HydroWeb: 'WWW based collaborative engineering in hydroscience'—a European education experiment in the Internet

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ABSTRACT

Modern information and communication technology enables new technical solutions to support collaboration in engineering over distance. The application of Web based project platforms and collaboration methods requires new kinds of soft skills, knowledge and experience—a task for education and training in hydroinformatics. This technical note describes a pan-European education experiment, where students from five European universities have solved a given engineering task in distributed teams in the Internet. The collaboration was based on the principle of 'information sharing' using a Web based project platform. In this course the students acquired experience in interdisciplinary teamwork, net based project co-ordination and Web based reporting. They strengthened their social competence to collaborate in heterogeneous teams with different habits, nationalities, ages and educational backgrounds. The described experiment might be the basis for introducing Web based collaborative engineering in the regular course programme of water related curricula.

Key words | collaborative engineering, technical culture, Web based education

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INTRODUCTION

The Internet and the World Wide Web are seen as innovative IC technology that offer new opportunities to support hydroengineering projects using distributed computer and network based project platforms. Concepts and implementations of such kinds of project platforms are now available. However, the application of these solutions and corresponding suitable working processes have yet to be introduced into education and practice. Working on the World Wide Web, collaboration on projects with colleagues from other disciplines and nationalities as well as sharing information in common working spaces is not only a theoretical possibility and a question of software installation and application, but even more a matter of acquisition of experience and the development of a 'technical culture' in the engineering society of today. This can only be achieved by practical experiments and exercises. Traditional course programmes in engineering do not cover collaborative engineering. To overcome this gap, five universities from Budapest, Cottbus, Delft and Grenoble organised the course 'WWW based Collaborative Engineering in Hydroscience' in June 2000.

COURSE CONCEPT

The idea of the course was simple: students from different locations in Europe were given a hydroengineering task that had to be solved within one week by small distributed teams (student groups) using Web based tools and techniques. Each team was composed of about eight students from at least three locations and different course programmes to ensure an international and interdisciplinary collaboration. The teams operated as independent units. The organisational structure, work plan, work distribution and co-ordination inside the teams were defined by the team members themselves. This meant that a team as a whole was responsible for the performance of the given engineering task without any instruction or influence from outside. As opposed to reality in practice, nobody could really lose such a game–the collection of experience by success or failure is always profitable from the point of view of education. By 'playing' this game the participants acquired knowledge, experience and competence in Web based collaborative engineering. In this way they might be better prepared for future challenges: to operate in a global market in international and interdisciplinary project environments and companies.

The composition of the 52 course participants was really heterogeneous: 15 nationalities and an age distribution from 20–35 years led to a mixture of different cultural and educational backgrounds as well as different habits, languages and social behaviour. The success of the course demanded as a prerequisite elementary skills in operating in the Web environment, a basic knowledge of the theoretical background in hydroengineering, the ability for creative and responsible engineering and, most importantly, the willingness to co-operate with colleagues from other countries over the Internet. To ensure the equal level of the participants a few selected lectures were held at all locations in advance of the course and common lecture notes were shared on the World Wide Web.

ENGINEERING TASK

The engineering task was the design of a flood protection system for a conceptualised river, based on the river Vida in the south of Denmark. The river discharges into the sea so that tides and surges affect the downstream reaches. The river is highly controlled by weirs and gates as well as some limited dredging to protect the river from tides and surges, to ensure the passing of floods from upstream after long rainfall, and to allow navigation with small pleasure craft at any time. The objective of the exercise was to introduce structures into the river, with the original data set being given without any structures, to ensure a suitable river management. Boundary conditions at the downstream and upstream ends of the domain were given for a specified time period. The necessary engineering software systems (especially Mike 11) were provided by DHI Water & Environment (http://www.dhi.dk).

WEB BASED COURSE PLATFORM

The course platform was designed to overcome the spatial distribution using available Internet and Web technology. Local facilities supported the participants at their working location, defined the individual's working environment, and were mainly composed of standard PCs, Internet access, Web browser, conferencing tools (NetMeeting) and course related engineering software (Mike11).

The shared facilities supported the collaboration inside the different teams, as well as organisation, observation and advice from the supervisors based on the principle of 'information sharing' in addition to traditional 'information exchange'. The shared facilities were composed of Web services for each team and the course as a whole, accessible to all course participants. In this way the student teams were able to define their own shared working environment. The Web services were provided by one central Web server installed at the BTU Cottbus, including shared file service, shared document service, bulletin boards and e-mail lists. Details of the course platform are described on the WWW: http://hydroweb.bauinf.tu-cottbus.de.

COURSE RESULTS

All seven groups delivered their proposed solutions for the given engineering task within the time allowed. The seven

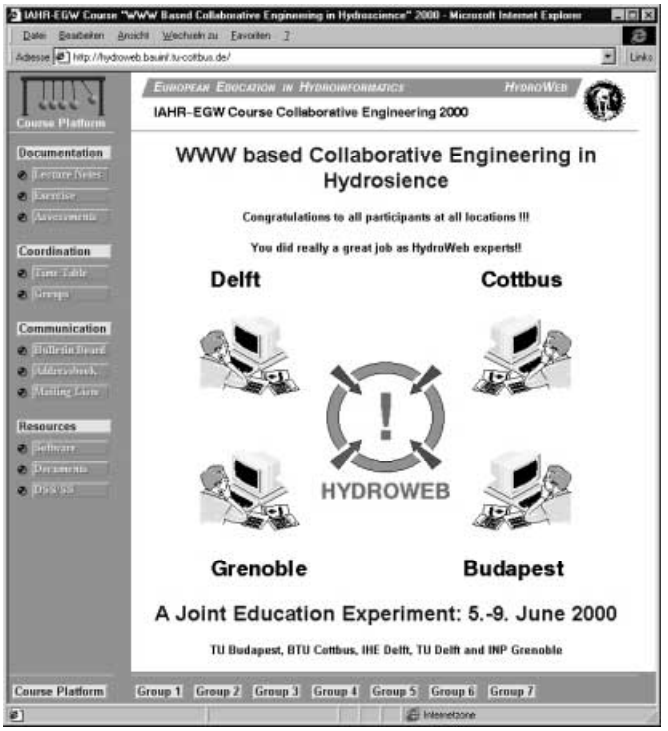

Figure 1 | HydroWeb: course platform (http://hydroweb.bauinf.tu-cottbus.de).

solutions were different in type and in terms of the locations of the river management objects/structures (weirs, dikes, dredging). They demonstrated a range of appropriate engineering alternatives for the management of the (conceptualised) river Vida. Of course the proposed solutions were not developed in terms of practical designs—the course duration of one week was too short to optimise the solutions, especially under economical constraints. Nevertheless, all seven groups were able to develop a reasonable engineering solution in a short period of time using the World Wide Web as a collaboration platform to overcome the spatial distribution of the participants.

ENGINEERING REPORTS

The progress of work during the course and the engineering solutions were documented in reports. Short daily reports from each team contained the current state in the engineering task, and described the work steps, problems, difficulties and exceptions from the work plans, collaboration methods and decisions made by the team. The supervisor's daily assessment commented on the daily progress made by each team and also contained administrative information and hints. Each team produced a final report at the end of the course describing the engineering solution and their collaborative experience. All reports were prepared and distributed as Web documents on the course platform (see http://hydroweb.bauinf.tu-cottbus.de).

COLLABORATION EXPERIENCE

The main target of this education experiment was the acquisition of knowledge and experience in Web based collaboration. This target was achieved in that all groups gained new experience in applying collaborative Web tools as well as in team work, information sharing, project co-ordination and reporting ('Learning by Doing'). From a technical point of view the facilities provided were appreciated and used between the different locations. An interesting experience was the extension of traditional information exchange tools by information sharing opportunities. Most participants were accustomed to exchange information from one personal working environment to another but not to share information in common working environments.

E-mail was well known and was therefore used most of the time for news and file exchange. The participants recognised that an e-mail to a single group member (1:1 message) lead to a lack of information for other group members. For this reason they increasingly used the bulletin board facility and mailing lists (1:*n* message) to share news and the common Web space to share files and documents. In this way they learnt in an intuitive way to apply information sharing with the related problematic nature of access control, joint editing and responsibility.

NetMeeting was used by all of the groups as a general tool for conferencing and discussion. NetMeeting supports audio/video communication for point-to-point connection of two locations. Fascinated by these features the

groups started to communicate by this tool. But team members from a third location could not join the conference, so for their shared discussions most of the groups used the chat module and the whiteboard of NetMeeting. This tool allows several group members at different locations to discuss various topics. A particular highlight of the course was two general chat sessions to discuss the content and structure of the final report. In these sessions twelve participants in total (five supervisors and seven group representatives) from each of the locations were connected over the Internet without any technical problems ($n \times m$ discussion). A further important feature of NetMeeting for this course was the application sharing module. This allowed partners to share an application over the net. For example, a participant in Cottbus was able to control a Mike11 application running on a computer in Delft, and to discuss in parallel during a chat session with the other group members in Delft, Budapest and Grenoble the location of weirs and the impact of the water level. In this way the groups were able to share information and to discuss them interactively online as a team. This was viewed as an important step, compared with the traditional approach of information exchange by file transfer and e-mail. The successful application of Web technology for group discussions demonstrates the potential of information sharing for distributed project co-ordination.

All groups presented their results in a final report as a Web document. It was the first time that most of the participants had to write a report as a team and as a common Web document. Using the interfaces of standard documentation systems (like Word) or standard HTML composers the participants were able to produce a Web report in collaboration (joint editing) and to share it on the Web platform without the additional effort associated with traditional paper based documentation and information exchange.

Besides this experience in the application of Web tools the participants improved their ability to work as a team. Most participants started the project with high motivation and a lot of ideas focused on their individual activity—as they would normally have done in their study exercises. On the second day, however, they found out that the other team members at the other locations did not necessarily take up their ideas and approaches—they followed their own ways in parallel or in different directions. There was some disappointment in the groups about 'collaboration', so they began to communicate and to discuss the different approaches they were using. By the end of the second day all groups had found by this 'trial and error' experience a suitable collaboration method, including communication rules, co-ordination methods and the specification of responsibilities. In this way the teams were able to develop a common team solution for the engineering task and to present it in a common report—not as independent solutions and reports from each team member/location.

SOCIAL ASPECTS

The student teams were composed of students with a heterogeneous background in language, mentality, education, culture and habit. This was representative of an international and interdisciplinary collaboration. The level of competition was low because of the non-existing commercial pressure in university courses. It was observed that all groups started their communication actively but retained a formal approach to each other. During the week the communication became more and more direct, and included the exchange of personal information such as the exchange of photos of children. A 'course society' arose with personal relationships. Inside the teams the members found their roles defined by their competence (e.g. in Web reporting, numerical simulation, project management, etc). They learnt to accept each other's particular competences and to combine their individual abilities towards the common success of the team. The joint work inside the groups led to a better understanding of their different characters and background. In just one week the students acquired a considerable amount of 'social competence' and 'soft skills' inside the teams as well as inside the society formed by the whole course. Nevertheless there was one important improvement to be made for the future: a face-to-face meeting of all participants as a kick-off meeting was missing. The net cannot substitute for the personal impressions and relationships of a real face-to-face meeting and the benefits of a social event like a drink

and talk at a bar in the evening. This would help to advance the course performance and to set up better understanding inside the teams.

CONCLUSION

The course as described above was an ambitious educational experiment to extend the normal course programme in engineering by a new topic: Web based collaborative engineering in international and interdisciplinary projects. The effort in terms of preparation and implementation was large, and not all of the planned objectives were achieved without problems. However, the experiment worked well; in particular, the students were able to work collaboratively via the net beyond all differences in language, nationality, habit, age, culture and educational background. The results and comments of the participants demonstrated the potential and importance of Web based collaboration for future engineering education.

The important issue has become one of developing a 'technical culture', that is, the ability and working methods associated with the application of modern information and communication technologies to distributed project platforms in a beneficial way. The course gave all participants valuable experience in this respect. We believe that such kinds of courses will become a standard part of academic education programmes in the future as they reflect the progress of the ongoing ICT revolution. International and interdisciplinary courses require considerably more effort than traditional courses but there are no alternatives to the acquisition of competence in this field.

ACKNOWLEDGEMENTS

The education experiment described was carried out by 52 students from more than 15 nations. Lecturers from the involved universities (especially Yonas Dibike, Vincent Guinot, Gerald Hildebrandt, Slavco Velickov, Micha Werner and Annette Zijderveld) prepared the course environment and supported the participants during the course itself. The enthusiasm of all participants and the close collaboration over the net that went beyond the traditional course programme made this course an unforgettable event for all 'HydroWeb' experts involved. We thank all the participants from Budapest, Cottbus, Delft and Grenoble for their involvement. Moreover we would like to thank DHI Water & Environment, and especially Lars Chr. Larsen, for their support of this European education experiment.