Enabling Network-Based Learning

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Abstract

The opportunity to utilize network based learning tools appeals to many practitioners in the engineering education arena, often for diverse reasons. This paper describes our involvement and experiences of working within a European collaborative project, NETPRO-II, and its aims of developing network-based solutions to enable learning aims to be attained.

In this paper we begin by presenting a background discussion of the Netpro project collaboration, its main aims, and the Netpro environment and tool-set. We then describe some of our own solutions and their integration into the Netpro philosophy. The goal of achieving common practice within this framework is not without problems, which we will highlight where appropriate.

The paper includes a discussion of 'LabServ' – a framework for serving laboratory problem sheets and collecting individualized activity logs from students in real time. We will also discuss our digital bread-board simulator tool and the pedagogical issue of simulation versus hands-on practice.

The paper concludes with a summary of the opportunities we foresee within our Netpro collaboration in the next two years.

1. Introduction

For the past 4 years a group of European academic partners have collaborated upon the development of project and network-based learning initiatives, under the banners of NETPRO and NETPRO-II.

The Netpro partnership is funded by the European Community Leonardo Da Vinci Programme, with NETPRO-II starting in 1997, and now in its second phase.

The aims of Netpro partners are to develop network and project based enabling technologies to support a range of pedagogical aims. Our colleagues in Evitech Institute, Helsinki, have responsibility for developing support tools to enable much of the experimental learning activities we are engaged in.

The main NETPRO tool-set provides support centres to manage, collate, and make accessible, student work outcomes, which we term 'deliverables'. In turn, the integration of student deliverables in a network environment creates the framework for better management of student goals by tutors, but extends into realms such as the enablement of peer review and peer assessment by participating students.

Of course, NETPRO partners have individual aims and interests as well as common aims and needs. One partner institute, DIBE of Genoa, has been highly active in production of teaching aids for electronics programmes, including their electronics simulator, and remote lab technologies. At York, we have produced

several developments, notably the digital bread-board simulator, and the LabServ environment.

The benefit of NETPRO is not just in the project management tools, but also in the integration of various tools and approaches to give a learning environment from which NETPRO developers can gain new insights into future pedagocical objectives and how best to support such aims with evolving technology.

2. NETPRO Collaboration

NETPRO was formed in 1997 to address the problems of the partners in achieving learning objectives in various departments of the participating institutes.

Partners include sites in UK, Finland, Italy, Bulgaria, Netherlands, and France, with each having slightly different requirements. For example, some institutes have very large student cohorts studying each course topic, and need to manage learning outcomes in a structured fashion.

Other institutes have smaller student numbers, but wish to enhance learning processes through approaches such as peer assessment. Both of these aims require some form of structured approach to managing the learning activities and outcomes.

Project based learning has also been a key factor which we have considered within the NETPRO collaboration over the past few years. Many of the early NETPRO developments centred around project based learning aims. Here a typical project might require a number of small teams of students, each with a project consisting of a number of milestones or 'deliverables', and each requiring a designated submission of work, such as a written report. Projects have included development of multimedia applications, design exercises based upon a CPU design project, and a digital weather station. [1, 2, 3].

However, at York, our recent interests have focused more upon effectively supporting laboratory work, with a practical element of activity in each successive laboratory session. This retains relevance to the NETPRO model however, since we can consider a series of laboratory exercises as a NETPRO 'project' and each individual laboratory outcome as a 'deliverable' within that project. The problem then becomes an issue of how to manage student produced outcomes on a lab-by-lab basis.

3. LabServ Laboratory Server

Our recent work within NETPRO has focused upon development of a client-server model of management of learning and learning outcomes, based upon a tool we have informally named 'LabServ' (Fig 1.)

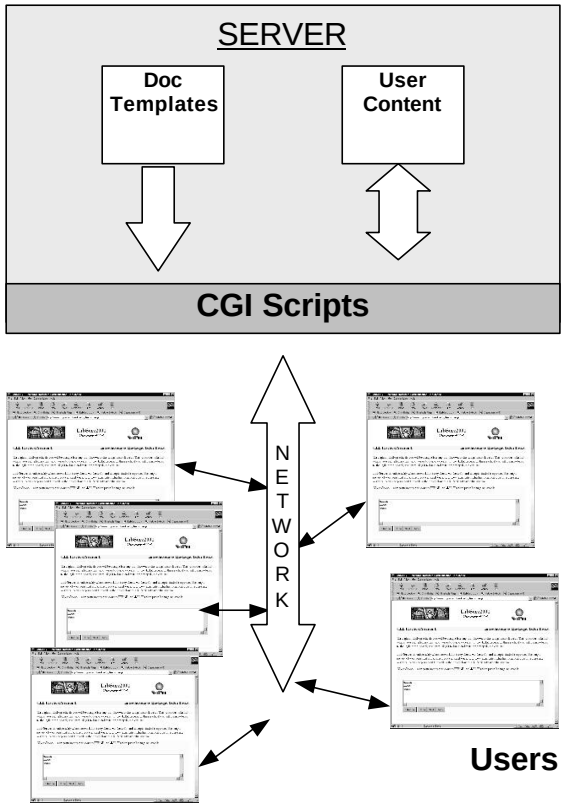


Figure 1. Labserv Concept

Figure 2a. Student view of LabServ document (digital electronics)

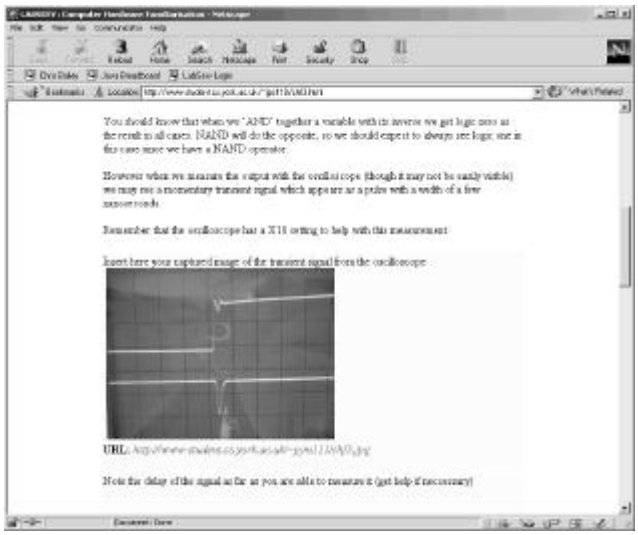


Figure 2c. Student view of LabServ document (digital electronics)

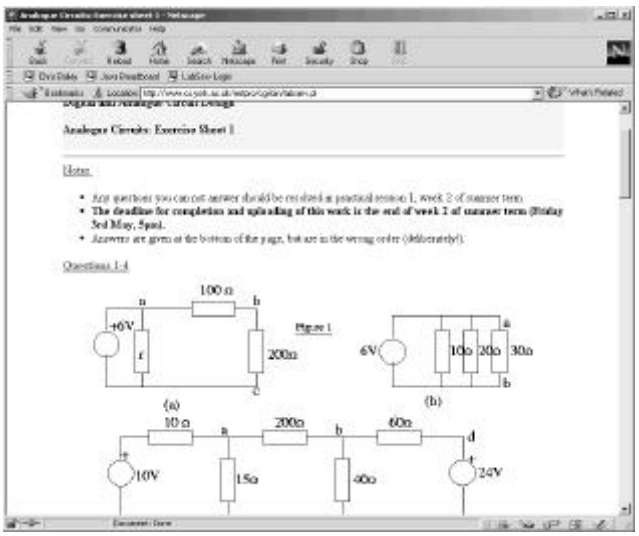


Fig. 2b, Student view of LabServ document (analog electronics)

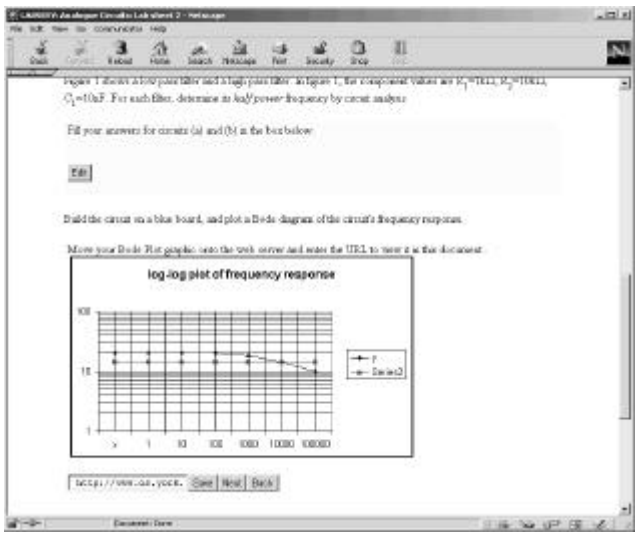


Figure 2d. Student view of LabServ document (analog electronics)

The LabServ tool takes standard HTML files, and serves them to students individually via a browser interface such as Netscape, or Mozilla. Tutors can make laboratory notes available by simply typing lab sheets up as a web-page, with as little or as much additional formatting and presentation effort as desired.

Consequently the student may gain access to the laboratory task sheet at any time from any computer with a browser. The laboratory task sheets are almost universally available without portability problems.

However, Labserv is not simply a display medium, but can allow user interaction with prepared laboratory task sheets (see Figs 2a-d). The tutor inserts certain simplified tags into the web-pages, (these pages are referred to as 'templates'). LabServ then recognizes these tags during the serving process, and dynamically inserts form-based interfaces as appropriate. Thus a lab sheet

could include boxes at the current task position, into which the student types notes, answers, or experimental measurements as requested. The student generated content is seamlessly merged with the tutor generated content, and can be viewed and printed as a final document when work is completed.

An exciting feature of LabServ automation is the ability to capture and incorporate digital images. This is particularly useful where students are working with equipment such as oscilloscopes, where they would normally make a sketch in their notebook.

Experimentation with graphics tablets showed us that there was no satisfactory way to replicate this practice on the computer system, the tablets were simply too troublesome to use effectively. Instead we decided upon making available a small number of digital cameras, (four for a block of 24 students). Students were then able to take snap-shots of oscilloscope screens where interesting results were observed, and could then incorporate these into their LabServ documents simply by supplying a URL pointing to the location of the picture on their student account.

It is important to note that a camera with 'macro mode' is probably essential here – however this does not necessarily imply an expensive model is required (ours cost under £140 each). Other pilot projects plan to utilise screen capture to generate digital images. For example, the module 'Digital and Linear Design' uses Pspice' simulation as much as hands-on circuit work, and thus simulation results can be easily captured graphically via the operating system of the computer being used, and similarly incorporated. This approach has been tested and works very effectively (Fig2d).

Once a student has completed his/her work, they can view the document in its final format, without input automation fields and buttons. The final document view can then be printed out or saved to disk for future use or distribution.

4. LabServ Pilot Projects

Our most recent pilot exercises were conducted in Spring 2002, with LabServ in full use over one term. Conversion course students studying basic digital circuit theory and practice have used LabServ in their laboratory exercises. Students were also required to complete each laboratory session and post their results on a PDC (Project Deliverables Centre) set up specifically for that class of students at the Evitech NETPRO Tool server site.

The PDC provides a graphical interface for student deliverables (Fig 3), primarily a set of icons for each student group, correspondingly one icon associates with each deliverable task, as set by the tutor.

Any student work posted as a deliverable is visible to all students in the class. However, a deadline management feature of NETPRO tools ensures that student work is not released for general viewing before a specific date, and also highlights any student teams who have failed to meet a deadline for delivery. This is an important point, since classes may be split and taught on different days, and students should not be able to view results of other class members until they themselves have completed their work in isolation.

Once a deadline has expired, students are free to view and consider each others work, hopefully learning from each other in the process. The PDC allows students to look at each other's work, and to gain better understanding of their own work as a result. Whilst this could be viewed as a form of informal peer-learning, and is a useful feature of the PDC concept, the PDC tool-set also supplies functionality for more formal activities. A more formal form of peer review, and peer assessment, can be conducted within the PDC, which can be configured to include templates for assessments which students apply to the deliverables posted by their peers, and results of which are posted as additional deliverables.

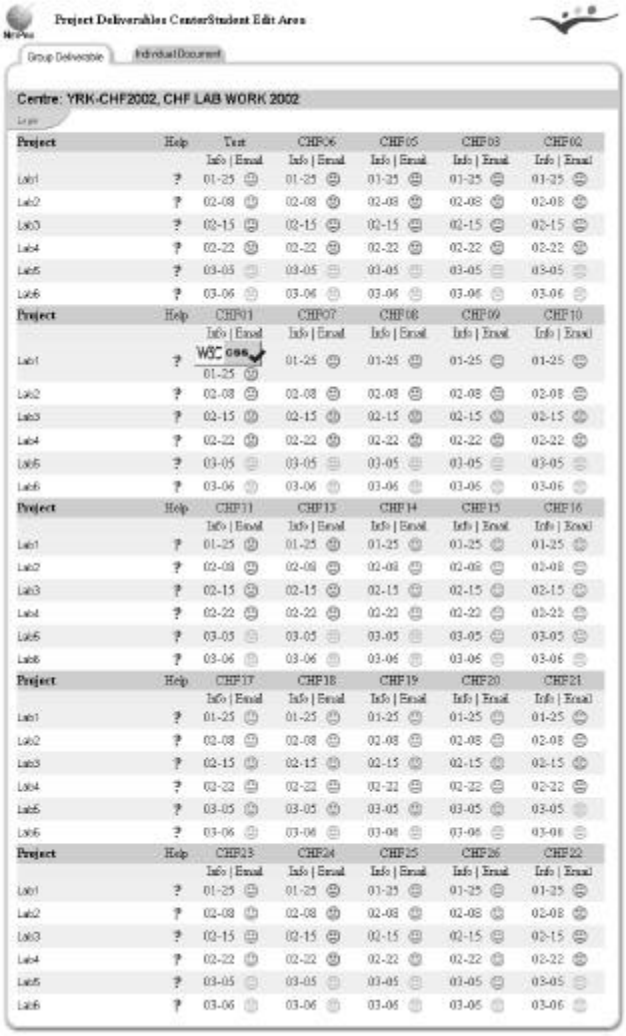


Figure 3, NETPRO PDC Example

Consequently every student might review another students work, and be reviewed themselves. Students will see both sides of a critical review process, and may improve their critical appraisal skills, whilst tutors can quickly identify struggling students, who might avoid attention in the classroom. We have not utilized peer-review, as yet, at York, since our laboratory-oriented focus does not lend itself to significant peer-review opportunities. NETPRO partners who have made use of these features have reported a good level of student motivation, although there is something of an 'learning culture adjustment' to be made: Some students are not comfortable marking their peers, or receiving marks from them, and there is a potential for bias, deliberate or unintended.

5. Integrating with NETPRO tools

Whilst LabServ has proven useful even at this early stage of its development, the use of locally developed tools is only part of the story. As mentioned earlier, the NETPRO project is developing tools for management of student learning outcomes, and our laboratory activities are also linked with this approach. The integration of LabServ with the PDC management tool-set has provided a powerful framework to manage practical-oriented work activities which would otherwise require pen-and-paper record keeping, which would make progress monitoring and peer access to work difficult at best.

Some NETPRO partners have developed interesting tool-sets, including a remote-lab web-suite. The Remote Lab allows a single set of real laboratory equipment and pre-prepared test circuit to be accessed in virtually real-time by an entire class of students. The web-interface faithfully reproduces the functionality and feel of the test equipment and allows students to transparently time-slice activities on the test platform. Each student appears to be accessing their own test circuit and equipment via the web interface. Such technologies can provide opportunities for distance or self-directed learning, where resources are not immediately accessible.

The value of the NETPRO tool-set is greatly enhanced here, since the PDC forms the primary point of contact for a distance learning community. We have begun to develop our own contributions, including a Java Digital Bread-Board simulator (Fig. 4), developed by Computer Science student Nick Glass.

Some experiments with distance learning have been conducted with PDC's, although primarly as inter-institutional joint projects (often involving more than one country). although these have tended to be troublesome to coordinate.

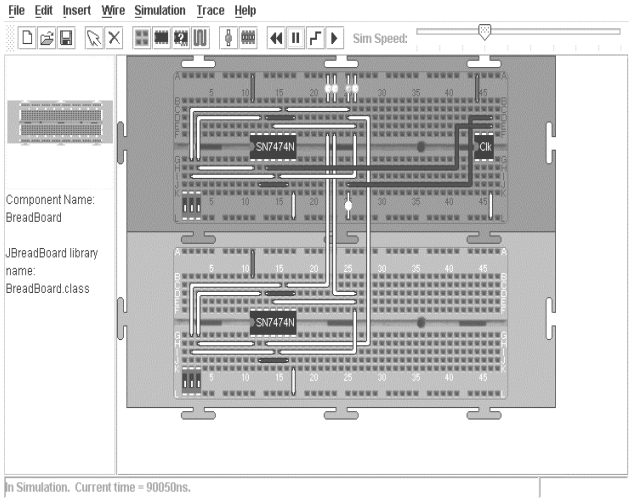


Figure 4, Digital Bread-Board Simulator

Difficulties with coordinating teaching schedules, topical alignment, and student ability levels have hindered our work in some instances of the inter-institutional approach, though the tools themselves were not a problem. However it is likely that true distance-based learning would be managed by a single 'host-institute' with a single set of aims, rather than a marriage of two parties.

We foresee future possibilities where many institutes could offer distance based learning packages which utilize the same NETPRO framework, and thus allow a degree of modularity in the learning community.

6. Evaluations

NETPRO-II includes a detailed evaluation process for each pilot project which, at the time of writing, has not yet been completed.

However our own brief survey of student attitudes toward the Labserv tools, and their use alongside the NETPRO PDC tools, have revealed positive results so far. The series of graphs at the end of this paper (figures 5a-h) illustrate the general satisfaction with the tool-sets. There was strong support for the use of Labserv rather than pen-and-paper log-books, with a slightly reduced affinity for use of the digital cameras. However the students did not have the alternative experience of sketching oscilloscope results by hand to compare with. It is notable that students generally agreed that viewing work of their peers was beneficial, they were not highly motivated to publish and make available their own work. Motivation would have been higher if the lab work had a direct impact upon course grades, which in this case it did not.

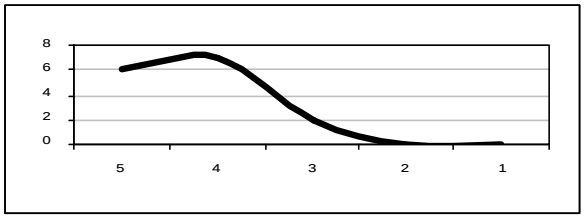
7. Future work and conclusions

NETPRO is an ongoing project, with an evolving tool-set. The use of NETPRO tools is not just an attempt to employ standard IT solution to enhance a learning environment, but to learn from each experience in order to influence and improve the tools themselves.

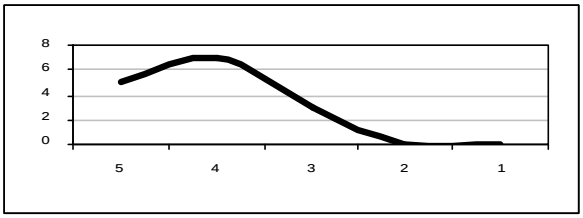
It is easy to become diverted from the main objective in this goal. For example, some NETPRO partners have devoted significant effort to developing learning applications, such as digital simulators, with the intention that all partners can use standard tools, and thus share coursework more effectively. We ourselves have been developing a Digital Bread-Board tool (developed by student Nick Glass), which has progressed very well.

The intention is that these tools can integrate with our learning environment to a higher degree in future years. The digital Bread-Board can be used within LabServ exercises, and LabServ work can be posted to the PDC, with the possibility of peer review and so-on. However at York we have been careful to use technology as an enhancement to the learning environment, rather than a replacement for real 'hands-on' laboratory experiences.

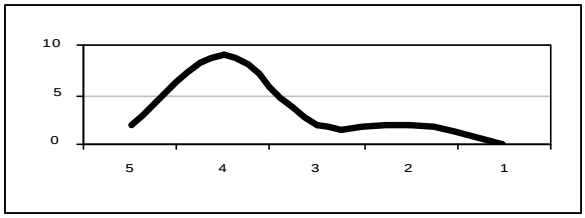
NETPRO will continue until 2004 and, we hope, beyond that to continue collaboration. Our goal is to develop a community in which learning activities can be supported by an effective toolset, whilst learning materials can be shared and re-used by the wider community.



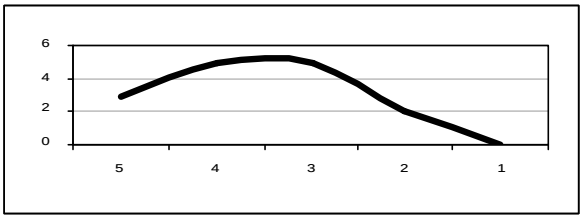
5a. Labserv useful for recording results



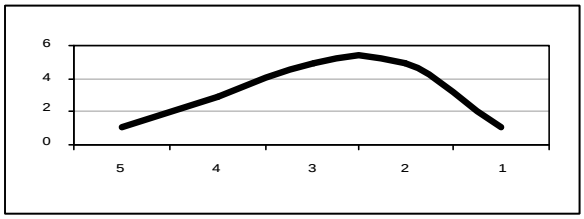
5e. LabServ interface usability



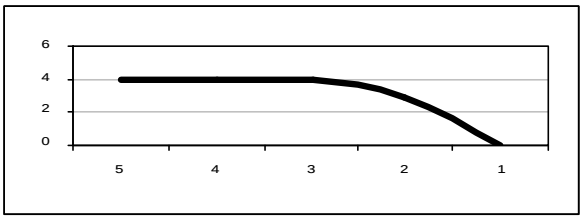
5b. Labserv preferred to pen & paper



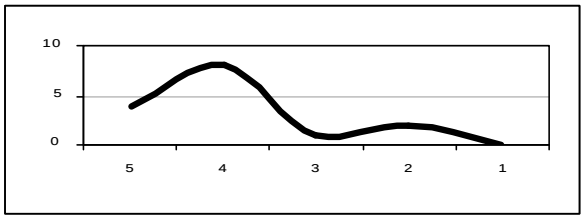
5f. NETPRO PDC interface usability



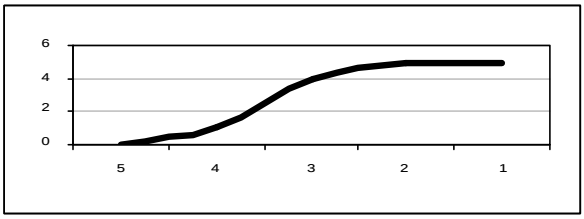
5c. Cameras useful for lab results



5g. Benefits of viewing peer's work



5d. Cameras were easy to use



5h. Motivation to assist peer viewing

NOTE: Y axis presents number of respondents, X axis ranks satisfaction left to right from 5 to 1 (5 highest, 1 lowest)

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8. REFERENCES

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