

University of Toronto
Department of Computer Science:
A Feasibility Study

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February 4, 2002

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Introduction:

Organization Description

The Department of Computer Science (DCS) at the University of Toronto was the first computer science department established in Canada. In a recent study it was rated the foremost Canadian computer science department and among the best in North America. Fields of study include Information Systems, Computer Science, Software Engineering, Human-Computer Interaction, Cognitive Science and Artificial Intelligence. Many programs combine another field with computer science, such as Economics, Mathematics, Physics or Statistics. The DCS offers the latest equipment and software to students. On all three campuses (St. George, Erindale, Scarborough) PC and UNIX workstation environments support the growing computing needs of all undergraduate and graduate courses.

The introduction of the World Wide Web has revolutionized the face of education. It is a rich source of information for students, lecturers, researchers, and professionals. It allows us to get information quickly and effectively. It has been embraced world wide as a universal means of communication. Therefore, for our study we chose to analyze the Department of Computer Science web system. We will discuss possible alternative solutions to the current system and determine which solution is the best.

Understanding the Current System:

Currently all computing support for undergraduate courses in the Department of Computer Science is provided by the Computing Disciplines Facility (CDF). In order to understand the current CDF infrastructure, we interviewed CDF System Administrator Lloyd Smith (See Appendix B). Lloyd is the Lead Administrator for the CDF-PC environment and is heavily involved with all aspects of CDF administration and user support. He was able to give our group valuable insight regarding the CDF infrastructure and users.

CDF hardware support consists of three Sun Solaris workstation laboratories, one Linux workstation laboratory, and two Microsoft Windows-based PC laboratories. All access to the CDF system, including any CDF applications, is granted through user accounts. Students are issued user accounts to the system under two circumstances:

- (a) Students enrolled in a Computer Science undergraduate program may request a permanent user account, which is deployed by the system administrators.
- (b) Students without a permanent account are issued user accounts on a per-student-per-course basis, which are removed from the system upon completion of the course.

Support for web initiatives in the Computer Science department is also provided by the CDF. Undergraduate course websites are stored on CDF servers. CDF system

administrators deploy and administer storage space on these web servers. It is important to note that all content on individual course web pages is created and maintained solely by the professor or teaching assistants.

Currently there is a main portal for the online CDF community, which exists at <http://www.cdf.utoronto.edu> (See Appendix A – Figures 1 & 2). Among other options, the current interface allows students to access a list of course websites for all undergraduate and graduate courses in the department. As the content is created and maintained by the professor, added functionality is included at their discretion. Current course website functionality includes; course syllabi, announcements, lecture materials, assignment information, course standing, sample tests, CDF account listings, and scheduling information for important dates.

CDF also maintains a news server with individual newsgroups for each course. The newsgroups provide a forum for individuals involved with the course to communicate (See Appendix A – Figure 6). Students use the newsgroup to ask questions, which are then answered by professors, teaching assistants, and other students. Some professors use the newsgroup to communicate announcements and other course related information. The newsgroup service is a stand-alone system, which is not incorporated into the course website, both being independent of one another.

In addition to the CDF Home Page, there exists a CDF online information system with limited functionality. The application is located at <https://www.cdf.utoronto.ca/students> (See Appendix A – Figure 3 & 4). This system contains functionality for the online submission of assignments. Professors update the information system with assignment deadline information so that students may submit their assignments from the internet. The system mimics the functionality of the assignment submission tool available to users working in the CDF laboratories.

There also exists a CDF tool in which the professors can enter their course marks, which are automatically formatted and submitted to the DCS. This tool was created by the system administrators to simplify the process of submitting course grades and ensure that they are in an acceptable format. This tool is a stand-alone application, operating independently of any of the aforementioned systems.

Scope of the Study:

The scope of this study will be limited to the means of communication between members of the DCS, specifically the undergraduate course web pages, newsgroups and email. The main focus of our analysis will be related to integration, standardization and simplification. The current system involves the use of multiple tools and formats. Some may not consider this to be a problem, however it is clear that integrating, standardizing and simplifying will save time.

The reason for limiting our study to undergraduate computer science students and faculty is simply due to higher technological literacy. For example, compared to English students, Computer Science students are generally more comfortable using newsgroups. This natural aptitude for computers guarantees that new technologies will be more readily accepted. It also allows our solution to capitalize on the newest technologies and hence be as effective as possible.

We are limiting our scope to course web pages, newsgroups and email because they are the most widely used methods of communication. Given their frequency of use, it is no surprise that user opinions were resolute and well informed. These facts ensure the integrity of our data and accuracy of our analysis.

Users:

The users of the DCS Information system can be split up into two groups; students and instructors. For this project we interviewed professors, students and teaching assistants in order to get their feedback on our proposed solutions.

Professors:

Currently, there are more than 90 individuals affiliated with the DCS at the faculty member level, providing instruction for approximately 52 courses. Professors use the web to post announcements and material, upload assignments, provide contact information, post marks, and facilitate communication with their students. Professors are usually responsible for updating web content for their various courses.

Interview - Professor Gries:

Professor Gries is a first year Computer Science lecturer at the University of Toronto. He currently teaches about seventeen hundred students. Professor Gries maintains his own course web pages and updates them about five times a day. He feels that it takes too much time to update his web pages with the current system. Professor Gries uses e-mail and newsgroups to communicate with students. He spends an hour and a half answering e-mail each day, receiving approximately three hundred course related messages from students each week.

Website Management Tool Concept:

Professor Gries would find this tool beneficial if it allowed flexibility for the professors. He feels that personal control on course web pages is very important and that the faculty of computer science would embrace a tool to automate the tedious updating to course websites. Professor Gries feels that there are many common aspects of course web pages and that they can be easily automated. If instructors had a standardized template to automate the majority of tasks, then they would be better off. Students will benefit from the extra time instructors will have. In addition he feels that his first year students would benefit from a standardized site. It would be less confusing to new users.

CSSC Portal:

Professor Gries would use many of our proposed tools. He is open to test a new system and find out if the students and faculty will embrace it.

Cost effectiveness:

Professor Gries feels that this will be a cost effective idea. He spends a lot of my time manually updating personal course websites and feels that a professor's time is valuable. Giving professors an hour extra per week is very cost effective. He feels this idea does not sound very expensive to implement since all the hardware is already available.

Interview - Professor Mylopoulos:

Professor Mylopoulos is the instructor for Information System Design and Analysis (CSC 340) at the University of Toronto. He currently maintains his own web page for this course, which is updated about once per week. The updates of the web page require an hour or two. He does not feel that this is too much or wasted time. His main concern is the inability to implement advanced features. Some of the advanced features he would like to see are chat rooms and secure access.

His main method of communication with students is the news page on the web site. While a newsgroup would allow more interactivity between him and the student body, he feels that it would create confusion. Having multiple sources to check for announcements makes it necessary for him to post announcements many times in different places. Students also suffer because they have to check each of the sources to ensure that they have all the relevant information. Two solutions that could help to alleviate these problems are integration of the sources or automation.

Website Management Tool Concept:

Currently, professor Mylopoulos edits the HTML in the web pages directly. The amount of labour combined with his proficiency with HTML severely limits the amount of functionality implemented in his web pages. He feels that any tool that would enable him to easily implement more advanced features would be very beneficial.

Interview - Professor Lee:

Professor Lee is the instructor for Discrete-event Simulation and Modeling (CSC 354), at the University of Toronto. Currently, the course does not have a web page. Professor Lee believes that course web pages lead to information overload on the part of the students. As such, it is not an effective teaching tool. He is adamant about his stance on web pages and would not implement a web page even if it was easier to do. While he does not maintain a web page, he does provide a directory on the CDF servers where students can obtain lecture overheads.

Professor Lee communicates with his students through office hours, lectures and email. He does not feel that he spends too much time on any of these methods of communication.

Despite being against course web pages, he does have some suggestions for any new system that would replace the current one. These suggestions are aimed at solving, what he sees as the current problems. Any new system should include just the bare essentials and be extremely straightforward both in use and design, basically an overall simplification of the system.

Students:

There are currently thousands of undergraduate students in the DCS. Many undergraduates utilize the web to research assignments, check for posted news and announcements, download lecture material, and communicate with other students and faculty.

For our feasibility study, we interviewed eleven computer science students at the University of Toronto. All students were enrolled in at least one DCS course and all of their courses had a supplemental course website. Most students check their individual course web sites at least once a day and usually more often closer to assignment deadlines. Students felt that course web sites are a great learning tool and every DCS course should offer one. Students had mixed opinions about whether a new system would be more beneficial. They felt that the current system met their expectations. Most students would like to see a change or upgrade to the current web systems. A few were opposed to the idea and some were indifferent.

Best means of communication

Many students felt that the best means of communication between each other, teaching assistants and professors are newsgroups and e-mail. They had many ideas about new tools that many improve communication such as:

- online office hours
- course chat rooms (e.g. csc340 chat room)
- web cameras installed on all computers in the CDF and CDF-PC
- online seminars
- implement net-meeting

Teaching Assistants:

Teaching assistants play an important role in the undergraduate program of the University of Toronto. As teaching assistants, they work in close partnership with faculty members in apprenticeships that are an integral part of graduate education. Many teaching assistants maintain both personal websites and course websites for professors.

For our feasibility study we interviewed two computer science teaching assistants. Both had their own personal website that they use to share information and communicate with students. They update their web pages on a continual basis and use simple HTML text editors. These teaching assistants discourage the use of newsgroups as a means of communication. They feel that it is unnecessary to utilize multiple sources of

communication and spend too much time answering newsgroup postings. E-mail was the preferred means of communication for these teaching assistants.

Website Management Tool Concept

Teaching assistants found the Website Management Tool useful. However, there were some added features that they felt should be implemented. Some suggestions were:

- Allow optional personal space on course websites for teaching assistants to post tutorial notes, office hours, and announcements
- Space to post sample assignments
- Allow teaching assistants to control accessibility to personal space on course website

Web Portal

Teaching assistants found the Web Portal to be a beneficial and cost effective proposal. Some proposed added features were:

- timetable application to enter office hours
- unimportant information should be filtered

Problems:

We will use the PIECES framework to understand and assess the current system further.

Performance:

Does the current mode of operation provide adequate throughput and response time?

No, the current mode of operation does not provide adequate throughput and response time. Professors spend a moderate portion of their time updating their course websites. Response time is degraded as professors are busy performing other tasks. They may not be able to upload lecture and supplementary material to the course website in sufficient time, due to the complicated process involved.

Information:

Does the current mode provide end users and with timely, pertinent, accurate, and usefully formatted information?

No, the current mode does not provide end users and with timely, pertinent, accurate, and usefully formatted information. From the evaluation of the current system's performance above, we can see that professors do not always have time to maintain the information, causing it to become outdated quickly. Some professors do not make use of all the advanced functionality for disseminating information as current components are not integrated with each other. For instance, to post a course announcement with the current system, the professor would be required to update the news section of the current website

and then post a message to the course newsgroup, as they operate independently of each other. There also exist many broken links on course websites, due to changing content and location of information on the Internet. The format of the information is not consistent on all course websites. Students have to become familiar with many different interfaces, causing them to spend more time locating pertinent information.

Economy:

Does the current mode of operation provide cost-effective information services to the Department of Computer Science?

No, the current mode of operation does not provide cost-effective information services to the DCS. Professors spend more time than necessary creating and maintaining their course websites, due to the current complexity of the task. This is not cost effective as the professors should be allocating this time to complete other tasks within the DCS.

Control:

Does the current mode of operation offer effective controls to protect against fraud and to guarantee accuracy and security of data and information?

Yes, the current mode of operation does offer effective controls to protect against fraud and to guarantee the accuracy and security of data and information. CDF administrators have taken a number of measures to ensure that the current system is secure and accurate. Professors have the choice of storing their course website content on the CDF servers or on their own servers (with the CDF redirecting the links to a given URL). All user accounts providing access to website directories are secured through standard UNIX password encryption. The CDF Secure Website (See Appendix A – Figures 3 & 4) encrypts all transfer of data using 128-bit strong encryption. Administrators have also added additional security measures to the course newsgroup component, so that anonymous postings are not permitted. This assists in ensuring that the information is pertinent and fraudulent postings (i.e. spam messages, etc.) are not included in forum listings.

Efficiency:

Does the current mode of operation make maximum use of available resources, including people, time, and flow of forms?

No, the current mode of operation does not make maximum use of available resources, including people, time, and flow of forms. As mentioned above in the performance and economy evaluations, professors' time is squandered trying to create and maintain their course websites. Therefore the current mode of operation is not only an inefficient use of their time, but also is a misuse of the DCS's funds. CDF hardware resources are capable of handling a more advanced system, making the current process an inefficient use of CDF infrastructure.

Services:

Does the current mode of operation provide reliable service?

Yes, the current mode of operation does provide reliable service. Administrators ensure that CDF services are almost always operational. All maintenance, that would require a disruption of service, is scheduled during off-peak hours and users are informed of maintenance windows well in advance.

Major Problem Areas:

The process of assessing the current system, using the PIECES framework above, has resulted in identification of problems in three key areas of the current system.

Simplicity:

The current system is very time-consuming requiring the professors to have thorough knowledge of HTML, in order to create and maintain web pages. This is a major disadvantage as professors have a limited amount of time in which to administer their courses. The complexity of the system will deter professors from using it and cause them to not implement the added functionality that would prove beneficial for the students.

Integration:

There are many components to the current system, all of which are excellent mediums for communication. However, none of the components of the current system are integrated together. There is too much work involved in using the advanced functionality so that all components are used. The components of the system include course websites, course newsgroups, online submission tools, a grade submission tool, and email correspondence. Although to utilize all of these components together requires students to use many different applications, which can be confusing to learn and resource intensive for their computers.

Standardization:

Currently there is no standardized layout for course websites. The majority of course websites have different layouts forcing students to investigate and learn where certain information is kept. At the beginning of each term they must familiarize themselves with new websites layouts. It is very likely that students do not find important information pertaining to their courses, due to the inability to locate it. Website locations change every semester forcing students to remember uncomfortably long URLs for each course.

Objectives and Requirements

We will use the three major problems, as defined by the PIECES framework, to outline our objectives and requirements. The three key problem areas are **Integration**, **Standardization**, and **Simplicity**. We will try to solve these problems using the following list of goals:

- Develop an environment for students to interact with professors, teaching assistants, and other students.

- Standardize course web sites contained within the community
- Increase usability
- Develop ways for professors to spend less time creating and maintaining their course websites.
- Provide students with an information resource of services
- Develop new systems that will be integratable with the current DCS system

Comparison Criteria:

The comparison criteria for our study are based upon the end users of the system, as well as, the people who must maintain it. The criteria are as follows:

Cost (Economic feasibility):

The cost of the system is very important in determining its feasibility. Both operational and developmental costs must be taken into account. Developmental costs are the one time payments associated with creating the new system. In our case this could be from the purchase of new software, servers, etc. The operational costs are a result of everyday maintenance of the system. This includes salaries of administrators, internet services, etc. Ideally a new system will lower the amount of time administrators spend maintaining the system. The time that teaching assistants and instructors spend communicating with students should be as effective as possible, whether it is through a web page, and email. The increased efficiency of administrators, teaching assistants and professors should increase their productivity and decrease operational costs.

Ease of use:

Any new system will affect hundreds of people. Ensuring that the new system is easy to use and learn will help ensure its acceptance. For our analysis, various factors will play a role in determining how easy an alternative is to use. Familiarity is probably the most important. Using technology that is well established decreases the learning curve of a new system. Another important factor is simplicity. A simple and intuitive interface will reduce the learning curve as well as being user friendly.

Ease of Implementation (Schedule feasibility):

This criterion evaluates the time and effort required to implement a system. Although the amount of time required to implement a new system is not critical, it still has some importance. Since information technology moves at such a fast rate, having the new system implemented quickly ensures that it is still up to date when being used.

Security:

The ability of the system to provide access to private information is important. Most of the information relevant to students is private to either themselves or a small group. For example, a project group may want to have a private chat room.

Reliability:

The system should be reliable and provide all of its promised functionality at all times. The students and faculty members are usually under tight time constraints and crashes that prevent them from accessing information can be very problematic.

Maintainability and Automation:

The amount of time and effort required for administrators to maintain the system. This does not include repair time, but rather the everyday “house cleaning” that must be performed. The ability of the system to perform these tasks by itself is an important factor.

Scalability:

While the scope of this study is limited to undergraduate course web pages and electronic communication, the ability to scale the system to include a larger demographic would be beneficial.

Ability to integrate with current technology:

This criterion evaluates the amount of technology that is required to implement a new system. The evaluation is done in comparison to the technology currently available to CDF. The more new technology, whether it is software or hardware, that is required will undoubtedly have an economic cost. For example, the time taken to purchase new technology could be spent doing something else.

Functionality:

The criterion evaluates the power and number of functions that the system provides to the user. Obviously there is the possibility to overload the user with too many options, but generally more is better. The functions that will be most important are the ones requested by the students, teaching assistants and professors.

Criterion	Weight	Reason
Cost	15%	The cost of the system is heavily weighed because there is no expected income from the system. All benefits are intangible. Given that there is no tangible monetary payback from the system, the more expensive it is the less appealing.
Ease of use	17%	This is the most important criterion. The acceptance of the system is based on this property. Almost all of the end users specifically stated that simplicity was extremely important for any new system to be successful.
Ease of implementation	5%	This criterion is at the bottom of the scale in terms of importance. The administrators are experts in their fields and can handle any system considered in this study. However the easier a system is to implement means more time to accomplish other things.
Security	12%	Accessing private information and being satisfied that the information is secure is very important. As stated earlier

		some of the most important information to a student is private (ie. Marks).
Reliability	12%	This criterion is important, however the information and services provided by the system are not critical.
Maintainability and automation	5%	This is not very important since administrators are only concerned with tasks requiring replication across multiple systems. They would rather have more control and less automation.
Scalability	5%	Another quality of the system that would be nice to have but not critical.
Ability to integrate with current technology	13%	The most important criterion for the administrators. They have explicitly stated that any new system should run on the available equipment.
Functionality	13%	This is important since the majority of students, teaching assistants, and professors have requested extra functionality. It is clear that the system that provides the most of them will be the most appealing.

Alternatives:

There are many alternative solutions to upgrade the current DCS website. After interviewing professors, teaching assistants and other students, we came up with the following list of the best alternative solutions.

Alternative 1– Maintain the Status Quo

Keep the current system and processes for creating and updating web pages

Alternative 2 – Policy on Course Websites

Instead of developing a whole new information system we could simply construct a written policy on creating websites under the DCS. The policy could encourage all instructors to ensure that their web pages followed the World Wide Web Consortium (<http://www.w3.org>). The policy would urge professors to follow a standard general template. The policy could discuss security issues and standards on content and communication.

Alternative 3 - CourseBoard

(See Appendix A – Figure 7)

The current system could be integrated with CourseBoard. CourseBoard is a Web-enabled course support system implemented by the Department of Geography at Erindale College (University of Toronto). CourseBoard helps instructors create and manage web pages related to courses currently being taught within the department. The pages provide an accessible point of contact between students and instructors as a course progresses. CourseBoard offers a hierarchical organization within the course, allowing the instructor

to set up sections specific to individual labs, topics, or other logical units. All of the structure and content is created and managed through a Web-based interface that gives the instructor freedom to update his/her web pages whether they are familiar with HTML or not.

CourseBoard website: <http://eratos.erin.utoronto.ca/CourseBoard/common/about.msq>.

Alternative 4 - WebCT Inc.

(See Appendix A – Figure 7)

Instead of developing a whole new information system we could integrate the current system with the tools offered by a company called WebCT. WebCT, Inc. is a provider of e-Learning solutions for higher education. WebCT's mission is to help institutions deliver on their commitment to educational excellence with enterprise-wide learning management solutions which integrate tools with existing campus infrastructure. WebCT is partners with more than 2,200 institutions in 77 countries around the world. The main products that WebCT offers are fully customizable online course materials, such as video animations, sample syllabi, lecture notes and quiz and test banks. Instructors will be able to start teaching online without having to create a course from scratch.

WebCT website: <http://www.webct.com>.

Alternative 5 – Website Generation Tool

This alternative will provide instructors with an on-line tool that will automatically generate standardized HTML pages. The instructor will login using a secure username and password. The user can then use the tool to fill in relevant information like:

- Contact information
- Assignment/test due dates
- Announcements
- News
- Teaching assistants and instructor office hours

The tool will also build a left navigation bar that will be standard for all pages under the DCS. This alternative will not have a backend database to store information. The consequence of this system is that the professor would have to make updates manually once pages were generated.

Alternative 6 – Online Interactive Course Management Portal (CSSC)

This alternative is similar to alternative five, but with a lot more functionality and automation features. We propose to create the Computer Science Student Community (CSSC). CSSC will be an online interactive information system for students in the DCS. The CSSC will be developed to provide an environment for students to interact with professors, teaching assistants, and other students. All course web sites will be contained within the community and be standardized for increased usability. Professors will spend less time creating and updating course websites, due to the standardized template. In addition, it will provide students with an information resource of services provided by the

DCS.

Website Management Tool:

In order to implement CSSC, we must first create a tool for professors to update their personal course web pages as efficiently as possible. The tool will be web-based and have a back-end database that will store the input given by the user.

The professor will login to the tool with a secure username and password. The system will recognize the username and password and then display a list of all “Computer Science” courses that this professor teaches. The user then selects a course to update. They will update new and old information such as:

- contact information
- teaching assistant lab/office hours
- assignment test schedule (using calendar tool)
- student grades
- tutorial sections

The user will have the ability to update any of this information and all changes will be reflected in the database.

A special feature is that the user will have the ability to choose what modes of communication they want to share with their students. They may choose:

- Online Forums for each course (supplementing newsgroups)
- Private Messaging (facilitate student communication and learning)
- Online Office Hours (Chat/Video Conferencing)
- Scheduling of tests and assignments (Online Calendar)
- Assignment submission tool

All information will be stored in a database, so it can be retrieved dynamically for further updating.

CSSC Portal:

All pages will now be created dynamically. It will reduce the need for manual updating. Students will have the ability to log into the CSSC using their CDF or CDF-PC accounts and view a personalized homepage. The page will display links to every course the student is currently taking. It will list all assignments/tests and due date. All web pages will have a standardized design which will allow for ease of use.

Alternative Analysis:

Cost Analysis:

The cost analysis is based on the best information that was obtainable at the time of the study. The wages and salaries are based on the average salaries posted at

salaryexpert.com. The figures are for Toronto based positions and given in Canadian dollars. The estimated development times are stated in man-hours and were obtained from a system programmer at Hostopia.com. Hostopia is an internationally recognized wholesale web hosting company.

Table: Alternative Development and Operational Costs in year of system implementation:

Alternatives	Development Cost	Operational Cost	Total	Total Difference from current system
Alternative 1	\$ 0	\$ 226,800	\$ 226,800	\$ 0
Alternative 2	\$ 1,500	\$ 226,800	\$ 228,300	\$ 1,500
Alternative 3	\$ 2,080	\$ 226,800	\$ 228,880	\$ 2,080
Alternative 4	\$ 0	\$ 234,633	\$ 234,633	\$ 7,833
Alternative 5	\$ 5,160	\$ 226,900	\$ 232,060	\$ 5,260
Alternative 6	\$ 10,600	\$ 226,900	\$ 237,500	\$ 10,700

To determine the profitability of each alternative the present value perpetuity of the cost was subtracted from the present value perpetuity of the savings. The perpetuity is calculated without the administrators' salaries because keeping any system running requires that cost. By eliminating that cost, we can more easily determine relative costs between our six alternatives. The discount factor used is 4.75%, which is the current prime interest rate.

Table: Lifetime profitability of each alternative:

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Development Cost	\$ 0	\$ 1,500	\$ 2,080	\$ 0	\$ 5,160	\$10,600
Present Value Perpetuity of Operational cost	\$ 0	\$ 0	\$ 0	\$ 172,738	\$ 2,025	\$ 2025
Total Present Value Cost	\$ 0	\$ 1,500	\$ 2,080	\$ 172,738	\$ 7185	\$ 12625
Present Value Perpetuity of Of Savings	\$ 0	\$ 0	\$ 809,463	\$ 4,856,871	\$ 1,618,947	\$ 4,856,871
Net present Value	\$ 0	\$ -1,500	\$ 807,383	\$ 4,684,133	\$ 1,611,762	\$ 4,844,246
Years to Profitability	N/A	Never	0.056	0.784	0.097	0.057
Return on Investment	0 %	-100 %	38,816 %	2,711 %	22,432 %	38,307 %

Alternative 1:

Development Costs:

There are no developmental costs associated with keeping the current system.

Operational Costs:

There are currently no licensing costs associated with the current system. CDF currently employs 5 system administrators. The current average salary for their position is \$45,360. The total current operational cost is $\$45,360 * 5 = \$226,800/\text{year}$.

Total Cost:

The total cost of the current system is \$226,800.

Alternative 2:**Development Costs:**

Establishing a formal written policy on web pages would require a technical writer. Their current expected salary is \$39,007. The approximate hourly wage is \$18.75/hour. We expect that this project would take 80 hours to complete. The total development cost of this alternative is $\$18.75/\text{hour} * 80 \text{ hours} = \1500 .

Operational Costs:

The only costs associated with this option are the administrators. Therefore the total operational cost is \$226,800/year.

Total Costs:

The total cost of alternative two is \$228,300.

Alternative 3:**Development Costs:**

The Courseboard software is currently free. Courseboard would have to be integrated with the current system. The estimated time to complete this job is 80 hours. A web developer currently makes \$53,969 or \$26/hour. The development cost for this alternative is $\$26/\text{hour} * 80 \text{ hours} = \2080 .

Operational Costs:

The operational costs are the same as alternative two. Once Courseboard is integrated into the current system, the administrators will maintain it. Therefore the operational cost of this alternative is \$226,800/year.

Total Costs:

The total cost of alternative three is \$228,880.

Alternative 4:**Development Costs:**

There are no development costs associated with webCT.

Operational Costs:

The operational costs associated with webCT were obtained by contacting the company. The information is basic pricing information. Specific prices could be obtained if the decision to implement webCT is made. There are three basic operational costs associated with webCT, an annual licensing fee, faculty support fee, and system administration fees.

The licensing fee is \$6480/year for an unlimited number of students. The faculty support fee is \$543/year and the system administration fee is \$810/year. The total operational cost for webCT is \$7833/year. The system administrators currently employed by CDF would still have to maintain parts of the system. Therefore the total operational cost for the first year is \$234,633/year. The present value of the perpetuity, not including administrator's salaries, is \$172,738.26.

Total Costs:

The total cost of alternative four is \$399,538.

Alternative 5:

Development Costs:

The development of a web page generation tool would require a web developer. The estimated time to complete this project is 160 hours. Given the hourly wage in alternative three, the cost of the tools development is \$4160. One time training sessions would also be required to introduce the tool to the faculty. This should take approximately ten sessions at \$100/session. Each session would be two hours and train about ten faculty members. Therefore the total training cost is \$1000. The total development cost is \$5160.

Operational costs:

The only operational costs for this alternative are due to the system administrators and one training session per year. The cost of the training session is estimated at \$100. This makes the total operational cost \$226,900/year. The present value of the perpetuity, not including administrator's salaries, is \$2205.26.

Total Costs:

The total cost of alternative five is \$229,005.

Alternative 6:

Development Costs:

The development of alternative six requires a web developer. The estimated time to complete the project is 320 hours. The estimated hourly wage for the developers is \$30/hour. It is higher than the estimated wage in alternative 3 because the required knowledge is significantly higher. The cost of this alternatives development is \$9600. One time training sessions will also be required. They will be the same as alternative five. The total development cost is \$10,600.

Operational Costs:

The total operational costs are the same as in alternative five, \$226,900/year. The present value of the perpetuity, not including administrator's salaries, is \$2205.26.

Total Cost:

The total cost of alternative six is \$239,705.

Benefits:

Table: Monetary, Tangible and Intangible benefits of Alternatives

Benefit Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Monetary	Ranks 5 th	Ranks 6 th	Ranks 4 th	Ranks 2 nd	Ranks 3 rd	Ranks 1 st
Tangible	Ranks 6 th	Ranks 5 th	Ranks 4 th	Ranks 2 nd	Ranks 3 rd	Ranks 1 st
Intangible	Ranks 6 th	Ranks 5 th	Ranks 4 th	Ranks 1 st	Ranks 3 rd	Ranks 2 nd

Alternative 1:

Tangible	Intangible
<ul style="list-style-type: none"> - No time needed to learn a new system - No extra time used by Professors and teaching assistants to recreate web pages - Reduces need for new employees 	<ul style="list-style-type: none"> - Professors, teaching assistants and students may be happy with current system

Alternative 2:

Tangible	Intangible
<ul style="list-style-type: none"> - No time needed to learn new applications 	<ul style="list-style-type: none"> - Students satisfaction improves with new policies on web page design (i.e. due to standardization) - Utilizing new policies give the DCS a better reputation with the University of Toronto.

Alternative 3:

Tangible	Intangible
<ul style="list-style-type: none"> - Learning time reduced because some professors within the geography department are already familiar with the system - Development time is reduced because system has already been developed and used in University of Toronto's Geography department. - Increases productivity of all end users 	<ul style="list-style-type: none"> - Professors are not required to know HTML - Having a proprietary system could increase the reputation of an academic institution such as University of Toronto.

Alternative 4:

Tangible	Intangible
<ul style="list-style-type: none"> - Reduce the time for professors to recreate/update their web pages - Reduces maintenance time since webCT provides system administrators. - Easily integratable - Offers enterprise wide learning management solution which integrate tools with existing campus infrastructure - Increases productivity of all end users 	<ul style="list-style-type: none"> - Professors are not required to know HTML - Implementing a major system like webCT could increase the DCS exposure - Could have a positive effect on reputation of DCS - Quality and customer service guaranteed by webCT

Alternative 5:

Tangible	Intangible
<ul style="list-style-type: none"> - Reduces the time required to recreate/update their web pages - Will not increase maintenance time of system administrators - Easily integratable - Increases productivity of all end users 	<ul style="list-style-type: none"> - Only basic HTML knowledge required - Students satisfaction improves with new policies on web page design (i.e. due to standardization) - Could have a positive effect on reputation of DCS - Having a proprietary system could increase the reputation of an academic institution like University of Toronto.

Alternative 6:

Tangible	Intangible
<ul style="list-style-type: none"> - Reduces the time required to recreate/update their web pages - Offers enterprise wide learning management solution which integrate tools with existing campus infrastructure - Increases productivity of all end users 	<ul style="list-style-type: none"> - Professors are not required to know HTML - Students satisfaction improves with new policies on web page design (i.e. due to standardization) - Could have a positive effect on reputation of DCS - Having a proprietary system could increase the reputation of an academic institution like University of Toronto.

Feasibility Matrix:

Criterion	Weight	Alternatives					
		1	2	3	4	5	6
Economic Feasibility							
Cost	15 %	4	1	6	9	7	10
Operational Feasibility							
Ease of use	17 %	4	3	7	6.5	7.5	8.5
Functionality	13%	5	5	2	10	6.5	8
Security	15 %	9	10	9	9	9	9
Reliability	12 %	8.5	9	8	9.5	8.5	8.5
Maintainability and Automation	5 %	4	3	5	6	5	7.5
Technical Feasibility							
Scalability	5 %	2	9	8	7.5	9	4
Ability to integrate with current technology	13 %	10	9	4	5	8	10
Schedule Feasibility							
Ease of implementation	5 %	10	9	7	6	7	5
Overall Score	100 %	6.4	6.1	6.3	7.9	7.6	8.5

Summary of Findings:

Alternative 1:

Keeping the status quo has a few marginal benefits. By far the biggest strength of this option is that it does not change the current system. In terms of economic feasibility, keeping the status quo also does not have any new expenses related to its implementation. However, no significant benefits arise from maintaining the current system.

This alternative scored 6.4, ranking fourth among all the options. This score is due to low ratings in the operational and economic feasibility.

Alternative 2:

Developing a policy on web page design is the weakest alternative. It scores poorly for ease of use and maintainability. This is due to the fact that making the professors and teaching assistants adhere to the policy requires a significant amount of work. We believe that this outweighs the benefit of standardized web pages to the student. Economically, the alternative loses money since it does not create any time savings for a professor. It is the only alternative which loses money. The policy option does score high in terms of technical and schedule feasibility.

This alternative scored 6.1, putting it in last place. This is because of extremely low marks in the economic and operational feasibility criterion.

Alternative 3:

This alternative essentially scales a current system at U of T's geography department to encompass CDF. Since the system is already implemented it has high marks for schedule feasibility. This alternative has a non-zero net present value, although it is the lowest among all the other non-zero net present value alternatives. The biggest weakness of Courseboard is its lack of functionality. It is an extremely basic system, with most of the implemented features being either useless or unwanted.

This alternative scored 6.3, placing it in fifth position. It receives mediocre marks across the board and does not excel any category relative to other alternatives.

Alternative 4:

WebCT is a very powerful system that ranks highly in almost all the criteria. Its biggest strength is in functionality, receiving a perfect score of ten. However, what it gains in functionality it loses in ease of use. The system is fairly complex and requires extensive training/learning to gain proficiency. This alternative receives its lowest marks in maintainability and automation as well as its ability to integrate with current technology. WebCT would maintain the system, removing the current CDF administrators from the system. As a result of this CDF loses some control. The risk of implementing this alternative is relatively low because the product is well known and has been on the market for some time.

This alternative scores 7.9, placing it in second. The number of criteria that received high marks outweigh the criteria with low marks, however the criteria that received low marks performed really bad compared with the first place alternative.

Alternative 5:

This alternative involves the implementation of a web page generation tool. It scores highly in most categories. The criteria with low scores are the relatively close to all the other alternatives. While this alternative does not score poorly in any category it's not the leader in any category.

This alternative scores 7.6. It ranks third among all the alternatives.

Alternative 6:

The largest problem with this alternative is the risk associated with large custom developed software. It scores highly in almost all criteria. This is mainly due to the fact that it would be custom developed and hence implement exactly what is required. Its two lowest scores are in scalability and ease of implementation, however these criteria have low weights and are relatively unimportant. The biggest strength of this system is in ease of use because it scores the highest among all alternatives. This is also the most heavily weighted criterion. Being easy to use ensures the acceptance and wide spread use of the system among all end users. The alternative also has the highest score in cost, which is the second most heavily weighted criterion.

This alternative scored 8.5 placing it in first by a large margin.

Recommendations:

Based on the in-depth analysis of all plausible alternatives, it is clear that alternative six is the best solution to update the existing DCS web system. Having received a higher total feasibility ranking than all other alternatives, it offers the most **functionality** and **ease of use**. Alternative six offers the greatest **ability to integrate** with the present DCS system. In addition, it is the most **cost-efficient** solution. Therefore, our recommendation is to implement alternative six.

The implementation of this solution requires developing the following functionality:

- standardized course web sites
- develop online forums for each course (supplementing newsgroups)
- allow private messaging (facilitate student communication and learning)
- construct online office hours (chat/video conferencing)
- develop interface for professors to create their websites easily
- create online calendar application
- develop assignment submission tool
- personalized welcome page

Conclusion:

It is clear that our goals of simplifying, standardizing, and integrating the existing system can be accomplished by implementing a custom designed web portal (alternative 6). As stated, it provides an interactive information system for students and standardization for increased usability. It provides students with an information resource of services and an array of communication tools. Overall, developing the Computer Science Student Community (CSSC) is our recommendation as the most feasible alternative.

Appendix A: Screenshots

This Appendix contains screenshots of websites mentioned throughout the feasibility study.

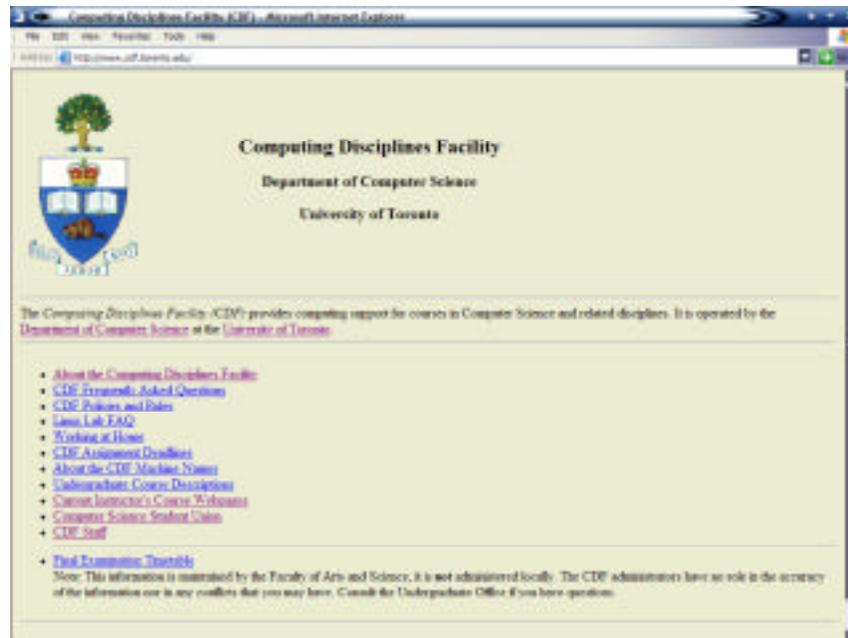


Figure 1 – CDF Home Page
(<http://cdf.utoronto.ca>)

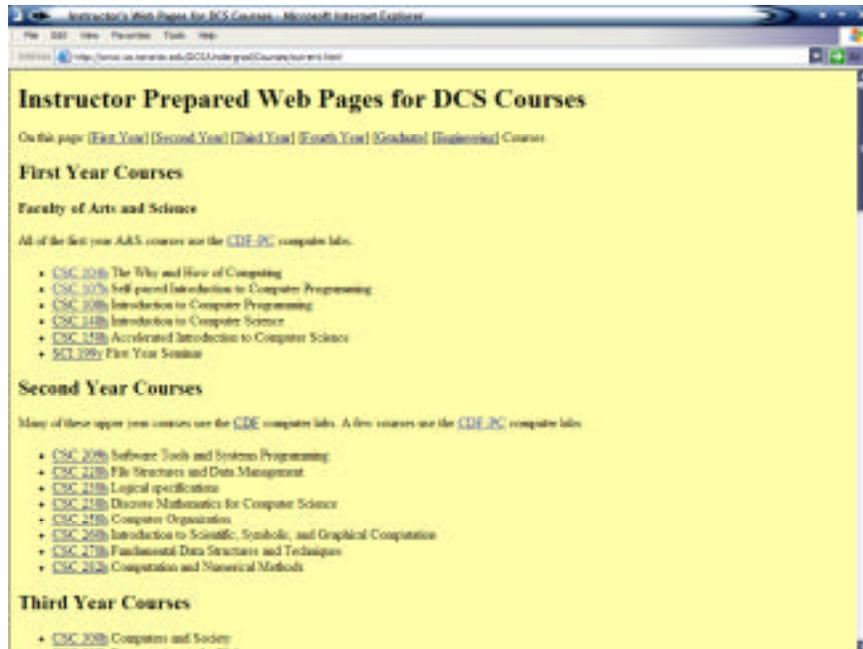


Figure 2 – CDF Course Listing Page
<http://www.cs.toronto.edu/DCS/Undergrad/Courses/current.html>



Figure 3 – CDF Secure Website
<https://www.cdf.toronto.edu/students/>

Course	Section	Assignment	Weight (%)	Deadline	Labs	Entered by
csc230h		Assignment One	10	Jan 29, 2002 14:30	CDF	st
csc209h	A1		10	Jan 30, 2002 23:55	CDF	read
csc410h		assign#1	15	Jan 31, 2002 15:00	CDF	karah
csc100h	A3		3	Feb 01, 2002 12:00	COFFPC	loyd
cac351h		Assignment One	10	Feb 01, 2002 14:30	CDF	st
csc340h	One		10	Feb 05, 2002 00:00	CDF	jm
csc2511h		Genre Classification	20	Feb 06, 2002 14:00	CDF	gwers
csc401h		Genre Classification	20	Feb 06, 2002 14:00	CDF	gwers
csc209h	A2a		5	Feb 06, 2002 23:55	CDF	read
csc148h	A2		5	Feb 07, 2002 10:30	COFFPC	pgries
csc230h	am	A1 - part B	10	Feb 08, 2002 10:10	CDF	gotzalo
csc100h	A4		5	Feb 08, 2002 12:00	COFFPC	heap
csc488h		Assignment 2	10	Feb 12, 2002 14:10	CDF	de
csc209h	A2 - part A		0	Feb 15, 2002 10:10	CDF	gotzalo
csc330h	A2b		5	Feb 25, 2002 23:55	CDF	read
csc351h		Assignment Two	10	Feb 26, 2002 14:30	CDF	st
csc351h		Assignment Two	10	Feb 26, 2002 14:30	CDF	st
csc148h	A3		5	Feb 27, 2002 18:00	COFFPC	pgries
csc488h		Assignment 3	10	Feb 28, 2002 14:10	CDF	de
csc100h	A5		3	Mar 01, 2002 12:00	COFFPC	heap
csc324h		Project 1	10	Mar 01, 2002 14:10	CDF	sastane
csc340h	Two		15	Mar 05, 2002 00:00	CDF	jm
csc488h		Assignment 4	5	Mar 08, 2002 08:10	CDF	de
csc230h	A2 - part B		15	Mar 08, 2002 10:10	CDF	gotzalo
csc148h	A4		5	Mar 13, 2002 18:00	COFFPC	pgries
csc434h	hw2		20	Mar 13, 2002 18:00	CDF	stahs
csc100h	A6		3	Mar 15, 2002 12:00	COFFPC	heap
csc100h	A7		15	Mar 18, 2002 15:00	COFFPC	read

Figure 4 – CDF Secure Website
[\(https://www.cdf.toronto.edu/students/\)](https://www.cdf.toronto.edu/students/)

University of Toronto – St. George Campus
 Department of Computer Science – Winter Session 2002

CSC 270H1Y: Fundamental Data Structures and Techniques

Welcome to the course web site for CSC 270H on the St. George campus. Please use the links below and in the menu bar in the left to find the information you need about this course. (If you do not see a menu on the left, please your browser does not support frames. In that case, [click here](#) for the menu.)

[Course information sheet](#)

This is the only handout that is provided on paper. If you have your paper copy, you can print the on-line one.

The course newsgroup and e-mail

The newsgroup is [sg.cdf.csc270h](#), and the instructor's e-mail address is [maccaul@cdf.toronto.ca](#)

Major announcements will appear on this web site, act in the newsgroup or by e-mail. Effectively, the newsgroup and e-mail are two ways of asking questions. The newsgroup is more public, so if you have a question you think might be of interest to other students, you can post to the newsgroup. All questions asked by e-mail will eventually be answered by me. Neither the newsgroup nor the e-mail will be a central medium for our discussions in the course. Replies to questions may refer you to the course web site, please make sure you have checked for relevant announcements before asking a question.

- Newsgroup postings should be in plain text, without even MIME or HTML formatting. Programming questions asked by e-mail should be in plain text too. After all, that's what your programs look like. (Here is an explanation of how to turn off MIME and HTML formatting.)
- Never post to the course newsgroup your solution to an assignment, or even your idea of how to solve an assignment, or even one small part of a program that is part of your solution to an assignment, etc. If you do this, it may be treated as a case of plagiarism with all the consequences that this entails.
- [Find](#) the newsgroup.
- [Post](#) a message to the newsgroup.
- [Send](#) e-mail to the course instructor.

Figure 5 – Example of Course Website
[\(http://www.cdf.toronto.edu/~maccaull/270/\)](http://www.cdf.toronto.edu/~maccaull/270/)

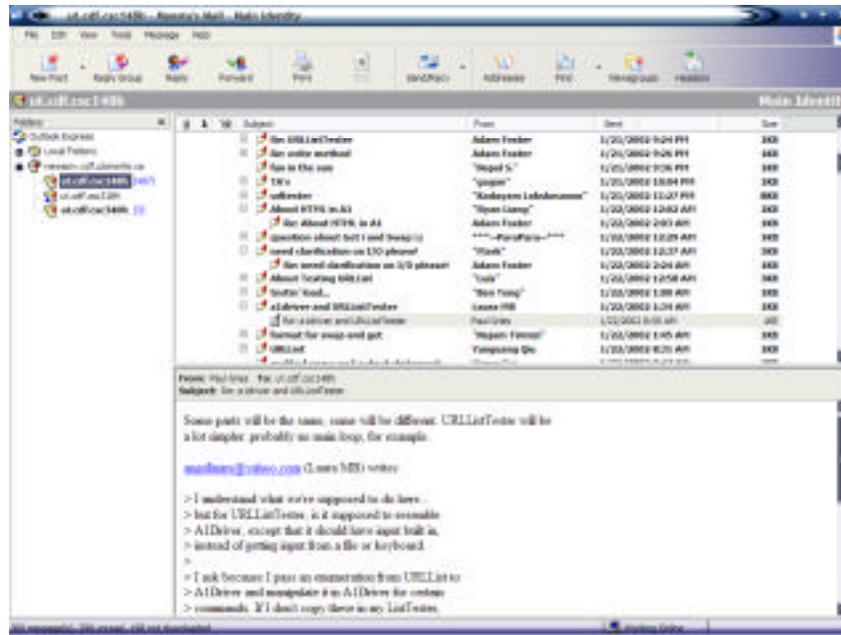


Figure 6 – Examples of Newsgroup (ut.cdf.csc148h)



Figure 7 – Example of CourseBoard Website (<http://eratos.erin.utoronto.ca/CourseBoard/faq/coursefaq.msql?course=GGR261>)



Figure 8 – WebCT Course Listing
https://webct.srv.ualberta.ca/webct/public/show_courses.pl

Appendix B: CDF Administrator Interview

All information regarding the current Computing Disciplines Facility was derived from an Interview conducted with Lloyd Smith. Lloyd is the Lead Administrator for the Computing Disciplines Facility – PC environment. Although a majority of his time is spent administering the PC environment, he is also heavily involved with administrative duties for the entire facility.

Please Note: This is an overview of the interview, and not a transcript of the dialogue.

Interview Start

Explain Website Management Tool and Web Portal Concepts (See Appendix C)

- Lloyd’s initial comments after hearing the concepts:
 - Lloyd thought it was a great idea
 - Professors have expressed interest in a similar system in the past
 - Currently there are many tools for communication, however they are not integrated with each other and this poses a usability problem.
- Lloyd then demonstrated an application for online submission, which was built by the system administrators (See Appendix A – CDF Secure Website)

- This tool allows for professors to create and update deadline information for course assignments
 - Students can check the website for deadline information, as well as, submit assignments online
 - All authentication to the website is done using a tool that the administrators built to authenticate users against their regular CDF account passwords
 - All data transfer is secured using 128-bit strong encryption, using an SSL certificate that was written by the administrators themselves
 - Assignments submitted online are uploaded to the course/assignment directory on the servers, using the standard assignment submission tool
 - Professors have expressed an interest in having functionality for assignment verification and compilation when a student submits his/her code
- The process of setting up and maintaining a course website
 - CDF Administrators deploy the space on the server and update the link on the main CDF Home Page (See Appendix A – CDF Home Page)
 - However, once the account is setup for the professor, it is his/her responsibility to maintain the site and all content within
 - Standards and Policies for course websites
 - There are currently no standards or policies in place for course websites in the Department of Computer Science
 - Lloyd informed us about CourseBoard
 - CourseBoard is a Web-enabled course support system
 - Courseboard was implemented by the Department of Geography at Erindale Campus (University of Toronto).
 - Not used in CDF
 - Not enough functionality and compatibility with current system
 - Computing and Networking Services (CNS)
 - <http://cns.utoronto.ca>
 - The CNS provides facilities, services and guidance to the University of Toronto Community to effectively use Information Technology to support the research, teaching and administrative programs of the University
 - Concept integration with current system
 - Current web development is done using PHP
 - CDF uses PostgreSQL database system
 - Online forums in portal would have to use NTP to synchronize with the current newsgroups.

Survey End

Appendix C: Survey Tools

Professor Survey

- 1) Do you currently maintain your course web pages?
 - a) If not, who does?
 - b) If not, then why not?
 - c) Would you maintain the sites, if the process was easier?
- 2) How often is your web page updated?
- 3) Do you feel it takes too much time to update your web pages with the current system?
- 4) What tools do you use to create your web pages?
- 5) What is your main method of communication with your students?
- 6) Do you feel that you spend too much time or too little time using this method?

Explain Website Management Tool Concept to professor (See Appendix C)

- 7) Would you find this tool beneficial?
 - a) If yes, please describe how it will be beneficial?
 - a) If not, please describe why?

Explain Web Portal Concept to professor (See Appendix C)

- 8) Would you find this portal beneficial?
 - If yes, please describe how it will be beneficial?
 - If not, please describe why?
- 9) Do you think that this will be a cost-effective idea? Why or why not?
- 10) Do you feel that a new CDF web facility will be beneficial to students? If so in what way?
- 11) Do you have any other comments or suggestions about our idea?

Teaching Assistant Survey

- 1) Do you currently maintain a personal web page with information relevant to the courses for which you are a T.A.?
- 2) How often do you update the information relevant to your courses?
- 3) What tools do you use to create your web pages?
- 4) How much input do you have on the contents of the official course web page?
- 5) Do you feel you have important information to add to the web pages? If so, give a few examples.
- 6) How often do you use the course web pages for which you are a T.A.?
- 7) When you use the course web pages are you adding information or using information presented on the page?
 - i) If you add information, what tools do you use?
- 8) Do any of the courses, for which you are a T.A., maintaining newsgroups?
- 9) How often do you check the newsgroups?
- 10) Do you find that you spend too much time reading and answering questions in the newsgroups?
- 11) Do you use any other electronic methods to communicate with students? (ie. Chat rooms, email, etc).

12) Which of any method of communication do you feel is the most important?

13) Would a more interactive medium of communication between yourself and the students be helpful? If so, what would you like to see implemented?

Explain Website Management Tool Concept to teaching assistant (See Appendix C)

14) Would you find this tool beneficial in allowing you to add information to the course web page?

Explain Web Portal Concept to teaching assistant (See Appendix C)

15) Would you find the portal beneficial and how so?

Student Survey

1) Are you currently enrolled in any CSC courses?

2) Do the courses that you are enrolled in have web pages?

3) Do you consider the information on the course web pages important/useful?

4) How often do you check your course web pages?

5) Do you feel that the content of the course web pages meets your expectations?

6) Do you feel that the content of the course web pages is presented effectively and efficiently?

7) Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?

8) On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)

9) Do the courses that you are enrolled in have newsgroups?

10) Do you consider the newsgroups an important aid to your studies?

11) How often do you use the course newsgroups?

12) Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)

13) Which of any methods of communication do you feel is the most important?

14) Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?

Website Management Tool Explanation

Overview:

In order for professors to update their personal course web pages as efficiently as possible, they will need a special tool to do the updating. The tool will be web-based and have a back-end database that will store the input given by the user.

The user will go to an Intranet site and login with a user ID and password. The system will recognize the user ID and password and then display a list of all “Computer Science” courses that this professor teaches. The user may select one course to update. They will now get a screen that contains past user information, like Name, phone number, e-mail address etc. The user will have the ability to update any of this information and all changes will be reflected in the database.

The user will see a series of screens that they can update (or leave the information as is). Once each page is update they will click the “next” button until they have updated all the pages.

Web Portal Concept Explanation

Problem:

Students need a better medium for communication. Current web system does not facilitate optimal communication and interaction between students and faculty. There is a need for full automation and standardization of the current DCS Course web sites.

Solution:

The Computer Science Student Community (CSSC) is an online interactive information system for students in the DCS. The CSSC will be developed to provide an environment for students to interact with profs, TAs, and other students. All course web sites will be contained within the community and be standardized for increased usability. Professors will spend less time creating and updating course websites, due to the standardized template. In addition, it will provide students with an information resource of services provided by the DCS.

Proposed Functionality:

- Standardized Course Web Sites
- Online Forums for each course (replacing Newsgroups)
- Private Messaging (facilitate student communication and learning)
- Online Office Hours (Chat/Video Conferencing)
- Interface for Prof’s to create their websites easily
- Scheduling of tests and assignments (Online Calendar)
- Assignment submission tool
- Personalized Welcome Page

Appendix D - Survey Data: Professors

Survey Start

Questionnaire Respondent: J. Mylopoulos, MSc, PhD
Current Course: CSC 340

- 12) Do you currently maintain your course web pages? **Yes**
- a) If not, who does? **N/A**
 - b) If not, then why not? **N/A**
 - c) Would you maintain the sites, if the process was easier? **N/A**

- 13) How often is your web page updated? **Once per week**
- 14) Do you feel it takes too much time to update your web pages with the current system?
- *Not worried about time*
 - *More worried about limited knowledge of Html, etc.*
 - *Would like to implement chat rooms and secure access but not able to*
- 15) What tools do you use to create your web pages? **Simple text editor**
- 16) What is your main method of communication with your students?
- *Newsgroups, Email, other*
 - *News page on web page*
 - *Currently there is no newsgroup since it is important to have a clear channel of communication. Multiple sources of the same information could result in confusion. He would find it acceptable if a post by the professor on the news page automatically got posted in the newsgroup.*
- 17) Do you feel that you spend too much time or too little time using this method?
- *No, I am satisfied with the time that I spend*

Explain Website Management Tool Concept to professor (See Appendix C)

- 18) Would you find this tool beneficial?
- a) If yes, please describe how it will be beneficial?
 - *Automatically implement more advanced features such as chat rooms, etc.*
 - b) If not, please describe why?
 - *Learning to implement these features can be time consuming*

Explain Web Portal Concept to professor (See Appendix C)

- 19) Would you find this portal beneficial?
- *If yes, please describe how it will be beneficial?*
 - *If not, please describe why?*
- 20) Do you think that this will be a cost-effective idea? Why or why not? **N/A**
- 21) Do you feel that a new CDF web facility will be beneficial to students? If so in what way? **N/A**
- 22) Do you have any other comments or suggestions about our idea? **N/A**

Survey End

Survey Start

Questionnaire Respondent: P. Gries, MEng.
 Current Course: CSC 148

- 1) Do you currently maintain your course web pages? **Yes**
- a) If not, who does? **N/A**

- b) If not, then why not? **N/A**
 c) Would you maintain the sites, if the process was easier? **N/A**
- 2) How often is your web page updated? ***Five times per day***
- 3) Do you feel it takes too much time to update your web pages with the current system?
 ➤ *Yes it does take very long*
 ➤ *Teaches csc148 and I have about 1700 students in course (3 campuses)*
 ➤ *There is a lot of updating to my website each day.*
 ➤ *More worried about limited knowledge of Html, etc.*
- 4) What tools do you use to create your web pages?
 ➤ *Emacs and simple text editors*
- 5) What is your main method of communication with your students?
 ➤ *E-mail to 148 accounts once a week on average, newsgroups*
- 6) Do you feel that you spend too much time or too little time using this method?
 ➤ *Spends 1 _ hours answering e-mail a day*
 ➤ *Receives about 300 course related e-mail messages from students in a week on average*

Explain Website Management Tool Concept to professor (See Appendix)

- 7) Would you find this tool beneficial?
 a) If yes, please describe how it will be beneficial?
 ➤ *I would use many of your proposed tools. I am open to test a new system and find out if the students and faculty will embrace it. I am open to positive change*
 c) If not, please describe why?
 ➤ *I feel that all websites should follow w3c standards. This should be included in your proposal*

Explain Web Portal Concept to professor (See Appendix C)

- 8) Would you find this portal beneficial?
 ➤ If yes, please describe how it will be beneficial?
 ➤ If not, please describe why?
- 9) Do you think that this will be a cost-effective idea? Why or why not?
 ➤ *Yes I feel this will be a cost effective idea. I spend a lot of my time manually updating my personal websites and I feel that professor's time is valuable and even giving professors 1 hour extra a week is very cost effective. Your idea does not sound very expensive to implement since we have all the hardware available*
- 10) Do you feel that a new CDF web facility will be beneficial to students? If so in what way?
 ➤ *If instructors had a standardized template to work with which automated a lot of tasks, then they would be better off. Students will benefit from the extra time*

instructors will have. I also feel that my first year students would benefit from a standardized site. It would be less confusing

11) Do you have any other comments or suggestions about our idea?

- *Fully functional calendar. This tool will display all 13 weeks of the semester. You can then choose and fill in the days that assignments/tests are due.*
- *T.A. lab hour application.*
- *Application for students to check their marks online*
- *Application for students to choose their tutorial online*
- *Lecture note update application*
- *Instructors should have choice whether to use application or not. The department is not a democracy. Instructors should not be forced to use the application.*
- *There should be a 1 year beta test phase, before application goes into full production. This application should be demoed for them. The benefits of this application should be carefully explained to them and it should be done by upper level dean or coordinators*

Survey End

Survey Start

Questionnaire Respondent: J. Lee

Current Course: CSC 354

- 1) Do you currently maintain your course web pages? **No**
- a) If not, who does? **N/A**
- b) If not, then why not?
- **Believes that will only contribute to information overload**
 - **will add more work for students since they will have to check the web page often as well as go to class**
 - **Feels that it is not an effective teaching tool**
- c) Would you maintain the sites, if the process was easier? **No**
- 2) How often is your web page updated? **N/A**
- 3) Do you feel it takes too much time to update your web pages with the current system?
- N/A**
- 4) What tools do you use to create your web pages? **N/A**
- 5) What is your main method of communication with your students?
- **lectures and email**

- 6) Do you feel that you spend too much time or too little time using this method?
➤ *No, I am satisfied with the time that I spend*

Explain Website Management Tool Concept to professor (See Appendix C)

- 7) Would you find this tool beneficial?
a) If yes, please describe how it will be beneficial? **N/A**
b) If not, please describe why? **N/A**

Explain Web Portal Concept to professor (See Appendix C)

- 8) Would you find this portal beneficial? **N/A**
➤ If yes, please describe how it will be beneficial?
➤ If not, please describe why?
9) Do you think that this will be a cost-effective idea? Why or why not? **N/A**
10) Do you feel that a new CDF web facility will be beneficial to students? If so in what way? **N/A**
11) Do you have any other comments or suggestions about our idea?
➤ *ensure that only the essentials are used*
➤ *straightforward interface*
➤ *automated “clean up”, i.e. do not want multiple buttons going to same place*

Survey End

Appendix E - Survey Data: Teaching Assistants

Survey Start

Questionnaire Respondent: Hui Bowen
Current Course: CSC 340

- 1) Do you currently maintain a personal web page with information relevant to the courses for which you are a T.A.? **Yes**
2) How often do you update the information relevant to your courses?

- a. *1 per term*
- 3) What tools do you use to create your web pages?
- b. *VI*
- 4) How much input do you have on the contents of the official course web page?
- c. *If any information absolutely need to be posted then the prof will post it for TA*
- 5) Do you feel you have important information to add to the web pages? If so, give a few examples.
- d. *Not really*
 - e. *A link to personal web page is provided*
- 6) How often do you use the course web pages for which you are a T.A.?
- f. *Once per week*
- 7) When you use the course web pages are you adding information or using information presented on the page?
- i. When you use the course web pages are you adding information or using information presented on the page?
 - o *Using information*
 - ii. If you add information, what tools do you use?
 - o *VI*
- 8) Do any of the courses, for which you are a T.A., maintaining newsgroups? *NO*
- 9) How often do you check the newsgroups? *N/A*
- 10) Do you find that you spend too much time reading and answering questions in the newsgroups?
- g. *Most people don't like to look in two places for information*
 - h. *Good for inter-student communication*
- 11) Do you use any other electronic methods to communicate with students? (ie. Chat rooms, email, etc).
- i. *E-mail*
- 12) Which of any method of communication do you feel is the most important?
- j. *E-mail*

13) Would a more interactive medium of communication between yourself and the students be helpful? If so, what would you like to see implemented?

k. *Prefers face-to-face communication*

Explain Website Management Tool Concept to teaching assistant (See Appendix C)

14) Would you find this tool beneficial in allowing you to add information to the course web page?

l. *As long as different TA for the same course don't post conflicting information*

Explain Web Portal Concept to teaching assistant (See Appendix C)

15) Would you find the portal beneficial and how so?

m. *Timetables of Teaching Assistants, professors, and personal timetable would be useful.*

Survey End

Survey Start

Questionnaire Respondent: Michael McGuffin

Current Course: CSC 191

1) Do you currently maintain a personal web page with information relevant to the courses for which you are a T.A.? **Yes**

2) How often do you update the information relevant to your courses?

n. *4 times a week*

3) What tools do you use to create your web pages?

o. *VI*

4) How much input do you have on the contents of the official course web page?

5) *Complete. I implement the official course web page.*

6) Do you feel you have important information to add to the web pages? If so, give a few examples. **YES**

7) How often do you use the course web pages for which you are a T.A.?

p. *4 times a week*

8) When you use the course web pages are you adding information or using information presented on the page?

iii. When you use the course web pages are you adding information or using information presented on the page?

- *Both*
- iv. If you add information, what tools do you use?
 - VI
- 9) Do any of the courses, for which you are a T.A., maintaining newsgroups?
 - *No, discourage the use since a lot of posts can be junk mail and can create a situation where there are multiple sources to check/posts to obtain/disseminate information*
- 10) How often do you check the newsgroups? N/A
- 11) Do you find that you spend too much time reading and answering questions in the newsgroups? N/A
- 12) Do you use any other electronic methods to communicate with students? (ie. Chat rooms, email, etc).
 - q. *E-mail*
- 13) Which of any method of communication do you feel is the most important?
 - r. *Webpage and in-class announcements*
- 14) Would a more interactive medium of communication between yourself and the students be helpful? If so, what would you like to see implemented?
 - s. *An automated real time system that tells students if the prof or TA is available and where so that face-to-face communication can happen as often as possible.*
 - t. *A system that integrates the best of phones and email. Allow the interactivity of phones and the ability to filter of email.*

Explain Website Management Tool Concept to teaching assistant (See Appendix C)

- 15) Would you find this tool beneficial in allowing you to add information to the course web page?
 - u. *Make options on the kind of space on page available to TA (e.g. Sections for assignments, Sections for each TA or no space at all). Allow TA's the opportunity to control their "accessibility".*

Explain Web Portal Concept to teaching assistant (See Appendix C)

- 16) Would you find the portal beneficial and how so?
 - v. *As long as irrelevant information is kept out*

Survey End

Appendix F - Survey Data: Students

* Please note - students chose to remain anonymous for this questionnaire

Survey Start

- 1) Are you currently enrolled in any CSC courses?
 - Yes – csc408, csc336
- 2) Do the courses that you are enrolled in have web pages?
 - Yes – All courses
- 3) Do you consider the information on the course web pages important/useful?
 - Yes I think having a website is vital for a computer science course. To do our assignments we must have a way to communicate with each other and ask questions. Also we need a place to find assignments, check for announcements and check our grades
- 4) How often do you check your course web pages?
 - I check it every day. Sometimes multiple times in a day
- 5) Do you feel that the content of the course web pages meets your expectations?
 - I think some web sites are better than other. Most fill the basic requirements but I bet there can be a lot of improvements
- 6) Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Yes I do. It could be better. There are a lot of ways to communicate with students like chat, net-meeting etc, that is not being implemented.
- 7) Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - Yes that would be a great addition. Saves me the extra time of switching pages.
- 8) On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 9
- 9) Do the courses that you are enrolled in have newsgroups?
 - Yes most of them
- 10) Do you consider the newsgroups an important aid to your studies?
 - Vital to our studies. I use them all the time to post questions to the professor.
- 11) How often do you use the course newsgroups?
 - I use them every day, especially close to assignment due dates
- 12) Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Email only

- 13) Which of any methods of communication do you feel is the most important?
- I feel newsgroups and e-mail are the most important. But we have not been given the opportunity to try any others.
- 14) Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
- Yes I do feel it would
 - online chat and forums for discussion
 - faculty news
 - Place where we could go and read the latest news about our department (online)

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - Yes
4. How often do you check your course web pages?
 - Every other day
5. Do you feel that the content of the course web pages meets your expectations?
 - Sometimes
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Sometimes
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - No
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 5
9. Do the courses that you are enrolled in have newsgroups?
 - Yes

10. Do you consider the newsgroups an important aid to your studies?
 - Yes
11. How often do you use the course newsgroups?
 - Every other day
12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Yes
13. Which of any methods of communication do you feel is the most important?
 - Email and newsgroup
14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - No

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - No
4. How often do you check your course web pages?
 - More than 5 times a day
5. Do you feel that the content of the course web pages meets your expectations?
 - No
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - No
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - Yes

8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 10
9. Do the courses that you are enrolled in have newsgroups?
 - Yes
10. Do you consider the newsgroups an important aid to your studies?
 - Yes
11. How often do you use the course newsgroups?
 - More than ten times a day
12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Email
13. Which of any methods of communication do you feel is the most important?
 - Newsgroup
14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - No

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - Some of them, ie. News group, past tests
4. How often do you check your course web pages?
 - Whenever I need to
5. Do you feel that the content of the course web pages meets your expectations?
 - Sometimes

6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Depends on the prof
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - No
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 4
9. Do the courses that you are enrolled in have newsgroups?
 - Some
10. Do you consider the newsgroups an important aid to your studies?
 - Very
11. How often do you use the course newsgroups?
 - Whenever I have questions
12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Email
13. Which of any methods of communication do you feel is the most important?
 - Email
14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Net meeting
 - Web cams on each terminal in the lab

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?

- Yes
4. How often do you check your course web pages?
 - Everyday
 5. Do you feel that the content of the course web pages meets your expectations?
 - Yes
 6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Yes
 7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - Yes
 8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 5
 9. Do the courses that you are enrolled in have newsgroups?
 - Yes
 10. Do you consider the newsgroups an important aid to your studies?
 - Yes
 11. How often do you use the course newsgroups?
 - Everyday
 12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - No
 13. Which of any methods of communication do you feel is the most important?
(left blank)
 14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Seminars

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?

- Yes
- 2. Do the courses that you are enrolled in have web pages?
 - Yes
- 3. Do you consider the information on the course web pages important/useful?
 - Yes
- 4. How often do you check your course web pages?
 - Once a day
- 5. Do you feel that the content of the course web pages meets your expectations?
 - Sometimes
- 6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Yes
- 7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - No
- 8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 3
- 9. Do the courses that you are enrolled in have newsgroups?
 - Yes
- 10. Do you consider the newsgroups an important aid to your studies?
 - Yes
- 11. How often do you use the course newsgroups?
 - Once a day
- 12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Yes. Email
- 13. Which of any methods of communication do you feel is the most important?
 - Email
- 14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Chat room for students
 - Web cams for each computer

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - Yes
4. How often do you check your course web pages?
 - At least once a day
5. Do you feel that the content of the course web pages meets your expectations?
 - Most of them
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Most of them
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - No
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 10
9. Do the courses that you are enrolled in have newsgroups?
 - Yes
10. Do you consider the newsgroups an important aid to your studies?
 - Yes
11. How often do you use the course newsgroups?
 - At least once a day
12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Yes. Email

13. Which of any methods of communication do you feel is the most important?
 - Email
14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Chat room
 - Web cam

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - Yes
4. How often do you check your course web pages?
 - Everyday
5. Do you feel that the content of the course web pages meets your expectations?
 - Yes
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Yes, most profs keep them up-to-date
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
(left blank)
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - Standardized layouts would be good not personalized
9. Do the courses that you are enrolled in have newsgroups?
 - Yes
10. Do you consider the newsgroups an important aid to your studies?

- Yes, very useful for assignment discussion
11. How often do you use the course newsgroups?
 - Very often before assignments are due
 12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Email
 13. Which of any methods of communication do you feel is the most important?
 - Email and newsgroups
 14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Nope

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - Yes
4. How often do you check your course web pages?
 - Frequently
5. Do you feel that the content of the course web pages meets your expectations?
 - Sometimes
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Sometimes
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - Yes
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)

- 5
- 9. Do the courses that you are enrolled in have newsgroups?
 - Yes
- 10. Do you consider the newsgroups an important aid to your studies?
 - Sometimes
- 11. How often do you use the course newsgroups?
 - 50%
- 12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - No
- 13. Which of any methods of communication do you feel is the most important?
 - ?
- 14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Basically the lab is a great way of communication. We work together.

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes
3. Do you consider the information on the course web pages important/useful?
 - Yes
4. How often do you check your course web pages?
 - Three times a week
5. Do you feel that the content of the course web pages meets your expectations?
 - Yes
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Yes

7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - Yes
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 7
9. Do the courses that you are enrolled in have newsgroups?
 - Some of them
10. Do you consider the newsgroups an important aid to your studies?
 - Not really
11. How often do you use the course newsgroups?
 - Every two weeks
12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Yes. Email
13. Which of any methods of communication do you feel is the most important?
 - O/H
14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Not really

Survey End

Survey Start

1. Are you currently enrolled in any CSC courses?
 - Yes
2. Do the courses that you are enrolled in have web pages?
 - Yes – all of them
3. Do you consider the information on the course web pages important/useful?
 - Most websites are very useful
4. How often do you check your course web pages?
 - Whenever assignments are out and periodically 2/week

5. Do you feel that the content of the course web pages meets your expectations?
 - Yes
6. Do you feel that the content of the course web pages is presented effectively and efficiently?
 - Yes, sometimes it could have been better
7. Do you feel that a single unified web page, that contained all of the information relevant to your courses, would be a more efficient and effective format?
 - *Probably not since content/layout may be different between profs*
8. On a scale of 1 – 10, 1 being strongly opposed and 10 being strongly agree. How would you react to a change in format of course web pages? (ie. Standardized layouts, personalized homepages, etc.)
 - 8
9. Do the courses that you are enrolled in have newsgroups?
 - Yes
10. Do you consider the newsgroups an important aid to your studies?
 - Yes
11. How often do you use the course newsgroups?
 - Very often. 4/week when assignments are out
12. Do you use any other electronic methods to communicate with other students, TAs and professors? (ie. Chat rooms, email, etc.)
 - Email
13. Which of any methods of communication do you feel is the most important?
 - Newsgroup, email, office hours, webpage
14. Would a more interactive medium of communication between other students be helpful? If so what would you like to see implemented?
 - Probably. So far, office hours are a good interactive medium and so are newsgroups.

Survey End

Appendix G: Detailed Explanation of Cost/Benefits Analysis:

The cost/benefit analysis portion of the study contains many assumptions. The assumptions were necessary to quantify certain information.

The major assumption made is that the lifetime of the system is infinite. This is clearly not true, but the goal of the system is to last as long as possible. Since the discount factor

rapidly decreases with each period, assuming an infinite lifespan is a reasonable and accurate assumption. The formula to calculate the present value perpetuity is, $(1 + r)/r * v$, where r is the prime interest rate and v is the monetary value of savings/cost per period.

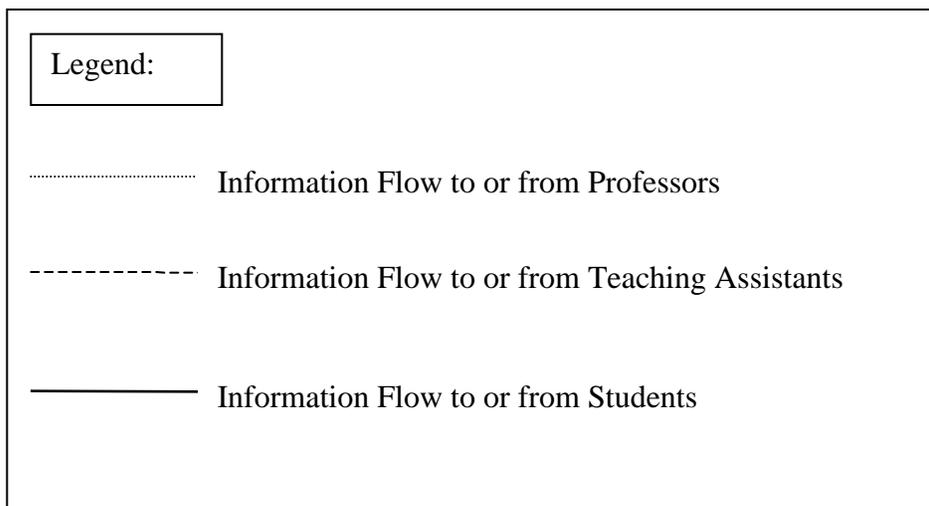
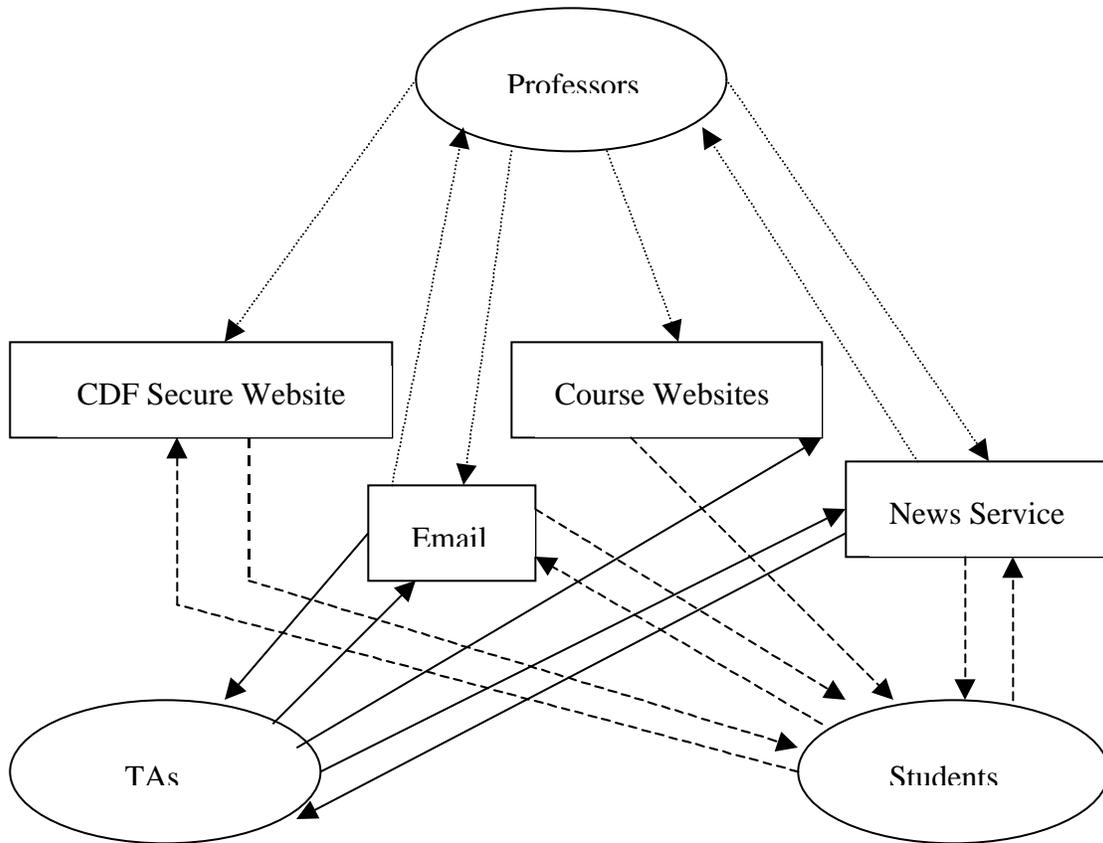
Another assumption made was that the monetary benefit of each system could be quantified. The quantity was determined to be the hourly wage of a professor * the amount of time saved using the system. The value was then scaled to equal the annual savings for all 77 professors in the department. A table below outlines the calculations. While the professors salary and hence the overall expenditures of the department don't decrease with any system, the opportunity cost of updating/creating internet media does.

The last major assumption made was that the annual salaries of the administrators are irrelevant in determining the present value perpetuity of costs. All of the alternatives required the administrators, so in relative terms it is not necessary to consider them. Another benefit to the ignoring the salaries is positive R.O.I (return on investment) and present value net costs.

Table: Calculation of annual savings from each alternative

	Estimated time saved per professor in hours/week	Annual Savings across department	Present Value Perpetuity of Savings
Alternative 1	0	\$ 0	\$ 0
Alternative 2	0	\$ 0	\$ 0
Alternative 3	0.25	\$ 36,706	\$ 809,463
Alternative 4	1.5	\$ 220,240	\$ 4,856,871
Alternative 5	0.5	\$ 73,413	\$ 1,618,947
Alternative 6	1.5	\$ 220,240	\$ 4,856,871

Appendix H: Information Flow



Appendix I: Glossary

DCS: Department of computer science

- CDF: Computing disciplines facility'
- CSSC: Computer science student community
- HTML: HyperText Markup Language
- Perpetuity: The present day cost/income of some cost/income that is constant over an infinite number of periods. For an explanation of how it is used in this study refer to appendix G.

Appendix J: Team Report Form

Team Report Form
(must be submitted with assignment)

Description of roles of each Team member:

All team members shared all roles and worked on the entire study collectively.

Name:	% of Team Effort:	Signature:
Arvin Kamboj	33.3%	AK
Amit Kaul	33.3%	AK
Lawrence Llaguno	33.3%	LL