STUDENT ENGINEERING OFFICE AND VIRTUAL INSTRUMENTATION AS A LEARNING ENVIRONMENT

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ABSTRACT

Engineering education has been changing essentially in the past few years. Curriculums, courses, devices and learning are different. The background of the students today is no more the same as earlier, but the young people also have many new skills and knowledge. Teachers and students can take advantage of the new technologies and methods. All this means challenges to the engineering education. One of the experiments and solutions is the engineering office with Virtual Instrumentation simulations. The software and hardware engineer's work is designing of new applications by using modern tools for graphical system design. The engineer is the expert "modeler". The three essential phases in his work are design; evaluating new research algorithms with models and simulations, prototyping; implementing models to the prototypes and integrating them to the hardware, deploying; build prototypes can be scaled to the field as customer devices. In this paper there are some examples of using the virtual instrumentation in the new learning environments. Virtual instrumentation is also model driven development. More generally Domain-Specific Modeling (DSM) is an approach for designing and developing the solution directly using the domain concepts. In the future there will also be other more specified environments for learning to build by DSM tools.

INTRODUCTION

1. HIGHER EDUCATION IN FINLAND

1. 1. OVERVIEW

Higher education system consists of universities and universities of applied sciences (polytechnics). The Finnish higher education system consists of two parallel sectors: universities and universities of applied sciences.

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

Students at universities may take a lower (Bachelor's) or higher (Master's) academic degree and also academic further education, consisting of licentiate and doctoral degree. Universities also arrange further education and open university teaching.

The universities of applied sciences (polytechnics) are usually regional higher education institutions which provide instruction in subjects from several sectors, and which emphasize the connection with working life.

The degrees they provide are higher education degrees with a professional emphasis. There are universities and universities of applied sciences all over Finland, and the ultimate aim is to ensure that all prospective students have equal opportunities for study, regardless of where they live. [1]

1.2. STATISTICS

There are 20 universities and 28 polytechnics in the Ministry of Education sector.
In addition there is Åland University of Applied Sciences in the self-governing Province of Åland and a Police College subordinate to the Ministry of the Interior.
The number of the age group in Finland has been between 62000 and 67000.
In 2007 the enrolment in degree programmes for new students are about 22 000 (universities) and 36 000 (universities of applied sciences).
In 2006 the numbers of graduates were 13 128 master's degree (universities) and 20 767 bachelor's degree (universities of applied sciences).
In 2006 the numbers of engineering students were: new students 3770 (universities) and 10 589 (universities of applied sciences); graduates 2962 (universities) and 5428 (universities of applied sciences). [2]

2. CHALLENGES OF ENGINEERING EDUCATION

2.1. NEW PROFILE OF STUDENTS

In the few last years many situations have been changing. Young people have more study possibilities and places than earlier. Students' background and knowledge profile is other. Their skills to use the Internet and new technology are excellent, but for example many engineering students today have studied only few science and mathematics courses during the high school. Easily that means more interruptions in studies. Many students want to change their field of study or to go to the working life. Some engineering students have a poor motivation to study and they have insufficient knowledge of studies and engineering careers.

2.2. PROBLEMS OF SMALL CITIES

If the schools are located in small cities, some students have plans to move to other schools only because of the size of the city. It's natural that young people have also other things than studies in their life. Small cities can not offer so many possibilities to practical training or part-time working. At the moment in Finland there is going on "the structural development" of higher education. All these bring many new challenges to teachers. Teaching demands reformation and development all the time.

3. CHANGES OF LEARNING AND TEACHING

3.1. SOME SOLUTIONS AND METHODS

Every teacher has some answers to these challenges. Teachers' work has been changed. Nowadays the teacher is a trainer. Teachers and students can use different kinds of methods: collaboration learning, team works, PBL, learning in practice, "learning by doing", e -learning, VLE, learning platforms, learning diaries, mobile learning devices, projects, etc.

3.2. STUDENT ENGINEERING OFFICE

As a case we (Oulu University of Applied Sciences/Raahe School of Engineering and Business) have carried out "learning in the student engineering office". Students can choose these kinds of means to take some study courses, e.g. Project work, Practical training, Free-choice studies, Bachelor's thesis. Students have normally studied already three years and this environment is the step towards the working life. Every day they have a normal eight-hours working time and teachers will give lessons about the half of this time. The rest students can continue their studies with team works and co-operations. Virtual Instrument and simulations have proved to be excellent tools in this learning environment. [3]

This autumn we have an experiment with our new engineering students. They will start their studies in "the student engineering office". During the first period (seven weeks) the students have some basic lessons and the main purpose is that they learn to study and work. One target is, that the new students can find a good motivation to their studies and engineer career. It will be taken advantage of Virtual Instrument simulations from the beginning of studies.

RESOURCES AND METHODS

4. MODELING AND SIMULATION

4.1. ENGINEERING WORK

The engineer in an IT company is a software or hardware designer. The design as work can also be seen as Graphical System Design in three phases: design, prototyping and deploying. This means first evaluating the new research algorithms with models and simulations, exploring and developing algorithms; design work. Then implementing models to the prototypes and integrating them to the hardware: prototyping phase of the work. And third phase is deployment when you have to continue design work so that prototypes can be scaled to the field as customer devices. Of course the specification work is included to the design phase and testing to all phases.

To practice these phases of the work of engineers the virtual instrumentation tool like LabVIEW gives a good possibility to go to the key issues in the problem solving. It gives a good way to learn and understand the phases of expert designer work from the evaluation of the algorithms to the building models, prototypes and final applications.

4.2. VIRTUAL INSTRUMENTATION

Building virtual instruments is programming. In Raahe School of Engineering and Business LabVIEW tool of National Instrument has been used already over ten years. In our degree program there are only two courses concerning virtual instrumentation but during the years students have made many Bachelor's Thesis works in the field of virtual instrumentation, for example applications to the industry like Ruukki, Steel Factory and Elektrobit, IT company. Those projects are done in the Engineering Office of our school.

When the tool like LabVIEW is used, programming is graphical programming, graphical design of the application. It gives a good possibility to reuse the existing code. Students learn the idea of patterns and framework in programming at the beginning. The prototype is quite easy to build by using icons, for example functions in the diagram window and wiring them together. Programming is data flow programming. Also the user interface is build in the front panel window by controls and indicators from the library. The final application is the virtual instrument, the software component, the executable file which can be implemented to the PC or can be downloaded to some other embedded hardware.
In our School we have build also virtual instrumentation applications about physics to demonstrate some basic physical phenomena. Also these "models" will be used by first year students to learn physics during the next autumn.
By using tool like LabVIEW you can learn and research of measurement and instrumentation. It is also possible to design, prototype, and compare the characteristics of simulated circuits with real-world measurements in a single electronics education platform, to research and teach control design concepts including controller design, dynamic system simulation and system identification. In our automation laboratory we have a laboratory work, application of real world I/O measurement. It is also possible to explore and simulate signal processing concepts, design filters interactively and learn RF and wireless communications systems and embedded systems. [4]

4.3. MODELING

Virtual instrumentation is one way to build models. To be expert designer it requires understanding of the very basic ideas of modeling. So in our school in programming courses and hardware design courses we emphasize the meaning of models.
Modeling helps to visualize the system and it enables to specify the structure or behavior of a system. The models you create profoundly influence how a problem is attacked and how a solution is shaped. Every model may be expressed at different levels of precision.
The best models are connected to reality. No single model is sufficient.
In the software engineering is used the de facto standard UML, Unified Modeling Language 2.0 means code visualization approach with 13 different diagrams.
Often models are used as a visualization of the code and programming is done separately. Then it means the round trip of the design documentation and the coding. The natural trend is to move to the model driven development in the embedded system engineering.

4.4. DOMAIN-SPECIFIC MODELING

Using LabVIEW tool is already filling the idea of the model driven development, specially building virtual instrumentation applications. More generally Domain-Specific Modeling (DSM) is an approach for designing and developing solution directly using the domain concepts in the software engineering. It uses graphical Domain-Specific programming Language (DSL) to represent the system. DSL is a programming language design for a specific set of tasks and support high level of abstraction. It is also seen like natural extension of code libraries and frameworks. Usually, after coding some features, developers start to find similarities in the code and patterns that seem to repeat. They must also resolve many time the same problems. Besides traditional CASE (Computer Aided Software Engineering) tool does not relate directly to the application domain but to the implementation. So modelers still have to perform the mapping from the domain solution to the code solution. The solution proposed by Domain-Specific Modeling is to use higher level of abstraction and directly use domain concept to define the system. Rising the level of abstraction reduces the complexity of models and hides programming languages. Thus model elements represent directly things of the domain world and not the code world. So to develop a system this way, modelers don't have to know how the code is implemented. They just need to be familiar with the problem domain. It is also possible to define specific domain notation to make models more understandable for people unused to modeling work. Using domain concepts require less effort and fewer low-level details to specify a given system than general purpose modeling languages like UML and make the development more efficient [5].

The Domain-specific Modeling tool's main aim is to automate code generation from the models. A UML based tool just provides basic code generation. Often, just the code skeleton is generated and developers still have to write the code manually. A DSM tool allows the generation of fully functioning code from models. The automation leads to a faster development process and better quality than if the code would be hand written by a normal developer. Modifications are also made easier. In fact, if some code modifications are needed, you just need to modify the code generator and regenerate models. And this change requires only the metamodeler's time. For example, the generator changes can be made to support a new platform. It's also possible to modify the metamodel, which automatically updates the relevant parts of models or add new concepts to the metamodel without a need to modify existing models.

There are several tools for building a DSM editor. These tools allow the building of a completely new modeling language, editor and code generator for a domain. This domain can be also something else than virtual instrumentation as the engineering education environment in the future [6].

RESULTS

At Raahe School of Engineering and Business there have been done several Bachelor's theses by using virtual instrumentation tool to solve problems and to build application also for the industry. The student engineering office has been offered to the one group of students after the studies of three years. Next autumn also the engineering office will be working as the starting environment for the first year students, It will be the place to learn to study and work during the first seven weeks. The basic ideas of modeling are included in the software and hardware study courses.

DISCUSSION

The challenge in teaching future engineers at the moment is that the students need to be advised how to study and work. Another challenge is to increase their motivation so that they will graduate as engineers. At Raahe School of Engineering and Business we are trying to solve these educational challenges with the student engineering office and teaching and learning development work, modeling, by using virtual instrumentation.

The engineering teaching and learning must develop continuously. The new ideas have to adopt wisely. In the future there will be also other more specified environments for learning build by DSM tools. It is important to understand also the key skills which are needed in the work of an engineer as the expert designer and developer of the new applications. To understand the higher level of abstraction by using the models and prototypes is not easy but to increase this understanding is one key task of the engineering teaching.

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