Innovation and Entrepreneurship in the Computer Systems Curricula and Nordic Master School in Innovative ICT

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Abstract[1] — **The paper describes how the innovation and entrepreneurship module as an obligatory study module within the computer systems curricula at Tallinn University of Technology has been developed. In the second part of this paper we will give an overview of Nordic Master School on Innovative ICT (NMS iICT) that has been implemented as an virtual umbrella organization in order to strengthen the Nordic Innovation Powerhouse and increase the quality, attractiveness and competence of the ICT education among the local students.**

I. INTRODUCTION

Computer Systems curricula must combine the science and technology of design, construction, implementation, and maintenance of software and hardware components of modern computing systems and computer-controlled equipment. It is a combination of both computer science and electrical engineering disciplines and it solidly grounded in the theories and principles of computing, mathematics, science, and engineering and it applies these theories and principles to solve technical problems through the design of computing hardware, software, networks, and processes [1, 2].

Increasingly, computer systems engineers are involved in the design of computer-based systems to address highly specialized and specific application needs. Computer systems engineers can find employment in all areas, including the computer, telecommunications, power engineering, manufacturing, automation and electronics industries. They design high-tech devices ranging from tiny microelectronic integrated-circuit chips, to powerful systems that utilize those chips and efficient telecommunication systems that interconnect those systems. Applications include consumer electronics (MP3 and DVD players, televisions, stereos, microwaves, gaming devices) and advanced microprocessors, peripheral equipment, systems for portable, desktop and client/server computing, communications devices (cellular phones, smartphones, tablets), and various medical devices (pacemakers, scanners, analysis equipment). It also includes

distributed computing environments (local and wide area networks, P2P networks, wireless networks, internets, intranets), and embedded computer systems (such as environmental, aircraft, spacecraft, and automobile control systems in which computers are embedded to perform various functions). A wide array of complex technological systems, such as power generation and distribution systems and modern processing and manufacturing plants, rely on computer systems developed and designed by computer systems engineers.

As a great deal of basic ICT-work keeps moving to the developing countries due to lower employer expenses, there is a need to concentrate on innovation and product development and the work that requires highest knowledge, specialization and education. Thus it is important to educate the ICT students not only in technology, but also in business skills and make them business aware young professionals already right upon graduation, as well as encourage them to build their own companies.

In this paper we will describe the principles we have followed while designing innovation and entrepreneurship module as an obligatory study module within the computer systems curricula at Tallinn University of Technology (TTÜ). In the second part of this paper we will give an overview of Nordic Master School on Innovative ICT (NMS iICT) that has been implemented as an virtual umbrella organization in order to strengthen the Nordic Innovation Powerhouse and increase the quality, attractiveness and competence of the ICT education among the local students.

II. INNOVATION AND ENTERPRENEURSHIP IN THE COMPUTER SYSTEMS CURRCULA

In many smaller countries the industry sector is dominated by small and medium-size enterprises (SMEs). Especially in Estonia, where the legal framework is very SME-friendly, the SMEs have strong support network and there are many possibilities to approach venture capital companies. Such SMEs are very dynamic, having sometimes short life expectancy and operating in extremely diverse domains.

Consequently, the university graduates must receive very broad education and their competences cannot be on very narrow subject, as otherwise they might have some difficulties on the labor market [3, 4].

One alternative way to improve the competitiveness of the graduates is to equip them with non-technical skills and competences. Especially, in an environment where entrepreneurial spirit can be very rewarding. Unfortunately, till now our students have been provided with high expertise, but a narrow perspective. Business schools teach a lot about making business, but quite little, if at all about technology. Engineering study programs teach a lot about creating technology, but quite little, if at all about how to benefit from it. The challenges what we are facing now are turning more efficiently technical results and inventions to innovations which can create sustainable economic development, as well as having young decision makers understand the actual cost and value of technology on which they should make financial decisions on. When people from these two different academic backgrounds come to work together, they lack a common language. Empowering the innovation and entrepreneurial skills has in recent years emerged as one of the key science and technology policies and significant efforts in developing the regional innovation environments is in progress.

Start-up companies are often in a situation where there is a good idea and enthusiasm, but little resources for effective realization of the idea. There may be a lack of funds upon initiation and development of the company as well as a lack of knowledge about the market. A lack of resources does not mean that the business will not take off, but it could take considerably more time and be a lot more expensive than upon involvement of suitable resources.

In order to address the above-mentioned issues we have introduced to our Computer Systems Master Program a mandatory 15 ECTS Innovation and Entrepreneurship (I&E) module. The objective is to develop courses that are close to real life, practical, competitive, and train students through solving various realistic problems. It should introduce students to the concepts of fund-raising and venture capital. The students will undergo business plan development and product designs trainings. All these trainings are devised by keeping in mind the ICT-background of the students and the specifics of the high-tech SMEs and ICT sector.

The long-term objective is to encourage students to think about the possibilities of starting their own companies, to increase their level of readiness to become an entrepreneur, and to motivate them to be more innovative.

The I&E module is developed in cooperation with the Tallinn School of Economics and Business Administration (TSEBA) of TTÜ [5] and Connect Estonia [6].

Connect Estonia is a network organization which combines various capabilities often needed in a growth industry. Through its activities, organized events and, first and foremost, the Springboard Program Connect Estonia grants start-up companies access to the information which will help attract these required resources. Experienced entrepreneurs, specialists and executives help to find the answers to the questions raised, such as: what the primary activities are, how an investor can be found, how to sell to foreign markets, etc.

TSEBA is an international business school within TTÜ, delivering and applying original business thinking and teaching, informed by the contemporary commercial environment. 80% of Estonian top managers are graduates of TSEBA. The main role of TSEBA is to provide students with necessary theoretical background what is needed in order to establish and to operate a company (such as human resources, legal frameworks, basic accounting rules etc.)

By combining from one side the strong theoretical background and long-term teaching skills of TSEBA and from the other side very practical experience on working with start-ups of Connect Estonia we hope to develop a module that is not only useful to students but also interesting and motivating.

While designing the module we used the following guidewords: practicality and applicability, competitiveness, new skills. The idea we have followed is "learning-by-doing" and one of the examples of such activity is Garage48, what we have used as an example. Garage48 [7] events started in Estonia in April 2010 and have expanded to other countries in Northern Europe and Africa since then. All Garage48 events are held in English and have about 100 participants from different countries. Participants have different skills, ranging from software development to design, marketing and management.

Garage48 events usually start at 5pm on a Friday evening. All participants gather together in a big room and pitch about 30 to 40 ideas on stage. Each idea is put on the wall and everyone can choose their favorite idea and team. Usually about 12-15 ideas will be selected and teams start working.

Garage48 provides mentors, food and drinks over the weekend, while teams are working on their projects. Sunday night 6pm is the deadline to step on the stage again and live-demo your project. Both, the jury and audience vote for their favorites and choose the winners.

Goals of Garage48 are:
-   Organize practical, international and fun startup events with a really lean budget
-   Show that teams can turn an idea into a working service or prototype within just one weekend
-   Prove that new web and mobile projects can be started with a good team and really lean budget
-   Promote entrepreneurship and startup culture
-   Teach people to work under a tough deadline - you need to focus on the core items of the project
-   Get to know new people from other industries, roles and countries
-   Less talk, more action and fun!

In the context of our I&E module we hope to organize such Garage48-type events in cooperation with some other study programs, with an objective to bring together people with different background and skills. In cooperation with Connect Estonia we intend to bring to such events well-known professionals, such that the students would receive high-quality feedback and establish valuable contacts for their future life.

The new I&E module will serve as a pilot and if successful it will be introduced also to the other ICT-related study programs at TTÜ. The objective of TTÜ is that all engineering study programs have also the entrepreneurship aspect included and therefore our I&E can be seen as an example for the entire university.

However, in a modern global world the graduates have to work also with partners or customers all over the world. Therefore, we have had for a long time cooperation with various Scandinavian universities and in 2010 we joined Nordic Master School in Innovative ICT (NMS iICT). NMS iICT gives our students a possibility to study one or several modules in any of the partner universities. Or to spend 1-2 semesters abroad. Most importantly, NMS iICT has designed a special NMS iICT Innovation and Entrepreneurship study module in the area of ICT-related innovation and entrepreneurship. In the following a more detailed overview of NMS iICT.

III. NORDIC MASTER SCHOOL ON INNOVATIVE ICT

Nordic Master School in Innovative ICT (NMS iICT) is a network of the International ICT Master Programmes at five world-class scientific universities in the Nordic countries: the University of Turku (UTU) and the Åbo Akademi University (ÅAU) in Finland, the Royal Institute of Technology (KTH) in Sweden, the Technical University of Denmark (DTU) and the Tallinn University of Technology (TTÜ) in Estonia. This global Innovation Powerhouse offers high expertise in research based iICT education [8].

The NMS iICT is a virtual umbrella organization that covers all ICT Master level education in the partner universities, building one of the largest educational initiative in the world with ICT and innovation focus. The NMS iICT aims to network the Nordic-Baltic universities more efficiently in order to strengthen the buildup of the Nordic innovation powerhouse concept and awareness and increase the quality, attractiveness and competence of the ICT education within participating universities for the local students.

NMS iICT offers the individual students a chance to gain the specializations and core competences of more than one university of the network through the exchange period. The exchange period also empowers the students with an international aspect and yet is ethically sound through the possibility for Green Exchange. Mobility is not an obligatory part of the program, yet highly recommendable. The curricula of the Master Programs of the different partner universities are synchronized so that the students, whether they go for an exchange period or not can clearly see the expertise they gain through their choice. Also the participating universities are encouraged in their quality and strategy work by committing the results through this synchronization.

NMS iICT aims towards a virtual school within the Nordic countries, where the universities' level of quality and recognition in their Core Competency areas are maintained and at the same time the students are provided with a greater freedom to acquire a holistic higher education background of any of these world class level areas offered via partnership, and giving them additional skills and tools in innovation and entrepreneurship in ICT. This background should empower them for continued life-long learning on both areas, while creating new, growing business with innovation, research and design – the power areas of the Nordic area. As considered by the Convention on the Recognition of Qualifications Concerning Higher Education in the European Region in Lisbon, 1997, these five institutes of higher education display great diversity of education systems, reflecting the cultural diversity. The NMS iICT exchange systems will plug into this exceptional asset and allow teachers and students with at least an introduction to the other Nordic countries, especially languages and cultures, but also on the environmental issues and how they are seen and handled around the Nordic countries. The NMS iICT exchange focus encourages the Nordic students to get to know the other Nordic countries and discover their own identity as Nordic citizens. We wish to teach our students the opportunities and challenges that are common to all Nordic countries, based on our geographical location and climate. The word 'home' is being expanded in the minds of students, teachers and researchers to refer to their European identity and still, internationality and foreign cultures are shown discoverable just a train trip away.

In a modern global world the young students have to be also innovative and learn the basics of entrepreneurship skills, as new ideas and business initiatives are needed to survive and excel in the future, especially when tackling with the globalization, climate change and other major challenges of today. The rapidly aging population forces us to face challenges both in terms of the potential lack of work force and in terms of need for new ICT solutions. At the same time the Nordic-Baltic countries are facing larger than before refugee and immigrant flows from the Third World. In the Nordic Master School, the national and the international students will learn to study together and possibly create common business ideas, too. We also wish and believe that the concept of Green Exchange will attract our national students to take an exchange period at least in another Nordic country, giving them more perspective to how it is to live in a foreign culture. All such positive interaction between people from different cultural backgrounds is expected to provide positive impacts on the society in a larger extend. Possibly that would in turn support the integration of people from all walks of life to the society. Despite of developing cultural sensitivity and understanding, the goal of the NMS iICT is

also to expose people to the Nordic values like freedom of an individual, tolerance, democracy, hard work, human rights, freedom of opinion, equality, gender equality, knowledge security. Those values have enabled the development of the Nordic welfare society and a world leader in innovations.

This framework will have a high potential to lead the EU educational development towards more institution level strategic alliances. The virtual school will accept students advancing in their master studies and gain concrete experience and a good set of best practices of running the NMS iICT framework kind of tertiary education. This experience and best practices could be offered for new interested partners as a framework to apply to their curriculum and work methods in effort to be able to join the NMS network. We have already agreed on the criteria of NMS iICT certificate granting, the joint degree criteria and student acceptance criteria. The NMS iICT is one of the largest educational initiatives in the world to integrate ICT studies with innovation and entrepreneurship content.

Innovation and Entrepreneurship study module is based on long experience in entrepreneurship and innovation research, teaching and development. At the Turku School of Economics the I&E study module can be chosen as a minor in Global Innovation Technology Management (GITM) master's degree program.

The module is also open for students participating specific Master's degree programs in University of Turku and all NMS iICT students. The module consist of four study units each valued for 5 ECTS credits. Students can also include additional 5 ECTS study unit in order to complement a minor.

The I&E module gives students a comprehensive picture of current issues in the field of innovation and entrepreneurship. Additionally ICT and related industries are the areas of interest during the studies. The various parts of the module are linked one to another and advance from general to more specific issues. The idea is to provide the student with a deep understanding and working tools to start-up and develop their own business.

The courses should be taken in the following order presented below:
Obligatory courses: I&E study module (20 ECTS)
- YRe510 Introduction to Innovation and Entrepreneurship in ICT context
- YR1 New business models
- YR520 Starting up and managing a new venture
- YRS8 Innovations and Global Growth

The I&E perspective is aimed to provide the technology graduates and business graduates with a common language. The NMS iICT I&E focus requires the Nordic students to get to know the other side of the business-technology culture split and empower them to more efficiently find common ground with specialists of both sides and develop new, innovative business in the region or work in a new manner in existing corporations. With their eyes opened for educational and research institutes within the whole of the Nordic region – the technical ones as well as the business ones – the graduating students are truly empowered to continue their life-long learning on both areas.

IV. CONCLUSIONS

In this paper we have described an mandatory Innovation and Entrepreneurship module that has been embedded into the Computer Systems Master program at Tallinn University of Technology. The module has been developed in close cooperation with the Tallinn School of Economics and Business Administration of TTÜ and Connect Estonia, thus bringing together the academic views and more practical, real-life views. In the second part of the paper we described Nordic Master School in Innovative ICT (NMS iICT). NMS iICT enables and supports cross-border studies in the Baltic Sea region and offers students not only technological skills but has turned special attention on developing also the innovation and entrepreneurship skills. We hope to see the first real results of both programs in 2-3 years time.

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