# IMPLEMENTATION AND USE OF A WEB-BASED LEARNING ENVIRONMENT

*The case of Control Web*

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**Abstract**: University teaching has been under pressure to change in recent years due to the financial pressure to decrease resources, the need to keep the quality and quantity of education offered high, and to give due consideration to changes in technology and learning methods. One response to these pressures has been to study if it is possible to build a rational learning environment for Control Engineering using modern technology. It could make studying more efficient by enabling better follow-up of learning and the use of interactive functions. The development of a web-based learning environment for Control Engineering started from a simple model of learning theories and course content; the model was applied to the Control Engineering context, and the learning environment was developed and implemented. The implementation is referred to as Control Web. Functions were added to Control Web and tuned according to student feedback. Student feedback, and grades during the years 1993 to 2000 were analysed. According to the results, the system implemented has performed well. However, the explicit influence of using the web-based learning environment can be seen in only few cases. The results and experiences yield an enhanced model for developing a web-based learning environment.

**Key words**: Learning systems, Internet, higher education

## 1. INTRODUCTION

The function of teaching, and the University as a whole, has changed because of the impact of many external factors, of which some are as follows (Bates, 1997; Karran, 2000).

- The growth of the Internet has led to enhanced access to learning tools and technologies for all citizens; new groups are involved in learning.
- Technology has provided an opportunity for a larger group of people to access learning and learning materials to the extent that the materials are freely available on the WWW.
- An increasing need for more education and training, for example the growing need for lifelong learning, has emerged because of changes in business and everyday life. This means that many people are forced to change their profession during their working years, perhaps several times.
- New paradigms and ideas for learning have developed that emphasize interactive learning and teaching.
- Economic considerations set new requirements. For example, in some cases, distance learning is the only means to provide learning to student groups located in several places, and thus modern technologies make it possible to save on costs. It also provides tools to respond to the requirement that all citizens should have equal educational opportunities.

It seems as if educational authorities aim to increase the productivity of teaching, meaning that they are paying more attention to the quality and efficiency of teaching. In the current economic situation, educational demand exceeds the limits of existing resources and the gap between them has to be filled, for example, by using modern methods and technology.

When the 1990s began, hypermedia was taken seriously and numerous studies were conducted throughout the world. The possibilities of hypermedia were also noticed in the Control Engineering Laboratory of the University of Oulu in the year 1990 where they took shape in the form of a hypermedia development project in the COMETT II programme. The project started in 1990 and lasted three years. The development of hypermedia packages continued after the project, and new modules were subsequently implemented and added to the collection. When the network was developed to a level where it could be used effectively in teaching, it was naturally taken into account and modern networked materials were developed for the use of students.

A virtual laboratory (VL) is one solution to meet the new demands posed by the changes in the domain on the one hand, and in teaching resources on the other. In co-operation with traditional teaching environments, a VL improves teaching and learning at the laboratory level in order to yield effectiveness and increased quality. A narrow interpretation of a VL defines it as a heterogeneous, distributed environment that enables a group of students at various locations on the Internet to work together on a common set of problems or projects. As with any other laboratory, the tools and

techniques are specific to the domain, but the basic infrastructure requirements are shared across disciplines.

Modern learning environments that are based on networks do not displace older environments; both are needed and can support each other. One interesting question is how to find a reasonable balance between different approaches and environments? Undoubtedly, the ratio of the use of modern and traditional learning environments varies between disciplines and courses.

## 2. IMPLEMENTATION

The development of most modern learning environments has largely been based on various learning theories. These kinds of environments set out to achieve a particular functionality based on a theory of 'learning actions' according to the theory in question (Korhonen, 1999). However, modern learning environments can also be developed from other starting points. One such alternative origin is rooted in the special needs of a course — this kind of learning environment is typically developed along with the course in an iterative, grounded praxis. The basis for such development is a need to solve a special course-related problem such as a particularly large enrolment or control of the learning process. The latter was the problem that was addressed in the development of the Process Control II course. The acuteness of the problem has led on to the use of alternative learning methods — as opposed to alongside — the traditional methods. In this case, both points of view have influenced the development of the Control Engineering learning environment as discussed below.

The Control Engineering Web-based learning environment was built in several stages on the Internet server of the Control Engineering Laboratory and was used in everyday teaching. The experiences gained have also been used in re-designing other control engineering courses. Students had access to the system using normal Internet connections. Changes in the learning environment were made according to the feedback and experiences gained during its use.

## 3. PROCESS CONTROL II

Graduates of this course should be able to design and carry out industrial experiments using common design methods e.g., Hadamard matrix, Central Composite Design and Taguchi, and using a range of statistical analysis methods to analyze the results obtained in such experiments. Course

exercises consist of experimental design projects that students carry out the in teams of at most five students; experience indicates that four seems to be optimal number. The teams study a particular process, which is usually based on the use of a rotary dryer. The teams examine details of the model and a dryer simulator. Based on this study the teams define the variables they need to use to design their experiments using a Hadamard matrix, and then carry them out using the simulator. Results are presented to the other students on the last day of exercises and also in the WWW environment. The simulation exercises are done partly independently and partly in a laboratory.

In the independent part of the simulation, the students are expected to do their preliminary tests on the WWW and, according to the results, choose the variables to study and to design the experiments. Independent study occurs largely over the WWW; the students can also use the WWW materials to support their work. Independent study means that the students deepen their knowledge on the subject by using the WWW resources. This part also contains the preparation of a written report on the experiment design project, and familiarisation with the network learning environment

There is little or no time for collective practice with the environment. An assistant helped students when they needed it, which proved to be quite a good strategy. In the beginning the assistant got only few emails concerning the use of the environment; in other words, the use of the environment seemed to be straightforward to the students. The use of the environment was studied once in the exercises, which took about one hour of time.

The course is given in the last period of the academic year (in the spring.) Three main problems have affected the implementation. Firstly, the students begin to leave for their summer jobs during the course. Thus they are spread all over the country, with some of them even abroad. The network component binds them to the course. Secondly, holidays during the period disrupt studies and, finally, May 1$^{st}$ activities at the end of the period further distract the students.

The number of exercise days varies according to the calendar. There are usually 8-10 days for exercises. The first is the motivation day. General aspects of the exercises are taken up, such as how to carry out the exercises, form the teams, additional exercises, what programs are needed, where to find them, and how to find things on the Web. The participation of all students is recommended. The same applies to the second day, when the experiment design part begins.

After the first two days, the teams go on with their work according to their own schedule. However, there are certain days when the assistant is available to the students if they want to do something under guidance or ask advice. Participation in the exercises is not compulsory, but is highly valued.

It has been observed that students who are absent miss out important information.

## 4. STRUCTURE OF THE CONTROL WEB

Building the Control Web environment started as early as 1995. Initially a hierarchical structure was chosen. Subsequently, development of the structure has been based on student feedback, which has led to the development of guidelines for the structure and functions that need to be included in the environment. Other guidelines have been adopted from other environments as the results of other studies of similar Web services have become available (Manninen, 1999; Lifländer, 1999). Also, closed learning environments (TELSIPro and Proto) were studied when they were introduced on the market.

The Control Web environment consists of hyperlinked WWW-pages that connect all the materials together. There is a main page for Control Web, which includes the link to the educational pages. The structure of the Web courses can be based on functions or on courses. The 'functions approach' means that separate pages correspond to distinct functions of the courses such as course descriptions, schedules, and the results of examinations. A division by functions means that, for example, the administration links for all the courses are on one page.

The other method is to keep the courses intact and include all the functions and information concerning a specific course in one place. According to the student's feedback, the division by courses is clearly preferable, and it is used in this application. The division-by-courses method was chosen initially because it was believed to be as good as division by functions, which was not implemented in this study. According to the responses on the questionnaires, the structure was both clear and functional for the users. Moreover, it was easy for the administrator, because the folder structure in the Internet information server is similar. In the physical folder structure each course has its own folder where the WWW pages of the course are located. One disadvantage of a division by courses is that it may lead to the repetition of pages, which can cause version-control problems. For example, in our solution, each course has its own page for grades, whereas in the division-by-functions solution grades would be on a single page. In the division-by-course solution, pages are connected by hyperlinks to each other and the solution uses shared pages whenever possible.

## 5. FINDINGS

The grades students earned on examinations during the years 1993-2000 were one of the factors studied. These are the years in which the course Process Control II was developed and new methods were taken into use. The results of examinations show that the changes in the teaching methods on the courses affected the distributions of the grades. Studying results from several years after the change can show the effect of methods and whether improvement has been achieved.

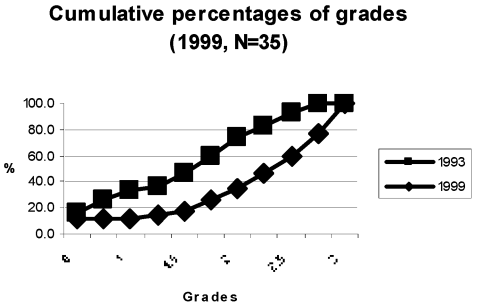


*Figure 2.* Distribution of grades in Process Control II in 1999

The cumulative percentages of grades in each year have been calculated and plotted on the chart along with the values for year 1993, which reveals the drop in failing grades and the shift in grades. Figure 1 presents one of the best years. The results of other years are similar to those of 1999. The analysis of fails can be a tool for teachers to identify when course parameters need changing.

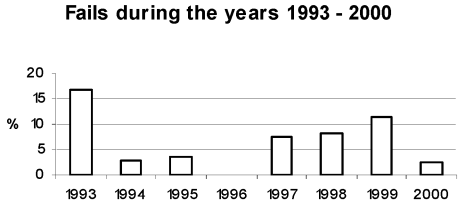


*Figure 2.* Fails in Process Control II from 1993 to 2000.

Figure 2 shows the percentages of fails from 1993 to 2000. A distinct drop in the number of fails can be seen in 2000, which was a year when the Web-based learning environment platform was used extensively.

## 6. CONCLUSIONS

According to the responses on the questionnaires, the structure of the Control Lab learning environment was clear and functional for the users. Moreover, it was easy for the administrator, because the folder structure in the Internet information server is similar. In the physical folder structure each course has its own folder where the HTML files (Web pages) of the course are located.

The results of examinations show that the changes in the teaching methods on the courses affected to the distributions of the grades. Sometimes a change, be it negative or positive, can lead to positive improvement, but studying results from several years after the change can show the effect of methods and whether improvement has been achieved.

On the basis of the results, experiences and feedback, Korhonen's (1999) model for building a learning environment can be enhanced to cover the factors that have been found to be significant. His model can be replaced with Figure 3 (Lindfors, 2002), which presents a model that can be used as the basis for the development of an open learning environment on the WWW.

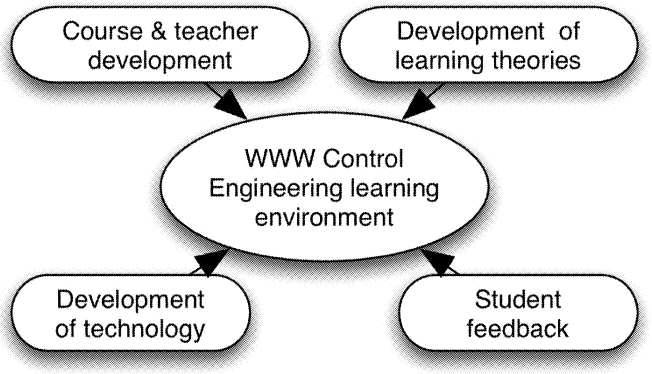


*Figure 2.* A model for the development of an open learning environment (Lindfors, 2002).

This model also takes into account the dynamic situation. Technology develops all the time, creating new possibilities to introduce better pages. Student feedback is essential after the first prototype of the system is launched; feedback can be used to fine-tune the system. The content of

courses changes over time, and the content of Control Web pages will need updating. The professional and educational abilities of the teacher will also change as time passes. These factors will change the contents of the learning system as different conceptions of learning get support at different times.

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## BIOGRAPHY

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