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Experiences with the Webware, Interfaces and Networking Experimental Laboratory [1]

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Abstract

This paper describes our experiences with the Webware, Interfaces and Networking Experimental (WINE) Laboratory. The WINE Lab was created to assist in teaching the topics of computer networks, user interfaces and webware. The goal of the lab is to provide students with the opportunity to complete projects, experiment with relevant techniques and make connections between topics with resources not available in a general purpose Unix-based computing environment. The results from offering courses with the lab show success in meeting these goals.

1 Introduction

The paper describes our experiences with the Webware, Interfaces and Networking Experimental Laboratory (WINE Lab) here at Worcester Polytechnic Institute (WPI). This lab was developed to assist in teaching the topics of computer networks, user interfaces and webware. The objective in developing the WINE Lab was to improve these three courses by providing students with the opportunity to complete projects, experiment with relevant techniques and make connections between topics with resources not available in our existing general purpose Unix-based computing environment.

Our premise for creating the lab is that students not only need to understand the important concepts in each domain, but may also need to better understand the effects of the interaction between the domains. Computer networking and user interfaces are two traditional areas of our discipline and ones in which we offer a junior/senior level course. We see the need to change the way in which we view and teach the topics of computer networks and user interfaces. Students not only need to understand the important concepts in each domain, but students need to better understand the effects of the interaction between them. With more interactive applications and a multitude of interaction devices, computer networks must handle network traffic that is more varied in its type, amount and quality of service needs. With computer networks potentially separating the user, interface and underlying application, the design of user interfaces must take into account network delays as well as interfaces to special-purpose devices only available over the network.

The importance of interaction between these two domains has only been heightened with the explosive growth of the World Wide Web. The Web provides a broad range of information of various types and media available through a single browser application. Originally the types of user interfaces available with browsers were limited, but changes such as Java applets and enhancements to HTML (Hypertext Markup Language) allow browsers to provide more sophisticated interfaces. The growth of the Web and the associated framework for development of its technology led our department to create a junior/senior level course "Webware: Computational Technology for Network Information Systems" [7].

Investigation of related work shows there is much discussion on the use of the Web and the Internet for support of teaching computer science courses [1]. There is also work on specialized labs for specific courses [2, 4, 6]. However at the time of creating the lab, we found no references to courses, labs or projects about teaching webware or integrating user interfaces and computer networks. A survey of other institutions found that what related laboratories do exist are primarily dedicated to research, and their impact on undergraduate education at these various institutions is unclear. A survey of industrial contacts indicated that the lab was a good idea and they felt it was an important one relative to other experience needed by our graduating students.

The WINE Lab has been used by students enrolled in each of the three courses and by students choosing to use its facilities for their senior projects. The academic calendar at WPI consists of four 7-week terms (A-B-C-D) with students typically taking three courses each term, each course meeting four times each week. The lab was set up during the Fall of the 1997-98 academic year and in the Spring semester was used by the Webware (C Term) and Human-Computer Interaction (HCI) (D Term) courses along with some senior projects. In the 1998-99AY the lab was used for HCI (B and D Terms), Networks (B Term) and Webware (C Term). It was also used for additional senior projects.

In the remainder of the paper we describe the facilities of the lab and how it was used. The paper goes on to present results based on comments from students enrolled in the courses. The paper concludes with a summary of our experiences to date.

2 Laboratory Equipment

The laboratory is consists of 15 Pentium-based PCs running Windows NT and equipped with audio/video capabilities. In creating the lab, we believed this platform provided us with the best price/performance ratio for the features we need with a broad range of software to choose from. We also wanted to expose our students to development on a Windows platform. Each machine is equipped with Microsoft Office and Visual Studio, which includes Visual Basic, Visual C++ and Visual J++, for software development. A package of software from Adobe (Acrobat, Illustrator, Pagemill and Photoshop) allows for image manipulation, drawing/painting and document production. Six copies of Macromedia Director, a tool for multimedia authoring, are also available.

The laboratory machines are connected via a switched Ethernet to the campus backbone. Three QuickCam Digital cameras are available for observing users, development of distributed conferencing and generating video traffic for studies of network traffic patterns. Three Wacom writing tablets and a Dragon Systems speech recognition system are available for experimentation as alternate input devices. A printer and scanner are also available in the lab.

3 Course Projects

3.1 Webware

The WINE Lab has been used twice for the Webware course, which were the first two times this course was offered. Detailed experiences with this course are available in [7]. As a junior/senior level course, the contents include World Wide Web network protocols, software (browsers and servers) and languages for describing content, including languages for both client- and server-side active content.

Students have used the lab for a number of projects. In one project, the students developed a simplified Web browser. This browser did not actually display Web pages, but was required to connect to a Web server and use the Hypertext Transport Protocol (HTTP) to request pages from the server. The students were required to use a Visual C++/Windows environment to complete this assignment; for most students, that meant completing the assignment in the WINE Lab. While the students were testing their Web browser, they connected to a Web server within the WINE Lab, to minimize the impact of an ill-behaved program on the rest of the campus network.

In other projects, students used the web-development tools of the WINE Lab to build personal web sites and to create a web-based grocery store. These projects exposed students to tools and software such as XML, XSL, Javascript and Perl as they implemented both a client and server for the project and made use of the Web server in the WINE Lab.

Another pair of projects in one of the course offerings assigned the students to develop a Web search engine, which included a crawler to discover Web content and build an index, and a Common Gateway Interface (CGI) script to accept user search requests, search the index, and return a Web page response to the user. In the follow-on project, students used some form of client-side active content (e.g., Java, VB Script, Dynamic HTML, etc.) to allow their search engine to provide different kinds of searches in response to user requests. In these assignments, students were allowed to choose whether or not to use the WINE Lab, and about half of the students used the development environments available in the lab.

3.2 Human-Computer Interaction

The WINE Lab was used by students for three offerings of the Human-Computer Interaction course. The students worked on a number of assignments, which utilized the facilities of the lab. One assignment involved students creating their own Web page for the course. Students used the QuickCam to take a picture of themselves or scanned in a picture with the scanner. Students then created a link from the page to explain their design criteria for the page such as metaphors used or strategies for aggregating information.

In another project using the lab, students designed and built a graphical interface using an interface building environment: Visual Basic. This project provided students an opportunity to apply many of the ideas and concepts that had been seen in the course. The task was to design and build a simple structured help system that used the text found in the Unix manual pages.

One of the final course projects required students to work in design teams to create a movie that tells a sentence. However, this sentence needed to be understood by users who did not know the language of the people who put the movie together. One such sentence given to the students was:

> Leo became sad when he was watching the movie "Titanic", thinking of all the people who sank with the ship many years ago.

Students created a design on paper and then used Macromedia Director, a multimedia authoring tool available in the WINE Lab, to tell the sentence using pictures, sound and music.

3.3 Computer Networks

One of the offerings of the Computer Networks course was taught once using the facilities of the WINE Lab for one of its projects. Two other offerings of the course could have used the lab facilities, but one did not because of resource concerns in overlapping with the Webware course in the first term the lab was available. The other offering did not because of a decision by a new instructor teaching the course.

The course offering that did use the WINE Lab was offered concurrent with one of the HCI offerings so resource overlap was a concern. Consequently, the project that used facilities was designed as a "closed lab" where it could be completed by students in a fixed amount of time. The project, which fits the lab theme of being experimental, involved students monitoring and studying the network carrying different types of traffic such as interactive, Web retrievals and other type of network traffic. Because the machines were dedicated to a single user and connected via a switched Ethernet, students could control the type and amount of network traffic being generated and received (other than spurious broadcast traffic).

3.4 Senior Projects

In the first year, few senior projects used the lab facilities because the lab was just set up and most projects had already been scheduled. One project that did use the lab was one on Java Network Management [3]. The students built on background from the Networks and Webware courses to implement a simple Java interface using JavaBeans for Simple Network Management Protocol (SNMP) auto-discovery. The development for the project was done in the WINE Lab and clearly illustrates the integration of HCI, Webware and Networks topics.

There were two notable projects using the lab in the second year. The Web Site Agent project helped users navigate a Web site [5]. This project revealed frequent access patterns to users by adding a suggestion service as a separate frame to each web page from a site. Another project augmented a version of the Netscape Navigator to allow users to view the HTTP traffic sent and received by the browser [7]. This project involved both Webware and Networking issues.

4 Results

A total of 166 students were enrolled in at least one of the three courses offered during the Spring semester of the 1997-98AY with respective enrollments for each class of 56 for HCI, 101 for Webware and 24 for Networks. A total of 232 students were enrolled in at least one of the five offerings of the three courses offered during the 1998-99AY with respective enrollments for each class of 130 for HCI, 70 for Webware and 116 for Networks. Obviously some students took more than one of the courses. Each one of these students was invited via electronic mail to participate in an electronic survey at the end of the each academic year. A total of 58 students took the survey the first year and 59 took it the second year. Students from all three offerings of the Networks course were surveyed. In the responses presented below those students using the WINE Lab are identified as "Networks-wl" and those students not using the lab are identified as "Networks-no".

The survey focused on the WINE Lab in general and more specifically on the interaction between topics in the three courses. Table 1 shows the percentage of students who agreed with a statement that there is an interaction between topics in two specific courses. 78perceived an interaction between topics in HCI and Webware. Students taking the Webware or Networks courses perceived an interaction between HCI and Webware topics at similar levels. When asked about specific topics, students indicated that web page design, menu design, choice of color, use of icons and consideration of handicapped users were topics that interacted between HCI and Webware. Specific Networks/Webware topics listed were network protocols, network connections, client/server communication, security issues and network bandwidth. Many fewer respondents perceived an interaction between topics in HCI and Networks. In listing specific topics, students noted the user interface as the application layer in networking and that visualization strategies are needed for displaying network information.

Table 2 shows the results from surveying the perceived change in interaction between topics. Students were asked whether their perception of the interaction between topics had increased, decreased or stayed the same based on taking one or more of the courses. As the results show, students perceived an increase in the interaction between Webware topics and those from the other two courses, while perceiving a decrease between HCI and Networks topics. Looking at the results by course taken, the Webware students per-

Table 1: Percentage of Students Perceiving an Interaction Between Topics in Course Pairs

Course Pair	Which Students HCI	Webware	Networks-wl	Networks-no
HCI/Webware	78	74	-	-
HCI/Networks	30	-	19	32
Networks/Web.	-	81	63	74

ceptions increased the most.

Table 2: Net Percentage Change In Perceived Interaction Between Topics in Course Pairs

Course Pair	Which Students HCI	Webware	Networks-wl	Networks-no
HCI/Webware	+17	+21	-	-
HCI/Networks	-06	-	-21	-20
Networks/Web.	-	+28	+25	+21

Examination of these results shows success towards of our goal of helping students better understand the interaction between topics in the domains. Interaction between Webware and other topics was perceived both at a high level and with an increase in the perception. Interaction between HCI and Networks was consistently perceived as lower. This result indicates there is less perceived interaction between the topics to begin with and that the course offerings did not sharply change this perception. There was not a large difference in the results between the two sets of Networks students.

Students were also asked to comment on positive and negative aspects of the lab overall. Students appreciated the opportunity to work in a dedicated laboratory with current software development tools. Students complained that the lab was too hot when filled with students and machines. They also requested longer laboratory hours, particularly near assignment due dates. These are both legitimate criticisms and we are happy to be moving the lab to a larger space in the upcoming academic year.

Because computer science students at WPI do most of their work in a Unix environment, the use of Windows NT as the operating system platform in the lab received both positive and negative responses. Many students appreciated the opportunity to gain experience in this new environment; others disliked being required to work in the Windows environment, and, when given the opportunity in the second and third assignments, Webware students returned to the more familiar Unix environment. Because this lab is our first running Windows NT, it also created new system administration problems.

The use of Windows NT machines in the lab did create a problem that was more acute as course enrollments expanded beyond original expectations. Because these Windows NT machines cannot be accessed remotely, students need physical access to the machines to use them. This limitation caused particular problems at the time in which larger projects were due leading to student complaints about lack of resources. One approach for managing student access to the machines is to introduce "closed lab" activities during particular periods during the course. We also used group projects to lessen the demand on lab machines.

Another continuing point of emphasis for us is to encourage more senior projects to be done using the facilities of the WINE Lab. We believe these projects are a golden opportunity for students to more fully explore what can be done with the lab equipment without the time constraints of a regular class. As more students are exposed to the lab through classes, we expect more of them to use its resources for projects.

5 Summary

Based on our experiences with the WINE Lab we have learned that creating a new lab, particularly for use by a large number of students is not easy. We believe the choice of Windows NT as the platform for the lab is a good one for exposing students to a new environment. However, the change in platform from Unix, which is typically used by our students, was both unfamiliar to some students and limits them in accessing lab machines via the campus network. Given the relatively large enrollments in these classes, access to lab machines is a central issue, which has led us to consider more controlled access using group projects and closed labs.

Our goals in developing the WINE Lab were to improve the three courses by providing students the opportunity to complete projects, experiment with relevant techniques and make connections between topics that would not be possible in our general purpose Unix-based computing environment. The results thus far show some success in reaching these goals. More information about the WINE Lab is available at `http://www.cs.wpi.edu/Resources/WINE/`.

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