Studying Engineer Skills With Simulation Based Learning Environment

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Abstract – HAMK - University of Applied Sciences in cooperation with industry and with public funding is developing a new way to improve the know-how in the area of local metal industry. The whole “package” - InnoSteel - consists of a group of projects which contain support for product development of innovative companies and new learning methods and equipment useful for educational institutes and small or medium size companies. The main projects are InnoSteel Factory, which is a training factory, and it's virtual learning environment, Virtual Factory. Virtual Factory is an eLearning environment mainly based on simulation and modeling. It consists of two environments: the full simulation models are used in InnoSteel classroom and the distance learning part containing web browser based user interfaces for the simulation models.

In networked production chains a design engineer has to manage a lot of new things in addition to the traditional technical skills. Since production is often outsourced to several companies in networks, the importance of designing the products to be easily and economically manufactured is getting more and more crucial. New network based collaboration methods have to be utilized, since supplier chains are often international thus requiring modern and efficient ways to communicate and transfer design information between the members of the networks.

To become a professional design engineer in addition to theoretical knowledge requires experience in different kinds of product design projects. To be able to offer methods for achieving this kind of expertise in an eLearning environment is a very demanding task. There are about 40 companies and educational institutes participating in the InnoSteel network at the moment. In this paper we explore the methods how to connect the experience of the design engineers of those - and later of course other - companies to the education processes of InnoSteel.

InnoSteel Training Environment

The main goal of the project consortium named InnoSteel is to increase know-how in companies and educational facilities related to the metal industry. The InnoSteel Factory -training factory is the heart of a diverse research- and learning environment, with the factory being a modern metal engineering shop with training-, research-, and production capabilities.

InnoSteel is actually a network based on public-private relationships. There are some 40 companies and educational institutes participating in different kinds of projects managed by the key actors of the network - HAMK and InnoSteel Factory Ltd. The network works in both ways: it is not only about schools providing services to companies but also the companies participating the engineering education processes.

Virtual Factory

With a project known as Virtual Factory, which is included in the same project consortium, an e-learning environment based on simulation and modeling, is being built next to the training factory. The central operating model for this environment is that studying should be, at least within reasonable limits, possible over the internet making studying independent from place, even though this can prove to be difficult to accomplish in a technical field of study.

When studying technical subjects the need to IT- tools will be inevitable. The assimilation of these types of tools requires the working and studying in the form of some practical exercises. Because professional IT- tools are not shareware type programs and in many cases contain connections to various subsystems, they typically require work in a classroom- or laboratory environment, dependant on time and place. This creates problems especially for people who are studying in addition to working, because they do not always have the chance to attend contact lessons.

A limited portion of the necessary learning environments can be executed by building web-based interfaces for

Index Terms - e-learning, simulation, networking, virtual processes

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San Juan, PR

9th International Conference on Engineering Education
M3E-21

July 23 – 28, 2006
simulation models and other systems in the consortium [4]-[10]. However the execution of customized web-based interfaces in connection to actual tool applications is quite time consuming. They also limit educational possibilities. This is the reason for pursuing to implement the possibilities presented by a virtual computer lab [11] in the Virtual Factory-project.

The virtual learning environment and its simulation models can be used for various purposes. In this paper we will mainly concentrate in machine designer viewpoint.

**Innovative eLearning**

The virtual computer lab is an educational technology that allows a student to study remotely without any limitations to the system or application in remote use. The virtual lab includes also a time reservation service to assure that the resources needed will be available at a desired point in time. Even though online educational technologies enable real time conversations over the internet, they do not enable simultaneous working for example around a joint CAD-model, which is possible in a virtual computer lab. In a virtual lab, work can be done in a collaborative way so, that the same application session can be used from multiple terminals. The communication will go through either audio or video channels. During the communication, the participants agree on who will operate the mouse or keyboard. A virtual lab is only suitable for studying individually or in small groups. It does suit to teacher oriented pedagogical approaches.

**Pedagogical approach**

To find the best pedagogical practices for the virtual computer lab is a new challenge. For example the skills of an online counselor operating in a virtual lab environment needs to be redefined. A proposal is offered in the presentation on how remote education and its counseling would be done in the Virtual Factory-project. A new pedagogical view point in the presentation is to introduce a collaborative learning experience into skill based information technology distant education.

The meaning of the concept "skill" has to be elaborated in many cases for educational objectives. For example in the ECTS- system (European Credit Transfer System) created to enhance EU’s internal student mobility; educational goals should be assessed according to knowledge, skill and attitude. These should be defined individually within each study module for what they are.

**ABOUT MACHINE DESIGN**

The role and job description of a machine designer are under great change. Also in the past, in addition to just being able to handle the basic tool of a machine designer, the CAD-program, the designer had to have perspective of designing
being a part of a overall picture. As design programs diversify designers are presented with possibilities to better inspect the design outcome with different simulations and strength calculations. In the hands of an experienced designer these tools in fact offer an efficient, fast and cost effective product development environment. In respect to less seasoned designers a risk is involved were designing becomes seemingly “easy”, and as possible basic skills and – information are lacking, products are designed, were practicality, resistance, maintainability, processibility and other various elements in the products life cycle –thought process could have not been taken into consideration.

The major metal industry and machine shop companies are strongly outsourcing their production. In this case production and especially mechanized component manufacturing will increasingly be done in machine shops without their own product design departments. There is clear room for improvement in the cooperation between component manufacturing and product design. Because processibility has not been taken into consideration in product design, the production costs and follow-through times of subcontractors could become unnecassarily large. Information flow and communication between design and subcontracting is important already in the early stages of product design, when the product characteristics are the most easiest to take into consideration concerning processibility. Cost effective production and short delivery times are in everybody’s best interest.

The mastering of the use of CAD- software requires in the addition of just the mechanical skills, experience of the used procedures and above all perspective of the overall picture.

Recently there have been news in the media about many relatively new buildings collapsing and causing losses of life. In some the reason has been overlaps during construction, but in some the fault can be traced back to direct design flaws. The lack of control of the overall picture can be found in the background, when searching the reasons for these design flaws. The designer’s inadequate experience and holes in basic skills and -knowledge can easily cause an uncritical approach toward the solutions provided by design software and this leads to an apparent danger of poor design outcomes.

**Studying Machine Design in a Network**

In the InnoSteel- projects learning environments and educational packages in particular for the needs of the metal industry. These packages are mainly based on learning objects, which allows a dynamic way to produce modular course contents. To be able to manage the course contents and the learning processes some kind of tool is required [2]. In InnoSteel the learning object and learning process management system is executed with open source applications.

One part of the package is the development of machine designer education. One of the main goals in InnoSteel is to apply new web based educational methods.

Also in the machine designer educational package these are utilized highly. The basis of the education is CAD-software education. This relies on online lectures, where the use of the Autodesk Inventor- application is taught by on-screen recordings. The educational material repeats the following pattern in its lectures.

- Each lesson has a specific goal, which is presented at the beginning of the lecture.
- It assumed that material from previous lessons have been assimilated as a mechanical performance by each new lesson. In practice this means that material taught during previous lessons is not addressed in detail.
- The exercises during the lessons continually evolve toward a situation, were the student should individually choose the right working method to reach the desired result.

**Figure 2**

**CAD LEARNING MATERIAL**

During the Cad-portion the student is hoped to ascertain a “toolbox” from the CAD- software, from where he or she can choose an instrument when needed best suited for each situation. The accomplishment of this goal naturally requires good knowledge of the tool and long term practice with it.

There are no real short cuts to reaching a comprehensive design perspective. An effective way to reach this goal is to capitalize the knowledge and skill of experienced designers. Concerning web based design exercises a system in cooperation between the companies and the schools can be formed, were experienced designers working for the companies can instruct student groups with their exercise works using the internet. They can comment on the conclusions and solutions made by the students. The goal is to achieve implementations, were not just the basic parameters have been taken into consideration in the design, but in addition processibility, if possible the technical simplicity and other factors effecting costs during the product life-cycle.
For evaluating the processibility of a product it very useful to be able to simulate the manufacturing process. In InnoSteel the real production line – InnoSteel Factory – is modeled using different applications [3]. These applications contain for example production simulation tools, CAM applications and robot off-line programming and simulation applications. The applications can be accessed in InnoSteel computer classroom. Hence the InnoSteel environment offers methods for simulated and real production.

Even though the virtual environment offers efficient tools for studying engineer skills, a new kind of problem arises when using simulation for studying. There is not much research done in the area of simulation based learning. The simulation is just a tool and requires very delicate designing of the learning tasks. On the other hand the definition of assessment criteria has to be done on a new basis since in simulated environment there are no “absolutely correct” ways to accomplish learning tasks.

Putting it All Together

The virtual computer lab is an operation model which enables the remote use of terminals in a classroom. The system software has been programmed in HAMK’s business information technology degree program. The remote use itself is based on existing solutions e.g. vpn and Windows remote desktop. The key element of the whole system is the time reservation server, which facilitates preliminary reservation of the terminals and also controls remote usage times.

**Workflow**

Using the virtual computer lab the student has the possibility to for example execute exercises from home, that would require commercial programs or applications that are difficult to install. Educational materials based on on-screen recordings can be used to replace the video projector used normally in computer labs. For collaborative projects a single terminal can be shared among several users in the virtual lab, which will create a sense of working together.

**Virtual Computer Lab**

In comparison to conventional group work software or collaborative web tools, where application sharing is indeed possible, the major advantage to a virtual computer lab is that the applications are situated on the computer in server room or in the actual classroom and they do not need to be installed on the students' (home) computers and with the use of the time reservation server distant education can be scheduled beforehand, because the resource requirements are exactly known in advance for a specific point in time. This also enables a high utilization rate of the software installed.

**Conclusions**

In InnoSteel network we are building a new kind of collaboration between educational institutes and private companies. The basic principle of it is in traditional co-operation methods between schools and companies, but in addition to that we are also seeking for more interactive methods to co-operate with companies. The traditional role for educational institutes in collaboration with companies has been in offering student resources for different kinds of tasks. This is of course still a good way to proceed but especially in networks like InnoSteel the collaboration could be more bidirectional.

There is a huge potential of practical experience in companies, which would be extremely useful for engineering students. One way to accomplish this goal is to activate the companies to transfer the know-how and silent information of the long experienced designers of the network to the students. In addition to activating the companies our role is also in finding and developing methods for making this dialogue possible. It is in everyone’s interest to help the schools to “produce” more open-minded engineers with practical experience. With a help of suitable and innovative information
technology systems InnoSteel offers an optimal environment for such activities.

REFERENCES


