Evolving the Learning and Research Experience in Human Computer Interaction

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Abstract We discuss the two-year evolution of an introductory course in Human Computer Interaction at the School of Computer Science and Engineering (CSE), University of New South Wales. We discuss how we migrated from lecture only delivery to include laboratory and tutorial components. Mac OS X has been used in laboratories since it provides a working case study to help students understand the meaning of a *positive user experience* and an opportunity to use an operating system that many are unfamiliar with. In addition, we describe how Apple technologies such as Netboot and Apple Remote Desktop have been used to manage the dedicated student laboratory. Finally, we describe the experience of developing a separate formal usability testing facility for user interface assessment.

Introduction

Human Computer Interaction (HCI) introduces students, primarily from a software background to the importance of user centred design in the software development process. Many of the projects students have undertaken in other courses have been restrictive in the sense that they have not been required to extensively work with end users nor have they had an opportunity to iterate through a series of designs *before* commencing code development. The course attempts to resolve this by providing students with exercises that requires interviews with potential users and walkthroughs of designs with users.

The experience that we provide is different from conventional programming courses, in fact there is no requirement for programming in the course. We concentrate instead on iterative design activities that reinforce the need for user interviews, paper based designs and interface evaluation. Practical exposure to user interface evaluation, development tools and iterative design is encouraged through tutorial work, laboratories and design assignments.

Bound paper design diaries are a compulsory component of the course encouraging students to continuously record their thoughts and ideas related to anything that they observe relevant to human computer interaction. Through this diary, we are trying to promote visual thinking skills in a discipline that is dominated by students trained to think analytically.

For several years prior to 2001, there were no tutorials and laboratories offered. Students did not get a chance to explore practical aspects of the course with a supervisor nor did they have a formal opportunity for small group discussion. Class sizes in lectures were fairly large and were not conducive to small group interaction. It was proposed that tutorials and laboratories be introduced bringing the staff to student ratio down to around 1:20.

The course is not compulsory for undergraduate students (COMP3511) and since the introduction of the new changes we have seen a large increase in undergraduate student numbers from 2000. In fact, we have had to cap student numbers until we have sufficient staff resources to manage new classes. For postgraduate students the course (COMP9511) is compulsory and so the enrolment numbers will reflect the overall postgraduate intake (0).

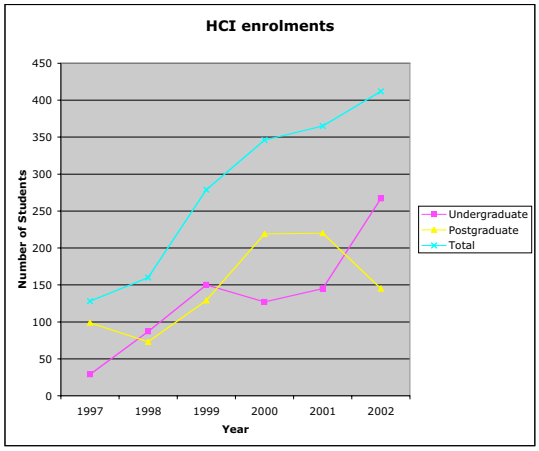

Figure 1. Enrolment numbers.

Student Laboratory — CHIL

In the selection of a desktop platform we were confronted with several considerations. We wanted to use an interface that supported a graphical user interface that would be beneficial to teaching the course. Being UNIX based would be an advantage, especially with security integration and maintenance issues since the school consists mostly of UNIX machines. The machines should also support a number of other teaching activities within the school including Computer Graphics, generic software applications, the ability to run Windows applications to provide overflow laboratory seats for existing first year classes. Physically we had limited desk space, so flat screens would be an advantage.

Mac OS X had been announced 6 months prior to the beginning of our decision making process. The 17" flat screen had also been announced as well. 15" screens were considered as being too small to be practical in our laboratory environment. The NeXT ancestry provided mature tools and environments to demonstrate the design of GUI software. Interface Builder was particularly of interest given that it was stable, mature and could be used independently of code writing activities. Students could learn about screen layout without having to consider issues relating to code design.

We were fortunate to be able to design the teaching space with a fresh outlook and we set out to create a teaching environment that was different in workflow to designs that had been deployed in other computer laboratories. This was made possible by working closely with the manager of building facilities, architects and computer support staff from the very beginning. The process reflected the user-centred design process we promote in our course — conceiving the design on paper before the space was built and validating scenarios throughout the process. It was informal but highly iterative and reflected the proactive and multidisciplinary focus of the team that came together. This was a bottom up process formed independently of management dictum.

Figure 2. Student laboratory following the installation of desks.

If we were to conceive the space again with more space we would have allowed for group meeting tables separate from the workstations where face-to-face discussion and paper designs could be reviewed. The row design does reduce the group effectiveness when we think of it as a design space. For tutorials and laboratories however, it works very well.

To comply with new occupational health and safety guidelines, all desks and chairs were required to be height adjustable. The layout of the desks was designed in 4 rows with 5 workstations per row. There are dividers between the desks, reminiscent of the early language laboratories that help maintain privacy. This is useful when conducting practical exams.

The hardware configuration of the laboratory consists of 20 G4 desktop computers and 1 tutors G4 machine that runs server software. We were able to deploy the week that the 17" flat screens were released and this saved considerable desk real estate. G4 Cubes were originally considered to maximise desk area since there was no need for PCI expansion but due to the demise of the product line we settled for PowerMac desktop machines.

Figure 3. Student Macintosh Laboratory

Laboratory Management

Given the timing of our deployment, our initial operating system deployment was based around Mac OS 9 and AppleShare IP 6 ([7]). We needed to install 4 weeks prior to the availability of Mac OS X 10.0. This turned out to be positive as we introduced students to Mac OS 9 and then forced them to switch to Mac OS X. Their experiences and their impression of the users' transition experience became a laboratory exercise that provided useful insights for both students and staff into the change over process. Changes of this magnitude such as this only happen once every decade — if that.

Whilst the course was running, we switched to Mac OS X on the client machines at around week 4 but continued with AppleShare IP 6 in the absence of Mac OS X 10 Server. Each machine was configured with one user account that was shared, creating a management issue for classes to reset accounts before each class. Setting up individual user login was complex given that Mac OS X only supported Netinfo and that our school had developed their own custom authentication scheme that would require resources to be allocated to modify for Mac OS X. We had not been able to migrate to Mac OS X Server during teaching session.

Apple Remote Desktop/Apple Network Assistant

Apple Remote Desktop Version 1.0 (ARD) ([4]) and Network Assistant played an important role in the day-to-day operation of the student laboratory. The screen sharing function has avoided the need to fit a separate data projector since the tutor's screen can be displayed on all 20 student machines simultaneously. Alternatively, an individual student's screen can be shared throughout the class. Apple Remote Desktop was very useful to stop students from browsing and reading e-mails at the beginning of tutorials and laboratories. The screen locking function has been invaluable in focussing student attention when required.

Some issues identified include:

- Millions of colours could not be transmitted effectively by ARD so the use of graduated backgrounds on PowerPoint slides is not recommended.
- File copying operations in early versions of Apple Remote Desktop were not reliable, especially for large files.

The recent release of ARD (Version 1.2) supports the installation of packages to several machines simultaneously.

Workgroup Management Tools

Network management tools ([5]) for Mac OS X were less than stable under Mac OS X 10.0 through 10.1.4. Throughout the evolution period, Apple was migrating its management tools from its Rhapsody Server1.2 model through to the 10.2 applications seen today. Many of the concepts used in the original Macintosh Manager for Mac OS 9 were brought into the product.

The tools have provided a significant step forward in laboratory management, enabling servers to be configured from any where on the Internet.

Disk Imaging

Effective disk image is the desire of all system administrators. Prior to an effective solution on Mac OS X we used file sharing or the FireWire portable hard disk approach. In other workshops we needed to deploy 2-4GB files locally on to all machines. File sharing was not an effective way to deploy this information. For external courses such as the AUC Server Training, we needed a solution to be able to reinstate our laboratory immediately following a course.

Two partitions on each hard disk became an important requirement to prevent important information from being erased when we reimaged a machine.

Several solutions have been explored including the use of Apple Software Restore and more recently with NetImage. Apple Software Restore has an image size limitation of 2GB.

Netboot

Netboot for Mac OS X () was introduced with 10.2 but had been available to support Mac OS 9 netbooting. We conducted live trials of Netboot for approximately 4 weeks during Session 2, 2002. Initial tests were encouraging but less than perfect. Login time could take a long period of time and all machines had to be rebooted around once per week.

Netboot requires that a single machine be able to provide DHCP to its clients. Originally, all machines were on a common subnet to other machines within the school and student laptops. In order to get Netboot to work we had to isolate the Mac lab, placing it on its own virtual LAN.

Student Laboratory Exercises

At present, approximately 300 students participate in a fortnightly laboratory. Several of the laboratories introduced over the past 2 years explore aspects specifically in Mac OS X.

In the first weeks of deployment students were asked to review the Mac OS 9 interface. For many students it was their first exposure to a Macintosh. Some students had used the Mac OS before but in early high school so they had not had recent experience. In the following laboratory students were asked to review Mac OS X for the first time and contrast their experience with the prior laboratory. We tried to illustrate how Mac OS X was different and the reasons certain changes had improved the user experience.

As an introduction to collaborative user interfaces we explored the concept of idea generation, comparing to face-to-face exercises with computer-supported results. Last year we introduced iChat ([9]) as the common application. The year prior we used Carracho 1.0b3 ([8]). iChat however has the restriction of only permitting peer-to-peer (or one-to-one) communication with Rendezvous. Whilst being restrictive, iChat illustrates the limitations of text based serial communication between people.

Not many students have had the experience of writing GUI based applications nor are they aware of the Apple Human Interface Guidelines (HIG) ([11]). We aim to show students the principles of graphical layout tools highlighting the concept of *guides* present in Interface Builder. The guides show the recommended spacings that a control element should be relative to other visual elements. Reading the HIG document in conjunction with using Interface Builder provides valuable insights into the importance of visual layout. Interface Builder

provides testing of the interface without requiring students to write code. This rapid development environment enables students to quickly build rich user interfaces that adhere to the user interface guidelines.

Accessibility is an important component of user interface design and is becoming more important given legislative requirements such as Section 508 ([2]) in the US and Australian Disability Discrimination Act of 1992 in Australia ([3]). We provide a role-play laboratory where students try to imagine what it would be like to use computer technology with some form of disability. The idea is to get them to consider how disabled people might use solutions like screen readers, and speech recognition or require other forms of support. With 10.2, the accessibility features such as screen zoom, greyscale, mouse under text can be explored by students.

Student Presentation Appraisal System

A new component introduced in 2002 is a presentation of their major assignment to their tutorial class. As part of this activity an application was developed to capture and print peer feedback about the presentation. At the completion of the presentation, students use a Cocoa based application to record comments and provide overall assessment of the presentation. The comments are anonymous and the data is immediately printed out and given to the students. This provides effective feedback to students about their presentation. This application makes use of Cocoa, Rendezvous and Distributed Objects.

Primary School Girls Workshop

As part of the School's Women in Engineering initiative, a workshop for primary school girls has been created to introduce girls to creative thinking, group work and an understanding the Engineering profession ([1]). The fundamental idea is to introduce young girls to technical disciplines such as Engineering and to give them confidence to explore an area that would have historically been seen as a career path for boys. The laboratory has become a key activity in the day-long excursion. Students spend around 1-1.5 hours learning how to construct a movie with iMovie. We brainstorm concepts behind making a movie and then take a step-by-step approach to assembling a movie, creating transitions, adding titles and sound effects. The experience is personalised by using footage taken at the students' school. In feedback surveys the iMovie exercise has been the most popular activity of the day.

HCI Research Laboratory

In parallel with the design of the student laboratory, a separate usability facility was being designed and was fully completed in March 2002. The physical laboratory space consists of a sound proofed experimental area and an observation room separated by a one-way mirror. The space was designed to conduct usability tests of people interacting with desktop software, web sites, handheld devices, consumer electronics or immersive technologies. The laboratory is equipped with multichannel video and audio recording facilities.

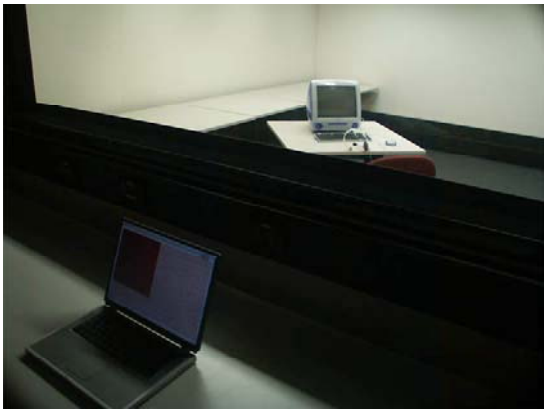

Figure 4. Observer's view of the experimental area (March 2001).

Figure. Panorama inside the experimental area (March 2001).

We are currently developing tools for logging and monitoring software applications leveraging technologies such as QuickTime, digital video and Rendezvous. All software development is based on Cocoa and has brought the development time of new tools and concepts down to a few days rather than weeks.

Mac OS X is used in the observation room to control video equipment (over FireWire and RS-232) and is also used for audio editing and MIDI control.

Digital videotape is used as the primary storage medium for video material and Final Cut Pro and DVD Studio Pro are used to review, analyse and archive important aspects of experiments.

The infrastructure provides in-house multimedia production facilities and has been used to record conference videos and edit content for the inaugural CSE student revue. Multi-purpose design was an important consideration in the original planning.

Time taken

Despite an overall positive outcome to date, the path taken has included several set backs. The logistics of teaching large classes and teaching courses other than Human Computer Interaction meant that sole focus on the development on a day-to-day basis was not always possible.

Three attempts to seek funding for the usability laboratory were made. The original proposal was submitted at the end of May, 2000 and funding was not gained until July 2001.The period between submitting the grant and actually receiving the funds was longer than 30 days and this meant that new quotes had to negotiated. Issues of dealing with external suppliers took more time than expected. Writing of grant applications is measured in weeks, not days.

We were fortunate to have an experienced project manager from the broadcasting industry work on the installation of the usability laboratory. This was of great benefit since he understood what we trying to do and gave us maximum flexibility especially for cabling design. However, the wiring task was subcontracted out to another party and many of the connections were soldered incorrectly. The job had to be redone, delaying the completion date.

The original design and planning for the student laboratory commenced in July 2000 a year before completion. Deciding on the final system was complicated given that Cubes were being discontinued and the release date of 17" flat screens was not clear until close to the final ordering date.

With the small number of people concentrating on infrastructure maintenance and the lack of solid imaging distribution model, keeping up with updates and file distribution has been a challenge. The new features in Apple Remote Desktop will improve this procedure.

Reflection

The introduction of small group tutorials and laboratories has made it possible to move from a mass teaching environment into a smaller practical learning space. Tutors work with a maximum of 20 students and have obtained valuable feedback from the students regularly throughout the teaching session. Such feedback is impossible to gauge from a large lecture group. Tutors are also learning from the experience of working *with* the students, rather than instructing the students.

Based on feedback from small classes, we are in the process of developing more on hands-on learning activities and migrating away from the traditional tutorial forms such as working through prepared worksheets. In addition we are exploring non-assessable forms of tasks that are high in learning value that also promote greater levels of group discussion.

If we were to change anything today, an important consideration would be the design of the tutorial layout. The arrangement works well for activities where hands-on computer-based exercises are interleaved with short instruction, however group activities that do not involve the computer are generally restricted to people sitting in a single row. Typically, friends sit next to each other and one of our challenges is to help students work with other people who they are not familiar with. The large monitors, whilst positive for OH&S reasons allow students to hide behind the screens reducing eye contact with the tutor.

The infrastructure to support a technology classroom is very important, especially to promote the concepts of collaborative work. We still have some work to do in reaching this goal. The recent availability of networking technologies such as Rendezvous will help in the development of new tools to explore multi-person interaction.

There is a certain level of intrigue with the Mac OS X laboratory, especially since the majority of students are unfamiliar with the technology but have a sense of the Apple brand. The aesthetics of both the physical hardware and the Aqua user interface provide sense of curiosity that initially engages the students to explore what is new compared to their previous experience. The challenge is to maintain this sense of curiosity, encouraging students to question what they see so they begin to understand the underlying design principles for

different platforms. Students however, should come to the conclusion that the visual design is only one part of the overall user experience.

Future

We have come to the end of the basic infrastructure-building phase and have moved into our tool development phase. Over the short term we will be concentrating on the software tools and systems that we can develop in house to extract maximum value out of the technology investment. With the programming environment offered by Mac OS X we envisage that progress will be rapid provided that we focus on training students with user interface design skills and software development exposure to Cocoa. As a lead up to a new course that will in part teach Cocoa, we will be running short courses for students and staff to bootstrap them as quickly as possible into Objective C and the Foundation Libraries.

Conclusion

When we reflect on what we have been able to achieve in a two-year period, creating two laboratories focussed on human computer interaction we realise that we were able to achieve many targets. Placing an emphasis on Mac OS X has enabled many things to happen immediately, for example digital video integration was made easier by adopting Mac OS X.

Laboratory management and server administration tools have matured considerably since 10.0 and the features in 10.2 are making this task easier, requiring fewer resources than before. The path however was not without frustration, but that is a risk one takes as an early adopter.

Adoption of Cocoa is proving to be a positive experience for first time student developers.

In the past two years we have enhanced the learning experience for students by creating a practical interaction environment where they can learn about the process of user centred design. Students have the opportunity to explore real user interface design issues in a small group of no more than 20 students and have access to Mac OS X to provide them with a working example rich with new user interface design ideas.

We continue to develop technologies that will strengthen the student learning experience but are also exploring directions in collaborative learning environment.

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