Virtual Laboratories for Collaborative Working in Environment Water

K.-Peter Holz, Gerald Hildebrandt and Tzveta Neltchinova

Abstract: *Modern information and communication technology (ICT) enables new technical solutions to support collaboration in environmental engineering over distance. The establishment of 'virtual laboratories' including application of Internet based project platforms, distributed team work and collaboration methods require new kinds of soft skills, knowledge and experience and a new 'technological culture' to be generated just by doing - a task for education, training and profession in Hydro-Informatics. This is a challenge for the European dimension, where in future experts and engineers from different countries with different languages, different mentalities as well as different specialization and professional experience have to collaborate in research, teaching and practice. Training of collaborating in such new environment is the challenge of the courses HydroWeb and HydroEurope which by collaboration of 23 universities world-wide will help to establish common high quality university teaching courses and establish links between students from the involved countries.*

The students are solving a given environmental engineering task in distributed teams in the Internet. The students acquired in this course experience in interdisciplinary team work, net based project co-ordination and Web based reporting. They strengthened their social competence to collaborate in heterogeneous teams with members of different habits, nationalities, ages, educational backgrounds. The described experiment might be the basis to introduce Web based collaborative engineering in the regular course programme of water-environment related curricula at universities.

Key words: *CSCW, Hydro-Informatics*

INTRODUCTION

Hydro- and Environmental-Engineering projects are becoming more and more complex and have to be carried out in close cooperation by several experts from different disciplines and locations. 'Multidisciplinary', 'Globalisation' and 'Collaborative Engineering' are typical keywords of this evolution. The Internet and the World Wide Web are seen as innovative IC-Technology that provide new opportunities to support engineering 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 been introduced to education and practice. Working in the World Wide Web, collaborating on projects with colleagues from other disciplines and nationalities as well as sharing information in shared work spaces is not only a technical matter and a question of software installation and application, but even more a matter of acquisition of experience and the development of a 'technical culture' of working in such environment in the engineering society of today [1][2]. This can only be achieved by practical experiments and exercises. Traditional education and training course programmes in engineering do not cover Web based collaborative engineering. To overcome this gap universities from different countries organise since 1999 each year the course 'Web based Collaborative Engineering in Hydroscience'[1]. The course intends to give participants the chance to acquire experience in the performance of projects in an international, interdisciplinary and distributed environment and in Web based collaboration to be better prepared for future challenges on the markets of engineering and research.

COURSE DESCRIPTION

The idea of these courses is simple: simulate a hydro-engineering project as a 'game' performed by collaboration partners at different locations in a Web environment. Collaboration partners are students/experts from different universities/companies world-wide to ensure an interdisciplinary and international team composition. The teams are operating as independent units in the sense of 'virtual laboratories' or 'virtual companies'.

[1] HydroWeb courses: http://www.hydro-web.org

The organisational structure, work plan, work distribution and co-ordination inside the teams are defined by the team members themselves. This means that a team as a whole is responsible for the performance of the given engineering task without any instruction or influence from outside except some advice provided by the course supervisors. Other than reality in engineering practice, nobody can 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 acquire knowledge, experience and competence in Web based collaborative engineering. In this way they might be better prepared for future challenges: to operate on a global market in international and interdisciplinary project environments and companies.
The last course in 2003 with a composition of 110 course participants from 15 universities was really heterogeneous: 20 nationalities and an age distribution from 20 to 35 years lead to a mixture of different cultural and educational background as well as different habits, languages and social behaviour. To make the course becoming successful elementary skills to operate in the Web environment, basic knowledge on the theoretical background in hydro-engineering, the ability for creative and responsible engineering and, most importantly, the willingness to cooperate with colleagues from other countries over the Internet were prerequisite. To ensure the equal level of the participants a few selected lectures were held on the spot or via Internet in advance of the course.

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 boats 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 (esp. MIKE 11) were provided by DHI Water & Environment[2].

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 working environment, and were mainly composed by standard PC's, Internet access, Web browser, instant messenger (e.g. ICQ) and conferencing tools (e.g. MS NetMeeting).
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 several services for each team and the course as whole, accessible for all course participants. In this way the student teams were able to define their own shared working environment. The shared facilities were provided by the course platform hosted on two servers at the authors institute at Cottbus:

- Web/File Server (Linux):
  - Apache Web server
  - Tomcat Web application server
  - Web based resource management & collaboration platform (DCMS)
  - Samba (file and print services to SMB/CIFS clients)

[2] DHI Water & Environment: http://www.dhi.dk

  - team home directories
- Application Server (Windows Advanced Server):
  - Tarantella
  - MIKE 11

The course platform architecture allows all participants to work on the servers at BTU Cottbus just by their Web browser from everywhere world-wide. The course organisers had to provide no local software installation, no local performance test in advance, no local firewall adaptations or licensing problems.

Web based resource management & collaboration platform (DCMS)

The Web based collaboration platform 'DCMS' was developed to support the sharing of heterogeneous information resources in distributed project environments by a common information base in the Internet on a semantic level [3][4].
The DCMS[3] is a meta-database designed to manage an arbitrary number of heterogeneous information resources over the Internet by referring and marking them up using a single domain ontology for the explication of implicit and hidden knowledge to overcome the problem of semantic heterogeneity. Basic functionalities are search mechanisms, resource browsing, resource editing, integrated resource visualisation, personal workspaces for registered authors, common address book management, bulletin board communication, automated email notification and mailing lists administration. It consists of a net-based server component (codename 'Obelix') to manage the information resources of a project domain by an administrator and a Web based user component (codename 'Asterix') accessible by all members of the project domain by their Web browser.
The resource management is handled by resource entries, which contain semantic mark-up about the data of the resource and information about the physical location of the resource, usually the URL of the resource. Only the resource entries are stored in the resource repositories meta-database, the resources themselves remain physically where they are generated, on any server worldwide and in the responsibility of their author.
For the user just a Web browser is necessary to operate and navigate with the DCMS on an always up-to-date common information base with the advantages of an 'any place' document availability and an 'any time' document validity.
Due to the flexible and project related definition of the single domain ontology, the DCMS is easily adaptable to every kind of research or education project independent from its discipline and is currently running in 30 different projects world-wide.

Tarantella

Tarantella[4] is a professional solution for network computing which allows to access all applications installed on any server in a LAN from everywhere through the simplicity of a Java-enabled Web browser. Tarantella requires no additional software on the client devices, extends the reach of existing applications and allows everyplace access to the applications. Tarantella offers LAN-like performance anywhere using the AIP protocol, copy and paste data between any application, regardless of type or location, follow-me printing to deliver hardcopy to where you are, and to any of the client's printers and client-drive mapping to open/save documents locally. Large screen applications can be scaled to fit any screen size.

[3] DCMS collaboration platform: http://dcms.bauinf.tu-cottbus.de
[4] Tarantella, Inc.: http://www.tarantella.com

EUROPEAN DIMENSION

The first HydroWeb course had been organised in 1999 as private initiative taken by Prof. R. Price from the UNESCO-IHE Institute for Water Education in Delft[5] and the authors from the Brandenburg University of Technology. There had been 26 students from two universities involved. Through European research and development projects as well as professional organisations such as International Association for Hydraulic Engineering and Research (IAHR)[6], as well as by personal relationships the course on Web based collaborative engineering expanded in 2003 to the size of 110 students from 15 universities participating. The majority of countries stems from Europe with a significant number from East-European and EU-ascendant countries. Though there are still some limitations technologically on network transmission rates and computer accessibility, the project work is going on smoothly with these participants. For communication process all students agreed on English, however, 'Internet'-English rather than 'Oxford'-English. This enables them to even communicate on their personal sphere besides technical matters like report writing.

Interesting is the participation of a few groups from Taiwan and the USA. Team members from these countries introduce the 'thinking in global time shift' and even take advantage by distributing workload over 22 hours / day. Besides these groups there are groups from Iran participating, showing how much border crossing and within the mentality of young people this Web based education experiment is.

Universities Activities

HydroEurope[7] is direct outcome of the early HydroWeb courses, an Intensive Programme within the Socrates/Erasmus framework, initiated by the Universite de Nice - Sophia Antipolis (France) and associated with four partners [5]:

- Vrije Universiteit Brussel (Belgium)
- Brandenburgische Technische Universität Cottbus (Germany)
- UNESCO-IHE Institute for Water Education (Netherlands)
- Ecole Polytechnique Federale de Lausanne (Switzerland)

HydroEurope is dedicated to students involved in five different master degrees specialized on water management and hydro-technologies. The objectives of HydroEurope is to promote, in a global European vision, the key concepts, the methodologies, the tools and the good practices which are today essential for a sustainable water management. Today, the problems related to water are more and more complex and must be analyzed in a global way and with the right tools. The sophistication of the situations imposes to reconsider the way of working: new practices, new tools, new technologies and new ways of collaboration.

The five partners of HydroEurope have decided to introduce the concept of Web based collaboration and to disseminate their experience from operating 'virtual laboratories' into each local universities program. The courses participation is mutually recognised by European Credits. Course teaching and collaboration on exercises over the Internet is complemented by a 10 days phase of face-to-face meeting of all participating students and teachers in one place. Over the time gained experience is being exchanged and disseminated to create model character for new courses.

[5] UNESCO-IHE Institute for Water Education: http://www.unesco-ihe.org
[6] International Association for Hydraulic Engineering and Research: http://www.iahr.org
[7] Hydro-Europe Intensive Programme: http://www.hydro-web.org/HydroEurope

Extension to Profession

To facilitate a European cooperation between profession and scientific education the HydroWeb courses had been taken up and promoted by several sections and chapters of the IAHR

- Engineering Graduate School Environment Water (EGW)[8]
- Section "Committee on Education and Professional Development" (CEPD)
- IAHR student chapters in Iowa, Stuttgart, Tehran and Thessaloniki

and TECHWARE[9], a Europe wide collaborative network of members, who are involved in all crosssectoral aspects of the water environment including companies, universities and research institutions, public authorities, professional associations and individual consultants.

Towards Virtual European Universities

To develop concepts and visions about future role of 'virtual laboratories' in teaching and research HydroWeb became an inherent part of the specific projects 'virtual laboratories' and 'distance learning opportunities' of the 'European Thematic Network of Education and Training for Environment-Water' (ETNET21)[10] financed by the Socrates II Programme of the European Commission.

The goals of the specific project 'virtual laboratories' are to promote perception of potential for training, education and research by 'virtual laboratories', to discuss experience gained from working in 'virtual laboratories' and advice interested groups of teachers and researchers on starting up and managing 'virtual laboratories' and to provide students information, teach them and train them on and within 'virtual laboratories' technology and collaboration processes.

The ETNET21 achievements and essential results are disseminated through a number of regional centres within EU and Accession Countries. These centres will operate Web based 'virtual laboratories' platforms using the results from ETNET21. This project is driven by the experience that dissemination of results just by reading traditional passive media is not sufficient in case of generating "skills" and "technical culture" of collaboration in 'virtual laboratories'. Thus, the developed 'virtual laboratories' platform will be used to provide the frame for integrating all network participants and information receivers into ONE active 'virtual teaching and training community' within and around the ETNET21 dissemination project[11]. The project is accompanied by representatives from a further European project in charge of "tuning" teaching and education in the spirit of the Bologna declaration.

CONCLUSIONS

The Internet and the Web functionality have opened the door towards globalisation in education and training as well as in research and professional engineering for the environment-water sector. Individuals from all fields relevant to environment-water engineering can collaborate according to the paradigm 'any place – any time' within teams from all over the world on common projects. This kind of 'virtual' collaboration demands for new 'technological' skills using the Web environment and collaboration platforms and for enhancement of 'mental' skills working with partners from different cultures, with different mentalities and mother tongues.

[8] Engineering Graduate School Environment Water (EGW): http://www.iws.uni-stuttgart.de/IAHR
[9] TECHWARE: TECHnology for WAter Resources: http://www.techwarenet.org
[10] European Thematic Network of Education and Training for Environment-Water (ETNET21): http://etnet.vub.ac.be
[11] ETNET21 Environment-Water dissemination project: http://etnet21.bauinf.tu-cottbus.de/

Courses in education and training have been run since 1999 on university master level to create and train such skills. The courses extended to now incorporating universities from all over the world showing the demand for activities in this field.
The area of environment-water had been selected for the Web based collaboration training as most of the water bodies are border crossing and thus international. The extension to other fields of engineering is straight forward. Application to civil engineering has a large potential. Buildings / facilities are no mass products but individually designed, calculated and erected. Specialists residing at different places are collaborating over the net. Though the software tools may be different, the demand for developing 'technological and mental' culture remains the same.
Also for university development and research 'virtual' collaboration becomes an essential. In days of mass universities and mobility programs Web based collaboration may support preparing for courses at other universities and sharing teaching programs on a distance. Due to further specialization in research, university professors can not expect to find all equipment and expertise for their individual research at their home universities. By collaboration within 'virtual laboratories' they have access to the leading institutions and professionals in their field. Together they may develop course programs on doctoral level for elite training within a 'virtual' European university.

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