the ~4000 students currently studying for engineering qualifications with the Open University (OU) [1] are mature students in full-time engineering related employment who study part-time through distance learning. This, together with the OU's open access policy (there are no formal academic entry requirements to the programme) and the range of different study pathways available, results in a particularly diverse student body and presents us with a range of challenges.

In this paper we describe our existing approach in three particular areas, and discuss planned initiatives to improve our provision. The three areas considered are: the need to ensure that new students are adequately prepared for study at the required level; the challenge of facilitating and assessing group work effectively within a distance learning environment; the limitations of relying on generic mathematics modules not specifically tailored to engineering.

We will also touch on how imminent changes to UK higher education funding are likely to impact on engineering education within the OU.

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