E-learningHUB of production automation

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With the development of ICT, usable technologies are becoming fast outdated. This is a special challenge for teaching in the field. The people working in the field must update their information regularly and educational facilities must be able to meet that demand. Studying while working is an everyday matter and the need for advanced- and further education will increase. It is difficult for employees to completely detach themselves from work during education. Education independent of time and place must be able to be offered.

The challenges brought on by modern times have been tried to meet with the help of web-based learning environments. When developing these environments it is not enough that we console to traditional educational methods with lectures and exercises, which have only been uploaded onto the internet. At the same time more illustrative interactive learning environments are wanted. People learn in different ways. Others learn best by reading, others by listening and others best by experiencing, doing. Progressive web-based learning environments include all of these elements.

Several pilot implementations of web-based learning environments related to automation education have been developed at HAMK University of applied sciences. It is possible to build into automation education, using various technologies, learning environments that meet the before mentioned demands, which are illustrative and interactive and believably mimic genuine situations (including virtual processes, online labs, interactive animations). We are pursuing for a situation, where students practice topics related to automation using web-based learning environments and simulation and after this they move onto exercises with actual equipment and processes; often also with solving actual company based problems. Production information systems are strongly related to production automation, which are more tightly integrated toward automation control systems. It is good that students use actual information systems used by companies already during their studies. Learning environments independent of time and place must be offered for this. Educational methods should incidentally imitate procedures used in modern industry. As companies are internationally networking and dividing their production and product development even to several continents, international teams and the web-based document management and web-meeting systems they use are becoming more and more ordinary in everyday use. One should grow into this world already during studies. Also students should function in international teams, where experts from different fields work to achieve a common goal utilizing these technologies.

An environment named E-learningHUB has been developed for HAMK's production automation and industrial service business education, which offers students access to various learning environments dealing with the topics. There are virtual laboratory applications, virtual processes, a remote operation system for work stations for using information systems, remote operable machines and systems, interactive animations, network lectures and so on. The system has been linked at the university to the learning platform in general use and the student management system. The system will also be tested among international student groups and the objective is to build common educational entities utilizing the system together with international collaborative educational institutions.

Keywords eLearning, production automation, learning object management system, remote laboratory

1. The need for web based learning environments

The development of production automation closely follows the general development of information technologies. The fundamentals of manufacturing technology change slowly, even though completely new procedures are implemented. The controls of production equipment and systems on the other hand

develop more rapidly in accordance with pc- technology development. The performance and integrability of controls continue to improve. Intelligence of various systems can be distributed to separate levels when needed. Intelligent field devices diagnose their own operations without necessarily straining the system's or machine's control. Production system controls are also distributed by integrating automatic identification (RFID) as a part of products and their packages. Development of information networks has initially led to the use of standardized field busses in industrial automation. Little by little Ethernet-based applications are generalizing also in this sector making traditional field busses obsolete. As the use of PC- based controls, standard information networks and –interfaces become more common information management becomes easier and systems can be connected to each other more easily than before. This enables the increasingly real-time use of information in system controls as well as in their operations diagnostics. This development brings about many benefits, but also causes the need for continuous learning. Usable technologies become outdated relatively quickly and there must be the capabilities to adapt new procedures, methods of working and technologies.

In engineering education students obtain basic competence to function in the field and information and skills, with which they can survive today's and the challenges of the near future. This still will not be sufficient for long as technologies renew very fast. A prerequisite for professional growth is life-long learning; the will and ability to continuously learn new things. A strong growth in adult and further education can now be seen in the teaching sector. These educations are mainly targeted toward people already in the working life, where education will be conducted along side of work. Especially in these cases studying is perceived to be independent from time and place. Students are more self-controlling and better oriented toward the subject, but more demanding and critical. So, learning environments have to be of high quality and learning platforms clear and illustrative. The amount of contact teaching is restricted and it is desired to be targeted toward learning-by-doing, preferably working with actual company based problem solving issues. This can also strengthen cooperation between university and Industry. [1]. Support is expected from web-based learning environments to increase basic readiness, understanding of basic ideologies and for so called "dry running" in a simulated environments. In this case attention must be give the guidance of web based education. The script of learning has to be thought through, how the learner proceeds through interactive web based exercises toward real problem solving.

2. Construct of the production automation E-LearningHUB

The production automation E-LearningHUB is a web based learning environment, through which one can gain access to various learning platforms. A learning platform (LOM) is related to the system, through which courses are guided, their administration and a bulk of the learning material as well as the student's web based guidance. Among other things text materials, network lectures, exercise instructions and various multimedia materials (animations, videos and so on) are distributed through the learning platform. A significant individual group of learning platforms form up the on-line laboratories, and virtual processes, which are used for illustrating automatic systems and the operations and control and adjustments of processes. The virtual classroom enables programming over the internet also in device specific applications as well as the remote use of production information systems and the execution of exercises related to them.

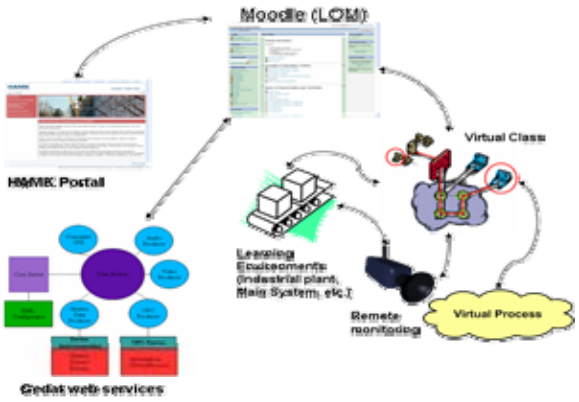

Fig. 1 The principal structure of the production automation E-LearningHUB

The principal structure of the production automation E-LearningHUB is presented in figure 1.

As one example-learning environment of the

E-LearningHUB, a factory automation learning environment is used, which is made up of a model of an industrial plant, through which the utilization of automation in industry is learned and illustrated.

The model consists of a factory hall and related offices. A miniature model of a brewery process is modelling a continuous industrial process in the factory hall. The execution of manufacturing-automation is represented by an automatic material handling system; conveyors system. The implementation building automation in the factory structure and offices is also related to the entity. The building automation implementation includes room specific heating\cooling systems, light control, continuous monitoring and adjustment of room specific moisture and temperature conditions, access control, anti-theft systems and related alarms as well as fire detection and – extinguishing systems. The building automation and production processes are all controlled with PC-based controls. The controls can be accessed via a joint-user interface, which offers also an outlook from production and structure conditions based on collected data. The user interface is web based and can be accessed via the internet securely. An MMI implemented with a touch screen has been worked into the model. Also a production information system learning environment is linked to the model, containing a computerized maintenance management system (CMMS) and in the future ERP (Enterprise Resource Planning) and CRM-system (Customer relationship management). The design, function, installation and use of building, process and manufacturing- automation systems can be studied through the learning environment. Web based multimedia materials (animations, videos, screen recordings and so on) are attached to the learning environment. The learning environment can be used in many topic related courses. The course materials will be distributed through the used learning platform.

3. Division and technical solution of the production automation E-LearningHUB

3.1 Learning platform

The core of the E-LearningHUB is made up by Moodle CMS (course management system), an open source learning platform. Moodle functions as a centralized data storage for learning. Programs, files and hypermedia material (such as animations, video clips, screen recordings and web links) related to learning are all saved in Moodle. It also functions as platform for interaction over the internet, including diverse forum, chat- and bilateral communication tools. It is easy to create revisable and reusable exercises entities for students in Moodle. From the exercise- tools various short- multiple choice-, return-, and research exercises can be found as well as a test tool with various question alternatives. Moodle also includes a tool for monitoring and evaluating students.

3.2 Virtual processes

Virtual processes are models created from actual processes, which simulate the functions of the original process as accurately as possible. The benefit of a virtual process when compared to an actual process is that when operating wrong, no hindrance or danger will happen to the processes controller, equipment attached to the process or any other party. A significant advantage is also that with one physical or virtual pc, it is possible to run several virtual processes simultaneously. Substantial cost savings in teaching can be obtained with the help of virtual processes, when using virtual processes over the internet as to physical devices. Virtual processes can be used among other things in the teaching of certain industrial processes or controls [2]. Construction of virtual processes has become a more and more current issue also in the industrial community. When building a virtual process, in-depth knowledge of the functionality of a process can be obtained [3]. Vogel (1991) has estimated that at least 50 % of new process awareness will come from building simulation models. [4].

3.3 On-line labs, remote controlled devices and systems

With the help of on-line laboratories access to physical systems independent of time and place is enabled. An on-line laboratory is a collection of remote controlled devices including their control systems as well as equipment meant for monitoring the control systems (web cams and browser based control rooms). The system has been built so that the system user can, via an internet browser, conduct the needed procedures and monitor what impacts the procedures have on the functions of the system and environment. These type of installations have many benefits. For example remote experiments are suitable for international exchange at university level of education in all its forms [5]. In the example of the factory hall, the user can monitor via a web cam video from the inside and outside and through a web based control room get information from the control system's operations itself.

3.5 Animations

Many real world phenomena include events and characteristics that can't be observed from the event itself. Typical examples are very fast or events or matters with trajectories making observation difficult, which are invisible in normal conditions. With the help of animations students can also gain explicit dynamic information, which can't typically be relayed with static graphics [6]. The animation can contain explicit information about process quantities and their optimal values and at the same time visually guides the user by illustrating which sensors and functional devices are switched on and at what stage. With animations the student will get a good picture of what is happening in the real world process at each stage.

3.6 Virtual classroom

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 typically 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.

The virtual computer lab is an educational technology that allows a student to study remotely without any major 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. [7]

3.7 Technical solution of E-LearningHUB

The user front of the learning platform consists of Moodle CMS and HAMK Portal. Moodle can run on any platform supporting PHP and MySQL, also other databases are available through ADOdb library. HAMK Portal is the supporting information system for the learning platform. HAMK Portal utilizes Oracle Application Server Portal technology, offering organization wide resources and applications through web based interface.

The learning environments offered utilize a number of technologies to facilitate interactive and co-operative learning. Access to devices and automation systems is made possible through two distinctive technologies. The virtual classroom described earlier provides access to a host of physical resources located at HAMK. The Unilink system is the complementing technology that provides a direct access to systems using web service technology. These two core technologies enable the use of real systems and processes independent of time and place.

5. E-learningHUB in the course's international joint execution

The E-LearningHUb has a significant role when developing international joint executions for production automation. Development of the HUB is also important when looking at the aspect of international research collaboration.

HAMK has been strongly building up various, often regional company networks. In the metal industry co-operation has been developed in the Innosteel network, where in different, mainly HAMK administered projects there have been nearly 50 companies and organizations actively participating. In the summer of 2006 a project was initiated at AutoMaint, which deals with the control of a networked model based production system. The operative model of networked digital machine production is tested and developed in the project, where the development and production of device is delegated to many contractors. A few example products are built from innovation platforms to prototypes. The products are designed, manufactured and tested first digitally. Through the HUB the use of the needed design software for planning and production will be distributed to the international teams. The product's final prototypes will be built in the universities own test labs, mechanical parts in InnoSteel, electronics in EleForss, which is an educational electronics factory of the university. There will be co-operation with Romanian technical university of Cluj Napoca. So an operations model will be created and tested in the project. On the other hand the project will act as a basis for planning for joint courses. A similar operations model can be in the future used for joint executions of similar courses, where a international student team would produce demo products using the same kind of operations model.

6. Conclusions and the needs for further development

E-LearningHUB forms a platform for integration, through which access can be gained to various web based learning environments. The same technology can be used directly in international research collaboration and when developing joint executions for international courses in production automation. The HUB enables the secure use of various information systems over the internet. Access can be gained to remote controlled devices (RemoteLab) and to virtual process through the HUB. At this moment the application is mainly in the universities internal use. The final objective is to develop a joint-European system, where similar learning environments being developed in different universities could be used through the same channel. Related to this we have initiated a preparation project, where we map potential partners in this sector. The factory automation learning environment and our other web based learning environments attached to the HUB will be presented to our potential partners and also we will get acquainted with their respective applications. It also a goal to apply for funding for an international production automation web based learning environment- project in for example the EU's 7. framework program.

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