INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN
ICED 05 MELBOURNE, AUGUST 15 – 18, 2005

RESULTS OF PRO-TEACH-NET - DEVELOPMENT AND EVALUATION OF AN E-LEARNING ENVIRONMENT

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Abstract

New media in education and training have been expected to foster both teaching improvements and knowledge transfer within the institutions of higher education. Both the evolution to a knowledge-driven society and emerging technologies for designing products have changed the teaching content in the area of product development and design. They have also changed the requirements to teaching itself. These developments foster a change from classic education approaches to new dynamic education networks, which are based on holistic concepts and the respective management of knowledge. Applying new media in education will create economical, didactical and learning psychological benefits. However, actual application results have shown that these benefits won't show up as fast as expected.

Keywords: Engineering design, e-learning, education

1. Introduction

Engineering Design is an important, determining process in the product life cycle, which influences all other areas of a company. For this essential process, new methods, working principles, and procedures as well as computer-based tools are researched, implemented and applied. To provide young designers with current knowledge for their professional life, new results of this research have to be transferred quickly into the education of mechanical engineers. It will be more and more difficult to meet the permanently increasing requirements of industry by the classical education methods.

By means of the modern constructivist teaching/learning approach, learning is a process of building-up one's own subjective knowledge. According to the constructivist approach, knowledge cannot be communicated by instructions, but should have been integrated by the learners into their existing mental models and constructs of reality.

For this reason, it seems to be meaningful to rearrange the area of educational methods. One of them is the intensified application of new media in education and training.

First attempts to use computers as supporting tool for education were accomplished in the 1970ies in the USA. "E-learning" is a comprehensive term for learning forms using computers [1]. Transferring learning contents by electronic mail, by real-time written communication (chat) or videoconferences are examples for such learning forms. E-learning can also be understood as a synonym for learning software. First, E-learning tools were learning programs provided at first on video tapes (that only allowed a sequential learning), later mostly on CD-ROMs, that supported a non-sequential, user-driven learning. Both tools enabled a quasi-autonomous learning via computers. However, one of the unexpected experiences was that, although facts were easily learned using these media, a comprehensive knowledge that links

the facts together and puts them into the right context couldn't be achieved. This has still to be done in a "classical" learning environment with human teachers.

The real spread-out of E-learning systems happened in the 90ies of the last century due to the emergence of the Internet [2]. Previous advantages of using multimedia have been completed by the possibility of synchronous cooperative learning. Frequent updates of contents and linking Internet contents to learning systems are since then easy to realise.

Both research results and practical experiences have supported that applying new media in higher education or industrial further education has economical, didactical and learning psychological benefits. Actual learning psychological approaches such as constructivism put emphasis on individual learning, cooperative learning and detecting learning. E-learning application are able to effectively support all these learning forms; they can also reduce travelling expenses and costs of non-productive time. The independence of location and the possibility to chose between different learning styles facilitates individual learning. In addition, E-learning platforms provide several communication tools to assist the cooperative learning process.

To make available the benefits mentioned above and to enhance the quality of education, the German National Ministry for Education and Research (BMBF) initiated a support program for the propagation of E-learning at university level.

2. Pro-Teach-Net project environments

Within the scope of this support program, six German universities (Bremen, Gelsenkirchen, Ilmenau, Karlsruhe, Magdeburg, and Rostock) started an E-learning project (called "Pro-Teach-Net") in 2000. The task was to develop an education network for Product Development and Engineering Design. The project gained the support of the ministry, so the consortium started to build up the educational portal in 2001.

2.1 Objectives

Main purpose of the project was to generate a novel electronic platform to support the education of Engineering Design. Further objectives were as follows [3]:

- Supplementation and (later) replacement of traditional educational forms,
- application of multimedia to improve the learning process,
- possibility for decentralised upgrading of the learning content, and
- support of team-oriented and project-oriented cooperative Engineering Design work.

2.2 Application

The relation of traditional lectures and supporting electronic learning matters can be specified in percentage. In distance learning the proportion of electronic learning converges to 100%. If a teacher shows only one or two pictures or tables during a traditional lecture, the proportion of computer support tends to zero.

Pro-Teach-Net was designed to support traditional education, therefore the part of electronic contents was targeted to a maximum of 50%. The Pro-Teach-Net platform can be used

- for students (individually or in groups) preparing a lecture (in order to learn the facts beforehand, thus allowing the teacher to link the facts and to put them into the appropriate context),
- as electronic assistance during a lecture (in order to provide "living examples" and to avoid cumbersome handling of transparencies),
- for handing out and collecting student exercises as well as for carrying out written examinations (tasks are provided and results are collected electronically),
- for voluntary monitoring of learning improvement without the given time frames of a lecture (by using test questions and tasks),
- as communication platform for distributed Engineering Design projects with students from different universities.

3. Configuration of the web portal

Diverse learning platforms were benchmarked in order to select the best-fitting platform. Considering the requirements of students, tutors, programmers, and IT-systems, the WebCT platform was selected.

The elaborated electronic contents are derived from the curricula of the participating institutes. The arrangement of subjects in different modules makes it easier to generate student accounts. Modules A – E contain material for undergraduate studies. The product-development-oriented contents of a graduated study are collected in the modules F – J (table 1).

Table 1: Topic of modules

Undergraduate study period	
Module A	CAD basics, descriptive geometry
Module B	Basic principles of design
Module C	Basics of structural mechanics
Module D	Machine elements
Module E	Task collections, tutorials
Graduate study period	
Module F	Design methodology
Module G	Special CAx methods
Module H	Virtual product development projects
Module J	Industrial case studies

Figure 1 shows the layout of a content page. Exploiting the possibilities of multimedia, numerous pictures, figures, and tables illustrate the textual contents. For more complex topics, comprehensible animations and videos were created.

The menu on the upper side is used for navigation within the subject (forward, backward, back to contents, reload page). Tools and domains of the module (homepage, curriculum, calendar, content, tests and communication tools) are available through the left-side menu. Communication tools (e-mail, chat, forum, whiteboard) provide a significant advantage com-

pared to traditional lectures. By means of it, students can discuss the topic of a lecture among themselves or they can ask the lecturer special questions.

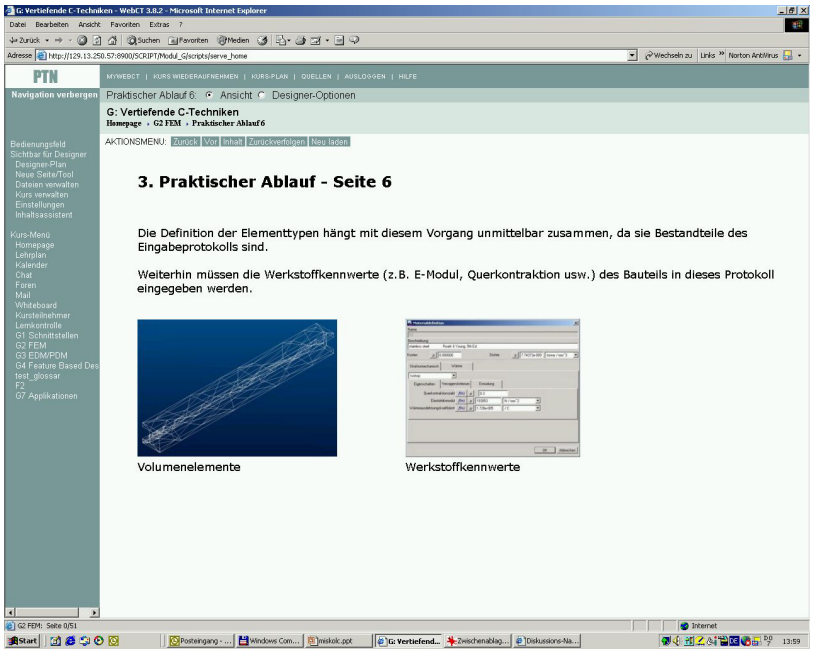

Figure 1: Layout of a content page

Accomplishing design exercises belongs by nature to the education of Engineering Design and product development. These exercises support transferring of learned matters into practical use, and assist the memorising process by generating experiential connections. Engineering Design in the daily routine of industry is carried out almost exclusively by teamwork, often in cooperation with external design bureaus, development partners, suppliers, or customers. One of the key elements of a distributed Engineering Design project is communication. To arrange the tutorials according to these industrial conditions, the realisation of collaborative Engineering Design projects is as well provided within the platform. Module H (c/f. table 1) is targeted to the learning of data exchange and coordination of these projects on-the-job. In addition to the several communication tools of WebCT, a videoconferencing tool and a CAD collaboration tool are applied for this purpose.

For monitoring the learning progress, the platform provides following checking alternatives:

- Tests or self-tests in form of multiple choice questions, matching questions, arithmetic tasks, or open questions, and
- Exercises and essays to submit via the platform.

The evaluation can be done in many cases fully automatically (e.g. tests with exclusively multiple choice, or matching questions). Based on the evaluation, the student receives a feedback of his learning progress.

4. Results and experiences

Although a lot of tools are provided today for content creation, and although most of the lectures were already available on electronic media (mostly as texts and slide shows), a significant effort was necessary to implement these into the platform. As worst case, it took about

100 hrs to create one single hour of content within the platform. The reason may be found in the presentation form of the existing lectures, which weren't always adequate for an e-learning approach, because the lectures were tailored mostly to the individual presentation and explanation skills of the respective teacher.

4.1 Application of the content modules

The platform has been in use trouble-free (i.e. without system crashes) since March 2003 at all partner universities. At our own chair, accounts for more than 70 students were generated for two modules supporting a lecture. Using the platform was recommended, however not compulsory. The activity of the students and the usage of modules or pages were reviewed by logging in with designer rights on the platform. This helped to analyse the usage of the platform. In the first active semester:

- 73,1% of the students did not use this account,
- 18,2% logged on only once,
- 8,7% used the system regularly.

In the following semester, another 30 students got an account, and three more modules were activated. Resulting on this, the usage slightly improved:

- 67% of the students did not use his account,
- 19,2% logged on only once,
- 13,8% used the system regularly.

4.2 Personal opinions of the students

In order to gather their experience with Pro-Teach-Net, the students were asked with a questionnaire. The results of this poll are summarised as follows:

- The students were not obliged to use the platform, so nearly 70% did not even log in. Main reason for this given by the students was that the actual work-load of the study is already so high that there is no time for additional activities.
- The time needed to get to know the system and how it works is quite short (and therefore acceptable).
- User interface and access potential were rated as to be good and the contents of the platform were positively assessed.
- Access problems occurred when loading pages via slow Internet connections (mostly in student dormitories), which were partly very cumbersome.

However, 42% of the students had the opinion that Pro-Teach-Net is only a partly adequate supplement for the lecture. We suppose that this is because the platform offers basically the same content and was designed quite close both to the layout and to the didactic approach of "traditional" lectures, which, beside others, provide all information and knowledge required for a successful examination. In other words, there seemed to be no additional attraction and benefits for the students to use the platform.

Although the platform provides many interactive features that make its handling very easy, they aren't visible when doing the first steps in the platform, which may also cause frustration to impatient users.

In the meantime, and as a result of these findings, the platform has become a part of the lectures of which it provides contents. So, the easy handling of the platform is demonstrated "on-the-job". Students are also reminded that the usage of the platform allows them to minimise their preparation efforts for the respective examination.

4.3 Engineering Design Exercise

The first collaborative Engineering Design exercise was realised in 2003 with six student groups from the participating universities. The task for the totally 20 students was to develop a packaging machine for shrinkable tubing (figure 2).

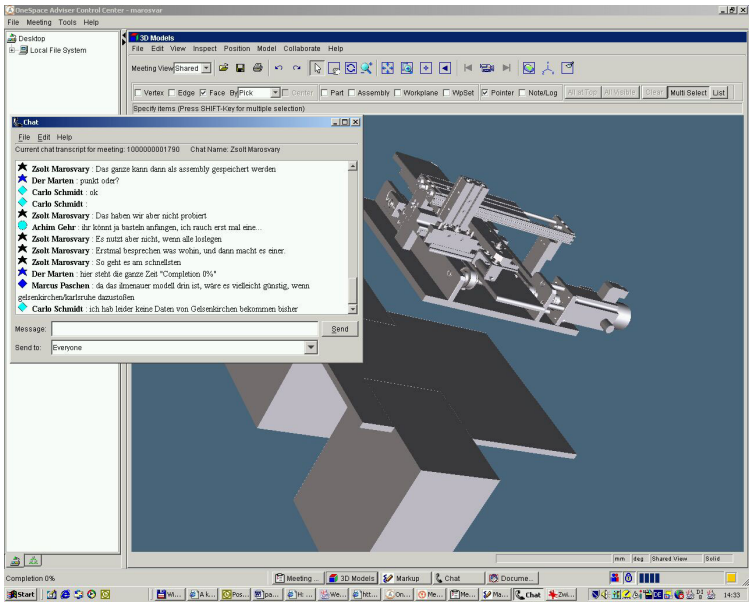

Figure 2: Assembling the modules via CAD collaboration

Based on a known task definition the teams had to work out own requirements lists, function structures, and solution principles. All design versions were cross-evaluated, after which either the best version was chosen or the benefits of several versions were combined to a new one. In the embodiment design phase, each team had to design one module of the machine. Finally the modules were assembled together during a special videoconference session.

Pro-Teach-Net served here as an all-round tool for communication and data exchange. Beside the tools within the platform, the conferencing tool “Marratech” and the CAD collaboration tool “OneSpace” were applied. By means of these tools, virtual conferences were organised at several stages of the project.

Marratech offers an effective multi-point audio and video conferencing possibility. After carefully setting both microphones and headphones level and using appropriate hardware, a good sound quality without delay could be achieved.

In later phases of the design process, OneSpace was applied for checking and assembling the CAD parts, which were modelled on different CAD systems. For all participants of a session ("clients"), OneSpace enables a visualisation and modification access on the uploaded parts. Before this, however, coordination and harmonisation of the modifying activities between the participants were necessary, in order to avoid parallel modification of one part by more than one designer. OneSpace can be effectively applied for checking of and assembling designed

parts. However, the modification of CAD parts within OneSpace has disadvantages or seems even to be impossible. E.g., due to converting proprietary model formats into the OneSpace neutral formats, parametrics get lost when parts are up-loaded.

4.4 Design exercise experiences

Focal point of the collaborative design project was of course the communication. In order to test the communication tools provided by WebCT, the students were only allowed to communicate via these tools. The most frequently used tools of the communication platform were "forum" and "chat". In our survey, the students also had to indicate the importance of these tools. It doesn't surprise that the most important tools were also forum and chat (both 80,5%). Communication tools that were accessible to all team members covered the majority of both synchronous and asynchronous information exchanges. Personal e-mails or peer-to-peer data transfer were rarely applied. This also fostered the correct distribution and provision of information and experiences.

Different researchers came to the conclusion that personal connections are essential for distributed Engineering Design projects, and that people with personal contact work together more effectively. The Pro-Teach-Net experiences are similar: All participants agreed that, besides the kick-off-meeting, more personal meetings would have been necessary. In addition, the overall view of the participants was that the available electronic communication tools are not always sufficient for that kind of collaboration.

All performed video conferences were trouble free from a technical viewpoint. However, our experience showed that for running Marratech and OneSpace on a computer simultaneously, approximately 512MB RAM and a Pentium 4 or equivalent processor is needed – a performance level that wasn't always available at a student's site.

5. Conclusion, outlook and future work

After a peak at the end of the 1980 years (and some years of disappointment afterwards), there are again high awareness and high expectations towards E-learning systems. Driven by this, the BMBF financed the development of 100 new E-learning solutions in the last four years [4]. The total number of E-learning projects can be estimated to be a multiple of this number.

Within the project Pro-Teach-Net, the quite optimistic expectations expressed in [3] weren't always met. The above-mentioned experiences have shown the need to improve the learning contents towards a better use of the E-learning possibilities. In conjunction with this, and as a precondition, it still is an important task (even in a more and more computer-oriented society) to replace "comfortable" habits by more holistic approaches that require different commitment and effort from the students. This seems to be especially true when it comes to a change in the role of the teacher (at least in our environment). Applying E-learning systems, his role will evolve from that of a "teaching entertainer" (who "fills" the blank papers of the students attending his lectures) to a coach whose main task is to create a comprehensive knowledge that links the facts together and puts them into the right context. This approach requires from a student that he acquires the facts in advance by individual effort using the E-learning platform or other media; and that he pays more attention to a lecture than today, mainly because he has to interact more with the teacher and with his colleagues. From the teacher, this approach requires, among others, a much broader lecture preparation effort and additional skills in motivating student involvement, group management, and solving of conflicts.

A more general picture of the application results of actual E-learning solutions is given by NIEGEMANN et al. [2]. Their results fit quite well to the experiences with our platform:

- Representing contents by multimedia means *alone* does not lead to build up usable and stable knowledge,
- Refreshing contents with multimedia brings not measurable motivational benefits,
- Problems of personal collaboration appear intensified by collaboration in virtual teams (because of the desiderative visibility of participants),
- Too much autonomy of the students results in high abort rates.

In the near future, these shortcomings of the E-learning systems have to be fixed, in addition the systems have to be lastingly integrated into the ordinary education. For this purpose mainly organisational actions are necessary. Personal and organisational preconditions to enable propagating electronic support systems for the education have to be created. The existing prototype systems have to be adapted to their „customers", i.e. mainly students and practitioners, who look for additional training to freshen up their knowledge.

These are also the aims of the newly announced support program of BMBF. In the framework of this program, new organisational models have to be elaborated that enable an increased use of E-learning systems. In addition, these models have to raise the quality and efficiency of education and to obtain new national and international user groups. Besides developing new organisational models, the projects have to take care of:

- refining existing learning materials,
- better user support,
- national and international marketing,
- quality assurance and
- the management of copyrights.

The long-term aims of BMBF are characterised by the fact that one primary criteria of the evaluation of applications will be the quality of the self-financing-plan after the end of the governmental support. Recently the partner institutes elaborated and submitted a corporate application. According to this, the future steps can be subsumed in three points, figure 3 [5]:

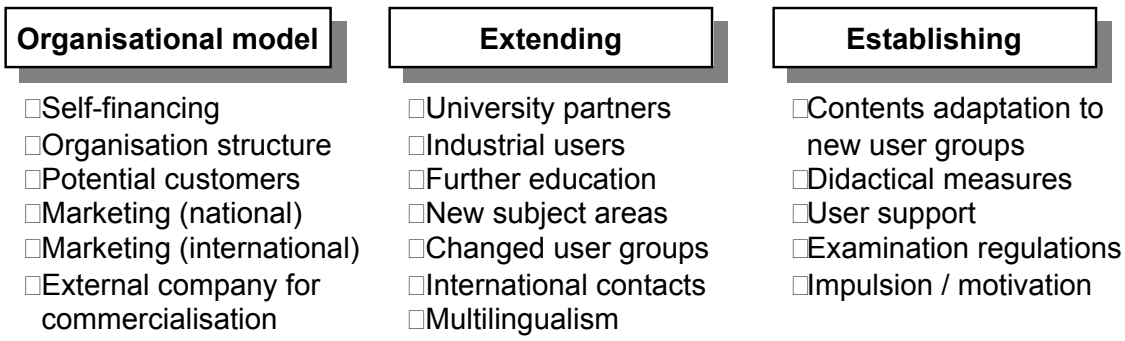

Figure 3: Major topics of future work

1. Elaborating an organisational model for a long-term self-financed operation

   An organisation shall be created that covers the educational needs of various branches, that continuously develops and adapts related learning contents, and that creates enough profit to sustain itself on a long term.

2. Extending the platform contents to other user groups

   The platform shall be offered for other universities and shall be made available for industrial users too. For this purpose, an application-oriented and branch-oriented adaptation of the contents is needed. It is expected that the mutual fertilisation will create additional benefits both in increasing the quality of learning and the spreading of the system.

3. Establishing/integrating the platform into university education.

   The terms of use of the platform by higher education has to be defined based on didactical studies on E-learning and the education of Engineering Design.

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