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Internet and multimedia for teaching and learning

A case study of using web-based services in higher education

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Title

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Abstract

The last decade has witnessed great advances in Internet technology. It is now capable of effectively managing rich multimedia content, and gives users access to powerful interactive tools. Yet, the field of higher education only utilizes basic internet based services (such as e-mails), leaving the majority of its potential completely untapped.

Before higher education can make use of the full internet capabilities, further research in this field needs to be performed. It is essential to first examine whether internet and multimedia tools are suitable for supporting education. It is also important to know which tools in particular are useful in an educational setting.

This research project revolves around the creation of a new Master course that teaches Human Computer Interaction principles. It plays a significant part in the design and implementation phases of the course. By analyzing the course's educational requirements, the project builds a support system using already available web-based tools and services. As a result of the project, students were offered recordings of the course lectures, an online manual, video tutorials, voice recorded instructions, online message boards, and an online collaborative reporting system.

As the course was given for Master students in the Delft University of Technology for the academic year 2006-2007, the implemented support framework was put to the test. The accessibility and usage of the tools were assessed by collecting usage statistics. Additionally, interviews and focus-group discussions were held with the students to gauge their opinions of the tools in particular, and the new course format in general.

The experiment results showed that the tools were well utilized by students taking the course. In particular, the lecture recordings, online manual, and video tutorials were heavily used, and were rated by the students as highly useful for completing course activities. Student feedback also showed that the majority of the students preferred this new course format to traditional courses and even said that it made the course more enjoyable.
The used tools presented benefits to course instructors as well. The open and accessible nature of the used online tools made it easier for instructors to collaborate on and manage course activities.

Additionally, by providing them with detailed usage statistics, instructors were able to observe how students used the provided course materials, allowing them to adjust their educational strategies accordingly.

Further research in the subject should explore other types of courses and determine the kind of tools that would be useful for each type of taught material. This should be followed by a comprehensive effort to develop sets of tool templates for each type of courses that can be easily implemented on all courses given within a university.

Contents

1. Introduction

Recently development has started on a new course on human computer interaction (HCI) for the master program Media and Knowledge Engineering in the Delft University of Technology. The course is called Intelligent User Experience Engineering (IUXE), and teaches the design and evaluation of user interfaces. Developing such a course is particularly challenging since research has suggested that traditional methods of teaching HCI and usability are not as successful as generally thought [1.1].

Internet developers are continuously introducing new interactive and multimedia web-based tools. Younger students who grew up with the Internet are well trained in using many of the interactive tools and services it offers. It may, therefore, be possible to exploit the experience they have by providing web-based tools to support HCI learning as individuals and in groups during projects [1.2,1.3,1.4]. However, the development and the deployment of methods to use such tools in education has been difficult [1.5].

This research attempts to explore the possibilities of utilizing the power of web-based tools, as well as multimedia tools, to support teaching and learning. The project revolves around the following research questions:

1. Can web-based tools be used to support the teaching of HCI?
2. What type of tools are suitable to help the teaching process?

The project goes through the entire process of constructing the IUXE course. It employs the newly developed Learner Centered Design (LCD) methodology for constructing education-oriented support systems. With the help of LCD, a comprehensive set of tools is developed to improve the IUXE course's teaching experience. The tools are evaluated in a real world test as they are used by the students taking the IUXE course in the academic year 2006-2007.

This thesis starts in Chapter 2 by discussing the IUXE course content and general organization. Chapter 3 explains the LCD methodology in detail, and shows how it can be used to develop a supportive system of educational tools. The LCD methodology is then applied on the IUXE course in Chapter 4, analyzing its requirements and suggesting the type of supportive tools it needs. The implementation of these tools is discussed in detail in Chapter 5, followed by an evaluation of these tools in Chapter 6. Finally, Chapter 7 discusses the project's results and give its conclusions and recommendations.

2. The taught subject matter

The course Intelligent User Experience Engineering (**IUXE**) was developed and given for the first time in the academic year 2006-2007. It is one of the specialization courses in the Man Machine Interaction (**MMI**) department for the Master program of Media and Knowledge Engineering (**MKE**). The course replaced two older courses given previously by the MMI department, namely Design of Highly Interactive Systems (**DHIS**) and Usability Engineering (**UE**). This was decided due to the overlap between the two courses, which meant that students who followed both courses were sometimes learning the same things twice. This chapter talks about the two old courses in Section 2.1, then turns the focus on the new IUXE course and what it teaches in Section 2.2.

2.1. The old courses being replaced

2.1.1. The DHIS course

The DHIS course discussed theories, principles, and guidelines necessary for the design of software tools or other interactive systems. Such systems can include, virtual worlds, mobile phones, video conferencing systems, knowledge management systems, websites, computer-based training, multimedia CD-ROMs, etc. The course taught the design principle outlined in the book 'Designing the User Interface' by Ben Shneiderman [2.1].

Taking part in the course involved:

- **Web-lectures:**
  Students were provided with online lectures that explained the theories and concepts handled in the course.
- **Weekly Homework assignments:**
  Each week students had to complete a homework assignment that used the material discussed in the web-lectures.
- **Weekly lecture discussion**
  Since the course material was explained in the web-lectures, the lectures took the form of a discussion of the material and the homework assignment.
- **Lab:**
  In the lab, students formed groups of four, where each group designed and implemented a prototype of an interactive system for a specific user group (e.g., children, the elderly, handicapped people).
- **Oral examination:**
  The course ended with an oral examination where the students' understanding of the course material was evaluated.

The method of using the web-lectures as the main channel to explain course theory was developed in collaboration with professor Jim Foley from the Georgia Institute of Technology [2.2]. The aim of using web-lectures was to Enhancing the Classroom Learning Experience. The Homework assignments

and lab determined 70% of the grade, while the other 30% depended on the oral examination. The DHIS course earned the students 4 **ECTS** (European Credit Transfer System) points.

2.1.2. The UE course

The UE course provided a coherent engineering approach to human computer interaction. It provided the student with a general framework to extend and apply usability knowledge. Based on this framework, available theories, methods, and technologies were discussed which can be used for designing and validating user interfaces. The course centered around the scenario based development of human-computer interaction as explained in the 'Usability Engineering' book by John Carroll [2.3].

Taking part in the course involved:

- **Weekly lectures**
  Normal course lectures explaining the course material
- **Web-lectures & homework assignments**
  Web-lectures were used to show examples and extra information related to the course material. These web-lectures were accompanied by homework assignments that students could complete for extra credit.
- **Lab**
  Students worked (in groups of 4) on the course's lab project, where they had to analyze a prototype of an interactive system, perform modifications to improve its usability, and evaluate the overall usability of the system.
- **Journal paper presentations**
  Each group was given a scientific journal paper to study. The selected papers focused on new theories, methods, and technologies in the field of usability engineering. The group also had to prepare a 30 minute presentation summarizing the content of the paper.
- **Oral examination**
  The course ended with an oral examination to evaluate the students' understanding of the course material.

For the UE lab, students were given access to the Morae evaluation system developed by TechSmith[1]. Using Morae gave the students a similar experience to using a full scale usability evaluation lab. Completing the UE course gave the students 5 ESTC points for their study program.

2.1.3. Overlap in the two courses

Master students interested in specializing in MMI often followed both of these courses. Therefore, an overlap between them represented a wasted effort by the students, and a missed opportunity to provide the students with a comprehensive and complementary learning experience.

[1] More information about Morae can be found at http://www.techsmith.com/morae.asp

As explained above, the design process of interactive systems played a great part in both courses. The DHIS course focussed entirely on the aspects of the development process, whereas the UE handled both development and evaluation. There was, therefore, a significant overlap in the courses when it came to theories about *development* of interactive systems.
This was again reflected in the lab for each course, where students examined the design requirement for a prototype of an interactive system in both courses. The UE course provided a partially complete prototype while DHIS students had to develop their own program. This again resulted in some overlap between the courses, forcing the students to perform similar types of analysis twice, together with the required reports and presentations.

2.2. About the IUXE course

The IUXE course combines the material given in both courses, and handles the design process of interactive technological devices. It concentrates on the traditional usability aspects (effectiveness, efficiency, and user satisfaction) as well as modern user experience issues. After completing the course, the student should have:

- A coherent approach for developing interactive systems that allow users to accomplish their goals effectively and efficiently, and with a high level of satisfaction.
- Knowledge of new theories and research-approaches for improving the user experiences in the development of intelligent systems.
- Practical experience in the application of theories and methods for the generation and testing of intelligent user interfaces.

In the course, the instructors deal with the students on two separate levels. Individual students will follow the course lectures, complete several homework assignments and finally be evaluated with an oral examination. This work will determine half the final grade for the course.
Additionally, while following the course the students will also take part in a lab project in teams of 4-5 students. There they develop an interactive system while observing the concepts taught in the course. The developed system is then evaluated by the students on aspects of usability and experience. The evaluation of the system is performed using Morae, following the same approach of the UE course. The group's work will be assessed by the quality of their designed system, and the quality of the project's reports and presentations. This determines the second half of the final grade.

Simply said, the IUXE course is designed to combine both DHIS and UE courses in one comprehensive corse that handles the entire design process. It includes a lab that takes the students through both development and evaluation stages. It also adds the new dimension of *user experience* to the development of interactive systems.
To reflect the larger scope of the IUXE course, the number of points students get for completing the course has been increased to 6 ECTS points, which is slightly higher than the old courses (see Section 2.1).

3. Theory and methodology

In order to create an adequate framework of tools to support the teaching of the IUXE course, it is crucial to carryout a methodical analysis of the course's requirements. There is a growing body of research currently working on designing computer technology to support the learning of complex work activities. Quintana et. al. [3.1] have constructed what they call the Learner Centered Design (LCD) process by building upon the already established User Centered Design (UCD) practices.

Learner-centered software incorporates what Quintana calls scaffolding strategies which support learners to mindfully participate in and develop an understanding of a new work practice. Understanding the LCD process is important since many learning-tools are usually developed intuitively, using "educated guesses" and ad-hoc design approaches rather than systematic design methods. Quantana's LCD approach provides designers with more specific design information.

Unfortunately, the limited time and resources available for this project means that designing new educational software falls outside the scope of this work. Therefore, instead of developing new software (as required by the LCD process), our work utilizes already available solutions. These solutions may include systems already developed by the TU Delft, commercially available software, and web-based services.

3.1. The LCD process

When following the LCD process, the developers think in three unique dimensions. The audience targeted by each design perspective, the central problem being addressed by each design perspective, and the underlying approach each perspective takes to address the design problems. These dimensions are discussed below using the traditional UCD approach for comparison.

3.1.1. The audience

The traditional USD approach addresses the need for a user to complete a certain task, whereas the focus of LCD is on building an understanding for a certain (work) practice. Therefore, the audience of LCD have a different characteristics which designers have to keep in mind:

- Learners do not have the same expertise about the work practice that users have.
- Learners are heterogeneous and usually have differences in culture and background.
- Learners may not be intrinsically motivated in the same manner as experts (they face more obstacles in successfully performing the work).
- The Learner's understanding grows while using the learning tools. They should, therefore, be adaptable to accommodate that growth.

3.1.2. The problems being addressed

The main difference here is that UCD addresses the conceptual gap between the user and the tool, while LCD addresses the conceptual gap between the learner and a work practice. According to the "gulfs" metaphor of Donald Norman [3.2], UCD deals with two gulfs between the goals of the user and the physical tool. The gulf of execution is the difference between the intentions of the user and the permissible actions on the tool. The gulf of evaluation reflects the amount of effort the user must

exert to interpret the physical tool state. Quintana [3.3] introduces an additional gulf in his LCD process which he calls the gulf of expertise that sits between the learner and the desired work knowledge. It is important to identify the "size" of the gulf of expertise, which is proportional to the amount of expertise the learner needs to gain in order to work successfully within the given work practice.

3.1.3. The approach to solve the problem

Norman [3.4] provides a model that illustrates the process of bridging the gulfs of UCD. The model (illustrated in Figure 3.1) Shows that the designer creates the system image based on his design model. Given the system image, the user begins to create a user model of the system. If the user model is consistent with both the designer model and the user's own work understanding, then the system is considered "usable". The designer can only achieve this through a good understanding of how people work with tools.

The LCD process involves additional conceptual models illustrated in Figure 3.2:

1. A work-practice model (an expression of the work practice learners are trying to understand) supplied by work experts.
2. The presentation of work practice knowledge must be guided by an educational model, (how to best facilitate the learner's understanding) supplied by educational experts.
3. The designer must design a usable system and realize the contributions of the work practice and educational experts.

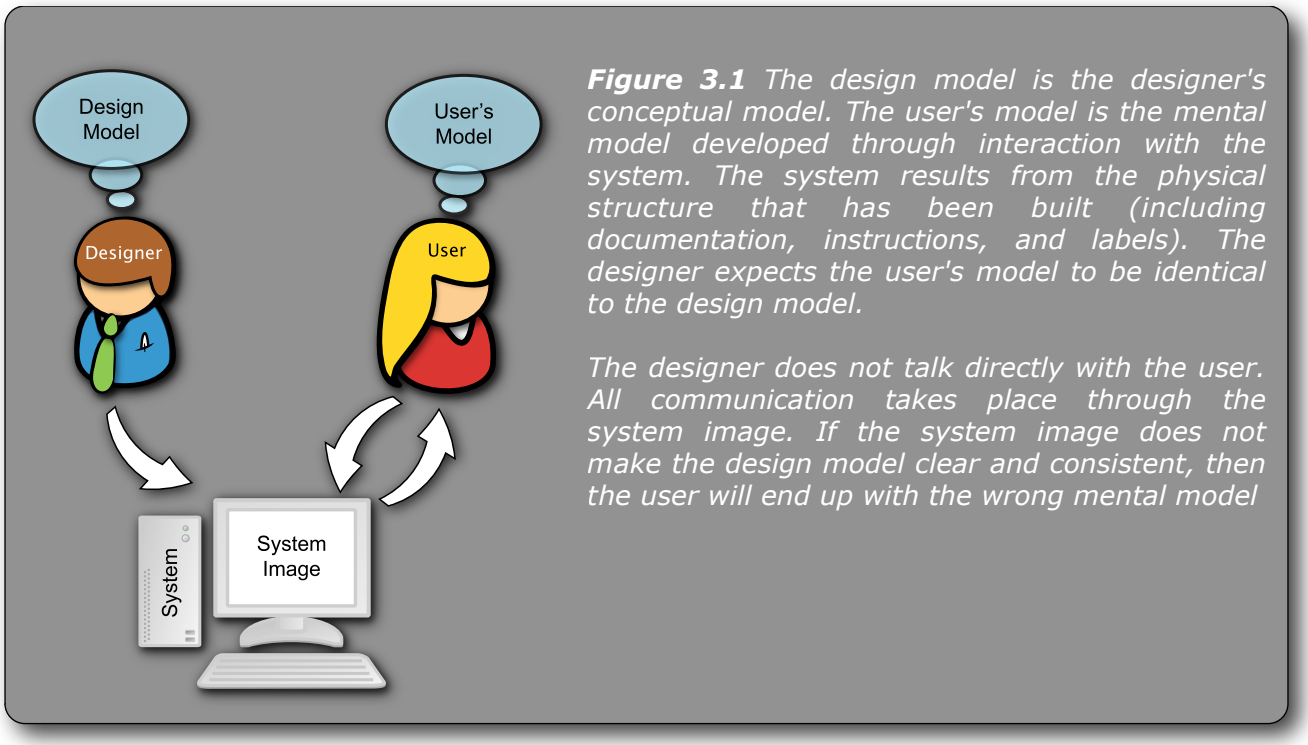


Figure 3.1 *The design model is the designer's conceptual model. The user's model is the mental model developed through interaction with the system. The system results from the physical structure that has been built (including documentation, instructions, and labels). The designer expects the user's model to be identical to the design model.*

The designer does not talk directly with the user. All communication takes place through the system image. If the system image does not make the design model clear and consistent, then the user will end up with the wrong mental model

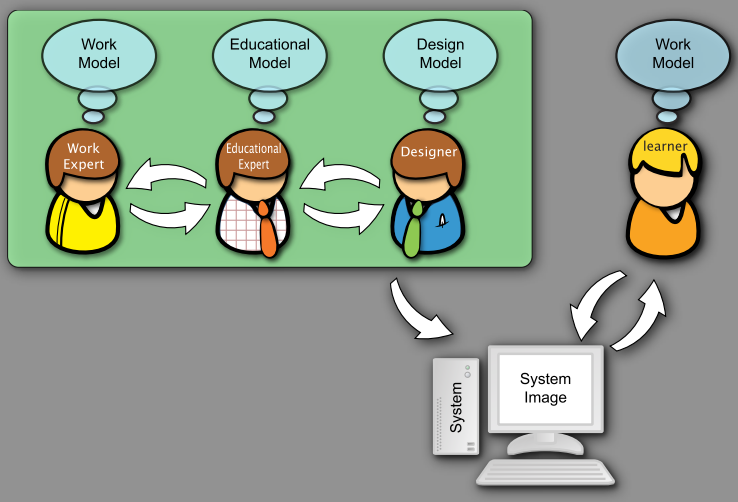


Figure 3.2 *The additional conceptual models are needed in the LCD design process. In addition to the designer required in the UCD approach, the LCD method involves a work expert that chooses what elements are most important in the work process. The educational expert then helps construct the educational model for the work practice. Finally, it is the job of the designer to realize the design of the educational expert. The operation involves close interaction among the experts.*

3.2. LCD teaching method

When developing LCD principles, it is useful to consider the social-constructivist learning theories [3.5] as the educational model to describe what is meant by "gaining expertise":

- Constructivist learning theory states that understanding and learning involves active, constructive, generative processes. Learning is not a passive information transfer process from expert to novice, but rather an active process that employs a "learning by mindful doing" approach.

- Social-constructivist learning theory states that learning is enculturation. That is, learning does not occur in a vacuum, but must occur within some representation of the work context so that learners develop an understanding of that work context and culture.

From the above, one can conclude that learners should actively engage in authentic activities from the work practice. Learning needs to be an active process, where learners:

1. ask questions;
2. collect and organize information;
3. assess their work.

This should be done by using tools and engaging in activities from the given work practice. By doing so, learners can begin to develop an understanding of the work culture. Learners, then, need tools that help them with this active engagement in a work practice. Since learners lack an understanding of the work practice, they need additional support (or scaffolding) in their tools to help them engage in the new work activities.

When designing tools for learners, learners cannot use the same tools that work practice experts use (i.e., user-centered tools) because of the difference in their levels of expertise. Therefore, a designer should develop tools modeled on expert tools, but scaffolded in ways that allow learners to participate in activities similar to those of work practice experts to mediate the learner's development.

3.3. The steps of LCD

The LCD process involves the following general high-level design phases (see Figure 3.3):

1. **Work Analysis:** Analyzing and understanding the work activities that will be supported by the LCD tools.
2. **Requirements Specification:** Determining the functional requirements for the LCD tools.
3. **Design:** Determining the conceptual strategies to carry out the requirements and determining the physical instantiations of these strategies in LCD tools.
4. **Assessment:** Determining the successes and failures of the LCD tools.

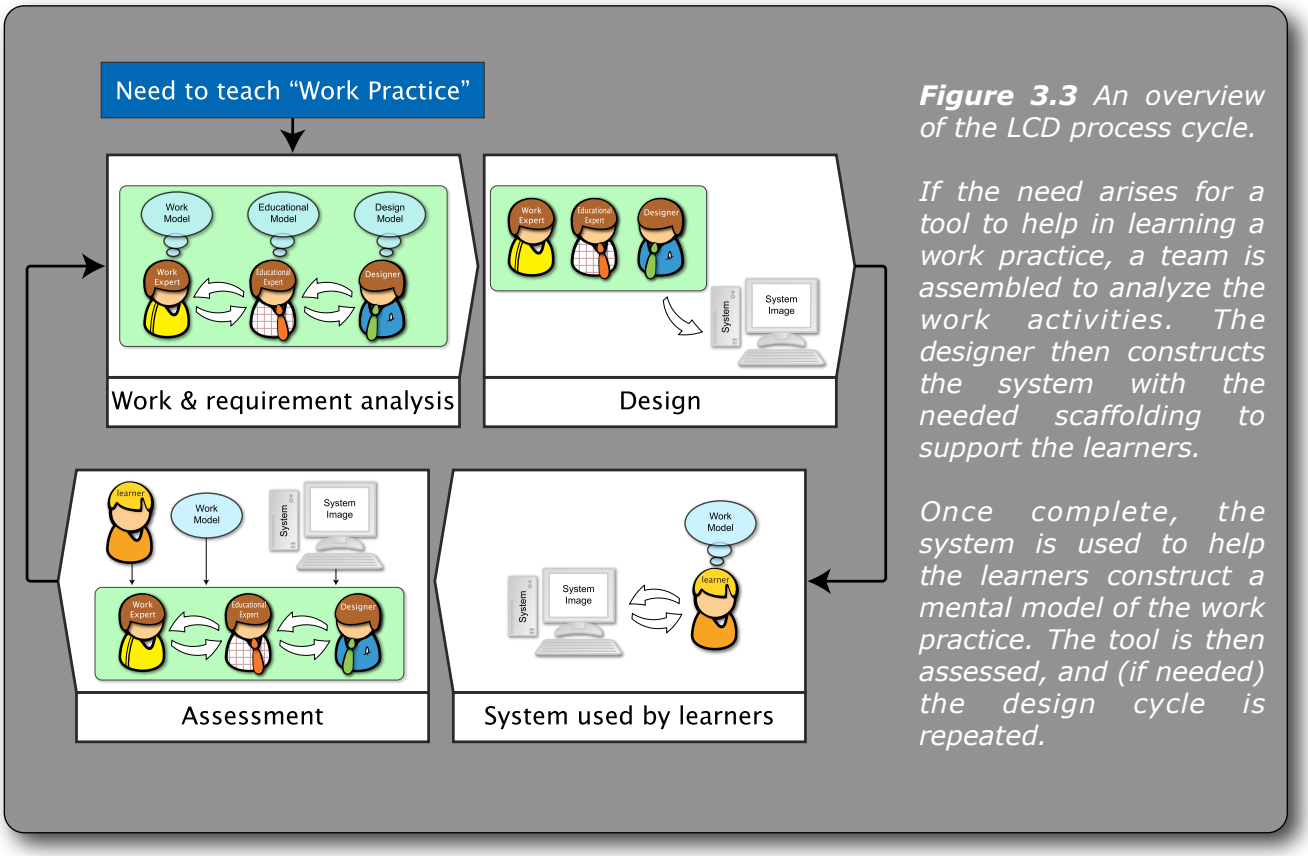


Figure 3.3 *An overview of the LCD process cycle.*

If the need arises for a tool to help in learning a work practice, a team is assembled to analyze the work activities. The designer then constructs the system with the needed scaffolding to support the learners.

Once complete, the system is used to help the learners construct a mental model of the work practice. The tool is then assessed, and (if needed) the design cycle is repeated.

3.3.1. Work analysis

Work analysis is very important because the focus of LCD is to design tools that support participation in a new work practice. A learner-centered designer must, therefore, have a thorough and detailed understanding of the work practice so that they can design appropriate support tools for the learner.

The process space model [3.6] is a useful framework for performing the LCD work analysis by helping to identify the components that make up complex work. These components include:

- Roles: The responsibilities undertaken by the participants of the work.
- Activities: The basic tasks and components carried out by the roles.
- Artifacts: Items produced by activities or items that mediate the performance of activities.
- Information Objects: Pieces of information used to perform the activities. Information objects are static items as compared to mediating artifacts, which may change throughout the work.
- Services: The tools used to perform activities.

After completing the work analyses, the following should be known:

- The full set of activities that compose a work practice, which shows the explicit and implicit work activities that may not be apparent to the learner.
- The range of artifacts that are produced in the work practice that must be organized and analyzed.
- The range of information objects that experts use to engage in their work (e.g., conceptual knowledge, procedural knowledge, content knowledge, etc.). This helps describe the kinds of information that learners need to acquire in order to be able to perform the work.
- The set of services needed while performing the work. This is important because this essentially defines the functional components that will be needed in the LCD software.

3.3.2. Requirement specification

Given an analysis of the work, a LCD team needs to determine the functional requirements for the software. A learner-centered requirement is an identified area where a learner needs support to engage in a certain portion of the work. The available empirical body of research has formulated a set of general learner requirements:

- Service needs: Unlike experts, learners may need explicit, additional services to perform work activities.
- Information needs: Learners need information that explains different aspects of the work practice, explain how to perform different work activities, and help see what work activities are possible at different stages of the work practice.
- Activity needs: Learners need explicit representations of the activities that may be implicit to experts.
- Management needs: Learners need support to manage the different artifacts they create as they engage in the work practice. By supporting easy artifact storage and access, learners can maintain their focus on their work tasks and not divert their focus to housekeeping "chores".

3.3.3. Scaffolding design

Given a set of learner requirements, a LCD team can begin designing the scaffolding for the tool that will address those needs. As with any software design process, the overall design phase can be described as two activities:

- Conceptual design: Determining the conceptual scaffolding strategies for addressing the learner needs.
- Physical design: Determining the physical instantiations of the conceptual scaffolding strategies in software.

3.3.4. Scaffolding assessment

After the software has been designed and used, a design team needs to assess the tools starting with their effectiveness, efficiency and ease of use. However, LCD scaffolding have additional evaluation criteria that assess the effectiveness with respect to learning the work.

Current scaffold assessment practices involve interviewing learners and videotaping them working with the developed tools. Learners are also given pre- and post-tests about the work practice they are engaging in with the software. Table 3.1 contains a summary of the assessment procedure. The assessment criteria used in the procedure are listed in Table 3.2.

Table 3.1 *Summary of the assessment procedure for LCD designed scaffolding.*

#	Assessment step	Description
1	Coding by Individual Work Activity	• Episode corresponding to specific activities from the work practice are defined from student videotape
		Result = Collection of work episodes
2	Scaffolding Usage Evaluation	• Each work episode is analyzed to isolate specific scaffolds that were used in the episode. • Every time a scaffold is used, the instance of use is assessed using criteria from Table 3.2
		Result = Collection of scaffold usage summaries
3	Scaffolding Meta-Summarization	• Define time units of analysis and assemble together the scaffolding usage summaries in each unit by scaffold. • Consolidate the scaffold usage summaries for each scaffold in a unit.
		Result = Group summaries describing how usage of a scaffold change over time

Table 3.2 *Assessment-criteria on which the usage of the scaffolding is assessed.*

Assessment criteria	Description
Accessibility	Can learners access a scaffold?
Use	Do learners use a scaffold?
Efficiency	How quickly and easily can learners access a scaffold?
Accuracy	Do learners accurately complete tasks supported by the scaffold
Progression	How do learners progress through their work? In linear fashion (i.e., novices) or in opportunistic fashion (i.e. experts)?
Reflectiveness	Are learners reflecting on or discussing tasks supported by scaffolds?

4. Designing the IUXE course

In this chapter, we use the methodology of LCD, explained in Chapter 3, for the development of the IUXE course. It is important to note here that LCD is designed to address learners for a complex *work* practice, which means that it is not specifically designed to address the needs of students studying in an academic institution. Therefore, this chapter also discusses how LCD was adapted to be usable for the purposes of this project.

4.1. The three dimensions of IUXE

4.1.1. The audience

The audience of the LCD tools here are the students taking the IUXE engineering. As mentioned in Chapter 2, the IUXE is one of the MMI specialization courses in the faculty of MKE in the Delft University of Technology. The course can be taken by any MSc student in the university as a free elective course, however the bulk of the participants will be MKE students and those should be the main focus of the course planning.

Since qualifying for this MSc program requires (among other things) a BSc degree in a related field, it is therefore possible to name a set of characteristics that the IUXE course audience will posses:

1. a fair share of knowledge of abstract sciences (e.g., calculus, physics);
2. good knowledge of the English language, though most will have Dutch as their first language;
3. experience with using computers;
4. access to the Internet (if not at home then in the university);
5. experience in programming;

4.1.2. The problems being addressed

Besides the theoretical content of the IUXE course, it also has a clearly identified practical flavor. It is therefor possible to view the course as a process of teaching a work practice to a group of learners. It is now important to identify:

1. What work processes are being taught? The course goals list the following processes:
   a. a systematic approach for developing "usable" interactive systems;
   b. improving the development of user experience in intelligent systems;
   c. evaluating the usability of prototypes and fully developed systems.
2. How big is the gulf of experience between the learners and the desired work knowledge? This depends on their background knowledge in each of the above mentioned processes:
   a. All learners taking the course have a BSc degree in a technical engineering field. This means that they have already had some training in design methodology and have worked (possibly in a team) on a design project for their graduation. They therefore have experience in system development approaches.

b. User Experience is a relatively new concept. Learners are not expected to have any previous experience with this process.
c. Evaluation is a unique field of study that is not likely to have been coupled with other courses the learners have followed.

4.1.3. The approach to solve the problem

As illustrated in Figure 3.2, the process of designing LCD tools involves the development of 3 conceptual models developed through the cooperation of work experts, educational experts, and system designers. For this project, these roles are filled by the following team:

1. Work Expert: Prof. Mark Neerincx is an expert in user-centered design and usability evaluation
2. Educational Expert: PhD. Charles van der Mast, an experienced university instructor specialized in Educational software
3. Designer: Hani Alers, an MSc student in the faculty of MKE.

4.2. The teaching method

The LCD process makes use of the social-constructivist learning theories (explained in section 3.2) to guide the basic development of an educational course. Fortunately, the Teaching method suggested for the IUXE fits well within these guidelines.

4.2.1. Learning by doing

Besides the lab project component of the course (see next section), students will actively participate in the delivery of the course material by:

1. Giving course Presentations: The course employs the “learning by teaching” philosophy to some extent. Students are asked to give presentations that explain some course related material. This will be followed by a discussion of the presented material between all students. It is Important to encourage all students to participate in the discussion and not just the presenters.
2. Workshops: There will also be some workshops where students can practice applying theories from the course material.

4.2.2. Enculturation of work practices

The course contains a lab project that runs through the entire duration of the course. The project involves two main stages, namely the development stage and the evaluation stage. Working in groups, students will start by analyzing and developing a prototype of an interactive system. The second stage will involve the students evaluating the new prototype they have created. It is important here to provide the students with a genuine work experience.

A. Choosing appropriate prototypes

In order for the project to achieve the desired educational goals, it needs to be planned carefully. One of the important aspects of the project is choosing which prototypes are to be used by the students. The goal of providing the teams with prototypes is to focus their attention and to jump-start their work to provide rapid results. A good prototype should be:

- Accessible: easy to learn, understand, and modify by students.
- Available: can be easily reached, edited, and tested. Preferably on-line for easy group cooperative work.
- Multi-disciplinary: requiring experience in different fields (e.g., programming, graphics design, information design) to ensure all students can effectively participate regardless of their skills.
- Distributed: having separate components to allow team members to work in parallel on different parts of the prototype.
- Low fidelity: still in an early development stage so not to limit possibilities, leaving enough room for change and improvement.
- Interesting: so it stimulates the students' creative potential.
- Educational: suitable for the development and evaluation of different aspects addressed in the course (e.g., efficiency, trust, pleasure).

B. Cooperative learning techniques

Students following the course will be arranged in groups to work on the project. It is therefore useful to follow some guidelines on cooperative learning techniques. A study performed by the cooperative learning center at the University of Minnesota lists the following cooperative learning methods [4.1]:

1. Positive interdependence: group members should perceive that they are linked with each other in a way that one cannot succeed unless everyone succeeds. Group goals and tasks, therefore, must be designed and communicated to students in ways that make them believe they sink or swim together. If there is no positive interdependence, there is no cooperation.
2. Promotive interaction: students need to do real work together in which they promote each other's success by sharing resources and helping, supporting, encouraging, and applauding each other's efforts to achieve. This includes orally explaining how to solve problems, teaching one's knowledge to others, checking for understanding, discussing concepts being learned, and so on. Each of those activities can be structured into group task directions and procedures.
3. Individual and group accountability: Two levels of accountability must be structured into cooperative lessons. The group must be accountable for achieving its goals and each member must be accountable for contributing his or her share of the work.
4. Teaching students the required interpersonal skills: Cooperative learning is inherently more complex than competitive or individualistic learning because students have to engage simultaneously in task-work (learning academic subject matter) and teamwork (functioning effectively as a group). Social skills must be taught to students just as purposefully and precisely as academic skills.
5. Group processing: Group processing exists when group members discuss how well they are achieving their goals and maintaining effective working relationships. Groups need to describe what member actions are helpful and unhelpful and make decisions about what behaviors to continue or change. Continuous improvement of the processes of learning results from the careful analysis of how members are working together and determining how group effectiveness can be enhanced.

These methods are going to be considered when constructing the support tools that for the LCD scaffolding for the IUXE course.

4.3. Applying LCD

4.3.1. Work analysis of IUXE

This is a job for the work experts since they are the most qualified to analyze their work practice. This is how the expert would perform the work, without any external help or scaffolding. As explained in Section 2.3, analysis of complex work is simplified by examining its components:

- **Roles:** usability developer, usability evaluator, programmer, graphics designer.
- **Activities**: task analysis, scenario development, claims analysis, developing prototype, evaluating prototype,
- **Artifacts:** discussion poster, development presentation, development report, test plan, evaluation presentation, evaluation report.
- **Information objects:** book, lectures, project manual,
- **Services:** activity evaluation tools (Morae + evaluation lab), communication tools, programming IDE's, web-development software.

4.3.2. Requirement specification of IUXE

Here, the needs of the learners are put under consideration. Now that the way experts perform a work practice is clearly analyzed, it is time to see what scaffolding or help methods are needed by the learners.

- **Service needs:** the ability to consult work experts.
- **Information needs:** learners need information about the development and evaluation processes, as well as information about the used prototype. This information can be acquired from the book, project manual, and the course lectures.
- **Activity needs:** since students are not familiar with the work practice, they need to be informed of what steps actions are involved in each activity. They also need to be shown how to use the services they need to complete the work.
- **Management needs:** Besides learning, students will be involved in producing a number of artifacts. The management tools should help in the creation and management (e.g., storage, distribution) of these artifacts.

Table 4.1 summarizes the work analysis and requirement specification of the IUXE course. The table also lays out the analysis with the regard to the different stages of the course.

4.3.3. Scaffolding design for IUXE

This step of the LCD requires performing conceptual and physical designs of the required scaffolding. However, considering the limited time and resources available to this project, no new software will be developed. Instead, the requirement analysis is reviewed and suitable solutions are selected from already available systems. This may include commercial and open source software, web-based tools and services, and learning support systems already implemented by the Delft university.

Table 4.1 *shows the Work analysis ☐, and requirement specification ☐, for each stage of the IUXE course.*

Comp-onents	Course stages				
	Studying prototype	**Improve Design**	**Develop**	**prepare experiment**	**Evaluate**
Roles	Usability developer	Usability developer	(depending on prototype) programmer, graphic designer, web-developer	Usability evaluator	Usability evaluator
Activities	Reviewing prototypes, discussion	Task analysis, claims analysis, scenarios	Implement new functions, change interface	Prepare evaluation experiment	Gather test subjects, evaluate prototype, analyze results
	Service need: consult expert	**Activity need:** list of required activities **Service need:** consult expert	**Service need:** consult expert	**Activity need:** list of required activities **Service need:** consult expert	**Service need:** consult expert
Artifacts		Discussion poster	Improved prototype, development report, development presentation	Test plan	Evaluation presentation, evaluation report.
		Management need: collaborative authoring, file sharing	**Management need:** collaborative authoring, file sharing	**Management need:** collaborative authoring	**Management need:** collaborative authoring, file sharing
Inf. Objects	Manual, lectures	Book, lectures	Book, manual, lectures	Book, manual, lectures	Book, manual, lectures
	Information need: info about prototype	**Information need:** Design principles and theories.	**Information need:** What information should be included in report and presentation	**Information need:** How to prepare for an evaluation experiment.	**Information need:** Using evaluation lab, analyzing results, report + presentation
Services	prototype manual.		(depending on prototype) programming IDE, Graphic design software, web development software,		Usability evaluation Lab and tools

A. Service needs

The students learning the course and working on the lab project will inevitably face many questions where they require the help of an expert. Naturally, students can wait till they meet the instructors face to face, or contact them using e-mail. However, a dedicated system that can simplify and speedup this process can be more superior. Also, having such a system facilitates a *management need* that reduces the workload of the students. Suitable alternatives for such a system are:

- **online message board**: where students can post questions and engage in discussion with each other and the instructors.
- **online chatting**: where students can have a real time discussion using text, voice, and/or video.

Even though the online chatting provides an interesting realtime aspect to the student, it requires the instructors to devote their immediate time and attention to such questions. In addition, the online message board allows other students to cooperate in solving problems and discussing ideas, which

realizes some of the *cooperative learning techniques* mentioned in Section 4.2.2. Therefore, using a message board system is more practical and beneficial for the purposes of this course.

B. Information needs

Since the students are learning the design and development principles while taking the course, they will heavily depend on the course's sources of information, namely the book, project manual, and the course lectures. The goal here is to improve the usability, accessibility and the efficiency of using these sources of information. This can be achieved with the following scaffolding:

- **Recording the course lectures:** as one of the main sources of information, it is important to give the students the ability to review the lectures whenever needed.
- **Putting the manual online:** to allow the students to access it whenever they need. Such a manual can also be corrected, edited and improved if the need arises. An online manual makes it also possible to include extra content and functionality such as sounds, animations, videos, links to external material, etc.

C. Activity needs:

The students will perform a number of tasks, produce artifacts, and use services which they have no prior experience with. They therefore need explicit representations of these activities. The ideal solution is to have the instructors explain how to perform these activities to each student, which is too demanding on the instructor's time. The often used alternative is to simply write down (e.g., in the project manual) how to perform each of these activities.

Scaffolding that satisfies the activity needs should give the same effect of a personal demonstration or explanation by the instructors without the extra demands on their time. The suggested scaffolds are:

- **Sound recordings:** by providing the needed information in a sound recording, instructors can give students the information in a more natural manner, making the instructions easier to understand.
- **Video tutorials:** Activities which require visual demonstrations should be explained using a video tutorial providing the students with a visual reference on how the activity is performed.

Creating video tutorials is useful for specific applications, however it is more demanding to produce (e.g., extra equipment, video editing software) and to use (e.g., larger file sizes). Therefore, video recordings should only be used where video is necessary. The rest of the instructions can be provided with sound only recordings.

D. Management needs:

The last requirement category focusses on managing the artifacts the students produce while taking the course. To help produce, store, and deliver these artifacts, students need a scaffold that help them share and manage files among themselves and with the instructors. Possible scaffolds are:

- **File sharing systems:** where students can store and share files, track changes, and submit completed work to course instructors.

- **Online collaborative reporting:** where students can compose, store, and share documents online.

The IUXE course requires students to produce many reports in close collaboration among group members. A number of drafts should also be submitted to the instructors for feedback and further improvements. Therefore, using a collaborative reporting system can be a great help in managing these course activities. Additionally, this makes a need for a file sharing system minimal. Therefore no scaffolding for file sharing will be implemented for the course.

4.3.4. IUXE scaffolding assessment

Since the process is being applied in an academic framework with the learners being university students, there are many limitations on the amount of monitoring that can be used. For example, it is totally impractical to videotape the students while using the tools as suggested in Section 3.3.4. Therefore, the assessment process will be adapted to fit this project.

Assessment of the scaffolding will use information gathered from:

- **Usage statistics:** providing information about accessibility, and usage of scaffolds.
- **Student feedback:** providing information about efficiency, accuracy, and reflectiveness.

The usage statistics will be collected automatically by the individual tools[1] throughout the duration of the project. These statistics will clearly show the **accessibility** and **usage** of the tools by the students.

Interviews will also be conducted to gather subjective feedback from the students. At the end of the first half of the course, focus-groups will be conducted with the students to discuss their opinions of the tools and how they are used in the course. Additionally, at the end of the course, individual interviews are conducted with the students where their opinions are measured using feedback questioners and open questions. All interviews are video taped for further analysis. The interviews will be used to gather data about the **usefulness** and **enjoyability** of the tools.

The gathered information is then used to assess each of the tools on accessibility, usage, usefulness and enjoyability. This is followed by a general evaluation of the course approach based on the student opinions of the course.

[1] Each tool is equipped with different usage statistics tracking capabilities. The quantity and type of collected statistics differ from one tool to the other.

5. Implementation of educational tools

Once the design process is complete, it is time to build the course with suitable implementations of the required tools and services. For the purposes of this project, it was possible to use the infrastructure provided by the Delft university and several third party online services. There were no new tools were developed in the course of this project. This approach was taken to try as many different tools as possible within the time frame allowed for the project.

This chapter explains the implementation process of the project. Section 5.1 describes what tools were used in the course. When necessary, more details are given about how the tools were configured to fit the needed requirements. Section 5.2 discusses the final architecture of the course and shows how these tools are used by the students and instructors.

5.1. Web-based tools and services

5.1.1. Blackboard

The Blackboard system has already been used in the TU Delft for years. It is an online course management systems that helps in organizing online course material and activities. The system provides the students with a constant location that contains all the information related to course work.

Each course given within the TU Delft has a dedicated page that incorporates all information and digital media related to this course. It also allows the course instructors to give 'announcements' which can reach the students in variety of ways. It also facilitates tasks such as enlisting in courses and communication between students and instructors.

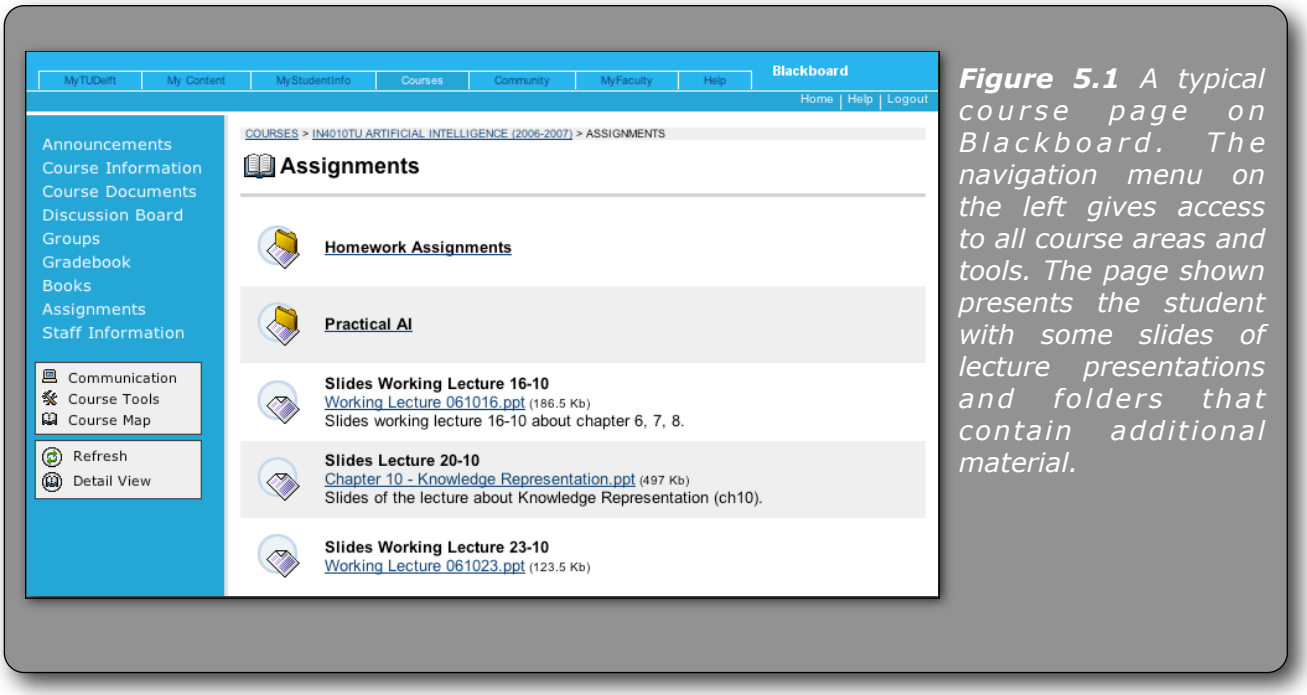


Figure 5.1 *A typical course page on Blackboard. The navigation menu on the left gives access to all course areas and tools. The page shown presents the student with some slides of lecture presentations and folders that contain additional material.*

The system is appreciated by the students because it collects information from all courses in one place. On the other hand, the way the system is used is different in each course. This is a result of Blackboard *massive* number of obscure tools. This makes it practically impossible for course

instructors to be fully aware of how to use these tools, which may result in more harm than good for their courses [5.1].

The Blackboard is well suited for course management as in distributing course documents and information to the students. However, it is not suitable to be used as an instruction tool. It simply is not designed for that purpose. This is also reflected in studies performed to evaluate it [5.2] [5.3].
In a study performed in 2005 by professor Munoz in Humboldt State University, 32 students were asked to participate in an experiment to evaluate the Blackboard system [5.2]. When asked whether Blackboard has 'enhanced course instruction', the majority of the students disagreed as shown in Chart 5.1.

Chart 5.1 *Did Blackboard enhance instruction?*

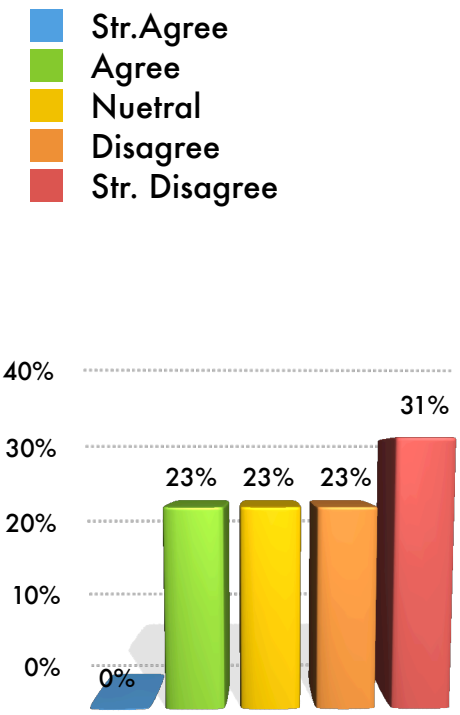
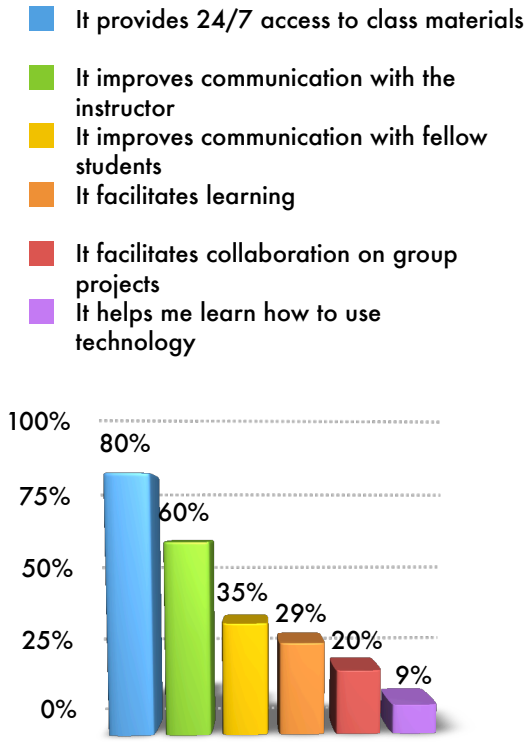


Chart 5.2 *I like Blackboard because*



A larger survey that involved 1821 students from the university of Denver [5.3] was performed in the winter of 2006. The students were asked to choose the reasons why they liked Blackboard. The result is shown in Chart 5.2 where **accessing class material** and **communication with the instructors** scored higher than 50%. Reasons such as **it facilitates learning** and **it facilitates collaboration** scored below 30%. Even thought the Blackboard has tools dedicated for these goals, it is simply not practical to use them.

As a result of what was said above, the Blackboard is used in the IUXE course as a place that gives students access to class information. This includes information about the course setup and downloadable material used in the course. To stay in line with the general approach adopted by the

TU Delft, The course's Blackboard page will be the place where the students can access the course and get announcements and information. From there, the students can access additional services used in the course such as Lecture-Recordings and the Online Wiki Manual.

5.1.2. Online-Manual

Courses that involve lab-projects usually have a project manual that guides the students. This manual is either printed or distributed to through the Blackboard as a PDF file. The IUXE course uses an online website instead of a document. By providing this information online, many possibilities become available at the instructors disposal, such as:

- updating content whenever needed;
- using hypertext links to interconnect relevant parts of the manual;
- using animations and interactive elements in figures;
- the ability to search the manual for specific subjects;
- embedding sound or video files.

A. Online collaboration

To add an extra level of flexibility, the implemented Manual Website is based on a Wiki system. The system used for the building the wiki is provided by the wetpaint[1] corporation. A wiki (sometimes wiki wiki) is a piece of software that allows multiple authors to edit web page content. This means that the it is possible for any visitor to edit the content of the manual, even the students. In the experiment however, the editing function was locked out and only made available for the course instructors. As an alternative, the students were given the chance to submit comments about the content of the manual using the discussion forums (please see Section 5.6).

The content of the online manual was mainly written by the teaching assistants under supervision of the two main instructors. This includes sections such as the project setup, implementation requirements, installing and configuring software, and so on. The writing process for such sections consisted of:

1. all instructors discussing the general layout and key points the section should contain;
2. the teaching assistants completing the content of these sections;
3. the two main instructors reviewing the content and editing it where necessary.

Some sections of the manual contained background information about the Super-Assist project. This project was used as the development theme for the IUXE lab-project. The project is headed by Olivier Henkemans, one of the three PhD. students associated with the course. Olivier was therefore in charge of writing these pages. Writing these sections involved:

1. Olivier writing the main content, providing resources (e.g., documents, figures) form the project;
2. teaching assistents adjusting layout to match manual style;
3. the two main instructors reviewing the content and editing it where necessary.

[1] Wetpaint can be reached at http://www.wetpaint.com/

B. Progressive release

The IUXE course was still under construction when this project was underway. This meant that not all parts of the course were already prepared. This includes the project manual which was delayed as a result of delays in choosing the prototype that will be used for the course lab project.

In addition, the instructors of the course have decided that the prototype used for the lab-project for the course should always belong to a current project being researched (e.g., a new prototype produced by the Super-Assist project). As a result, large portions of the project manual will need to be rewritten every year. Coupled with inevitable delays, it is difficult to have the complete project manual ready before the beginning of the course.

By the time the course started, many segments relating to the second half of the course were missing. However, this did not effect the students since they did not refer to the uncompleted sections of the manual while still in the half of the course. By the time the second half of the course started, all sections of the manual were completed and ready for use.

Having the manual online also allowed the instructors to add extra content, correct mistakes and typo s, and make improvements whenever needed. This also allowed the students to use the comments function (see Section 5.6) incorporated within the online manual, or simply mention to one of the instructors to point out areas in the manual that they did not understand or thought needed extra clarification. Instructors were able to immediately respond to these comments and improve the content of the manual in order to prevent similar problems from being repeated with other students.

Changing the content of the manual has the potential to cause the students some confusion. If students suddenly see significant changes in a part that they are actively using, it may cause misunderstandings. Such changes may even be completely missed. Therefore, instructors should be careful with how they edit the content of the manual:

- all sections of the manual must be complete *before* the time that they are used by the students;
- changes to sections in active use should only serve to clarify ambiguities and correct mistakes;
- students should be made aware of changes in the manual.

One new technology that plays an important role in keeping students up to date with updates and changes to the manual is **RSS** (Really Simple Syndication) feeds. An RSS feed is a term that refers to a family of web feed formats used to publish frequently updated content such as blog entries, news headlines or pod-casts (see section 5.3 for more on pod-casts). All recent releases of the major internet browsers (e.g., Firefox, Opera, Safari, Internet Explorer) can be used to subscribe to internet feeds, while dedicated (so called) **RSS**

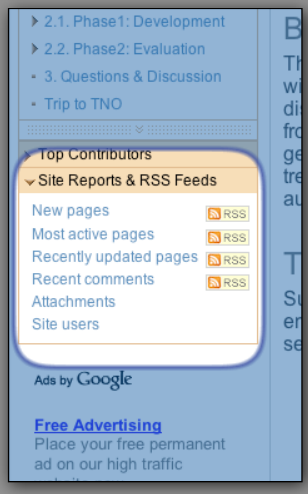


Figure 5.2 *The Online-Manual has a number of RSS feeds. These RSS feeds send automated updates to the students keeping them informed of any new developments to the content of the online manual.*

reader programs offer specific extra functionalities. The feeds provided by the online-manual (shown in Figure 5.2) inform the students about, among other things, recent updates to the content of the online manual. When the content is updated, the students are immediately (and automatically) notified with a new entry in the RSS feed. The entry contains:

- the location of the update;
- the changes made to the content;
- a link to the manual page where the update was performed.

Other RSS feeds provided by the online manual inform the students if any new pages are added to the manual. This is useful when new content is added that explain a specific portion of the course lab project in more detail. Such additional content included pages that explain the theory (from the course content) behind each step of the project, and pages with extra help and references on what to write in the project reports. Of course, students can choose which feeds to subscribe to depending on which information they feel is more relevant to them and their course work.

Clearly, none of the above mentioned functionality would have been possible to implement using the traditional approach of the PDF manual. Such an approach would have required multiple releases of the manual each containing some revisions and improvements. Insuring that all students have the latest edition of the project-manual becomes an additional challenge for the instructors, particularly if the latest update in the manual contained critical information for the students.

5.1.3. Voiced instructions

As an additional dimension in the way instruction are given to the students, some of the course instructions were provided in the form of audio recordings. This approach was adopted in part as a result of the relatively complex course setup explained in Chapter 2. The voiced instructions aimed to achieve a number of goals:

1. keep students on top of course activities;
2. provide an alternative to text-based instructions;
3. provide audible information which is difficult (or impossible) to convey in text.

Written text has been the de-facto medium for instructors to communicating with students. However, since practically all university courses depend on a sort of a personal instruction either in lectures or supervised workshops, it is obvious that a printed textbook is not sufficient. In fact, the only reason that printed text has been so wide spread in teaching is that it was the only medium available for educators. Today, switching to other multimedia channels may still be more difficult than using plain text. However, with the help of the internet as a distribution medium, and with the use of powerful new software and readily available computing power, producing rich multimedia material now requires a fraction of the effort it would have needed just a decade ago.

The IUXE takes advantage of these multimedia possibilities by giving instructions through a wide variety of channels. using the analyses in Chapter 3, it has been decided to give three types of information using the medium of audio recordings. These channels are:

- **Weekly course news and activity updates:**
  Every week, a sound recording of about five minutes was released that took the form of a weekly 'news bulletin'. These bulletins started with information about the course, such as lecture locations, homework deadlines, and so on. This was followed by a list of activities that listed and explained shortly all the activities that the students were expected to complete.

- **Providing alternative instructions:**
  Activities which were explained in text were some times explained again in audio (or video as discussed in Section 5.4). It is thought that students find the sound recordings to be a more natural and accessible method to get instructions.

- **Providing additional information:**
  Some activities had extra instructions and advice provided as extra sound recordings. For example, when the students were required to write a report, a short list of requirements was given that contained the different sections the report should include. Additionally, students were provided with sound recordings that talked about what each section is supposed to discuss and gave references to topics and examples in from the course's text book that can be used to help with writing that section of the report. It would have been impractical to provide such information with text alone.

Delivering these audible recordings to the students required the use of many different software and internet technologies. The next three sections will discuss what tools where used and the role each of these tools played in the process. Keep in mind that this is not meant to be a step by step manual of how to use these tools. However, with the help of these sections, and with some effort from the reader, it is possible to recreate the type of materials used in the IUXE course.

A. Creating the recordings

Since all publishing takes place on the internet, making the recordings on a computer is easier, cheaper, quicker and simply much more convenient than using specialized recording equipment. The program chosen to perform the recording and editing steps is called Audacity[1] (shown in Figure 5.3). Using Audacity has a number of advantages:

- it is open-source and available for free on the internet;
- it provides advanced sound editing and processing functionalities;
- it has a considerable popularity with a large support base on the internet.
- it is platform independent with simultaneous releases on Mac, Linux, and Windows.

The main disadvantage of using Audacity is the relatively steep learning curve. If course instructors with no technical knowhow are expected to create such content a more user friendly alternative is needed. A good candidate is a program called Propaganda[2] which costs $49.95 and works only on Windows.

[1] Audacity can be downloaded at http://audacity.sourceforge.net/

[2] Propaganda can be found at http://www.makepropaganda.com/download.html

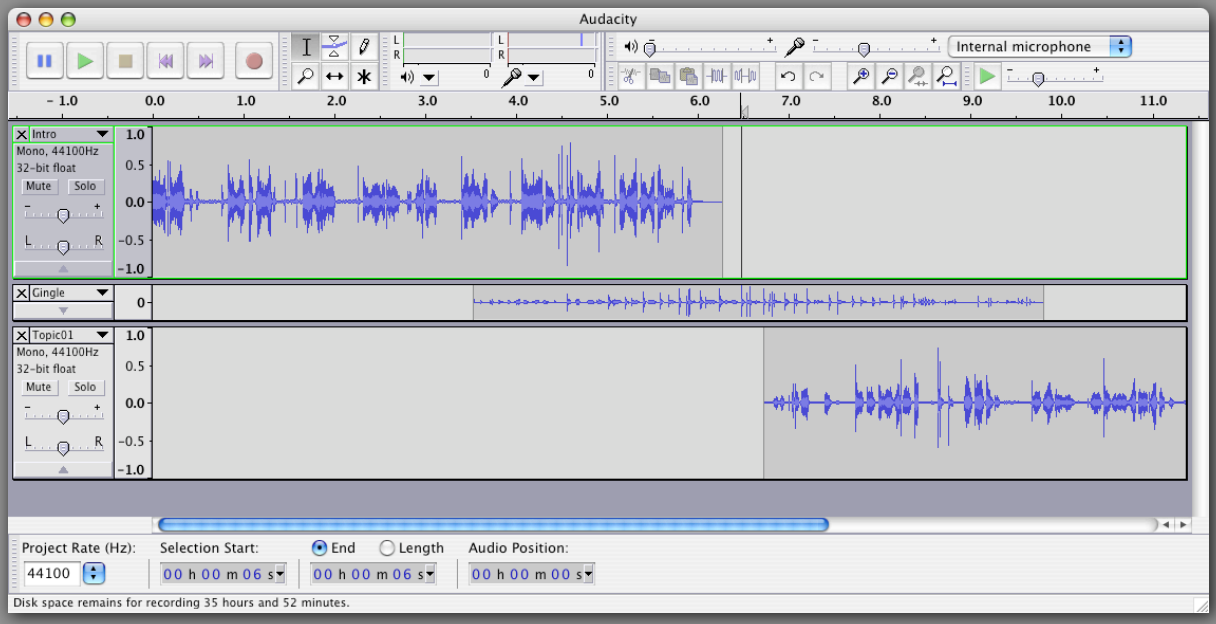


Figure 5.3 *A screen shot of the* ***Audacity*** *digital audio editor application. This free open source program has more than enough functionality for producing educational audio material (e.g., multiple tracks, importing external files, exporting in variety of formats).*

It is also important to use a good quality microphone with some noise canceling technology. Microphones designed for speech recognition will provide a good quality sound without being prohibitively expensive.

When preparing online media, one should follow a number of guidelines:

- **Provide separate short segments**

  Provide separate concise segments of information in each recording. This helps to keep the listeners engaged. Additionally, this makes it easier search for a specific piece of information in the future.

- **Keep it error free**

  The recording should be free of speech poses (e.g., umm, uhh). This helps in keeping the recording short and keeping the listener interested. Unless the speaker has a natural talent for this task, this can be achieved by scripting the recording session or by post-editing. Preparing a script of the text in the recording poses a risk of making the recording sound monotonous and uninteresting, while post-editing is a difficult and time consuming process.

- **Ensure proper pronunciation**

  Since the majority of the students following the course are not native English speakers, they may have difficulties understanding non native English speakers. This is a particularly important consideration for Chinese students [5.4]. If the recordings can be reused every time the course is re-given, then it may be worthwhile to get a native speaker to create the recordings. Otherwise, foreign instructors my find some pronunciation lessons helpful.

Once both the recording and editing procedures are complete, it is time to export the content from the raw format in the editing software into a sound file. Choosing the parameters for the exported file depend on how it is going to be published:

- If the file is going to be distributed to the students without alteration (as explained in Section 5.3.2) then the files size needs to be as small as possible (to facilitate easy online trafficking) while keeping the sound quality within an acceptable range.
- If the file is going to undergo further conversions (as it does in Section 5.3.3), then sound-quality needs to be as high as possible while keeping the file size within a reasonable range.

Since both the above approaches were used in the course, the used export parameters had to be a compromise of both above mentioned recipes. The exact export settings were:

Format: MP3 (MPEG1-Layer3)
Bit rate: 128[Kb/s]
Sample rate: 44[KHz]
Channels: Mono

The chosen format for all produced sound recordings was a high quality .MP3 [wiki-mp3] file. Choosing .MP3 means that a small fraction of the sound quality is permanently lost. It does, however, provide significant compression and enough quality for most intents and purposes.

B. Publishing using a podcast

A podcast is a digital media file, or a series of such files, that is distributed over the Internet using a syndication feed (such as an RSS feed mentioned in section 5.2.2) for playback on portable media players and personal computers. The term **podcast** is a portmanteau of the name of Apple's portable music player, the iPod, and broadcast.

By creating a podcast feed, the **podcaster** (the host or author of a podcast) can automatically send published sound (or video) files to subscribers. An instructor can create multiple podcast feeds to provide different types of material to the student. The student subscribes to the feeds using a so-called podcast aggregator such as iTunes[1] and automatically receives any new sound recordings published by the course instructors. In general, using podcasts have the following advantages:

- students acquire a local database of all published sound material on their local machine;
- easy to use on the long term since once subscribed, the process is fully automated;
- students can use the program of their choice to listen to the recordings;
- recordings can be copied on a portable music player so students can listen to them on the move;
- instructors are fully free to adjust file setting whenever they need to.

On the negative side, podcasting is still a relevantly new phenomena, meaning that many of the students are not already familiar with it. Additionally, the process of subscribing for a podcast feed poses a learning curve which may put some students of completing the process, particularly if it was optional (as is the case with the IUXE course). This section next explains the two stages of creating a

[1] iTunes can be downloaded at http://www.apple.com/itunes/

podcast feed, and subscribing to that feed using a podcast aggregator (also known as a pod-catcher).

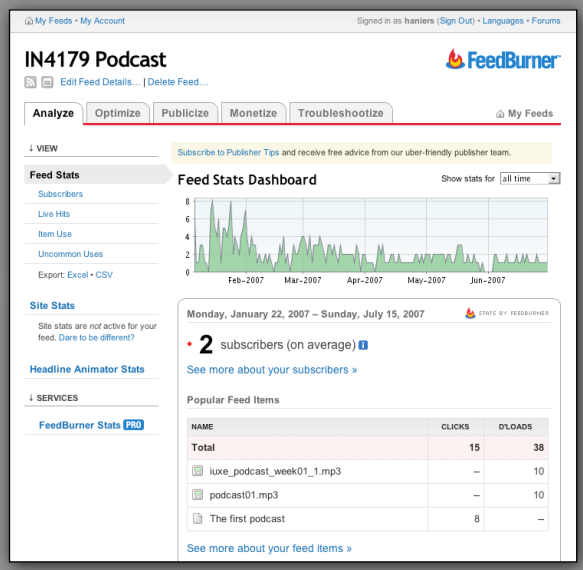
1. Publishing a podcast feed

There are many different ways to create a podcast feed. Currently, there are companies such as Podshow[1] which can help the podcaster to complete all the steps needed to create a proper podcast feed. For the IUXE course, however, instructors took a more traditional approach[2] which manly involves:

1. **Upload the .MP3 files to a server**

   Once the sound recordings are exported to .MP3 files, these files have to uploaded to an online server. The **server** is simply a computer system that can host files and keep them available for download using internet based protocols. the MMI department has a dedicated server named Yukon[3] which is exclusively used for hosting educational multimedia files online.

A) the IUXE page on Blogger



B) the IUXE page on Feedburner

Figure 5.4 *Screenshots of the course's Blogger (public) and FeedBurner (login required) pages. Each entry in Blogger refers to a podcast, with the text giving a description of the content. The FeedBurner page shows statistics about feed subscribers and allow the podcaster to change some feed settings.*

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[1] Podshow can be reached at http://www.podshow.com/

[2] to get detailed step by step tutorials on how to create a podcast feed, simply search in google for "tutorial podcast blogger feedburner" to get a list of tutorials explaining the procedure. The website www.how-to-podcast-tutorial.com provides easy to use video tutorials of this process.

[3] Yukon can be reached at http://yukon.twi.tudelft.nl

2. **Create the podcast feed**

   To create the podcast feed that links to the .MP# files on the server, a Blogger[1] account is created first. **Blogger** is a free online service that allows users to publish their own personal **blog** (or web-log), and create a syndication feed in the Atom[2] format. By providing a link in the blog entries to the .MP3 files uploaded to the Yukon server, a link to these files will be added to the created.

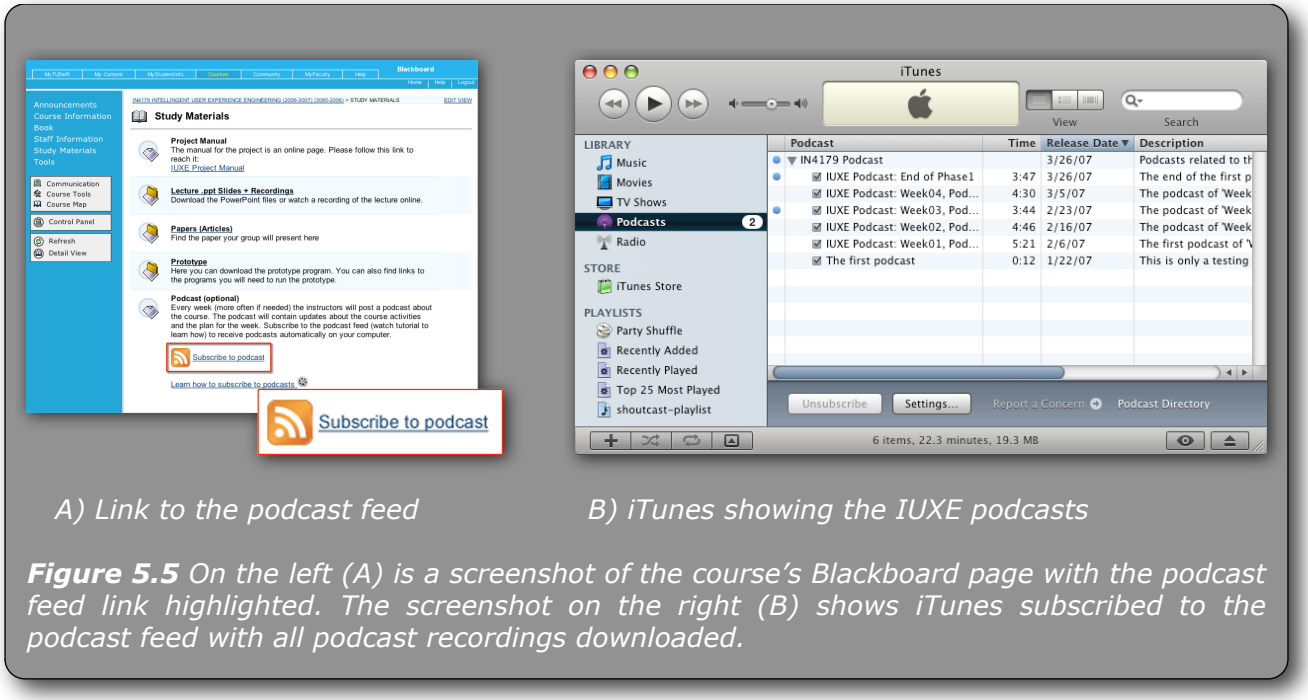
   Since the standard for podcast aggregator systems is the RSS 2.0 format, the Atom feed needs to be converted to this format in order to be used as a podcast feed. A simple way to do that is by using FeedBurner[3], which is a free service. Feed burner also provides basic statistics of the number of subscribers to the podcast feed as shown in Figure 5.4. By providing a link to the RSS feed on the IUXE website, students are capable of using this link to subscribe to the podcast feed.

2. Subscribing to a podcast feed

To subscribe to the podcast feed, a student needs to have an internet connection and a podcast aggregator program. Since the process requires installing new software, some students may feel put off going through with the subscription process. In order to subscribe, the students should do the following:

1. Get a podcast feed aggregator

   Students need a program that can understand podcast feeds and use them to download the podcast files. Depending on which program the students use, they can automate some functionality such as the process of downloading new podcast files, deleting old files, and copying



A) Link to the podcast feed *B) iTunes showing the IUXE podcasts*

***Figure 5.5** On the left (A) is a screenshot of the course's Blackboard page with the podcast feed link highlighted. The screenshot on the right (B) shows iTunes subscribed to the podcast feed with all podcast recordings downloaded.*

[1] Blogger can be reached at https://www.blogger.com

[2] The Atom Syndication Format is an XML based language used for web feeds. The development of Atom was motivated by the existence of many incompatible versions of the RSS syndication format, each with its own shortcomings.

[3] FeedBurner can be reached at http://www.feedburner.com

the files to a portable media player. Students of the IUXE course were advised to either use **iTunes**[1], or **Juice**[2] with complete instructions on how to install and use each of these programs to subscribe to the IUXE podcast feed.

2. The student should then use the the program (iTunes, Juice, or any other podcast aggregator) to subscribe to the IUXE podcast feed. A link to the feed is provided in the course's Blackboard page. There, the students can also watch a video-tutorial (see Section 5.4 for more on video-tutorials) that explain how the students can subscribe to the feed. Figure 5.5.A shoes the Blackboard page with the link to the podcast feed and (below it) the link to the video-tutorial. On the right in Figure 5.5.B, a screenshot of itunes is shown with the IUXE podcast channel open.

C. Embedding recordings in web-pages

An alternative way to deliver sound recordings to the students is by embedding them on internet pages. There are many available on-line companies that provide so-called **widgets**, which are basically small Flash based programs that work within an internet browser. One such company called iJigg[3] provides widgets that act as a sound players. Additionally, iJigg provides a free and easy to use hosting service which eliminates the need for an online server as with podcasting. In order to publish a sound recording using iJigg, one should:

1. Create a free account at the iJigg website or any equivalent online service.

2. Log-in to the iJigg account and upload the .MP3 sound recording file you created. iJigg will save the file at its server ready for any listener to download.

3. iJigg provides (for each uploaded .MP3 file) a line of html code that allows you to embed the recording in a web-page. You will need to copy this code on any web-page where you want the recording be available, where it is possible to post on file on multiple pages or multiple files on one page. Once the page is loaded in the web browser, the recording will appear in the form of a small player widget[4] as shown in Figure 5.6.

Using embedded sound recordings have two very important advantages over podcasting. These advantages are:

- Easy to use:
  Once the widget is embedded on the web-page, all the user has to do is to press the big play button.

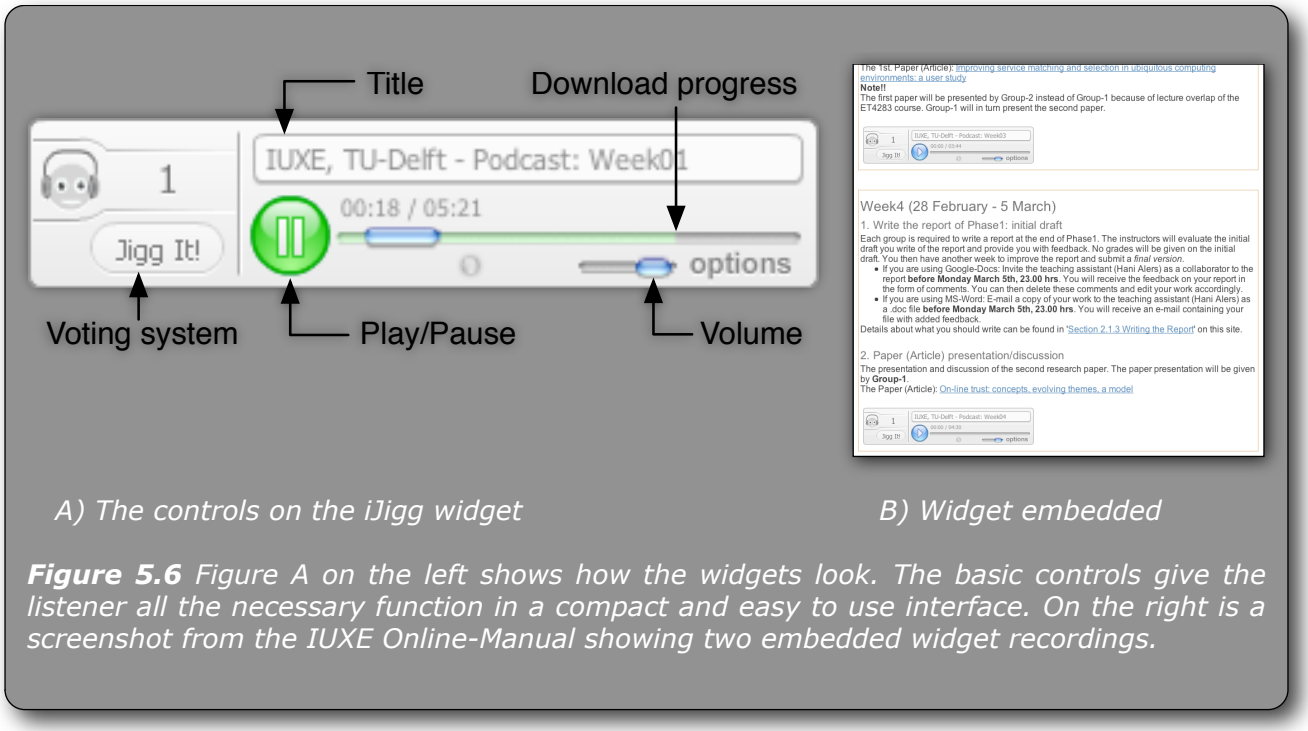
---

[1] iTunes is a popular .MP3 player which can also be used as podcast aggregator. It can be downloaded at http://www.apple.com/itunes

[2] Juice is a small open-source podcast feed aggregator with versions for Windows, Mac, and Linux, making it platform independent. It can be downloaded at http://juicereceiver.sourceforge.net

[3] iJigg can be reached at http://www.ijigg.com/

[4] The player widget used by iJigg is programmed in Flash. In order for the player to run, the must have a web-browser with the Flash player plugin (version 7 or later) installed.



A) The controls on the iJigg widget *B) Widget embedded*

Figure 5.6 *Figure A on the left shows how the widgets look. The basic controls give the listener all the necessary function in a compact and easy to use interface. On the right is a screenshot from the IUXE Online-Manual showing two embedded widget recordings.*

- Linked to relevant content:
  Since the recordings are embedded within web-pages, they can be directly linked to relevant content. Figure 5.6, for example, shows the agenda page from the course's Online-Manual, where each entry has a voice recording that explain all the activities in that entry.

On the other hand, used embedded recordings means that one will loose all the advantages of using podcasts (mentioned in Section 5.3.2). Additionally, since he sound recording will only start loading once the play button is pressed (in order not to conserve bandwidth), the user should have an adequately fast connection[1] in order for the process to work seamlessly.

5.1.4. Video tutorials

The IUXE course involved using a number of different applications (e.g., Netbeans, MySQL, Morae), sometimes requiring adjusting specific settings. Explaining such procedures in text often results in big cryptic blocks of text which are hard to use.

As an alternative, students were provided with video-tutorials that take them through these processes. As shown in Figure 5.7, the tutorial shows a screen-capture of someone (usually one of the teaching assistants) performing the same tasks that the student is expected to. The tutorials also give commentary explaining the actions taking place on the screen.

[1] The voice recordings published in the IUXE course have a bit-rate 128 [Kb/s]. This means that the minimum download speed one would need to use these recordings is again 128 [Kb/s]. Voice recordings can be encoded using much lower bit-rates and still be understandable. However, the deterioration in the sound quality may put-off some listeners from using them.

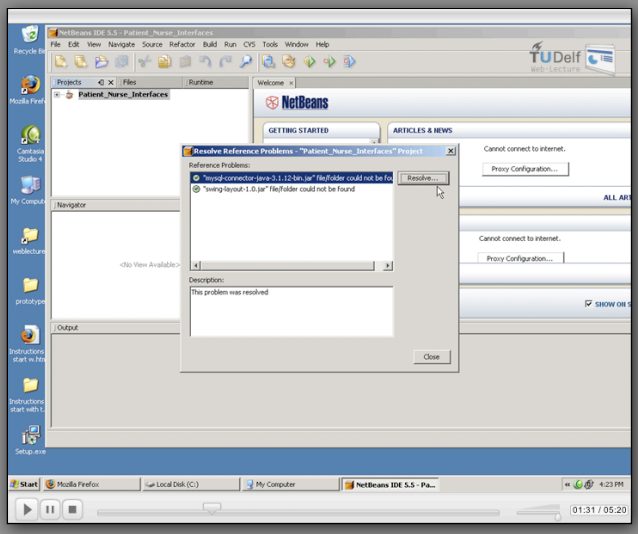


Figure 5.7 *A screenshot of one of the video tutorials provided for the IUXE curse. The video is played within the web browser in Camtasia's embedded player.*

The player has the basic functionality such as volume control and play/pause buttons. A progress bar also allows the user to quickly skip to any position in the video.

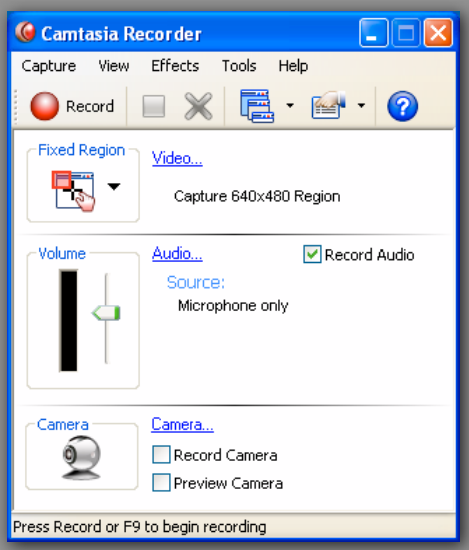
The video tutorials are created using the Camtasia[1] program. This program is in fact a collections of many separate tools and plugins, which makes it very flexible to use by course instructors. As a result, it was also used for creating the lecture recordings (see Section 5.5) and the web-lectures.
Instructors of the IUXE course used the following tools:

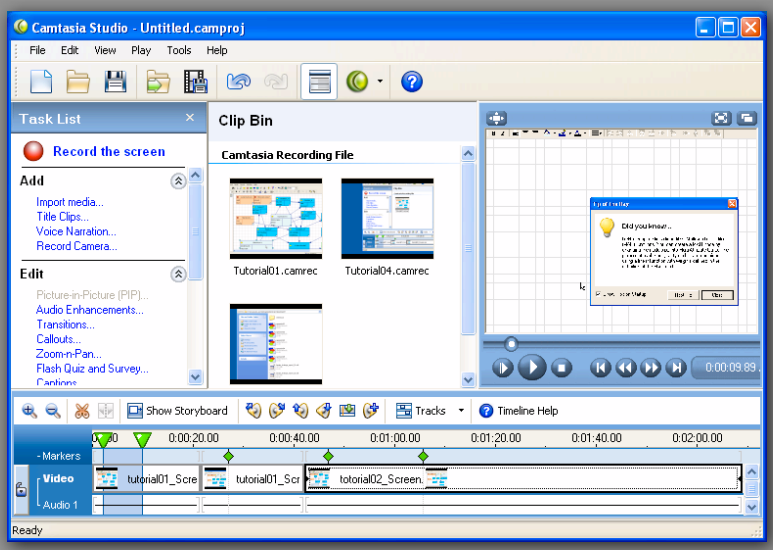
1. **Screen Recorder:**
   The recorder has very simple user interface, as shown in Figure 5.8.A. It can capture a user defined area on the screen, or the entire screen as the user sees it. Sound can include either or both computer generated sound and used annotation. An interesting function is the ability to record a video of the commentator using a webcam. As a result, A complete recording with video and commentary of the instructor can be saved in one take, saving the instructor from a lengthy recording session.

2. **Camtasia Studio:**
   This is the main component of the Camtasia package. It is mainly a video editing program, but its power lies in its great flexibility. It can import any video file whether created by its own Camtasia Recorder, or any other source[2]. It has an easy to use interface (shown in Figure 5.8.B) with a law learning threshold for new users. Yet, it provides the user with plenty of powerful editing tools such as picture in picture videos, audio noise cancellation, adding subtitles, and embedding watermarks to name a few.
   Once the user is done editing the video, the times come to publish this video. Here is where the

[1] The instructors used Camtasia Studio 4 which was purchased online from TechSmith. The package included 4 licenses for USD 149. Camtasia Studio is available at http://www.techsmith.com/camtasia.asp

[2] Videos can have any one of many file formats, and video **codecs** (Compression/Decompression algorithm). In order to play these videos on a PC, you need to have installed the appropriate software. Camtasia studio will only be able to import video files once the needed playback software has been installed. In other words, if you can play the video file on your PC, then you can also edit it within Camtasia Studio.





A) *Camtasia Recorder* ***B)*** *Camtasia Studio*

Figure 5.8 *To the left (A) is a screenshot of the Camtasia recorder. The Program allows you to capture a specific area or the complete desktop. Sound options include capturing sounds produced by the PC and commentary spoken through an external microphone. There is also an option to record a video of the commentator through a webcam.*

On the right is the Camtasia Studio where all recorded videos can be imported and edited. The program can also use videos recorded by other programs. Once editing is finished, the program can export the completed video in a wide variety of formats.

main strength of Camtasia lies. It gives the user the choice between 8 completely different video formats each suitable for different types of applications. It also gives the user the ability to customize the exported video settings for each format in order to optimize performance.

The format used for all videos within the IUXE course was FLV (Flash Video), which insured that the videos can run on any platform (Linux, Mac, or Windows) and using any internet browser that can display Flash animations. Since all students are expected to use the internet to access Blackboard and other online course material, students can watch the videos without the need to install any additional programs.

By embedding video recordings in web-pages, instructors can get benefits similar to those of embedded sound recordings (mentioned in Section 5.3.3). They can be placed exactly next to relevant material on the course's Online-Manual. In order to avoid cluttering the course web-pages, the videos themselves were given their own pages that open once any of the links are clicked (the video player is shown in Figure 5.7). To help

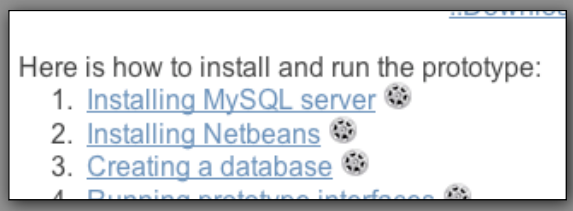


Figure 5.9 *Links to video tutorials are given an additional 'movie' icon to distinguish them from normal page links.*

students find the video tutorials quickly on every page, a small movie shaped icon is placed next to each link leading to a video-tutorial, as shown in Figure 5.9. The aim was that the students will start watching the tutorials soon after reaching the page to quickly understand what type of activity they are join to perform. Afterwards, they can read the page in further detail and (if needed) refer to specific parts of the video-tutorial.

5.1.5. Lecture recordings

All class lectures were recorded and published on the internet. The lectures were recorded using the PowerPoint plugin from the Camtasia software package (mentioned earlier in Section 5.4). The recordings contained a video recording of the image signal sent to the projector during the presentation. In other words, any animations or videos from the presentations were also available in the lecture recordings. Additionally, movements of the mouse cursor performed by the presenter were also recorded. Since no video of the presenter is available, these mouse cursor movements were used (instead of a laser pointer for example) to point out areas in the slides.

The recordings were exported, without editing, using Camtasia studio. Students were able to access these recordings through the course's page on BlackBoard. When a link to a lecture recording is selected, the recording would play within the internet browser in a similar manner to the video tutorials.

A screenshot of a lecture recording is shown in Figure 5.10. The PowerPoint plugin used to record the lectures also records the time for each slide transition. These are then used to create a navigation table with slide titles as shown on the left of the screenshot in Figure 5.10.

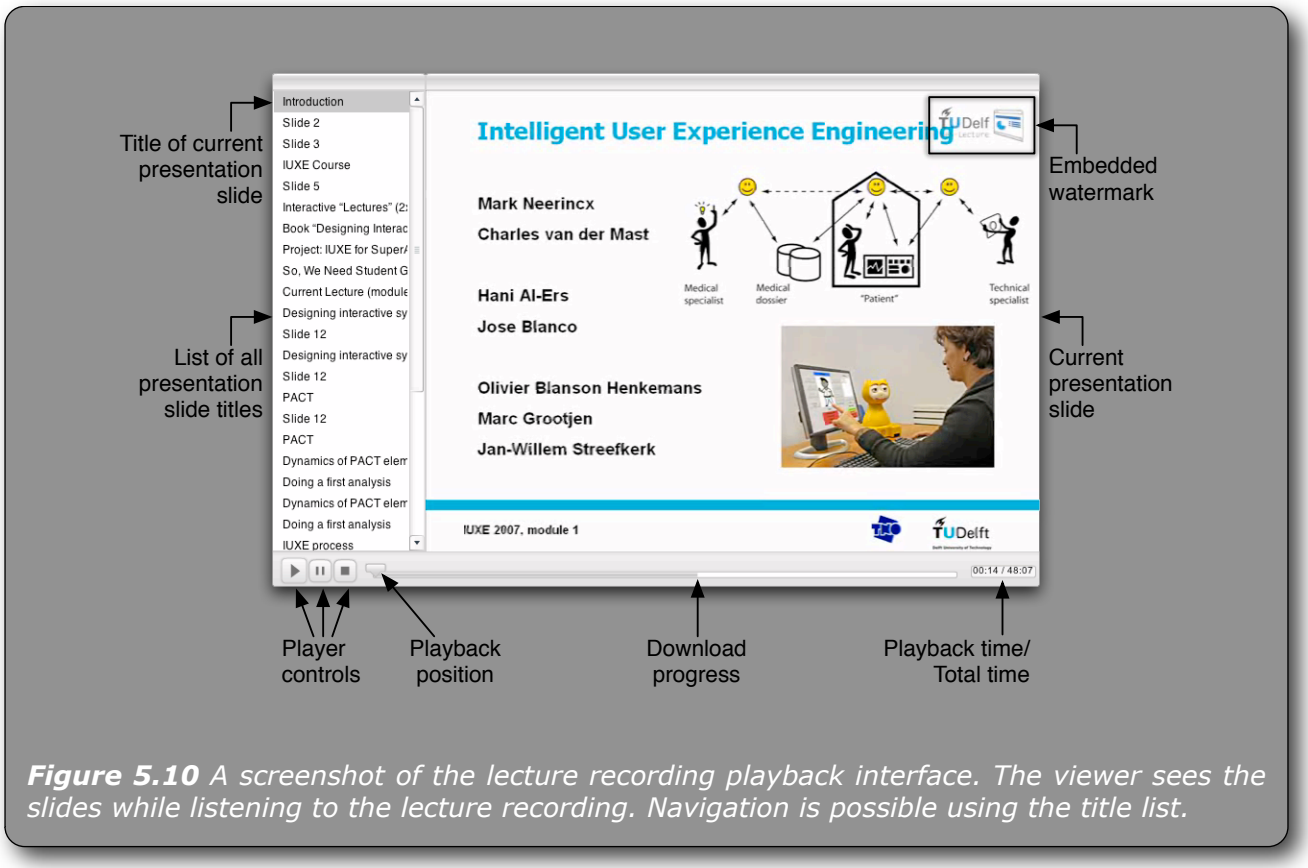


Figure 5.10 *A screenshot of the lecture recording playback interface. The viewer sees the slides while listening to the lecture recording. Navigation is possible using the title list.*

The goal of providing the students with these recordings were so that they can use them as references while reviewing corse material. Students were provided with the PowerPoint files of the slides used in the lecture presentation. Students were expected to use these slides (together with the course's textbook) as the main learning material for the course. However, when students see something in a slide which they cannot understand, they can refer to the lecture recording, and use the navigation menu of slide titles to immediately listen to what the instructor said about the slide. This way, the students can get access to the specific information they needed quickly and easily.

Another potential use for the lecture recordings is as an alternative to attending the lectures. A common problem among students in the TU Delft is overlap in lectures. A lecture overlap between two courses makes it impossible for the students to attend both lectures. The result is often that the students choose to follow only one of the courses.
Providing the the student with lecture recordings is not a perfect alternative. The student are not able to see the presenter which means that information conveyed with gesture, expressions, and body language are all lost in the recordings. Additionally the student cannot be involved in the in-class discussion. However, when attendance is not possible, it is still an adequate alternative to no lectures at all.

5.1.6. Message boards

Students were provided with an extra channel of communication with each other and with the instructors through the online message boards. The used discussion forums were integrated within the Online-Manual. Each page on the manual contained a message board on the bottom where anyone can post comments and questions.
Students were encouraged to use these message boards to leave comments about the manual pages to point out things that they did not understand in the manual. Additionally, the manual had a page dedicated for additional questions and discussion where students can ask about anything

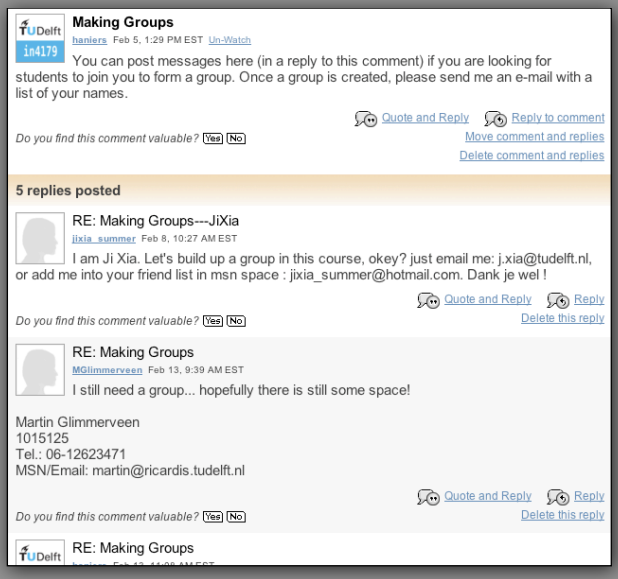


Figure 5.11 *A screenshot of a message board thread using the message board system embedded in the course's Online-Manual.*

Students can use the message boards to communicate with the course instructors and other students to ask questions and discuss ideas.

Students used the message boards at the beginning of the course to construct their groups.

related to the course. An example of the message thread is shown in Figure 5.11, where the students used the message-board to create their groups.

Using message boards for communication between the instructors and the students has plenty of advantages:

1. **Greater reach:**
   Since the IUXE course has a total of 7 instructors, each with knowledge about specific aspects of the course, it is sometimes difficult for the students which instructor to ask about what. Posting a question on the message board, on the other hand, always insures that the question will reach the proper instructor. Other instructors can simply ignore these questions. This saves time for both students and instructors.

2. **Fast response:**
   The message boards were also linked to an RSS feed[1] which gets a new entry as soon as a message is added. By subscribing to these RSS feeds, the instructors can be notified automatically when a message is added. This way, the respond time for questions on message board can be just as short as an e-mail

3. **Public discussion:**
   The message boards are publicly available for all the students to read. This means that information discussed in the message board can also benefit other students.

4. **Linked to content:**
   By having a message board at the bottom of each page in the manual, the students can use it to ask questions and discuss information directly related to the page content.

5. **Accessible:**
   The students only need an internet connection to ask a question.

5.1.7. Online collaborative reporting

By taking advantage of the advancements in internet technology, the Google Corporation has created an online document editing application called Google Docs & Spreadsheats[2]. This system was used as the platform for students to submit reports and homework assignments for the IUXE course.

Using such an online system was aimed at streamlining the process or submitting documents and gathering feedback. It was also meant to facilitate collaboration among the students within groups and between the students and the instructors.

In order to use this service, each student (and instructor) needs to create a Google-ID account at the Google Docs & Spreadsheats website. The instructors provided the students with a Google-ID that they should use to invite the instructors as collaborators to their work.

---

[1] RSS feeds were discussed earlier in Section 5.2.2.

[2] Google Docs & Spreadsheats can be accessed at http://docs.google.com

By using such an online reporting system, it is possible to gain the following advantages:

1. Collaborative work:
   Students in groups are able to edit the same document online. The system even allows for simultaneous collaboration, allowing more that one person to work on the same document at the same time.

2. Rapid feedback:
   Since the instructors can also be collaborators on the documents, they can contribute to the work. By reviewing the progress of the students and providing meaningful feedback in the form of comments, it is possible to provide the students with an iterative and dynamic learning experience.

3. Track changes:
   The system keeps track of all changes applied to the document. This allows the instructors to see a complete history of the document's evolution. The instructors can also find out the level of contribution of each student to the written document.

4. Easy document sharing:
   Since the documents are available online, it is relative easy to distribute and share them. Anyone with a Google-ID can be invited as a viewer or collaborator to the document. It can be published on the internet, or sent by e-mail as an attachment all from within the application interface.

5. Database of earlier work
   The system works as a database of all created work with complete record of all changes, comments, discussions, and feedback performed on the document. This makes it ideal for future referencing.

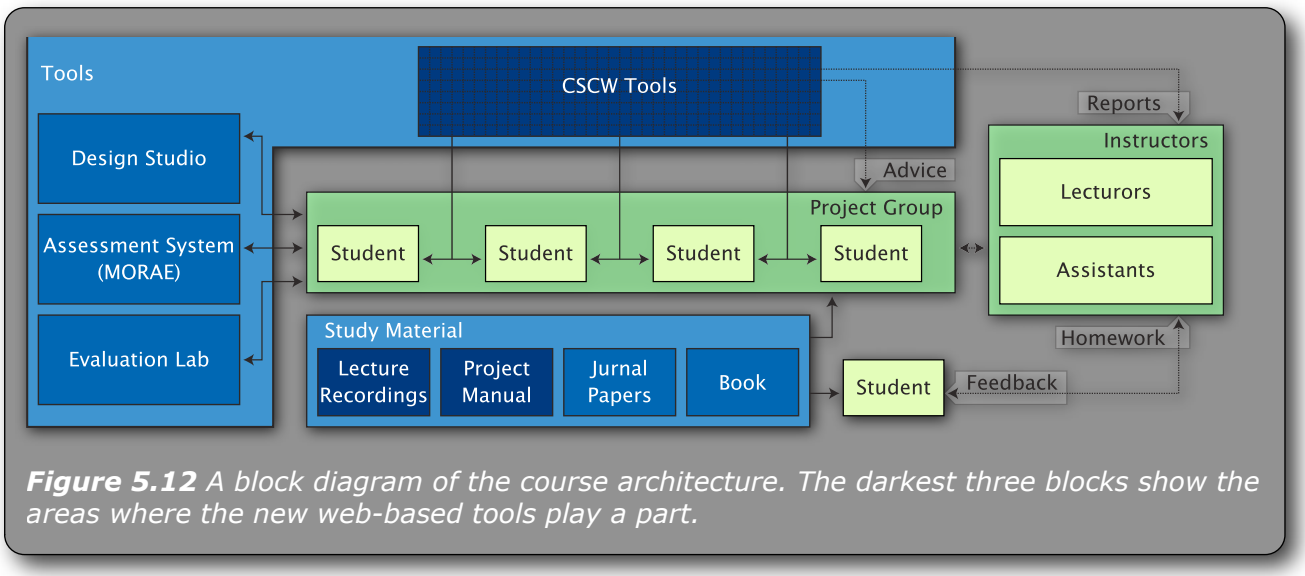


Figure 5.12 *A block diagram of the course architecture. The darkest three blocks show the areas where the new web-based tools play a part.*

5.2. The completed course

After choosing all the tools mentioned in the previous section, they were all brought together using the course architecture shown in Figure 5.12. As shown in the figure, the course deals with the students on too levels. As individuals, students follow the course, study the material, and complete homework assignments. For the project, the students work in a group of 4-5 students to develop and evaluate a program prototype. The students use many tools and material while following the course. The areas where the new web-based tools are implemented are represented with three dark blocks in the figure. The project manual is one of the tools discussed in the previous section, and it contains many of the other tools as discussed below. The lecture recordings form another source of course material, and the Computer Supported Cooperative Work (**CSCW**) block contains the collaborative reporting and the discussions forums.

5.2.1. The online manual

As mentioned before, the online-manual formed the central online platform for many of the other web-based tools (see Figure 5.13). **The manual contains 15 sections** and subsections. Its construction required a total of 436 entries and revisions. Chart 5.3, shows how these contributions are distributed among the different groups of instructors. The mixed portion refers to the main administrative account on the wiki system, which was occasionally used by the teaching assistants and the head instructors. The chart reflects that the accessible nature of the online manual allowed for effective collaboration of all members of the teaching team, with the main part of the workload being taken by the teaching assistants. The head instructors were able to monitor the progress of the manual construction online, only contributing when needed.

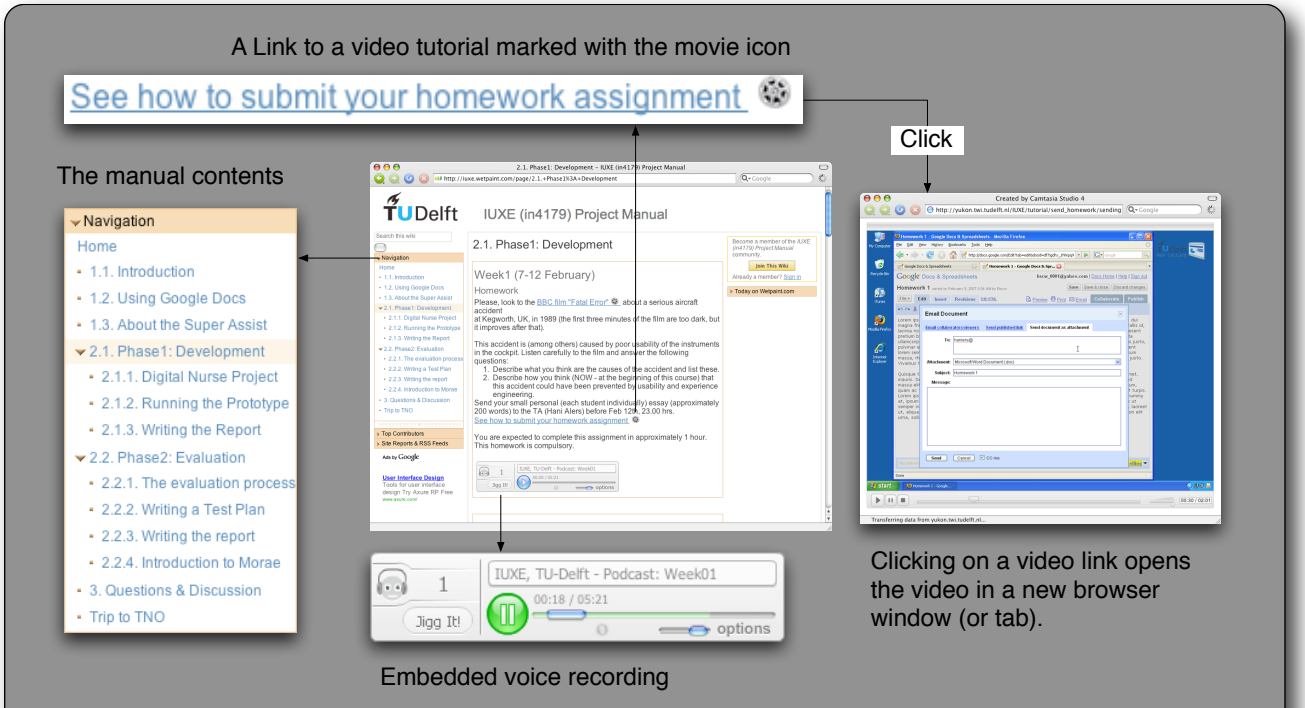


Figure 5.13 *A screenshot of the completed Online-Manual. The manual acts as a central platform for many of the online tools used in the course.*

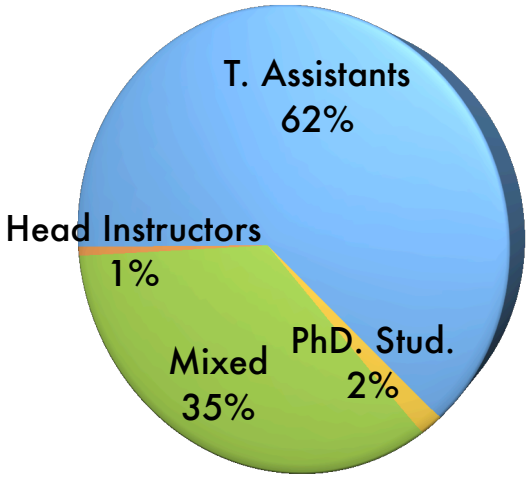


Chart 5.3 *The percentages of how many times each group of instructors edited or added content to the online manual.*

This pie-chart shows that the majority of the actual editing and formatting of the online manual was left to the teaching assistants. The Head supervisors were able to ensure the quality by closely supervising the progress online and making changes to the content where needed.

The manual now contains **11 video tutorials** illustrating how to use the manual, use Google Docs & Spreadsheets, install and run the prototype, subscribing to podcast feeds, and using the Morae suite. Each tutorial is 3-5 minutes long. The manual also hosts **4 web-lectures** which give the students information about the used prototype, and evaluating user experience. The length of these web-lectures is between 10-15 minutes. The embedded voice recordings were also presented to the

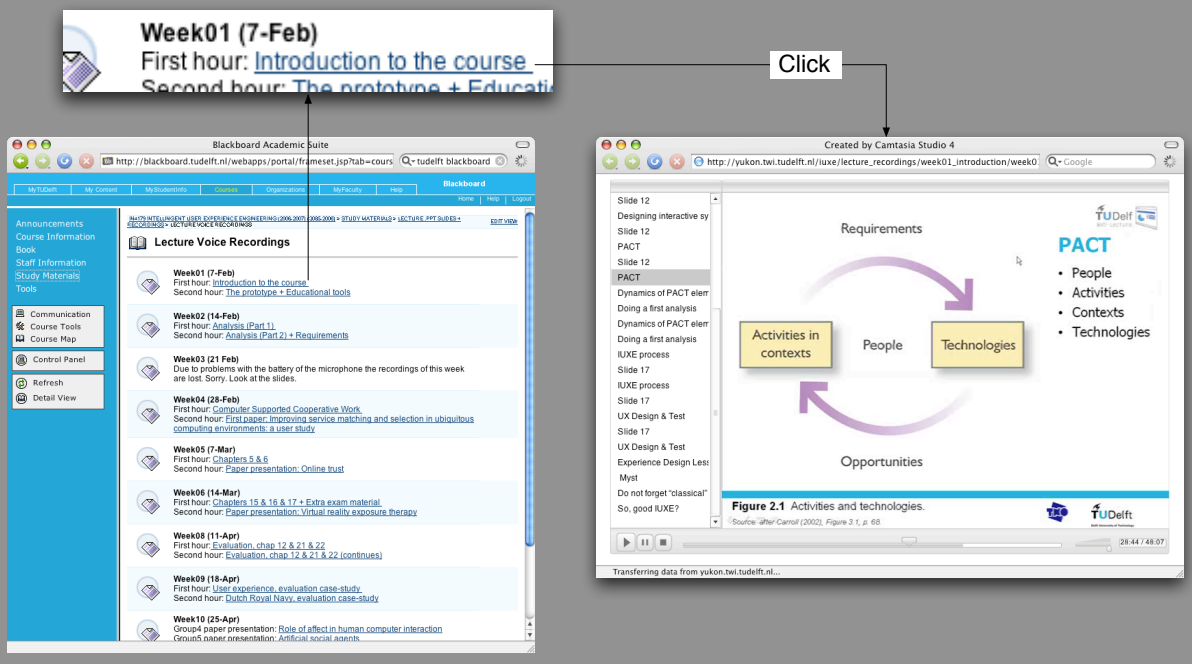


Figure 5.14 *A screenshot of the lecture-recording repository on the blackboard. When a link is clicked, the recording is played in a new browser window.*

students using the manual. It contained **13 voice recordings** ranging between 2-4 minutes in length. The voice recordings mainly contained instructions about course activities.

5.2.2. The lecture recordings

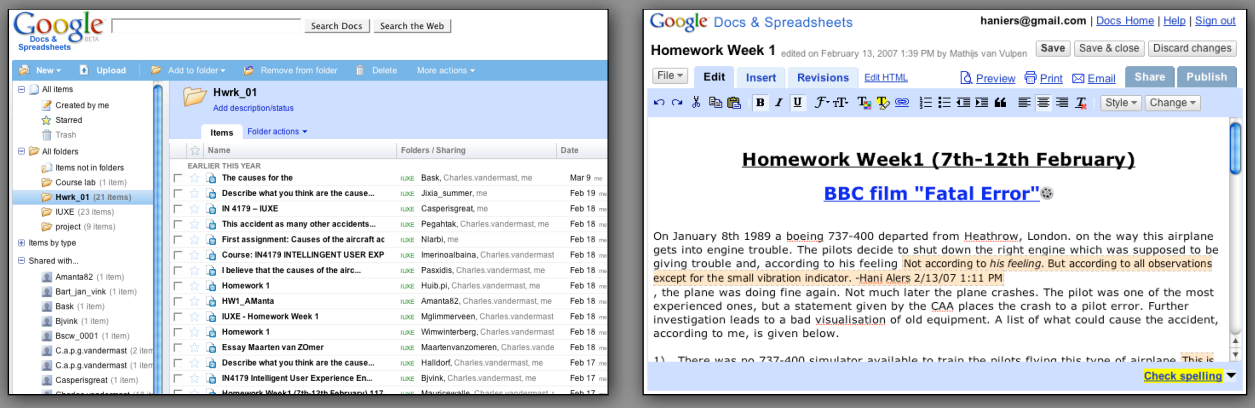
As mentioned earlier, the students were provided with recordings of the actual lectures. Which posted on the course's Blackboard page (see Figure 5.14). All but one of the lectures were successfully recorded and posted online. The only exception is the third lecture which was not recorded properly due to hardware failure[1]. Also, lectures that contained student presentations and discussions were not recorded.

By the end of the course, the lecture recording repository contained **19 lecture recordings**. The recordings for each lecture is split in at least two parts for each lecture hour. If separate topics were discussed in each lecture , then the recordings are separated accordingly.

5.2.3. The CSCW tools

The main tool for computer supported cooperative work is the Google Docs & Spreadsheets system. Students were given the possibility to use the system to compose and submit documents for the course. The system was used by the students mainly for the homework assignments (see Figure 5.15). The system allows for multiple access to the documents by all the course instructors and the ability to easily send comments and feedback to the students, as shown in Figure 5.15
The system is also used by the instructors to keep student records and share evaluation of student activities.

The second CSCW system is represented by the message boards provided to the students. As mentioned before, the message board system used in the course is incorporated within the online



***A)** All created and shared documents* ***B)** The document editor*

***Figure 5.15** Two screenshots of Google Docs & Spreadsheets. Figure (A) shows the shared documents database for one of the course instructors, while figure (B) shows the document editor that works within the internet browser.*

[1] During the recording of the third lecture, everything seemed to be working properly. However, it turned out later that the audio was not recorded due to a failure in the lecture hall's wireless microphone system.

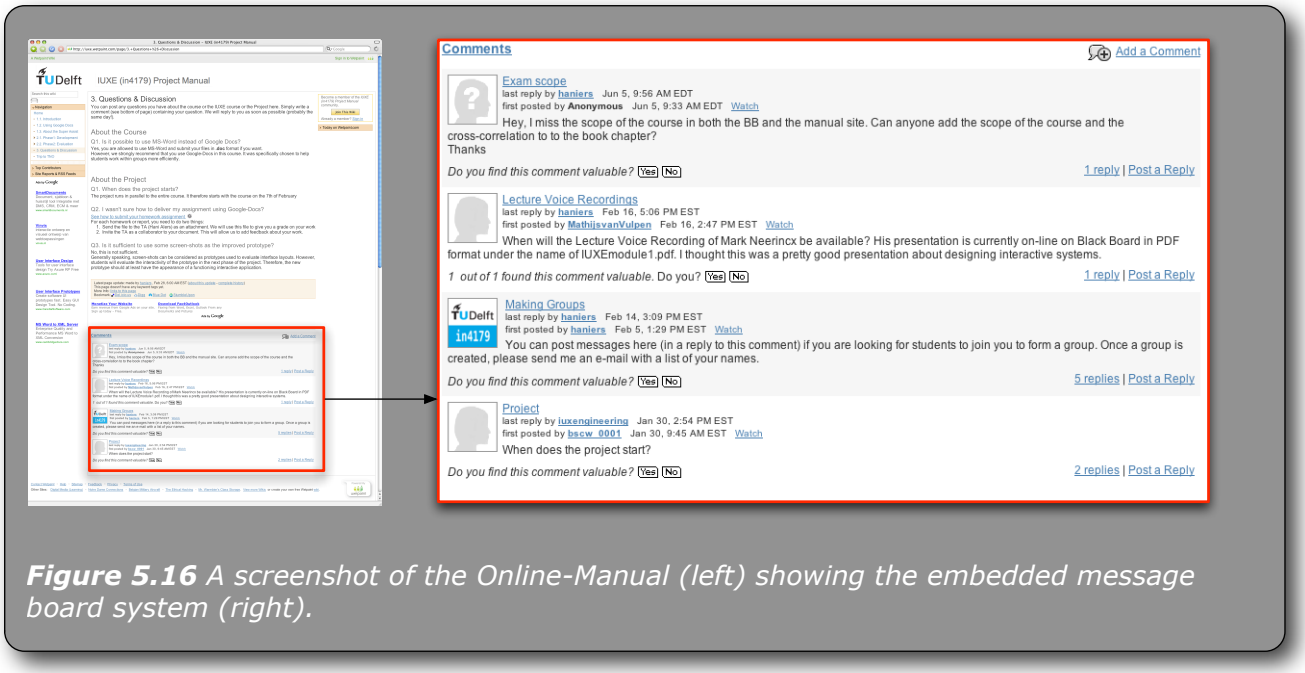


Figure 5.16 *A screenshot of the Online-Manual (left) showing the embedded message board system (right).*

manual. A screenshot of one of the message boards is shown in Figure 5.16, where students submitted questions on the Questions & Discussion page of the online manual. Since every one of manual pages, students are also able to leave comments and discuss the content of the manual and related course activities with the instructors and each other.

6. Experimental evaluation of implemented tools

6.1. Experiment design

The experiment comprised of the IUXE course. The course started on the 7-February-2007 and ended on 30-May-2007. All the tools mentioned in Chapter 5 were used in the course, This Chapter will evaluate the level of success that these tools achieved.

The IUXE course was created to replace two older courses which were phased out of the TU Delft educational curriculum. These two courses were the Design of Highly Interactive Systems (**DHIS**) and the Usability Engineering (**UE**). The DHIS course was designed to teach students the principles of designing user interfaces, while the UE course concentrated on the process of evaluating interactive systems on grounds of effectiveness, efficiency, and ease of use. Both courses included a lab project that allowed the students to try and use these concepts in practice.

The new IUXE course is designed to teach students the same design and evaluation principles which were given in those two courses. The lab project of the IUXE has been designed to combine the two old projects as well with two separate phases, where students first design and develop an interface prototype and then evaluate it with respect to usability. In addition, the course structure of the IUXE course was based on the UE, which was adapted to accommodate the extra material from the DHIS course.

It is therefore clear that a comparison between the new IUXE course and the old DHIS and UE courses would be as good an indication as possible to the effect of adding the new educational tools. For that reason, when those two courses were given for the last time, we asked to the students to participate in focus groups where we collected feedback regarding these courses.

6.1.1. Conditions

The experiment took place within the framework of the IUXE course, with the test participants being the students taking that course. The new developed tools were all provided as *optional* additional ways to participate in course activities. In accordance with the LCD development method (see Chapter 4) the used tools only serve as scaffolding, meaning that its role is to provide *support to the students*

6.1.2. Participants

The participants in the experiment were the 19 students following the IUXE course. All students were fourth year students following a Master course in the Delft university. Most students were following the Media and Knowledge Engineering program, however a few were from the Computer Science and the Electrical Engineering department.

Due to the international nature of the Masters study program in Delft University, the participants included students from Asia, Africa, South America and Europe. Still, the majority of the participants were from the Netherlands.

Figure 6.1 *Images of the focus group interviews performed halfway through the experiment.*

6.1.3. Experiment protocol

The course is given for the duration of 1 semester. The first lecture was given on 07-February-2007, and the last oral exam took place on 27-June-2007. The students were introduced to all the tools on the first day of the course and are free to use them throughout the course duration. The instructors provided support for any questions or problems with the tools.

Halfway through the experiment, video recorded focus groups were held with each group of students[1]. These served as an elementary evaluation of the tools and a chance to see if any changes or improvements can be introduced to improve the tools. After the course ended, students were individually interviewed and asked to take a survey to express their opinions of the used tools.

6.1.4. Measures

When conducting studies that involve educational software in particular and academic experiments in general, it has always been difficult to measure the amount of success achieved by the experiment. The obvious method is to use the grades that students achieve for the course and attribute better grades to positive experimental results. However, such an experiment would require giving the same course to two separate groups of students, preferably in separate locations in order to avoid any interactions that would effect the experimental results. Even then, there might be other factors that effect the student grades such as the difference in location, the type of students that choose to take each type of course, the effect of the different instructor, etc.

Considering the limited resources available for this project, a simpler approach is adopted. The tools used in this experiment are evaluated based on:

1. Usage statistics gathered for each of the tools showing how much they were used during the course.
2. Student feedback gathered using:

[1] The students were already divided in four groups for the course's lab project. The same group structure was used for the focus groups.

2.a. Video interviews and focus group discussions conducted with the students at the end of the course and halfway through (see figures 6.2 and 6.2).
2.b. Feedback surveys measuring student opinions of the tools after following the course.

6.2. Evaluating the individual tools

6.2.1. The Online-Manual

The Online-Manual was used by the student as an alternative to a printed manual. Students accepted the manual and used it throughout the course with no complaints. In fact, it was used rather heavily by the students, with measured statistics[1] showing a total of 3516 pages viewed in 982 separate visits to the manual website[2].

By collecting statistics of the viewer behaviour, educators can make many interesting conclusions. For example, Chart 6.1 show a selection of the collected viewing statistics from the Manual-Website on the entire course duration. When we compare the number of **page-views** for each visit and **visit duration,** we can see whether the students are actually spending their time reading a specific section, or wandering through the site trying to find the information they need.
The chart shows that the number of page-views starts high and decreases as the students become more familiar with how the manual is organized and stabilizes around 3 page-views per visit. The

Figure 6.2 *Some images of the individual interviews performed at the end of the experiment.*

[1] These statistics were collected by using a statistics collection service provided by Sitemeter (www.sitemeter.com).

[2] The number of 'visits' is the total number of distinct visits made to a site for a given period. The number of 'pageviews' is the number of single web pages viewed by a human through a browser.

spike in the number of page-views on the week of 6-April-2007. reflects the instructors working on completing the second half of the manual in the March/April exams break.

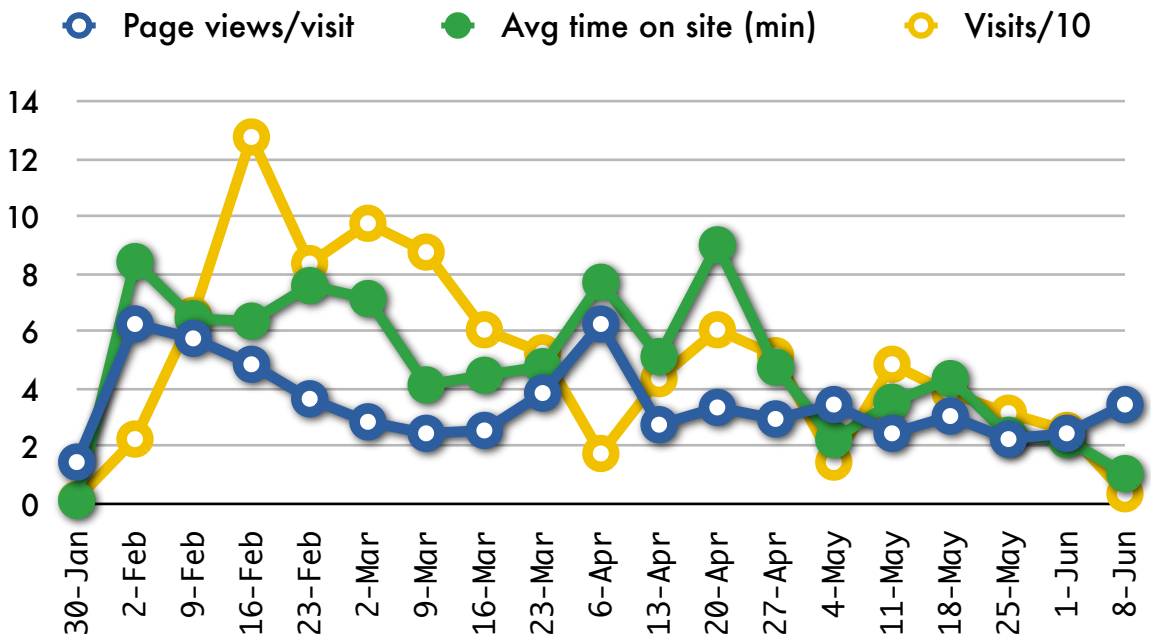
The average time on-site shows how much time the students are spending preparing for project work. Naturally, a high time on-site combined with low number of page-views indicate the viewer concentrating on a specific section of the manual. Each surge in the time on-site line can be directly related to a course activity, such as preparing a 'Poster presentation' (period 21-27 February) and evaluating the interface prototypes (started on 18 April).
The information shown in the figure reflect the student activity. By comparing it to the course's time-table one can check weather the student are working as expected. Problems in the course planning and organization will be reflected in too much or too little time on certain assignments. This helps the instructors in identifying problems in the course organization so that they can make adjustments where necessary.

Table 6.1 *Calculated Confidence-Interval for student survey regarding the usefulness and enjoyability of all educational tools used in the IUXE course. Questions were scored on a 0-4 scale where higher numbers are better.*

Aspect	Tool	Mean (0-4 scale)	Standard deviation	(with 95% confidence-level)	
				Confidence-Interval	mean range
Useful	Blackboard	2.6	1.1	±0.50	[2.08 - 3.08]
	Manual	3	0.8	±0.37	[2.63 - 3.37]
	Sound Rec.	2.3	1.4	±0.64	[1.68 - 2.96]
	Video tutor.	3	1.1	±0.47	[2.53 - 3.47]
	Lecture Rec.	2.9	0.9	±0.41	[2.54 - 3.36]
	Mesg. board	1.6	1.1	±0.50	[1.13 - 2.13]
	Col. report	1.9	1.4	±0.64	[1.31 - 2.59]
Enjoyable	Blackboard	1.9	1.1	±0.52	[1.37 - 2.41]
	Manual	2.1	1.3	±0.57	[1.48 - 2.62]
	Sound Rec.	2.2	1.3	±0.57	[1.64 - 2.78]
	Video tutor.	2.7	1.2	±0.54	[2.14 - 3.22]
	Lecture Rec.	2.2	1.2	±0.52	[1.64 - 2.68]
	Mesg. board	1.5	1.1	±0.51	[1.02 - 2.04]
	Col. report	1.7	1.4	±0.62	[1.06 - 2.30]

To measure the student's opinions of using an online manual, students were asked to rank what they thought of the Online-Manual in terms of usefulness and enjoyability. For comparison, students were also asked to rank the BlackBoard according to the same criteria. The results for these questions are shown in Chart 6.2. The Online-Manual outperforms the BlackBoard in both usability and enjoyability.

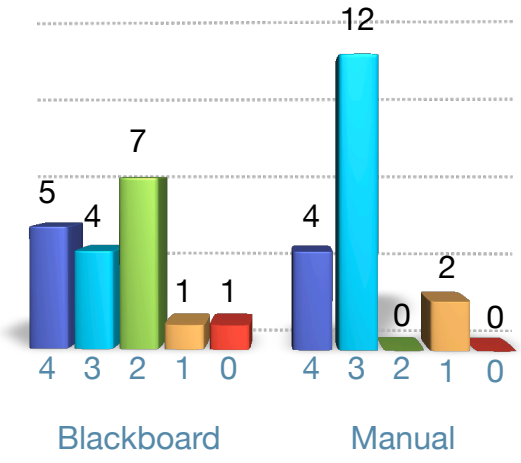
Chart 6.1 *Statistics gathered from the Online-Manual. Chart shows how many pages were viewed in each visit, and the average time each visit lasted. As a reference, a scaled chart of the number of visits has been added as well.*



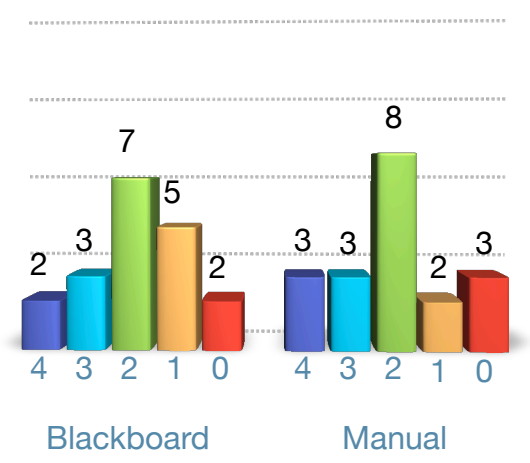
To identify the statistical significance of the numbers shown in the chart, the mean and standard deviation are calculated, and then used to find the **Confidence-Interval** [6.1] for each question. The calculated Confidence-Intervals are shown in Table 6.1. Using the first Confidence-Intervals, for example, we can say that we are 95% certain that the students (on average) value the usefulness of

Chart 6.2 *How useful/enjoyable did you find each of the tools?*

A) *Useful*



B) *Enjoyable*



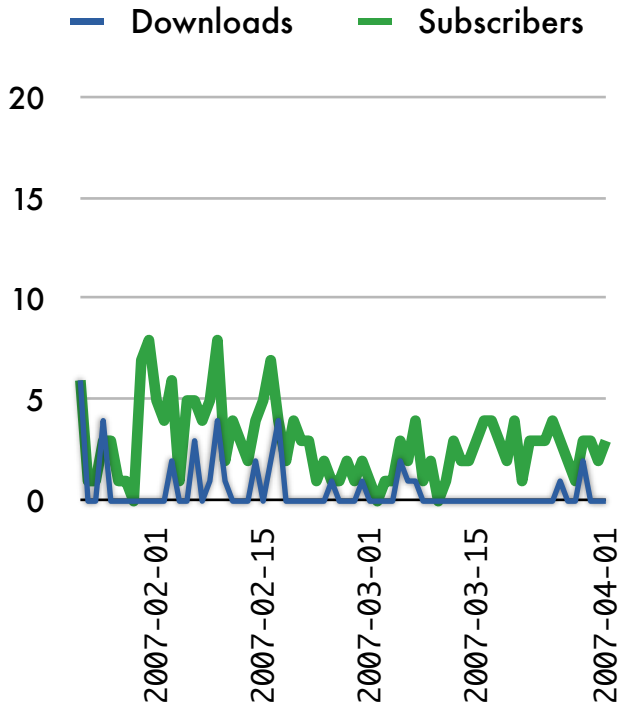
the Blackboard somewhere between 2.08 and 3.08 (on a scale from 0 to 4). Naturally, a higher score indicates a better tool, and a smaller interval indicates a high confidence level in the measurement.
By looking at the mean values, we see that the Online-Manual outperforms the well established Blackboard in both usefulness and enjoyability. Particularly in terms of usefulness, the manual gets an mean score of 3 (only 1 mark under the maximum score 4) with a relatively narrow confidence-Interval.

Further discussion with the students showed that they find Blackboard useful and easy to use. They like the fact that they can access all the data for all classes in one central location, and that they can access this information whenever they want. On the other hand, they find the amount of information presented in the Blackboard to be limited since it mainly provides students with downloadable material (e.g, manuals in .PDF format) where they can access course information. Students also complained about the interface of the blackboard being difficult to use and that it sometimes stops working without warning.

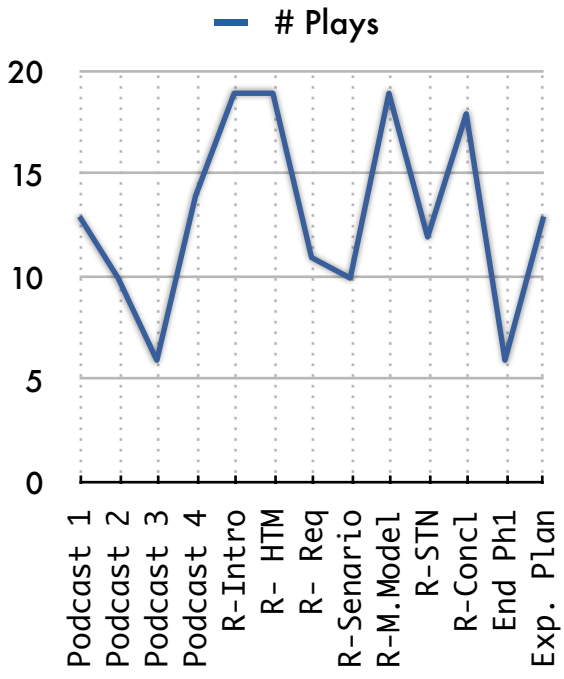
The Online-Manual proved to be a good complementary on-line asset to the Blackboard. Students liked the fact that they can find all the project information on the internet. They appreciated the fact

Chart 6.3 *Statistics gathered on the sound recordings produced for the IUXE course. On the left (A) is the number of listeners to the number of students subscribing to the pod-cast feed. On the right is the number of times each recording (embedded in the manual) was played. Statistics were automatically collected by the used online services (see Chapter 5).*

A) *Podcast feed*



B) *Embedded player widget*



that the manual was accessible and easy to use.

Regarding the Online Manual, the students sited the following main advantages:

- Manual is always accessible on-line.
- information can be updated and errors can be corrected quickly.
- Information is clearly organized and easy to understand.

Students did, however, point out some disadvantages in using the Online-Manual:

- Big changes to manual content can cause confusion

Some students also mentioned that they would prefer it if the manual was somehow implemented within the Blackboard itself, while others preferred the fact that they could immediately access it without the need to input a password. In general terms, the Online-Manual was successfully implemented and proved to be popular among the students.

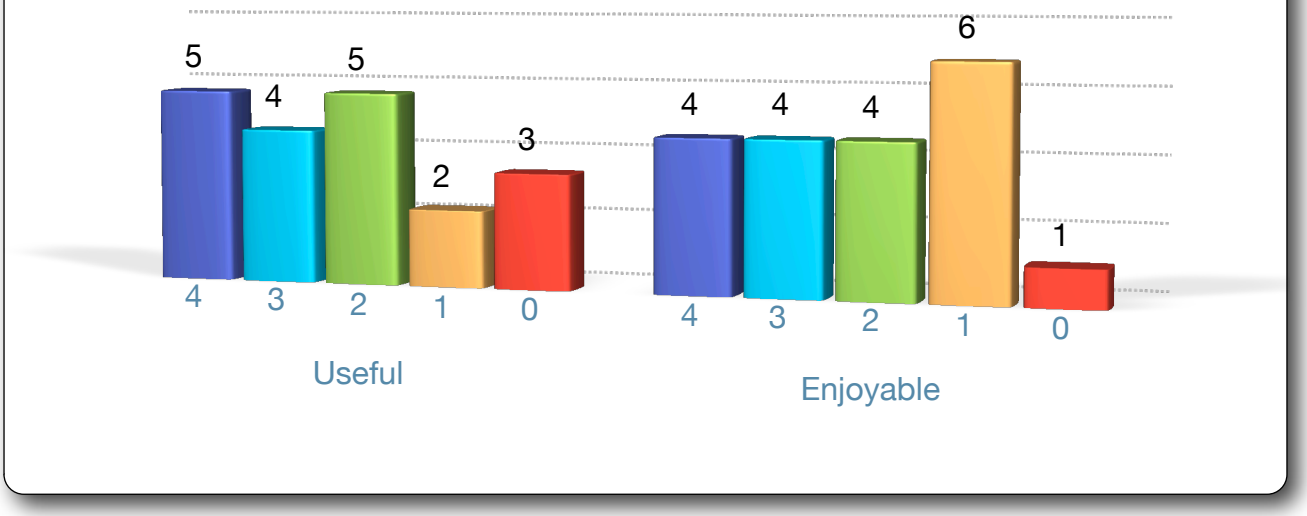
6.2.2. Voice recordings

The voice recordings were delivered first to the students through a podcast feed. The Blackboard page of the course included a link to the podcast feed and a short video tutorial on how to subscribe to it. Statistics of the number of students and the number of downloads for each podcast were tracked by the Feedburner service.

The results for these statistics are shown in Chart 6.3.A. The chart shows that the number of students subscribed to the feed stabilizes around 3 students. This number is quite low considering that 20 students were taking the course. After discussion with the students, it became apparent that they found the process of subscribing to the feed to bee cumbersome, requiring the installation and configuration of new pod-cast aggregator software. Since the pod-casts themselves were provided as an **optional** extra source of information, most students decided to simple ignore them.

To overcome the shortcomings of the pod-cast system, an alternative method to deliver the sound recordings to the students was presented in the form of the imbedded recordings inside the online Manual. As explained earlier (see Section 5.3.3), the recordings are playable from within the web-

Chart 6.4 *How useful/enjoyable did you find the pod-casts and sound recordings?*



browser with no need to any additional software. Since there is no feed to subscribe to, the usage statistics for these recordings are calculated by counting the number each recording was played[1]. As shown in Chart 6.3.B, the number of listeners increased significantly when the embedded recordings were used. Even the first 4 podcasts (which were reproduced as imbedded recordings) were played up to 14 times. This clearly shows that once the tool became easy to use, it was quickly accepted and utilized by most students.

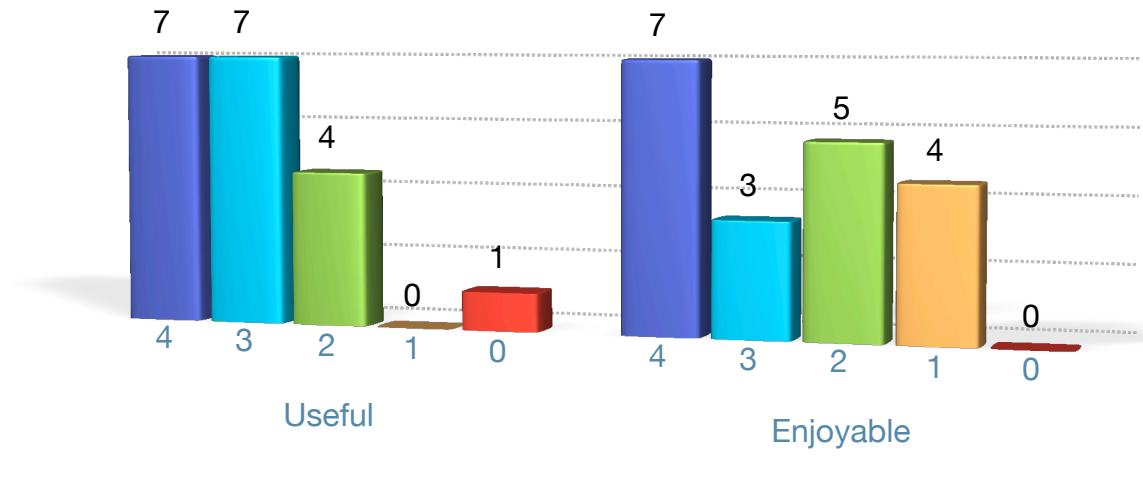
The results of the satisfaction survey are shown in Chart 6.4, where students evaluated the sound recordings on grounds of usefulness and enjoyability. The figure shows that the overall response of the students is quite positive. Using the numbers listed in Table 6.1, we can say that we are 95% certain that students on average find the usefulness of these sound recordings to be between 1.68-2.69 (on a 0-4 range). In comparison with the Blackboard, for example, the sound recordings scored a bit less than on usefulness. This indicates that students found the sound recordings to be quite informative. During the interviews students reinforced this conclusion by indicating that the recordings:

- allowed them to listen to them while involved in other activities
- helped them in organizing their schedules better
- contained useful extra information about the course activities

On enjoyability, the sound recordings received an average score of 2.2 (on a 0-4 range), which is higher than the 1.9 score of Blackboard. Students who used the sound recordings described them as:

- a fresh new way to perform course work
- a more intimate communication channel with the course instructors

Chart 6.5 *How useful/enjoyable did you find the video-tutorials?*



[1] The iJigg service which was used to host the recordings also gathers basic statistics on the number of times a recording is played.

Students noted that providing some of the instructions in ways other than text is a welcomed development. It helps in breaking monotonous nature of course activities and make the process more interesting.

6.2.3. Video tutorials

Video tutorials are presented in the course as optional information channels. Some of these tutorials are used to illustrate step by step textual guides, whereas others give quick guides to using. All the tutorials were accessible through links in the Blackboard and the Online-Manual.

Students found these video tutorials quite useful, since they provided them with an extra dimension of information in the form of the video animations. As chart 6.5 clearly illustrates, the majority of the students found the tutorials to be both useful and an enjoyable way to learn. In fact, by referring back to Table 6.1, we can see that the tutorials received an average score of 3 (on a 0-4 range) for usefulness, putting it (together with the Online-Manual) on the top of all the tools used in the course, including blackboard.

When we look at enjoyability of the video-tutorials, Table 6.1 shows that the video tutorials were the most enjoyable of the tools used in the course. In fact, their average score of 2.7 (on a 0-4 range) gives them a significant lead of 0.5 points ahead of the nearest scores. Students clearly found something in the video tutorials that appealed to them.
During the interviews, students expressed their great appreciation for the provided video-tutorials. They pointed out that the tutorials them to have a visual reference, which is something not easy to convey through other means of communication. Students particularly mentioned that video-tutorials:

- help save time by giving clear and easy to follow instructions.
- shows exactly what needs to be done leaving little room for misunderstandings.

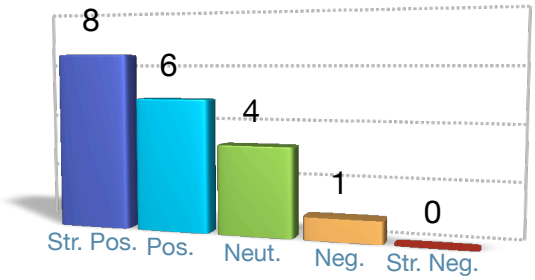
Students were given extra questions pertaining to the video-tutorials. The questions also asked the students for their opinions of the platform used to display these video, referring to the embedded video player provided by the Camtasia software (please see section 5.3 for more information on the Camtasia software suite). An overview of these questions and the students given results is shown in Chart 6.6.

For the calculation of the confidence intervals, we evaluate how many students gave a positive answer to the questions. For example, when asked about their attitudes toward the content of the video-tutorials, 63% of the students were positive, 37% were neutral, and none was negative. As a result, we can be 95% certain that the true proportion of the students with positive attitude to the presented content falls into the range from 44% to 81%.
When asked about how useful they found the video-tutorials, students confirmed the positive results shown before with an overall positive reply of 79%. Which, considering the size of the interviewed sample, puts the confidence-interval of students with a positive opinion about the usefulness of video tutorials anywhere from 64% up to an astonishing 94%.

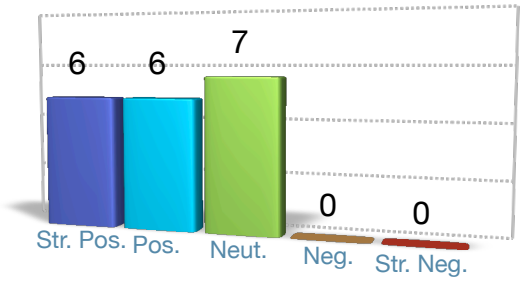
Regarding questions about the quality of the recording and production quality of the video-tutorials, reactions of the students were equally positive. When asked about what they thought of the player that was used to show the videos and their opinion of the quality of the interface, students again had a positive reaction of 74%. This is a good improvement over the older videos used in similar previous courses which were based on the Microsoft Producer[1] system. The system also used an embedded player that worked within an internet browser. However, in order to work properly, the player required the student to have an Internet Explorer browser working on a computer running Microsoft Windows. Even when these conditions were met, the player's performance was not reliable and often resulting in problems during playback, and occasionally students failed to use the produced videos completely.
The new system using the Camtasia flash based player was tested on multiple releases of Windows, Linux, and Macintosh operating systems, and on different internet browsers including Mozilla Firefox,

Chart 6.6 *Additional questions about the video material*

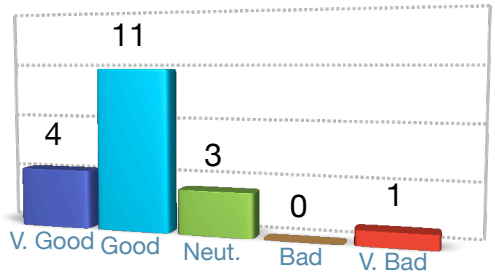
1. Attitude about the navigation controls of the player interface?



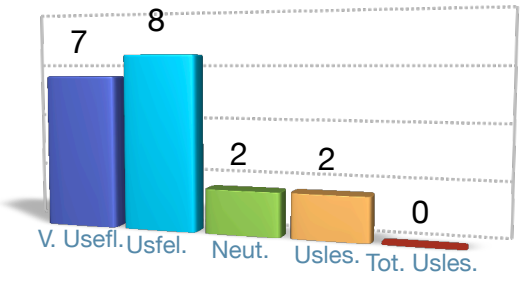
2. How would you rate your attitude about the material in the video-tutorials & web-lectures?



3. How would you rate the production quality (i.e. image/sound quality) of the web-lectures?



4. How useful do you consider web lectures for use in education in general?



[1] Microsoft producer is freely available plugin for Microsoft Powerpoint, which can be downloaded from the internet. The plugin acts as a video editor that allows the user to combine videos with PowerPoint presentations, and produce them as a combined web-lecture.

Internet Explorer, and Opera. The system always functioned flawlessly as long as the internet browser contained a recent Flash plugin (version 7 or higher).

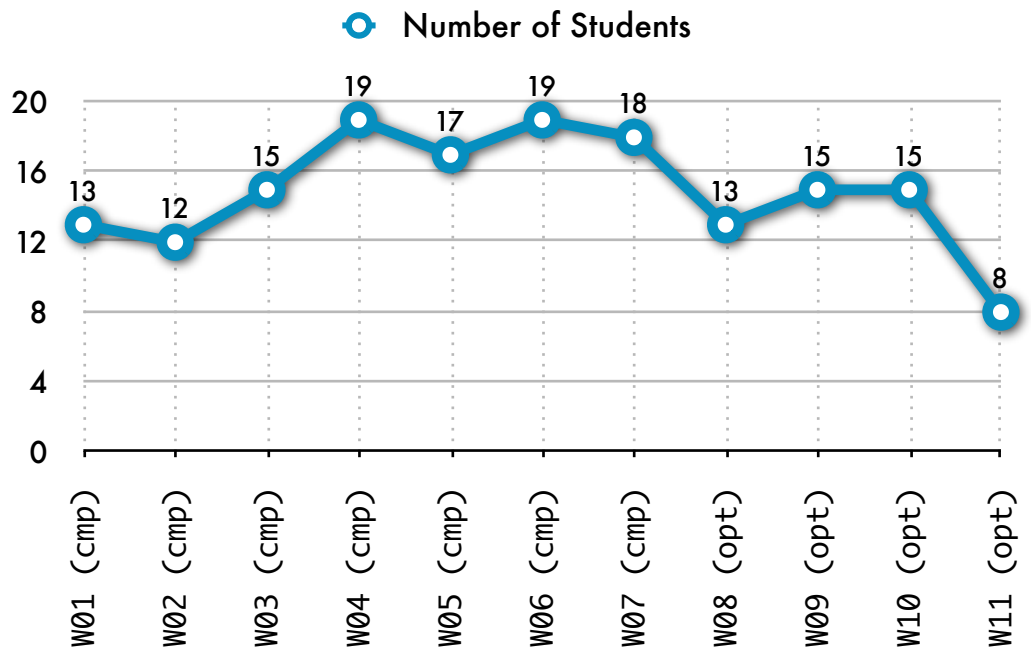
Again, the students' reaction regarding the production quality was mainly positive with 79%% of them saying that it was good or very good. Since the Camtasia software is optimized for screen capture and web publishing, it was well suited for producing these tutorials.
One should again point out here (as explained before in Chapter 5) that no professional setup or equipment were used for this project. All recordings were performed on a 2 year old laptop by 1 or 2 instructors, none of whom is specifically experienced in multimedia production. As for software, the only none open-source software used in the curse was the Camtasia studio, which only costs $179 for educational uses. The fact that the production quality was so positively evaluated is a testament to the power of the hardware and software available today.

Never the less, during the interviews students expressed some minor complaints regarding the videos:

- Streaming the videos required a high speed internet connection.
- The volume on some of the recordings was too low.

These complaints were reported by a limited number of students. Additionally, with more experience with producing such material and with the continuing improvement in internet technology, one would expect these problems to be easily overcome.

Chart 6.7 *The number of students attending each of the lectures. Note that attending the first 7 lectures was compulsory, whereas it was optional to attend the last four lectures.*



6.2.4. Lecture recordings

As explained in Chapter 4, all the regular lectures were recorded and then offered for the students to review at home. These recordings were not intended to be an alternative to attending the real lectures at the university. In fact, student attendance was compulsory for most lectures. Instead, the recordings were expected to be used for referencing by the students during the course duration, and as a revision tool for the course's final examination.

Chart 6.7. shows the student attendance during the course lectures. Student attendance during the first 7 lectures averaged on 16 students, even though attendance was compulsory. This number only dropped to 13 students per lecture for the last 4 optional lectures. This does indicates a small drop in attendance numbers, however it clearly shows that students do not consider the lecture-recordings as an alternative to attending the real lectures. This conclusion has also been show previously in similar educational experiments such.
The eClass project, for example, performed a similar study which was applied on 98 courses and spanned 3 years. By comparing attendance statistics among the courses that participated in the project and those that did not, researchers were able to conclude that providing lecture recordings does not encourage what they called 'class skipping' [6.2].

Chart 6.8 shows the usage statistics of the lecture recordings gathered by the Blackboard system. Since the Blackboard requires users to sing-in in order access course material, is is possible to track identify the users who accessed the lecture recordings.

Chart 6.8 *The number of visits to the lecture recordings folder. The orange areas indicate visits by the students, while the blue area shows the total visitors (students + instructors).*

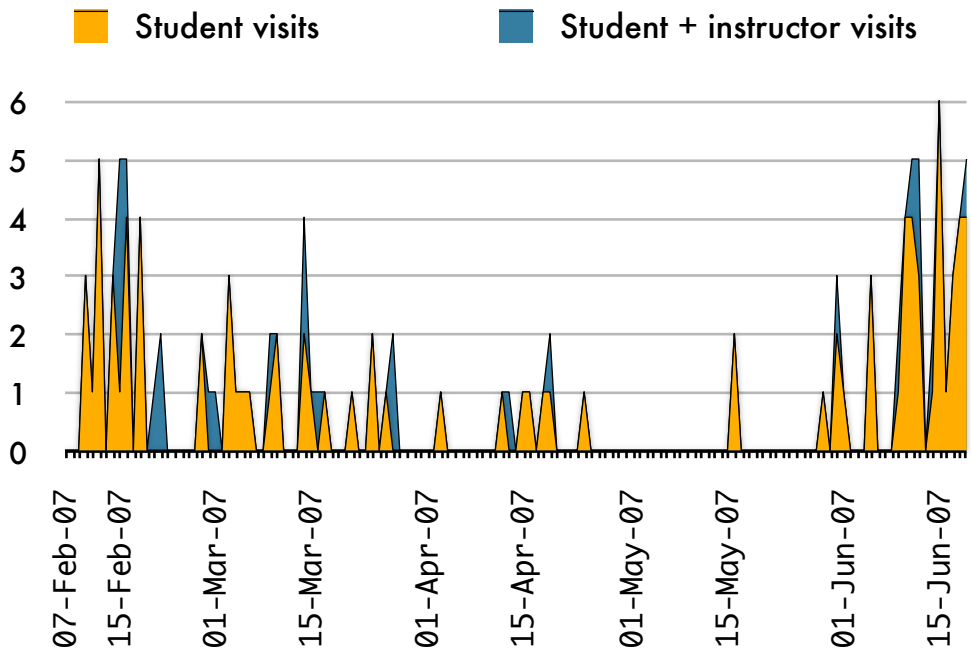
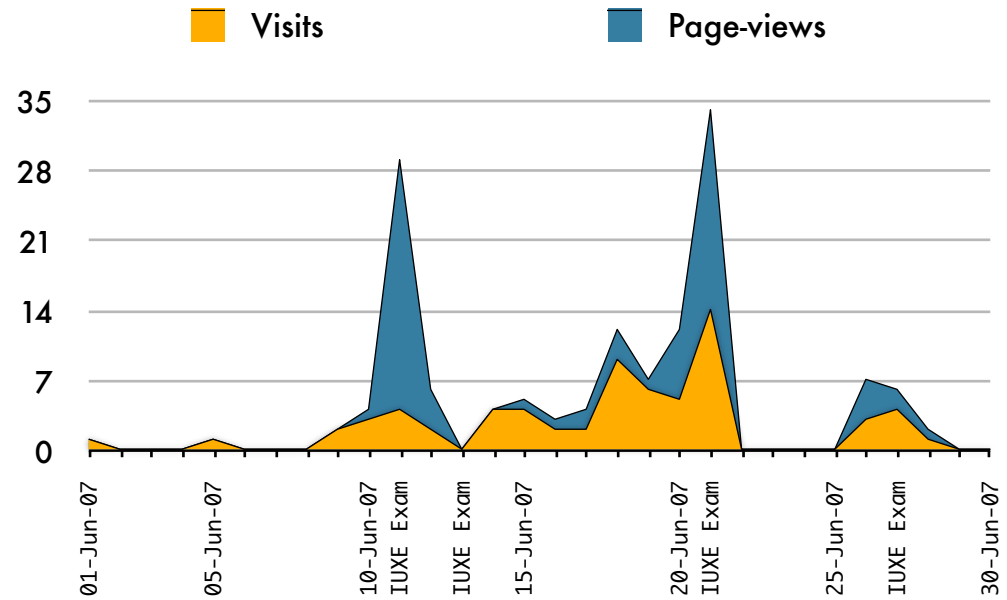


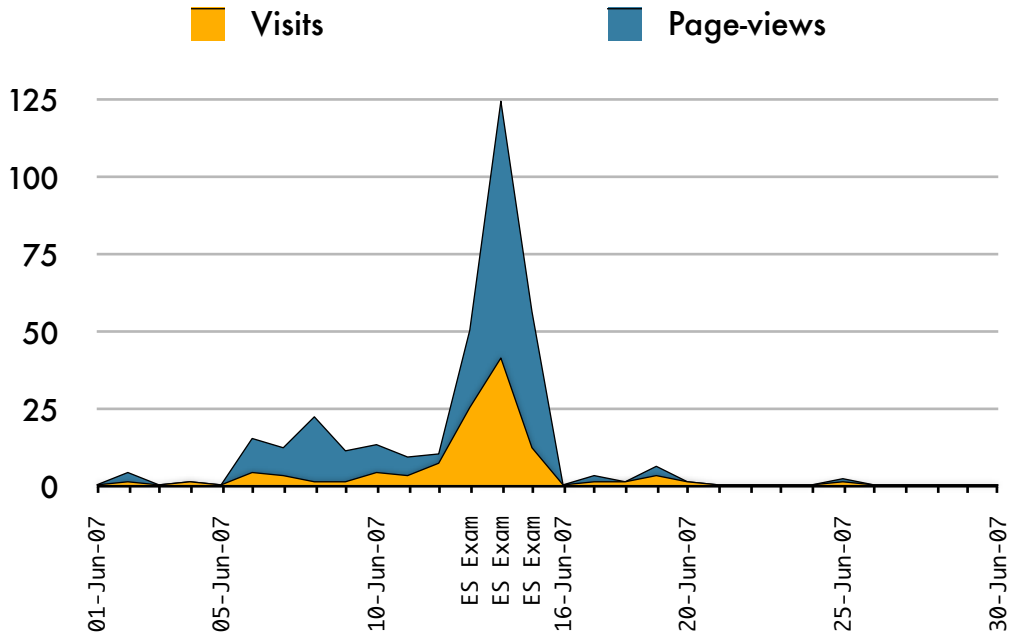
Chart 6.9 *The number of visits and page-views for the lecture recording of the IUXE course for the month of June.*



The chart shows an interesting (and unexpected) result, which is that the course instructors actively used the lecture recordings. The lecture recordings proved to be practical for a number of tasks:

- **Reviewing taught material:**
  Since the lectures were given by several instructors, the recordings were a practical way of reviewing lecture material

Chart 6.10 *The number of visits and page-views for the lecture recording of the ES course for the month of June.*



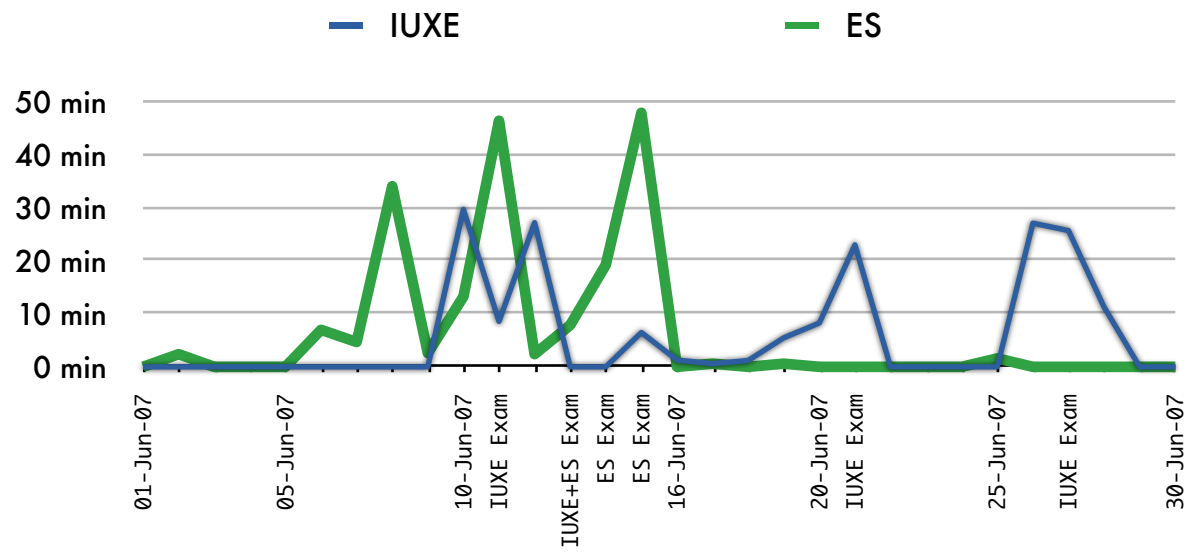
- **Assessing lecture quality:**
  Be examining the quality of the given lectures and planning improvements for the following lectures or for when the course is given again next year.

- **References to answer student questions or inquires:**
  With a database of all given lectures, it is possible to refer students with questions to specific lectures that will provide them with the information they seek.

Students used the lectures as well throughout the course duration. The first few weeks of the course show high access frequency to the lecture-recordings. This was the result of a lecture overlap with another course called 'Advanced Digital Image Processing' which caused students following both courses to miss the first 4 lectures of the IUXE course. During the interviews, students noted that being able to follow these lectures online was the only way they could have taken both courses. They also noted that following the lecture-recordings, though not equivalent to attending the lectures, was sufficient to understand the material and follow the course progress.

The chart also shows an increasing level of activity which starts around the beginning of June. This reflects the students preparing for the course examination which were scheduled individually for each student. The dates where oral exams were held are indicated on the figures.
During this critical period, the viewing statistics were also monitored using the Google-Analytics[1] service. The number of visits and page-views as recorded by Google-Analytics is shown in Chart 6.9. The chart shows that visitors often view multiple lectures in each visit. This is also shown in the lecture statistics recorded for the ES course shown in Chart 6.10. The higher number of hits shown in the chart is a natural result of the higher number of students following that course.

Chart 6.11 *The average time students have spent watching the lecture recordings during each visit to the lecture-recordings website.*

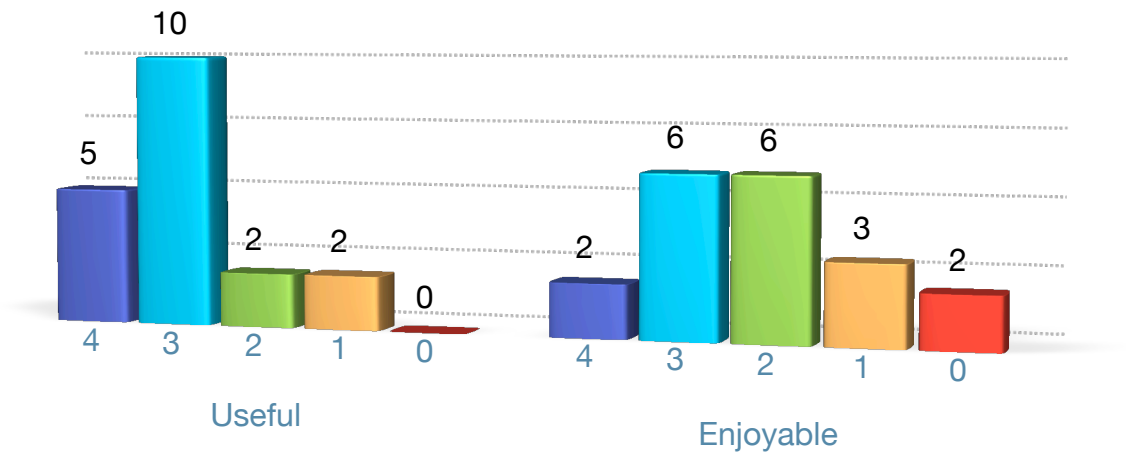


[1] Google-Analytics is a free service offered by Google that generates detailed statistics about the visitors to a website. Its can be found at http://www.google.com/analytics.

Website statistics services also provide lots of information that can be useful for the instructor. Information such as how early before the exams (or projects) do students start to study the theoretical material, or which part of the course are students spending most of their time trying to understand.
Chart 6.11 for example shows the average duration of **each visit** to the lecture recording database for both the IUXE and the ES courses. As a result, the information shown in this chart is independent of the number of students who are following the course, and only shows the average time per student. The chart shows that students of the ES course are (on average) spending significantly longer amounts of time watching the lecture-recordings than students of the IUXE course, which may be an indication that the lectures of ES are more difficult to follow and understand.

The gathered statistics contains numerous other types of information which an educator can use to get a better understanding of how students go on studying their courses. For example, the statistics shows that the most viewed lecture recording is the lecture of week 2, with a relatively short average viewing time of 2 minutes. This indicates that the slides for that lecture were not easy to understand and that students referred to the recordings to get further clarification.
On the other hand, the lecture which students, on average, spent most time watching (29 minutes) was the last lecture given in the course. This was the lecture missed by most students (see Chart 6.7) at the end of the course. This indicates that many of the students watched a great deal of the recording as an alternative for missing the actual lecture[1].
These are just a couple of examples of the type of data found in the statistics and how they can be interpreted. This information may not be ground-breaking, however it helps the instructor to get a better understanding of student activities. It can also point out problem areas in the course and indicate areas which needs change or improvement.

Chart 6.12 *How useful/enjoyable did you find the Lecture-Recordings?*



[1] Note that the last lecture was given after 2 weeks with no lectures, which may have lead some students to expect no lectures in the final week of the semester. There is no evidence indicating that students were missing the lectures because they were able to watch the recordings on the web, as discussed earlier.

In a similar manner to all other tools, students were asked to evaluate the level of usefulness and enjoyability of the lecture recordings. The results are shown in Chart 6.12 above. The Lecture-recordings gained an average score of 2.9 (on a 0-4 range) with a relatively narrow confidence interval, which ranks them as 3rd. among the tools used in the course. During the interviews students repeatedly expressed how much they enjoyed the fact that these recordings were available on line, even students who did not use the recordings appreciated the idea. Some of the opinions which were expressed repeatedly is that lecture-recordings help:

- **Overcome language problems:**
  Since none of the instructors nor students are native English speakers, it is sometimes difficult for the students to fully understand the lectures. This is especially true for Chinese students who have problems understanding the English dialect of native Dutch speakers [5.4].
- **Following overlapping courses:**
  Students often have to choose between two (or more) courses they want to follow because of lecture overlap. With lecture recordings, it is possible to follow courses regardless of lecture overlap.
- **Reviewing missed lectures:**
  It is difficult for students to attend *all* lectures of a course even if they want to. Watching a video recording of a missed lecture, though not ideal, is a suitable substitute.

6.2.5. Collaborative reporting

As mentioned before, the IUXE course used Google's Google Docs & Spreadsheets (**GD&S**) service as the tool for collaborative reporting. The goals was to facilitate cooperation among the students and allow the instructors to give help and advice.

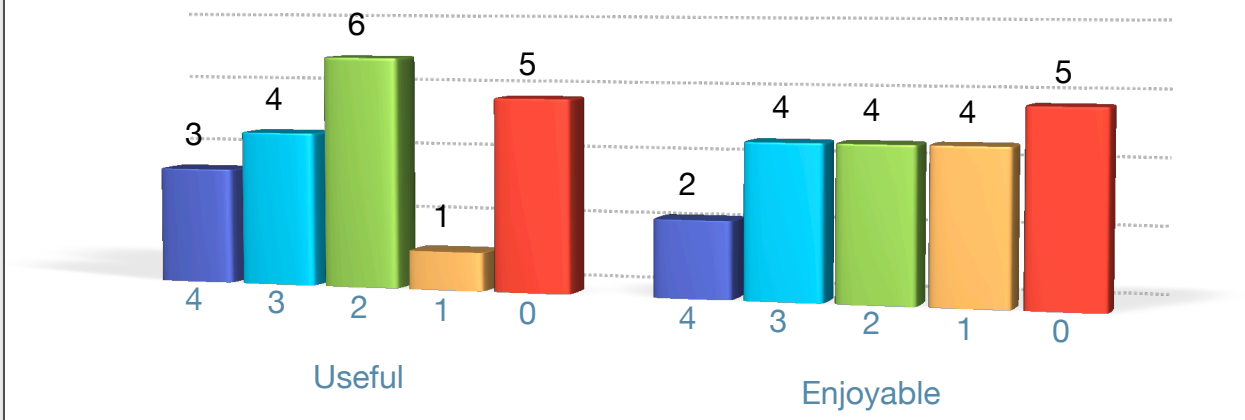
Initially, all students used GD&S to submit their homework assignments. However, when writing reports, students stopped using GD&S, and went back to using word processing software such as Microsoft Word. During the interviews, the students pointed out that they enjoyed using GD&S and appreciated the rapid feedback they received on their homework assignments. Yet, when they tried to use GD&S to write full reports, they were quickly frustrated by the system's limited functionality and unfamiliar user interface. As a result, none of the groups ended up using GD&S to write their reports.

When asked about their opinions of GD&S, the students gave it an average score of 1.9 for usefulness and 1.7 for enjoyability (on a 0-4 range). Even though it was not heavily used within the IUXE course itself, many students mentioned that they are using it for other courses. Students particularly fond of GD&S because:

- It is accessible allowing them to reach their documents from any internet connected computer.
- It automatically creates a searchable database of all their work
- It is lightweight and easy to use

Surprisingly, one of the students used the online collaboration feature that GD&S provided. Students pointed out that when working within a group, it was hard to persuade all members to use this new system in place of a classical word processing program.

Chart 6.13 *How useful/enjoyable did you find Google-Docs and Spreadsheets?*

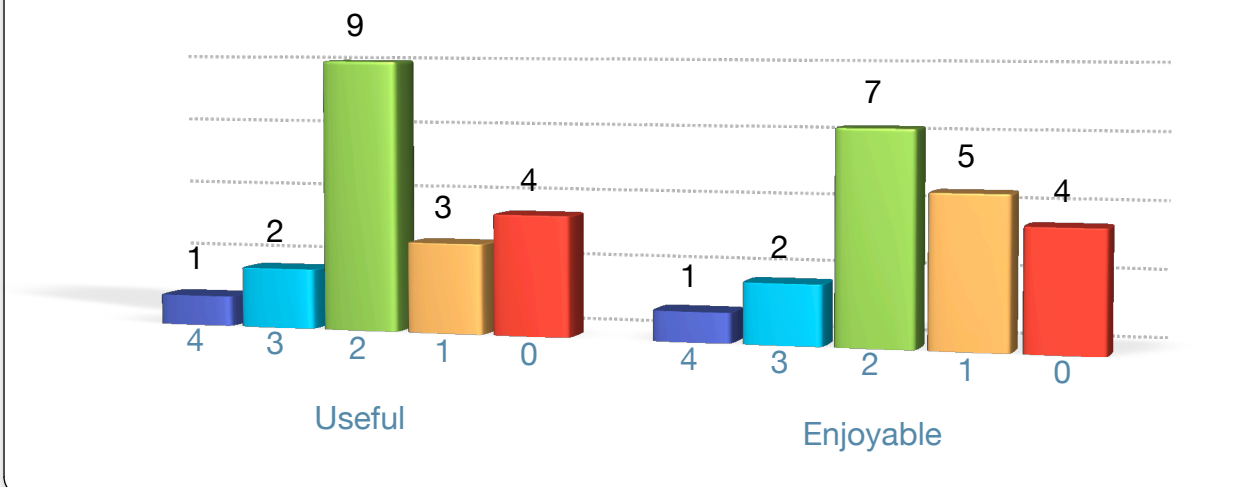


6.2.6. Message boards

The message boards were intended to facilitate quick communication with all course instructors. By the end of the experiment, the message board was only used by 9 of the course students and 3 of the instructors, with a total 32 posted messages. Since the course had weekly lectures, the students were in close contact with the instructors and each other. Therefore, communication was mainly conducted through direct contact and e-mails. Unsurprisingly, the message boards had the lowest scores among all the tools with and average of 1.6 for usefulness and 1.5 for enjoyability (on a 0-4 range).

It may be worth noting that the message board was mainly used in the first couple of weeks by students looking for partners to create lab groups. Though once students became aquatinted they abandoned the message boards. It is therefore likely that a other types of courses (e.g., distant courses) would have benefited more from such a tool.

Chart 6.14 *How useful/enjoyable did you find the message boards?*



6.3. General results for course format

6.3.1. Comparative analysis

As explained in Chapter 2, the IUXE was constructed to replace two older courses given by the MMI department in the Delft university. The DHIS and UE courses taught the same theories of design and evaluation of highly interactive systems. These courses even used an earlier version of online web-lectures, though a different system was used to produce these web-lectures and they were used in a different manner. For more information on the DHIS and UE courses, you can refer back to Section 2.1.

As a part of this project, a feedback survey was conducted to measure the student opinions of both courses. The survey was given at the end of the academic year 2005-2006. All students of both courses were invited to participate by receiving an e-mail with a link to the online questionnaire. The survey was completed by 8 students from the DHIS course and 5 students from the UE course, forming 36% and 31% of the total number of students respectively.
At the end of the IUXE course, the survey was repeated using the exact same questions. The goal was to gather some comparative data to see how well is the new approach of teaching HCI design fared against the way it was taught previously. Table 6.2 shows the results off all three surveys giving the mean score for all questions. The table also gives the difference values between the mean score for the IUXE course and those of the old courses.

A quick glance at the above table reveals that the IUXE course appeared to be significantly more ‘well planned’ than the old courses. When one takes into considerations that all courses were given by the same instructors, handled the same subjects, and had a similar setup, it is a good indication that the new tools used in the IUXE course played a role in the higher score for that question.

The results for question 3 are particularly interesting since they handle the manner in which the course material was presented. This directly compares the traditional book and printed manual approach to the new online multimedia channels used in the IUXE course. Again, the IUXE course outperforms both of the old courses with a healthy margin. It is worth noting here that a significant portion of the material in the DHIS course was presented using web-lectures. They may have played part in its higher score compared to the UE course.

While looking at question 7, one should take into account that the lab project for the DHIS only involved developing a program prototype and earned the student 4 ECTS points. Similarly, the UE course lab involved only the evaluation of a prototype program interface, earning the students 5 ECTS points. On the other hand, the IUXE project lab involved *both* the development and evaluation steps, practically doubling the work students need to perform for only 6 ECTS points. The fact that the IUXE course gets a better score for question 7 than the older 2 courses means that students felt less overwhelmed with course activity. This can be used to indicate the success of the new tools used in the IUXE course to streamline course activities and simplify accessing course information for the students. As mentioned in Chapter 4, by taking care of the learners’ “management requirements”, they can concentrate on the learning process.

Table 6.2 *The average scores for the feedback questionnaires for the IUXE course and the old DHIS and UE courses. The table also shows the difference between the score for IUXE and each of the other two. Questions were scored on a 1-5 scale where higher numbers are better.*

#	Question (score between 1-5)	IUXE	DHIS	UE	IUXE-DHIS	IUXE-UE
1	The use of information technology teaching resources (e.g., web-lectures) helped the delivery of course material.	4.16	3.75	3.60	0.41	0.56
2	The use of information technology resources was necessary for presenting course material.	3.11	3.00	3.00	0.11	0.11
3	The course material was presented in an organized manner.	3.58	3.00	2.60	0.58	0.98
4	The requirements of the course (projects, papers, exams) were adequately explained.	3.84	3.88	3.20	-0.04	0.64
5	The course appeared to have been carefully planned.	3.53	2.50	2.20	1.03	1.33
6	The general climate in this course was good for learning.	4.21	3.88	4.00	0.33	0.21
7	The credits assigned for this course were appropriate to the workload.	3.89	2.75	3.80	1.14	0.09
8	The amount of work required in this course was appropriate.	3.58	3.25	3.60	0.33	-0.02
9	I would recommend this course to other students.	3.74	3.38	3.80	0.36	-0.06
10	In this course, I always felt motivated to learn.	3.32	3.13	2.60	0.19	0.72

Since both old courses used some online educational tools in the form of web-lectures, it is important to compare their level of success compared to that of the IUXE used tools. Again the IUXE gains a significantly higher score than the old courses, which is quite impressive when considering that the DHIS course *mainly depended on web-lectures* to deliver the course material to the students (see Chapter 2 for more information on the old courses).

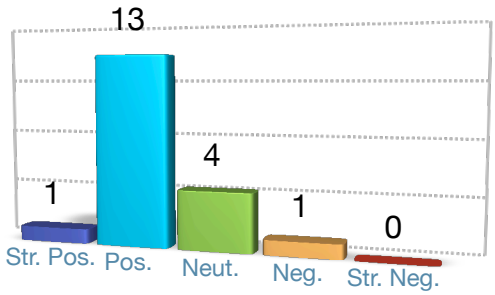
This result shows that simply using additional tools like web-lectures does not automatically improve the course. An analysis step using the LCD (or another equivalent) approach should be applied first to carefully assess what tools can be used in the course and for what purposes.

Finally, question 10 which asks whether students felt motivated to learn while taking the course shows that the tools played a role in stimulating the student. By designing the tools to assist the students to help them concentrate on learning, simplify access to course information, and take care of management needs, students enjoy a better learning experience where they are more motivated to learn. During the interviews, some students pointed out that simply seeing how much effort was put in the development of the course and its different tools made them feel more motivated to work harder on course activities.

Looking at Table 6.2, one can see that the IUXE course received either superior or similar result (compared to the 2 old courses) in *all* aspects touched upon in the feedback survey. Of course, many other factors can play a role in effecting these results, since the table compares 3 different courses. The results would have been more conclusive if the same course was given to two separate groups of students, one using the new web-tools while the other using a traditional text book approach. Then again, this type of studies can also have inaccuracies since experimenters have no control on student activities outside the classroom, not to mention the high level of resources required by such a study. In the light of the limited scale of this project, making a comparison with these 2 older courses is an adequate compromise. Additionally, the overall highly positive results received by the IUXE course give a good indication to the level of success achieved by the new tools.

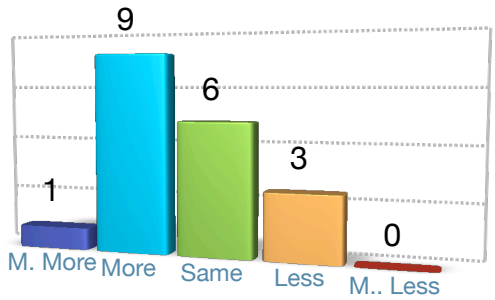
Chart 6.15 *Additional questions about the course format*

1. Based on your experience with the new educational tools used in the course, how would you rate your attitude toward the course?

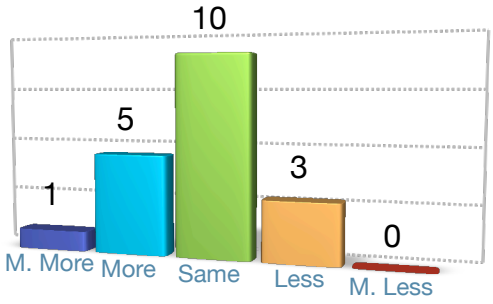


2. If you compare the new course format with the traditional format, how would you rate the new course setup in comparison?

3. All else being equal, in comparison to other courses you have taken, how much did you enjoy this course?



4. All else being equal, in comparison to other courses you have taken, how much did you learn in this course?



6.3.2. Attitudes regarding new course format.

The last part of the questionnaire asked students for their opinions on the general course format. In other words, the questions concentrated on measuring how much value did the students assign to the added tools. The questions and results are shown in Chart 6.15.

The first question simply asks the students for their opinion of the using the new tools in the course. The question received a positive reaction from 74% of the students, with only one student saying that he had a negative attitude towards the tools. It is, therefore, possible to say that the student like to see these tools used in the courses thy are taking. This is further supported by the results of question 2, where 79% of the students thought that the new course format used for the IUXE course was better (or much better) than the traditional way of teaching.

Finally, questions 3 and 4 ask the students to assess how much they learned from the course, and how much they enjoyed it as a result of the addition of the new tools. The students clearly thought that the new tools made the course more enjoyable. However, students did not believe that they learned *more* as a result of using the additional tools, with question 4 only receiving a slightly higher than average result. This result fits well with our consensus that educational tools in general do not result in students learning more or gaining higher exam results.
Again, it is important to note here that students following this course gained the theoretical and practical experience of both old DHIS and UE courses which it replaced (see Chapter 2 for more details). By gathering the material taught in both courses and providing the students only 6 ECTS study points (instead of the combined 9 ECTS points of the old courses), one can argue that the students *did* learn more in this course.

7. Conclusions and recommendations

This project has implemented and tested an educational support system composed of different multimedia and web-based tools. With predominantly positive results, it is safe to say that the project has been successful in that pursuit.

This chapter discusses the conclusions of the project. It starts with answering the research questions that the project started with, then moves on to more general conclusions of the performed experiment. The chapter ends with recommendations for further work in this field.

7.1. Answering the research questions

The project started out with two goals formulated in the project's research questions:

1. *Can web-based tools be used to support the teaching of HCI?*
   Both objective and subjective results gathered by the project where mostly positive. Usage statistics show that the implemented tools were well used by the students throughout the course. Additionally, student opinion was also positive, giving three of the tools an average grade of 3 on usefulness (using a 0-4 scale where higher numbers are better).

2. *What type of tools are suitable to help the teaching process?*
   The answer to this question will be different for each type of course. Something like providing recordings of course lectures will most likely benefit all types of courses. However, video tutorials are not likely to be as valuable to purely theoretical courses as they are to practical courses like the one used in this project. Therefore a comprehensive answer to this question requires further research.

7.2. General conclusions

Designing educational tools using LCD

The approach used to choose the educational tools for this project employed the so called Learner Centered Design (**LCD**) approach. Despite being targeted towards work-practices, it served well as a systematic method to develop the tools for this project. Still it had two shortcomings:

- It does not specify which tools to use, only providing a list of requirements the needed tool should possess.
- The evaluation component of the LCD approach was not applicable in an educational setting, and had to be significantly modified for this project.

In addition, it is likely that LCD will not work as well for a course that mainly discusses theoretical concepts such as, for example, pure mathematics.

Benefits of using educational tools

As mentioned above, each type of courses will use different tools in different ways. The type of benefits each course gains will differ accordingly. However, for the course used in this project, it is possible to list the following gained benefits:

- Benefits for students
  - It Increases the student's motivation in doing course work, with 53% of students saying they enjoyed the course more thanks to the used tools.
  - Students gain access to additional learning material which is rich in content, immediately relevant to their study, and accessible as long as they are connected to the internet.
- Benefits to instructors
  - The created content is also useful to instructors for reviewing purposes. For example, 18% of the total usage of the lecture recordings was by the course instructors[1].
  - Topics covered by any of the used tools can be reused every time the course is given, saving the instructors' time and effort.
  - Instructors can see detailed usage statistics showing them what parts of the course content are being studied by the students at what times and for how long. Such information helps instructors improve the course content accordingly.
  - The accessible nature of the tools allow the instructors to collaborate more effectively on course activities. For example, the head instructors only needed to perform minor adjustments to the course's Online Manual, leaving the bulk of the work to the teaching assistants.

Coast of building the tools

The project's expenses were surprisingly low. The total cost of software and hardware specifically purchased for this project was less than 200 euros. Naturally, these resources are now available if similar projects were to take place. In addition, no professional help was required to build these tools or any of the created content. The course instructors have created *all* the tools used in the course. If anything, this is a testament to how powerful, and easy to use, current technology has become.

7.3. Recommendations

Further research is needed to classify the different types of courses given by the university, and selecting the type of educational tools that would be beneficial to each one of these types. The result of this work should be a set of toolkits (one for each type of courses) that can be easily applied whenever a new course is created, or the need arises to improve an already existing courses. Each toolkit contains a set of tool templates (suitable for a specific type of courses) which can be easily customized and used by the course instructors.

It is also important to have a coherent and consistent approach to the developed educational tools by the university. In other words, different courses should use the same tools and services whenever possible. This will make it easier for the students to use these tools, and allow the university to better manage and assist courses that use them. Of course this will be easier if the above mentioned educational toolkits are created by the university.

[1] This number does not take into account the usage statistics for the exams period in the last month of the course. The actual percentage is probably a little less than 18%. These statistics were lost during the upgrade of the Blackboard system.

Finally, the university should provide instructors with clear support channels for the creation of such tools. It is very likely that some instructors will run into problems in the implementation of educational tools for their courses, which can easily deter them from pursuing such efforts. It is therefore essential for the university to provide clear support channels that instructors can rely on when they are working on such a project. This will of course be easier to implement if the two above recommendations were followed.

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App. A. IUXE course feedback likert form

These are the feedback questionnaires given to the students at the end of the course. They were aimed at measuring student opinions of the new course format in general and their specific opinion of each tool used in the course.

Questionnaire

Department of Man-Machine Interaction
Faculty of Media & Knowledge Engineering
Technical University of Delft

General opinions

		Strongly agree	Agree	Nuetral	Disagree	Strongly disagree
1	The use of information technology teaching resources (e.g. web-lectures) **helped** the delivery of course material.	☐	☐	☐	☐	☐
2	The use of information technology resources was **necessary** for presenting course material.	☐	☐	☐	☐	☐
3	The course material was presented in an organized manner.	☐	☐	☐	☐	☐
4	The requirements of the course (projects, papers, exams) were adequately explained.	☐	☐	☐	☐	☐
5	The course appeared to have been carefully planned.	☐	☐	☐	☐	☐
6	The general climate in this course was good for learning.	☐	☐	☐	☐	☐
7	The credits assigned for this course were appropriate to the workload.	☐	☐	☐	☐	☐
8	The amount of work required in this course was appropriate.	☐	☐	☐	☐	☐
9	I would recommend this course to other students.	☐	☐	☐	☐	☐
10	In this course, I always felt motivated to learn.	☐	☐	☐	☐	☐
11	Compared to this course, I think the internet is **not** being used properly to help the educational process in **other courses** in the TU-Delft	☐	☐	☐	☐	☐

Questionnaire

Department of Man-Machine Interaction
Faculty of Media & Knowledge Engineering
Technical University of Delft

Attitudes about Video Recordings (Web-lectures + Video tutorials + Lecture Recordings)

1. How would you rate the production quality (i.e. image/sound quality) of the web lectures?

☐ Very Good ☐ Good ☐ Neutral ☐ Bad ☐ Very Bad

2. How useful do you consider web lectures for use in education in general?

☐ Very Useful ☐ Quite Useful ☐ Neutral ☐ Quite Useless ☐ Totally Useless

3. How would you rate your overall attitude about the navigation controls (i.e., pause/rewind/fast forward playback controls and table of contents) provided by the video player interface?

☐ Strongly Positive ☐ Positive ☐ Neutral ☐ Negative ☐ Strongly Negative

4. How often did you watch all or part of a video more than once?

☐ Very Frequently ☐ Frequently ☐ Sometimes ☐ Rarely ☐ Never

5. How would you rate your attitude about the material in the Video tutorials & web-lectures:

☐ Strongly Positive ☐ Positive ☐ Neutral ☐ Negative ☐ Strongly Negative

Attitudes about the Course Format

6. Based on your experience with the new educational tools used in the course, how would you rate your attitude toward the course?

☐ Strongly Positive ☐ Positive ☐ Neutral ☐ Negative ☐ Strongly Negative

7. If you compare the new course format with the traditional format, how would you rate the new course setup in comparison?

☐ Much Better ☐ Better ☐ About the same ☐ Worse ☐ Much Worse

8. All else being equal, in comparison to other courses you have taken, how much did you ***learn*** in this course?

☐ Much More ☐ More ☐ About the same ☐ Less ☐ Much Less

9. All else being equal, in comparison to other courses you have taken, how much did you enjoy this course?

☐ Much More ☐ More ☐ About the same ☐ Less ☐ Much Less

Department of Man-Machine Interaction
Faculty of Media & Knowledge Engineering
Technical University of Delft

The tools

Q. During this course, how **useful/enjoyable** did you find each of the tools?

	Useful					Enjoyable				
	0	1	2	3	4	0	1	2	3	4
Blackboard	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Online wiki Manual	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pod-casts & sound recordings	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Video tutorials (install prototype, ...etc)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Recording of normal lectures	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Discussion forum	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Google Docs	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

App. B. IUXE feedback results

This appendix lists the gathered results of the students' feedback collected at the end of the project using the likert form shown in Appendix A. From the 20 students who participated in the experiment, 19 have completed this feedback survey.

Course Feedback: Intelligent User Experience Engineering [in4179]					
General Opinions	**S. Ag.**	**Ag.**	**Nut.**	**Dis.**	**S. Dis**
1- The use of information technology teaching resources (e.g. web-lectures) helped the delivery of course material.	6	11	1	1	
2- The use of information technology resources was necessary for presenting course material.	1	7	4	7	
3- The course material was presented in an organized manner.	2	10	5	1	1
4- The requirements of the course (projects, papers, exams) were adequately explained.	5	8	5		1
5- The course appeared to have been carefully planned.	3	7	7	1	1
6- The general climate in this course was good for learning.	5	13	1		
7- The credits assigned for this course were appropriate to the workload.	4	11	2	2	
8- The amount of work required in this course was appropriate.	2	10	4	3	
9- I would recommend this course to other students.	5	5	8	1	
10- In this course, I always felt motivated to learn.	2	4	11	2	
Attitudes about Video Recordings					
	Very Good	Good	Neutral	Bad	Very Bad
How would you rate the production quality (i.e. image/sound quality) of the web lectures?	4	11	3		1
	Very Useful	Quite Useful	Neutral	Quite Useless	Totally Useless
How useful do you consider web lectures for use in education in general?	7	8	2	2	
	Str. Positive	Positive	Neutral	Negative	Str. Negative
How would you rate your overall attitude about the navigation controls (i.e., pause/rewind/fast forward playback controls and table of contents) provided by the video player interface?	8	6	4	1	
	Very Frequently	Frequently	Sometimes	Rarely	Never
How often did you watch all or part of a video more than once?		2	8	7	2

Course Feedback: Intelligent User Experience Engineering [in4179]					
	Str. Positive	Positive	Neutral	Negative	Str. Negative
How would you rate your attitude about the material in the Video tutorials & web-lectures:	6	6	7		
Attitudes about the Course Format					
	Str. Positive	Positive	Neutral	Negative	Str. Negative
Based on your experience with the new educational tools used in the course, how would you rate your attitude toward the course?	1	13	4	1	
	Much Better	Better	About the same	Worse	Much Worse
If you compare the new course format with the traditional format, how would you rate the new course setup in comparison?	6	9	2	2	
	Much More	More	About the same	Less	Much Less
All else being equal, in comparison to other courses you have taken, how much did you learn in this course?	1	5	10	3	
	Much More	More	About the same	Less	Much Less
All else being equal, in comparison to other courses you have taken, how much did you enjoy this course?	1	9	6	3	

Question asks “During this course, how useful/enjoyable did you find each of the tools?” where higher numbers are better.

The tools	useful						enjoyable				
	4	3	2	1	0		4	3	2	1	0
Blackboard	5	4	8	1	1		2	3	7	5	2
Online wiki Manual	4	13		2			3	3	8	2	3
Pod-casts & sound recordings	5	4	5	2	3		4	4	4	6	1
Video tutorials (install prototype, ...etc)	7	7	4		1		7	3	5	4	
Recording of normal lectures	5	10	2	2			2	6	6	3	2
Discussion forum	1	2	9	3	4		1	2	7	5	4
Google Docs	3	4	6	1	5		2	4	4	4	5

App. C. Feedback results of old courses

Results of feedback surveys for the courses Design of Highly Interactive Systems (DHIS) and Usability Engineering (UE), which was conducted as a part of this project. All students of both courses were invited to participate by receiving an e-mail with a link to the online questionnaire. The survey was completed by 8 students from the DHIS course and 5 students from the UE course, forming 36% and 31% of the total number of students respectively.

Course Feedback: Design of Highly Interactive Systems [in4034]	S. Ag.	Ag.	Nut.	Dis.	S. Dis
Course Materials and Evaluation					
The course materials (e.g. book, readers) helped me understand the subject matter.		4	4		
The course materials were adequate for learning the subject matter.		3	3	2	
The use of information technology teaching resources (e.g. web-lectures) helped the delivery of course material.	2	3	2	1	
The use of information technology resources was necessary for presenting course material.	1	3		3	1
The assignments were appropriate.	1	4	1	2	
The assignments helped me learn.	1	5	1	1	
The evaluation methods were fair.	1	4	2	1	
The examinations reflected the important aspects of the course	1	5	1	1	
Course Organization	**S. Ag.**	**Ag.**	**Nut.**	**Dis.**	**S. Dis**
The course material was presented in an organized manner.		3	2	3	
The requirements of the course (projects, papers, exams) were adequately explained.	2	4	1	1	
There was a close agreement between the stated course objectives and what was actually taught.	1	5		2	
The course topics were dealt with in sufficient depth.		4	3	1	
This course was clearly relevant to my program of study.	2	4	1	1	
The course appeared to have been carefully planned.		1	2	5	
The physical facilities provided for this course were appropriate (e.g. classroom/lab space, PCs, etc).	1	5	2		
The general climate in this course was good for learning.	1	6		1	

Course Feedback: Design of Highly Interactive Systems [in4034]	S. Ag.	Ag.	Nut.	Dis.	S. Dis
The credits assigned for this course were appropriate to the workload.	1	2	1	2	2
In general, the level of difficulty in this course was appropriate.	1	3	2	2	
General Opinions	**S. Ag.**	**Ag.**	**Nut.**	**Dis.**	**S. Dis**
The course objectives were clearly explained.		6	1		1
As a result of taking this course, I have more appreciation for this field of study.	3	2	3		
This course has broadened my views greatly.	1	2	4	1	
This course helped me develop my creative capacities.	1	4	3		
The relevance of the subject matter to real world issues was made apparent.	3	5			
The amount of work required in this course was appropriate.	1	3	2	1	1
The course was challenging, but not overwhelming.		4	4		
I would recommend this course to other students.	1	2	4	1	
Overall, I learned a great deal from this course.		4	4		
I felt involved in this course.	1	4	3		
In this course, I always felt motivated to learn.		3	3	2	

Course Feedback: Usability Engineering [in4083]	S. Ag.	Ag.	Nut.	Dis.	S. Dis
Course Materials and Evaluation					
The course materials (e.g. book, readers) helped me understand the subject matter.	1	3	1		
The course materials were adequate for learning the subject matter.	1	2	2		
The use of information technology teaching resources (e.g. web-lectures) helped the delivery of course material.		3	2		
The use of information technology resources was necessary for presenting course material.	1	1		3	
The assignments were appropriate.		2	3		
The assignments helped me learn.		3	2		
The evaluation methods were fair.		4		1	
The examinations reflected the important aspects of the course		3	2		
Course Organization	**S. Ag.**	**Ag.**	**Nut.**	**Dis.**	**S. Dis**

Course Feedback: Usability Engineering [in4083]	S. Ag.	Ag.	Nut.	Dis.	S. Dis
The course material was presented in an organized manner.		1	2	1	1
The requirements of the course (projects, papers, exams) were adequately explained.		3	1		1
There was a close agreement between the stated course objectives and what was actually taught.		2	3		
The course topics were dealt with in sufficient depth.		2	2	1	
This course was clearly relevant to my program of study.	1	3	1		
The course appeared to have been carefully planned.			2	2	1
The physical facilities provided for this course were appropriate (e.g. classroom/lab space, PCs, etc).		2	3		
The general climate in this course was good for learning.	1	3	1		
The credits assigned for this course were appropriate to the workload.	1	3		1	
In general, the level of difficulty in this course was appropriate.		2	3		
General Opinions	**S. Ag.**	**Ag.**	**Nut.**	**Dis.**	**S. Dis**
The course objectives were clearly explained.		4	1		
As a result of taking this course, I have more appreciation for this field of study.	1	2	2		
This course has broadened my views greatly.		3	2		
This course helped me develop my creative capacities.		1	4		
The relevance of the subject matter to real world issues was made apparent.	2	2	1		
The amount of work required in this course was appropriate.		4		1	
The course was challenging, but not overwhelming.		1	4		
I would recommend this course to other students.	1	2	2		
Overall, I learned a great deal from this course.		3	2		
I felt involved in this course.	1	3	1		
In this course, I always felt motivated to learn.			3	2	

App. D. Paper abstract

This paper abstract was submitted to the ICL (Interactive Computer Aided Learning) international conference of 2007.

A case study of using web based services in higher education

(abstract for a full paper)

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1. Introduction

Since the rise of the Internet, many new tools and methods have been developed and used to support teaching and learning. However, the development and the deployment of such educational software have been difficult [1]. It is not easy to use such tools and methods without a structured model of the content and didactic strategies, how the media is selected, and the ways to optimize the engagement and attitude of the learners [2,3].
Younger students who grew up with the Internet are well trained in using many of the interactive tools and services it offers. We can exploit the experience they have by providing web-based tools to support learning as individuals and in groups during projects [4,5,6].

Recently a new course on *human computer interaction* (HCI) was developed for our master program Media and Knowledge Engineering. The course is called *Intelligent User Experience Engineering* (IUXE), and teaches the design and evaluation of user interfaces. This course is based on several years of experience with two separate courses that handled the design and evaluation aspects separately. In addition, the new IUXE course concentrates on the topic of user experience in the design process. The learning objectives were merged and the subject matter was integrated. Students following the course have to work in teams. They have to learn to use a number of supporting tools (Morae, etc.) and methods (scenario-based design, etc.). This results in the need to provide tailor-made manuals and guidelines to improve group-work efficiency. We implemented a set of integrated educational software tools for this course which include Blackboard, wiki, discussion forums, Google Docs, pod-casts, video-tutorials, and lecture-recordings.

The goal of this paper is to describe the way these tools were implemented and how they were used by the student teams. We present subjective (questionnaires) and objective (recordings and loggings) measures to evaluate the way the tools were used [7,8]. The results of the experiment show how the tools were used by the students, and how successful they were in achieving the desired goals set by the educators.

2. Implemented functionalities

The Delft University of Technology is developing a large assortment of web-tools to offer to their staff of educators. However, even though great efforts and resources are being dedicated for implementing these tools, very little information is available on how to best utilize these new tools in the educational process. The department of *Man-Machine Interaction* (MMI) has therefore performed a small-scale experiment that would test many of these tools, examine how to best utilize them and how successful they are.

The experiment started by trying to identify which potential problem areas in the new course can be addressed using the new tools. This was done by performing feedback surveys of students who followed another course which used a setup similar to the IUXE course.
From the feedback it became clear that the students had trouble keeping up with the different course activities due to the course's complex construction. The course consisted of a number of separate stages, it used diverse sources of information, and involved using a number of tools and programs that students were not familiar with. Therefore, the main focus for the new tools became the reduction of the course complexity.
Additionally, the instructors wanted the tools to play a significant part in delivering the instructions to the students. The aim was to create an interactive information environment that is both accessible and appealing to the students. Choosing what tools to use and how to use them was done based on a Learner Centred Design approach [9]. This meant that a portion of the tools will help learners when necessary, and fade away once they are more familiar with the course material.

Here is a list of the tools used in the course:

- **Blackboard** is the main tool for the whole university where all general course information and announcements are given. It therefore formed the starting point that links to other course components.
- **The wiki course manual** forms the central base of all the used tools. The wiki nature of the manual allowed the team of instructors (five in total) to collaborate on building the content of the course manual. It also allowed for continuous improvements of the manual content while being used by the students.
- **The discussion forums** give students quick access to instructors and fellow students. By linking forums to pages of the wiki-manual, students can easily find relevant discussions to what they are reading.

- **Google docs and spreadsheets** serves as a centre for course-work where students (in groups of four) can collaborate on their work and get real time feedback from course instructors.
- **Pod-casts** are produced containing weekly news bulletins about course activities.
- **Video-tutorials** are provided illustrating the usage of some software packages used in the course.
- **Lecture recordings** allow students to review full recordings of the course lectures.

The full paper will contain more detailed description of the tools including a few screenshots of their contents.

3. Results

The experiment is still currently running, and will conclude in June 2007. By the time the full paper is written, the complete result analysis based on usage statistics and feedback surveys will be presented. However, based on some interviews carried out halfway through the experiment it is possible to give some intermediate results.

The majority of the students welcomed the new tools and the whole interactive approach of the course. They found that using rich multimedia tools makes them feel more motivated when performing course work. Some even said that seeing the amount of effort being put in the construction of the course made them feel compelled to work harder.

On the other hand, some students complained about the large amount of new tools being used in the course, and few even refrained from using the majority of the offered tools. This will allow us to perform a comparative analysis between those who use the tools and those who do not.

For results on the specific tools:

- **Wiki manual:** students found it very accessible and easy to use, and liked having control over the content. However, many complained when significant changes were made to the content.
- **Discussion forum:** was initially used for communication among students. However, as the course progressed and students became acquainted, the forum was abandoned. It may be more useful for distant learning or courses with high number of students.
- **Google docs and spreadsheets:** some students appreciated the accessibility it offered them and enjoyed the quick feedback from the instructors. Other students did not like its limited functionality.
- **Pod-casts:** very few students went through the process of subscribing to the pod-cast feed. However those who did found them to be both informative and an enjoyable source of information.
- **Video-tutorials:** most students preferred to use the video tutorials to learn how to use the software applications. They were described as great time savers.
- **Lecture recordings:** some students used the recordings when missing the real lectures. Students with poor English also appreciated the ability to review the lectures. It is expected that these recordings will be heavily used in preparation for the course examination.

4. Conclusions

With very little investment of time and money, it was possible to construct a course that uses multimedia channels and interactive tools. Preliminary results show that most students liked the tools provided by the course. They found it enjoyable to get course instructions through alternative multimedia channels, and felt more motivated to do course work. Since the majority of the tools offered in the course were optional, the fact that the students opted to use them is a good indication of their success.

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