

Course-Management System: Final Report

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ABSTRACT

The final report for a design project for a course-management system is presented here. The proposed course-management system allows university students to enroll in courses, view their schedule and perform other course-related tasks from a web portal.

Firstly, the proposed project and suggested improvements over existing systems are explained. To inform this, four Canadian university course-management systems were surveyed, and the surveys are presented after the suggested improvements. Each survey has a brief description of the software followed by a critique of the major usability flaws and strengths. Three personas are then presented to demonstrate the potential users of the system that guided the design process. Following personas, information about the usability tests conducted for this system is presented followed by the results, discussion about the results, and final conclusions about the project.

NOTE ABOUT FORMATTING

This document strictly follows the ACM CHI format. Extra spacing between paragraphs is created by LaTeX to better arrange content, and is not directly controllable by the creator. The format used for the Personas section is based off of the format given along with Milestone 2 to fit into the 2-column layout, with images included inline (which does not violate the ACM CHI template). Extreme care has been given to follow the specified format exactly, including fonts, margins, and figures.

INTRODUCTION

The project proposed in this document is the design of a new university course-management system. Through scrutinization of several pre-existing systems, we will apply design concepts discussed in class to determine what features and design choices are crucial to the success of a course-management system's design.

Users of the proposed system should be able to perform the following functions:

- enroll in courses
- change time slots for lectures, tutorials, and labs of enrolled courses
- view weekly schedule
- view exam schedule

In the following section we will introduce several possible improvements that could be made to existing systems, informed by the system surveys conducted. These suggested improvements were incorporated into designs mockups for the new system, and into the final design of the working system.

Suggested Improvements to Existing Systems

We have outlined several improvements over existing systems that have been incorporated into the design of the new system. The software surveys identified several key areas of weaknesses, and solutions to those are presented below.

Dynamic Element

One of the highlighted points of weakness in all the systems surveyed was the ability to surface the most relevant data to the user quickly and consistently. To improve this aspect, the concept of an intelligent, “dynamic” element was proposed. This prominent element is the first thing users see on the home page of the new system. Several factors including the current date and enrollment status are used to determine which task the user is most likely to perform.

For example, when the user accesses the system during exam season, the element displays the student’s exam schedule. During the course registration period, the element displays information related to course registration. If a user is not yet accepted into University, the element displays their application status.

This dynamic element helps users quickly find the information they are looking for by making information more visible and easier to access. All functions continue to be displayed below in a static and consistent manner, in case the user wishes to perform a less common task.

Improved Navigation

Many tasks performed by users of course-management software are broken into several steps. A weakness of the existing products was in visually showing the user at which step they were at. To solve this, a “breadcrumbs” navigation element was added when the user is engaged in a multi-step task. This element shows which step the user is currently on, and includes the ability to go back to a previous step, or jump ahead to the first uncompleted step.

This visual indicator improves the user’s comprehension of how the system works, and gives them the ability to better navigate between steps. It also improves user satisfaction,

as they are less likely to become impatient when they know exactly how many steps they have completed and how many remain.

Smarter Schedule Generation

An initial proposal for the system was to have the system generate several possibly schedules based on the users wish-list, and rank them based on several factors such as early classes, gaps between classes and having certain days completely off. We do believe this would be a meaningful addition to a course-management system, however decided not to include it in the final product due to time and resource constraints.

RELATED WORK

Four course-management systems from Canadian universities were selected for review. For each system, a brief description was followed by a critique of the major usability flaws and strengths. From this, the main goals and tasks of users using the systems was extracted.

McMaster University – Mosaic

The purpose of the software is to allow students to manage their courses (enrolling, dropping etc.), and view information about their current status (current timetable, enrollment status, financial balance etc.). The main interface for the software consists of several collapsible modules encapsulating different aspects of the software in a main column. These include Academics, Finances, Personal Information, and Admissions. A small column to the right holds less common sections, such as Enrollment Dates and Graduation. The focus of this analysis is on two common tasks – enrolling in courses and viewing one's course schedule.

Critique

The largest usability flaws in Mosaic center around difficulty to access required information. Combined with an unintuitive and inconsistent navigation interface. The HTA for enrolling in a course (Appendix: Figure 7) demonstrates this through the large number of steps required to perform a routine and common task. Other functions are hidden behind dropdown menus, and are difficult to discover.

The navigation is separated into a top navigation bar separated by user-type (e.g. Students and Employees). Within the student center page, functions are separated into modules, an effective strategy to group related functions. Navigating to one of the sub-functions (such as enrolling in a course) presents secondary and tertiary menus below the main one. Navigation within one of these is handled by blue text hyperlinks back to previous pages. Native back and forward browser functionality does not work. There is little visual indication of where the user is beyond the navigation bars at the top, which do not go to a depth sufficient to cover all pages used when performing common actions, such as enrolling in a course.

Guelph University – WebAdvisor

Guelph University's course enrollment software, WebAdvisor, provides a variety of functions for students to manage their courses. The student page interface contains two columns – a main column with course-related news, and a righthand column with links to each of the functions (Register for Courses, View Schedule etc). These “function” pages are one column, and may contain several sub-pages as processes are broken into steps. Navigating between sub-pages is done using native browser back and forward buttons. If an error occurs, such as no courses found for specific search criteria, a large box is displayed with information about the error and the option to search for a solution.

Critique

There are a variety of usability issues associated with WebAdvisor that could be improved upon, especially in the area of navigation. There are also certain strengths to the system as compared to others surveyed. The navigation issues largely stem from a lack of consistent navigation elements to show the user where they are. For example, when enrolling in a course there are several steps that must be completed (Appendix: Figure 13). The user is not aware how many steps there are total, how many they have completed or how many remain. Another large usability issue is an inefficient use of space on the main page. The visibility of important functions is reduced by putting all functions in a small column to the right of the main content. This main content contains news items, such as exam period times and service outages, generally information that the user is less likely to need than the functions beside it.

WebAdvisor does do some things quite well from a usability perspective however. One of the most common tasks is enrolling in a course, and WebAdvisor has the most streamlined process of all universities surveyed. Although it is not always clear at which step the user is at as discussed above, the process is straightforward and contains much fewer steps than performing a similar task using a different system.

Carleton University – Central

Central is the course-management system for Carleton University. It has a similar feature-set to the other systems surveyed. This includes allowing users to enroll in courses and view their schedule. The user interface for Central primarily is based on text links to different pages, with very little use of icons or colour. The main student page is a one-column list of text links to the various student-related categories of functions. A tab bar at the top lets the user switch between different sections of the system including Student Services and Employee Services.

Critique

There are a large number of prominent usability flaws in Carleton University's course-management system. Visibility of common functions on the main page is very low, as a long list of hyperlinks contains all the categories (e.g. Registrat-

tion, Student Records etc) requiring the user to read each one until they find the correct one. Once a category is selected, then another list of hyperlinks to each of the functions in that category is shown. Again, the user must read through each one until they find the desired function.

Another large usability flaw is the poor mapping between many actions. For example, when adding a course, the user first enters a course number into one of several (unlabeled) input boxes, and then they click the Submit button (Appendix: Figure 16). The submit button is aligned with other buttons for Class Search, which takes the user to a separate page, Reset, which undoes their changes, and Return to Worksheet which navigates the user to a page showing them their preferred courses. These buttons are not all related, and grouping them together may confuse the user.

Overall, Central is a relatively unintuitive system, requiring users to spend more time finding the information they need through poor mappings and a lack of a visual hierarchy.

Waterloo University – Quest

The Quest system is designed to let students manage several aspects of their university enrollment, such as course management, financial inquiries, and contact information. Students can also sign up for a GO Bus pass, view their grades and transcript, and check the status of scholarships and other applications. The main page is broken up into 8 collapsible sections, 4 main sections (Academics, Finances, Personal Information, Admissions) with another four sections in a sidebar (Holds, Finance Information, Academic Information, Other Useful Links). The critique will focus on enrolling in courses and viewing a user's course schedule.

Critique

Quest has some major usability issues when it comes to providing the user to information and functions they can use. The system is notorious for hiding options and menus from the user, requiring several screens of drill down menus before being able to access any meaningful options. The menus look unfinished or poorly formatted, and it is easy to become lost and confused while navigating the various pages. Navigation on the main page uses hyperlinked text, while traversing the deeper options is done using blue menu tabs. Native browser back and forward commands generally work as expected, which makes navigation a little more manageable.

PERSONAS

Presented are the personas used to develop our design. These personas were based off of the *Persona Template* as linked from the assignment outline from McMaster University, COMP SCI 4HC3. These personas were created to archetype the most common user types, and have been integral to developing a product that will satisfy all of them.

Trevor Clark



Figure 1: "When do classes start?"

- Born: London, ON
- Age: 22
- 3rd Year Engineering Student at McMaster

Trevor is a third year Civil Engineering student at McMaster. He currently lives 10 minutes away from campus with some friends he met in first year. Trevor's parents are paying for his tuition and he has a student loan which he uses to pay for rent and food.

Trevor is unorganized and rarely goes to class. He also forgets to hand in assignments on time. Trevor is not a part of any clubs and prefers to spend his free time with his housemates playing video games.

Trevor has trouble remembering important dates, like his course selection or when his exams are. When he searches for information, he usually gives up after five minutes if he cannot find what he is looking for. Trevor would like it if the new course management system was quick and easy to use. He also would not mind it if certain information was made more accessible during certain times of the year (easy to see link to exam schedule around exam season).

Candice Smith



Figure 2: "I don't know what electives I want to take for university next year"

- Born: Oakville, ON
- Age: 18
- Grade 12 High School Student

Candice has been accepted to the chemistry program at McMaster. Candice currently lives at home with her parents and will be moving into residence in the fall. Her parents are paying for her tuition, but Candice is paying for her residence and meal plan. Candice works part time at the Fortinos in her home town to save up money so she can go to the movies whenever new movies come out.

Candice has done well in all of her classes in high school and is a part of several high school groups; such as the volleyball team, track and field team and the Harry Potter fan club.

Candice has several electives that she can take, but she cannot decide which ones to enrol in. She has heard that she can change courses during the first couple weeks of class and plans on doing that if she ends up changing her mind. Candice has already made a list of classes she would like to take in her first year and is waiting for the course registration to open up. Candice would like the new course management system to allow her to browse all the courses available to her and would like it if there were descriptions for each course that she could read before she registers.

Adrian Lopez



Figure 3: "I have a lot of new things to get used to in Canada"

- Born: Mexico City, Mexico
- Age: 20
- 2nd Year Geography Student on Exchange to McMaster

Adrian is a geography student from Mexico on exchange at McMaster for the year. Adrian is living in a house 20 minutes away from campus with other students in the foreign exchange program. Adrian's tuition is being paid for by a grant he received for being a part of the foreign exchange program. His parents are giving him some money for rent and food but Adrian has to pay for some of it himself. Adrian is a hard working individual during the week and can be found in the Thode library between classes. Adrian likes to get all of his assignments done during the week so he can spend his weekend going to clubs with his housemates and friends.

Adrian is a part of the improv club which he regularly goes to. Adrian has chosen a light course load this year as he would like some time to experience Canada before he goes back to Mexico next September.

Since English is not Adrian's first language he sometimes has trouble reading and understanding websites that are primarily text, and he can get confused while navigating to the information he is looking for. Adrian would like it if the new course management system was easy to navigate and intuitive enough that he doesn't need to read an instruction manual to know how to use it.

DESIGN MOCKUPS

Please refer to the appendix for final design mockups of each screen. They were closely adhered to when developing the system, as can be noted by examining the screenshots from the new system at the end of the appendix.

USABILITY TESTS

Overview

This section of the document describes a plan for conducting a usability test for our course management software. This usability test plan will be based off of the Usability Test Plan Template created by the U.S. Department of Health & Human Services. The goals of this usability test are to establish a baseline of user performance, establish and validate user performance measures, and identify potential design concerns to be addressed in order to improve the efficiency, productivity, and end-user satisfaction of the product.

The usability test objectives are:

- To determine design inconsistencies and usability problem areas within the user interface and content areas
 - Navigation errors: failure to locate functions, failure to follow recommended screen flow
 - Presentation errors: failure to locate and properly act upon desired information in screens, selection errors due to labeling ambiguities
- Exercise the web site under controlled test conditions with representative users. Data will be used to access whether usability goals regarding an effective, efficient, and well-received user interface have been achieved.
- Establish baseline user performance and user-satisfaction levels of the user interface for future usability evaluations.

Procedure

The following details about the usability tests are sufficient data for others to replicate the tests in a consistent manner.

Test Conditions

The participant's interaction with the application will be monitored by the facilitator seated in the same room. The facilitator will be responsible for taking notes and logging data during the tests. All tasks will be run on the same machine, using the same web browser. The machine will be a desktop computer running Windows or Mac OS X. The browser used will be either Safari (7 or later), Chrome (39 or later), or Firefox (29 or later).

Task Setup

The facilitator will initially explain that the amount of time taken to complete the test task will be measured as well as how many errors were made and other notes about the participant's interactions with the software.

Before each task, the facilitator will ensure that no courses are enrolled in by navigating to the system's enroll page and dropping all current courses. The facilitator will then navigate to the home page of the system. The facilitator will instruct the participant to 'think aloud' so that verbal record exists of their interaction with the application. Then, they will inform the participant of the task's objective, and allow the participant to control the computer.

Task Procedure

As soon as the participant starts the task the facilitator will begin to time the participant. The facilitator will observe and enter user behaviour, user comments, and system actions. After the participant has completed all tasks they will be asked to complete a 14-question questionnaire (see Appendix: Table 1) using a 5-point Likert scale with 1 being *very easy* and 5 being *very hard*.

Tasks

Following is a list of the tasks the participant will complete. Note: the reason the courses in tasks 1.1 and 2.1 are different is that dummy courses were used for the new system, and have different course codes.

- **Task 1.1** - Have user enroll in the following courses for the *Winter 2016* term through Mosaic, selecting lectures, tutorials, and sections so as to eliminate conflicts as needed:
 - ANTHROP 1AA3
 - ANTHROP 1AB3
 - COMPSCI 2DM3
 - BIOLOGY 1A03
- **Task 1.2** - Have user find their exam schedule for the Fall 2015 semester on Mosaic
- **Task 1.3** - Have user find their weekly schedule for the Fall 2015 semester on Mosaic
- **Task 2.1** - Have user enroll in the following courses using the new system selecting lectures, tutorials, and sections so as to eliminate conflicts as needed:
 - ANTHROP 4AA3
 - ANTHROP 4M03
 - COMP SCI 1TA3
 - BIOLOGY 2AA3

- ANTHROP 4AA3
- ANTHROP 4M03
- COMP SCI 1TA3
- BIOLOGY 2AA3

- **Task 2.2** - Have user find their exam schedule for the Fall 2015 semester using the new system
- **Task 2.3** - Have user find their weekly schedule for the Fall 2015 semester using the new system

Success Metrics

Success metrics refers to user performance measured against specific performance goals necessary to satisfy usability requirements. Scenario completion success rates, error rates, subjective evaluations, and scenario completion times will be used.

Scenario Completion

Each scenario will require that the participant performs a specific, common task. The scenario is complete when the scenario's goal has been obtained or the participant requests sufficient guidance to warrant scoring the scenario as a critical error, at which point the facilitator will terminate the task.

The goal for scenario completion is that the participant successfully completes the task to completion.

Errors

Errors are deviations from the target behaviour necessary to complete the scenario. Participants may or may not be aware that they have deviated from the target behaviour. Errors may be procedural, in which the participant does not complete a scenario in the most optimal means (e.g. excessive steps and keystrokes). These errors may also be errors of confusion (such as attempting to edit an un-editable field).

The goal for errors is for the new system to have at most the same number of errors for each task as the old system. Optimally, some (if not all) tasks will have less errors than the old system. It is important to note that some participants may have experience using Mosaic, and so will make less errors. Even if this is the case, the goal remains the same as we are performing tests to see if a replacement system would be an improvement, in which case the current system would have the advantage of most users having experience.

Subjective Evaluations

Subjective evaluations regarding ease of use and satisfaction will be collected via questionnaires, and during debriefing at the conclusion of the session. The questionnaire will utilize a 5-point Likert scale, and will ask participants their perceived ease-of-use of a variety of functions and features. Each question will be asked once for Mosaic, and once for the new system.

The subjective evaluation goal is to have an average response number across all participants and all questions that is at least

1 point higher on the Likert scale for the new system, as well as to have no questions with an average response for the new system more than 1 point below the response for the same question for Mosaic. This ensures that the overall experience is significantly better from a user standpoint, and there are no areas of particular weakness with the new system.

Scenario Completion Time

For each scenario to be tested, the time it takes the participant to complete the scenario will be recorded, to the nearest second. This time begins as soon as the user starts the task, and finishes as soon as the task is completed. If the task is not completed, the time is not recorded and the result is noted in the errors section.

The goal for scenario completion time is to have the average completion time of each task be at most 10% slower on the new system, and the total completion time for all tasks on the new system to be at least 20% less than with Mosaic. This ensures that no task is significantly slower with the new system, and the overall benefit of the new system is significant.

RESULTS

The above usability tests were conducted with 8 different participants, all of whom had some experience using Mosaic. All participants were students at McMaster University.

After analysis of the intersystem task results and the questionnaire results, several conclusions can be drawn. Both the questionnaire and the test tasks reflected a nearly ubiquitous distinction between the subjective usability of the two systems (Mosaic and our newly implemented system).

Scenario Completion

All participants successfully completed all scenarios in both Mosaic and the new system.

Errors

There were two errors in the new system that were very common during the tests. When users were first asked to enroll in a course, they navigated to the Enroll from Wishlist page, and spent several moments trying to find out where to go next (the page stated that their wishlist was empty). The other common error was when users were selecting criteria to search for courses. The two dropdowns for course level and course code were designed to be mutually exclusive, however a majority of users first selected a course level, and then selected a course code (blanking out their course level choice). There were significantly more errors using Mosaic, including participants trying to continue without the radio button for the term selected, participants trying to add courses that had conflicts, and users taking extra steps to view the exam schedule. Due to the much larger number of errors in Mosaic, the success metric was met.

Subjective Evaluations

Very clear distinctions can be observed between the two systems in terms of subjective ease-of-use, as was found in the questionnaire results. Participants each recorded the difficulty of completing a handful of tasks on Mosaic, and then the difficulty of completing the same tasks on the new system. The average difficulty for Mosaic tasks was recorded at 3.5 (on a 5-point Likert scale, with 5 being most difficult, 1 being most easy) whereas the new system scored an average difficulty of 1.4 (Appendix: Table 2). This satisfies our first success metric for subjective evaluation. The second success metric is also met (Appendix: Table 2) as there were no tests that had an average score at least 1 point lower on the new system (the closest was enrolling in courses, where the new system had an average score 1.75 *better* than Mosaic).

Scenario Completion Times

The most notable distinction recorded is in the consistency of enrollment time between the two systems. During the task of enrolling in a course on Mosaic, participants ranged in completion times from 0.7 to 5.53 minutes. The standard deviation for time spent enrolling in a class on Mosaic was roughly 1.6 minutes. Alternatively, the same task on the new system had completion times ranging from 1.02 to 1.68, and a standard deviation of only 0.2 (Appendix: Table 3). The completion times clearly satisfied the first success metrics, as the average time for each task for the new system was never more than 10% slower than Mosaic. The second metric was also met, as the total time for Mosaic was 34:22 and the total time for the new system was 12:19, an improvement of 35.8% for the new system.

It can be observed, then, that amongst the participants tested there is qualitative and quantitative data suggesting higher usability for the new system. The new system is found to be both easier to use and more efficient than Mosaic.

DISCUSSION

The results of the usability tests will now be discussed in terms of the positive and negative aspects of the new systems, where it could be improved in the future, and how the results relate to the original goals of the project.

Positive Aspects of New System

The results shown above show that the new system was consistently preferred by participants over Mosaic. This can be seen in the questionnaire results, with a consistently higher rating for the ease-of-use of functions in the new system over Mosaic. It can also be seen more objectively by examining the significant improvements to scenario completion time as in Appendix: Figure 4.

There were several particular areas of strength for the new system as noted by comments from participants and ongoing evaluation by the facilitators as they worked on the tests. Each of these strengths will now be discussed, as well as how best to incorporate them going forward.

Accessing Features from Home Page

One of the largest complaints with Mosaic was the difficulty in finding common features such as a user's exam schedule. The improved navigation of the new system significantly reduced the time it took participants to find features, even though all participants had experience with Mosaic and no experience with the new system. Providing large, accessible buttons as well as a prominent dynamic element (see *Introduction: Suggested Improvements*) for the most common functions on the home screen allows the user to quickly find what they are most likely to need. Improved navigation was one of the main focuses of the new design, and the results demonstrate that the focus was an important factor in improving efficiency and user-satisfaction.

Visualization of Course Times

During the usability tests, most participants did not acknowledge Mosaic's course times when searching for courses. They instead chose the first available lecture and tutorial and added the course to the wishlist, resolving conflicts when actually enrolling. In the new system, the lecture, tutorial, and lab times are shown directly in the search results in a visual manner (*Appendix: New System – Screenshots*). The same visual structure is used when enrolling in courses, and as a result most participants were able to quickly understand why a course had a conflict and how to fix it.

Navigation Between Enrolling Steps

The “breadcrumb” navigation pattern was initially added to the course enrollment pages so that a user can quickly switch between searching for courses, seeing the results, and enrolling in courses. This proved to be an effective pattern, and almost every single participant used the element as the primary way to navigate between pages when enrolling in courses. Mosaic does not have a similar element, and it was noted during the tests that many users would add one course to their wishlist in Mosaic, return back to the home page, and then navigate back to the search courses page. It was our goal to eliminate this inefficiency with the new system, and the results of the completion time tests for enrolling in courses show that it was achieved (*Appendix: Figure 4*).

Although we have outlined the above features, there were a variety of other, less prominent enhancements that were appreciated by the participants during the tests. These included a less-cluttered UI, more obvious calls to action (i.e. bright green buttons), simpler conflict management (*Appendix: Figure 5*), and an improved weekly schedule (courses colour-coded, rows all have consistent height).

Negative Aspects of New System

Although the overall results from the usability tests were very positive, there were two main areas of weakness, where participants consistently encountered errors. Both areas would be primary areas of focus for future iterations.

Selecting Search Criteria from Dropdowns

One of the design decisions for the new system was to allow the user to select *either* the course level for a given subject when searching or the specific course code for the subject. The reasoning behind this was that the user would be able to quickly see all courses for a given subject and year, or they could manually choose one if they knew the code. In reality, participants consistently chose the course level and then without clicking search, would choose the course code, blanking out the course level dropdown. The design attempted to mitigate this with a large “OR” label between the dropdowns, and a bright green highlight for the selected one, but participants continued to make the error.

Initially Enrolling in Courses

Task 2.1 asks the user to enroll in several courses. The initial action by almost every user was to click the “Enroll/Drop” button on the main page, taking them to the page for enrolling in courses from the wishlist. Two large boxes are shown saying that they are not enrolled in any courses and their wishlist is empty, but there is no indication on how to add courses. Most participants looked around and eventually found the “Search Courses” button in the breadcrumb navigation at the top.

The above two areas of weakness led to the vast majority of errors during the usability tests for the new system, and mitigating them should be prioritized for future iterations.

Future Improvements

When designing future versions of the software, there are several important improvements that could be made, as can be seen in the results.

Improving the two weaknesses discussed above should be prioritized. For the search criteria dropdowns, the design should not require the two options to be mutually exclusive. Instead, selecting a level should filter the number of course codes available in the course code dropdown. If the user does select a course code, there should be an option to quickly add the course to the wishlist without leaving the search criteria page. This will improve the time for enrolling in courses if the user knows which courses they would like to enroll in. To improve the initial enrolling steps, a large prominent call to action from the enroll page should be shown if the wishlist is empty, pointing the user to the “Search Courses” page. As soon as a course is added to the wishlist, the link would disappear.

Another future improvement to the system would be to include the smarter schedule generation feature as discussed in *Introduction: Suggested Improvements*. This would improve the process for selecting time slots, and would increase user satisfaction, as it will reduce the effort to create a schedule, while improving the schedule quality.

Comparison with Original Goals

The original goal of this project was to create a university course-management system that is easier to use, smarter, and more efficient than existing systems. To create our design, we applied well-known design principles such as visibility (green buttons), mappings (course times shown on days of week table), and good conceptual models (breadcrumbs to show step-by-step nature of enrolling). The results from the usability tests clearly demonstrate that there are major usability issues with the current system (Appendix: Figure 5), and that the new system improves upon many of the usability aspects (Appendix: Figure 5). All success metrics were met or exceeded, demonstrating that the proposed system is a viable foundation for a new course-management software system.

CONCLUSION

We proposed a design for a new university course-management system with several new features and enhancements to reduce the amount of time it takes for students to perform common tasks. We then surveyed and critiqued four existing university course-management systems, and used this information to inform our design proposals. Personas were then created to demonstrate potential users of the system and were used to guide the design process. This process involved an iterative process of design for each of the pages of the system, which resulted in a set of mockups (appendix: *New System – Final Design Mockups*) using a consistent design language and incorporating the improvements outlined earlier.

The mockups were used to create a working prototype of the system, implemented using common web technologies. A database of “dummy” courses was created to test a variety of features, and edge cases were closely examined to ensure consistent behaviour.

After development of the new course-management website was finished, several usability tests were created to gather data on the effectiveness of the new system compared to Mosaic. The responses from the questionnaire show that users overwhelmingly preferred the new system over Mosaic in terms of user experience. The scenario completion time results showed similar times for finding weekly schedules and consistently lower times for finding exam schedules (in some cases significantly so). The most improved task in terms of completion time however was enrolling in courses, with times improving by large margins in all trials.

Some potential problems identified through our usability tests are the poor visibility of the exclusive nature of the dropdowns in the search page, and the lack of instructions on the enroll page when no courses are added yet.

The system is clearly not a replacement for Mosaic – it implements a small subset of Mosaic’s functionality – however, the results of the usability test and the software surveys show a need for improvement in university course-management software. The conclusion of our usability study is that the proposed system makes significant improvements over the current system and is a reasonable starting point for future changes.

APPENDIX
Usability Tests – Results

Table 1: Usability Questionnaire Questions (5-point Likert scale)

Question #	With Mosaic, how easy is it to...
Q1	find classes for enrollment?
Q2	add classes for enrollment?
Q3	find your weekly schedule
Q4	navigate your weekly schedule
Q5	select tutorial, lecture, and lab times for your course
Q6	enroll in courses
Q7	resolve schedule conflicts
<i>Questions 8 through 14 are identical to 1 through 7, but with the new system instead of Mosaic</i>	

Table 2: Usability Questionnaire Results (5-point scale, lower is better)

Participant #	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
1	5	4	2	3	3	4	5	2	1	1	1	1	1	2
2	4	4	2	2	2	4	3	2	3	1	1	1	3	2
3	4	3	4	4	2	3	5	1	1	1	1	1	2	1
4	4	4	5	4	3	4	4	2	1	1	2	1	2	2
5	3	3	2	3	3	3	4	2	3	1	1	2	3	3
6	4	4	3	4	4	3	5	1	1	1	1	1	1	1
7	3	1	5	2	3	3	4	4	1	1	1	1	1	1
8	5	4	2	4	3	4	4	1	2	1	1	1	2	1

Table 3: Usability Scenario Completion Time Results (min:sec)

Participant #	Mosaic Enroll	New Enroll	Mosaic Exam	New Exam	Mosaic Weekly	New Weekly
1	5:32	1:01	0:51	0:03	0:06	0:06
2	1:59	1:27	0:20	0:03	0:03	0:02
3	2:56	1:26	1:26	0:04	0:03	0:03
4	5:01	1:20	3:42	0:03	0:05	0:05
5	0:47	1:23	0:37	0:05	0:18	0:06
6	3:24	1:35	0:15	0:03	0:11	0:04
7	2:46	1:41	1:03	0:02	0:04	0:02
8	2:36	1:31	0:11	0:02	0:06	0:02

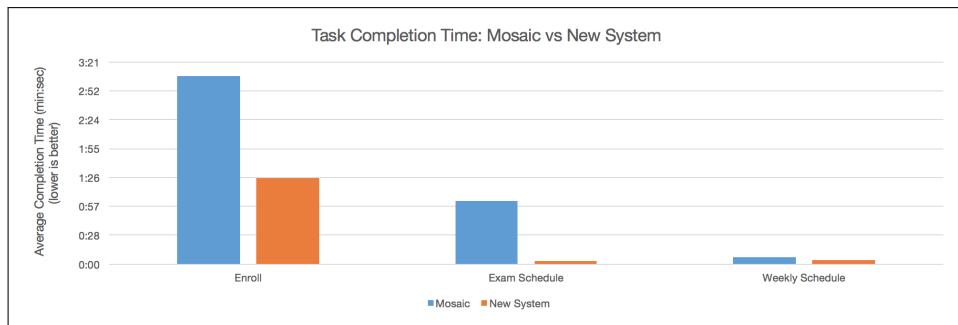


Figure 4: Task Completion Time: Mosaic vs New System

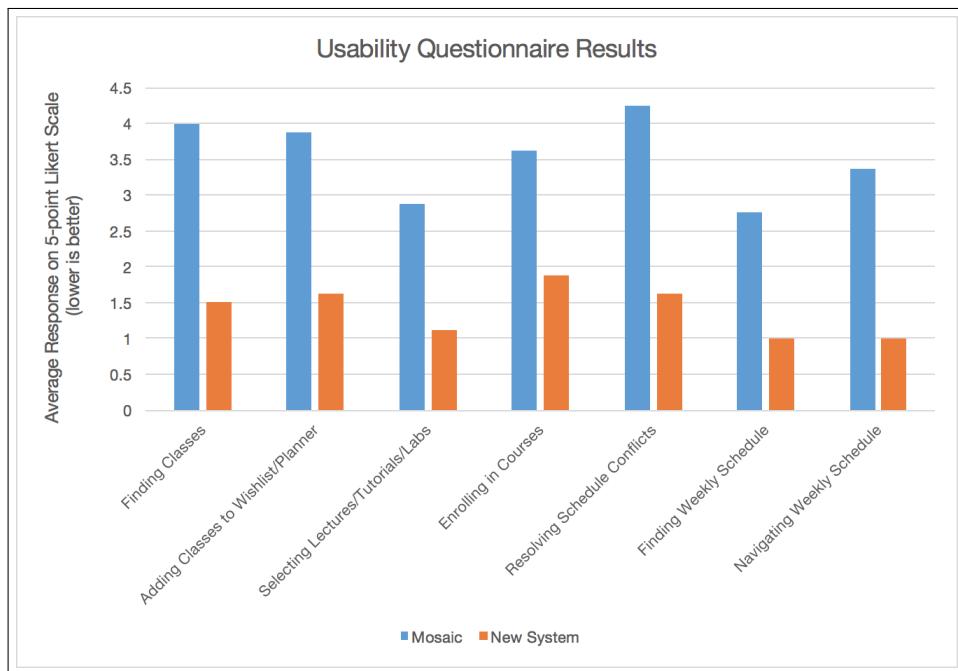


Figure 5: Usability Questionnaire Results

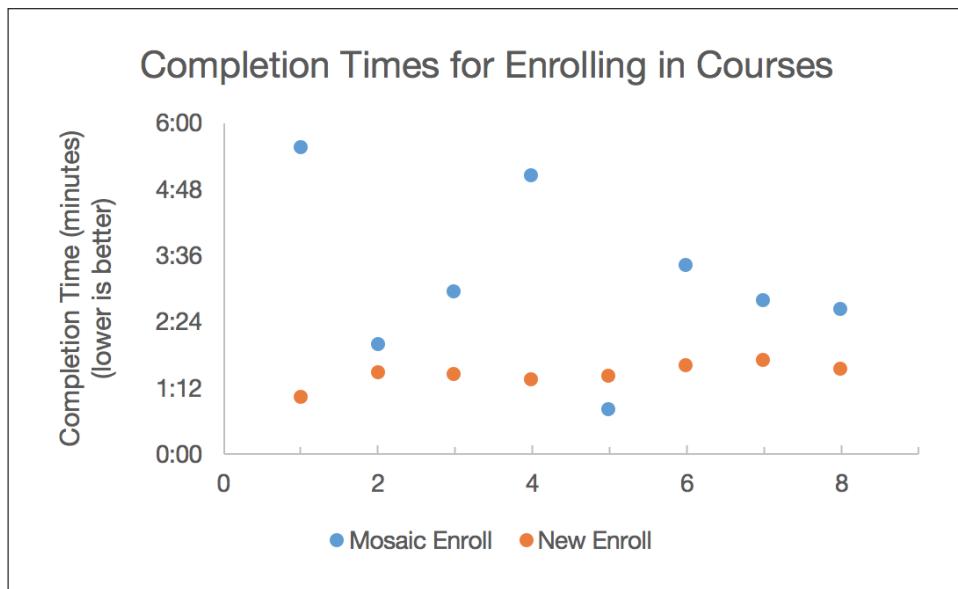


Figure 6: Completion Times for Enrolling in Courses

Other Systems – HTA's

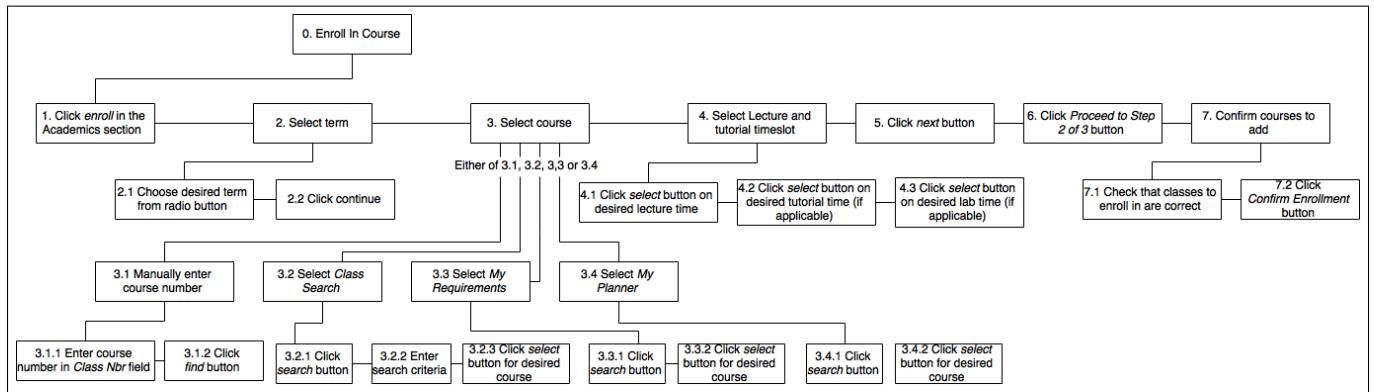


Figure 7: Mosaic HTA – Enrolling in a Course

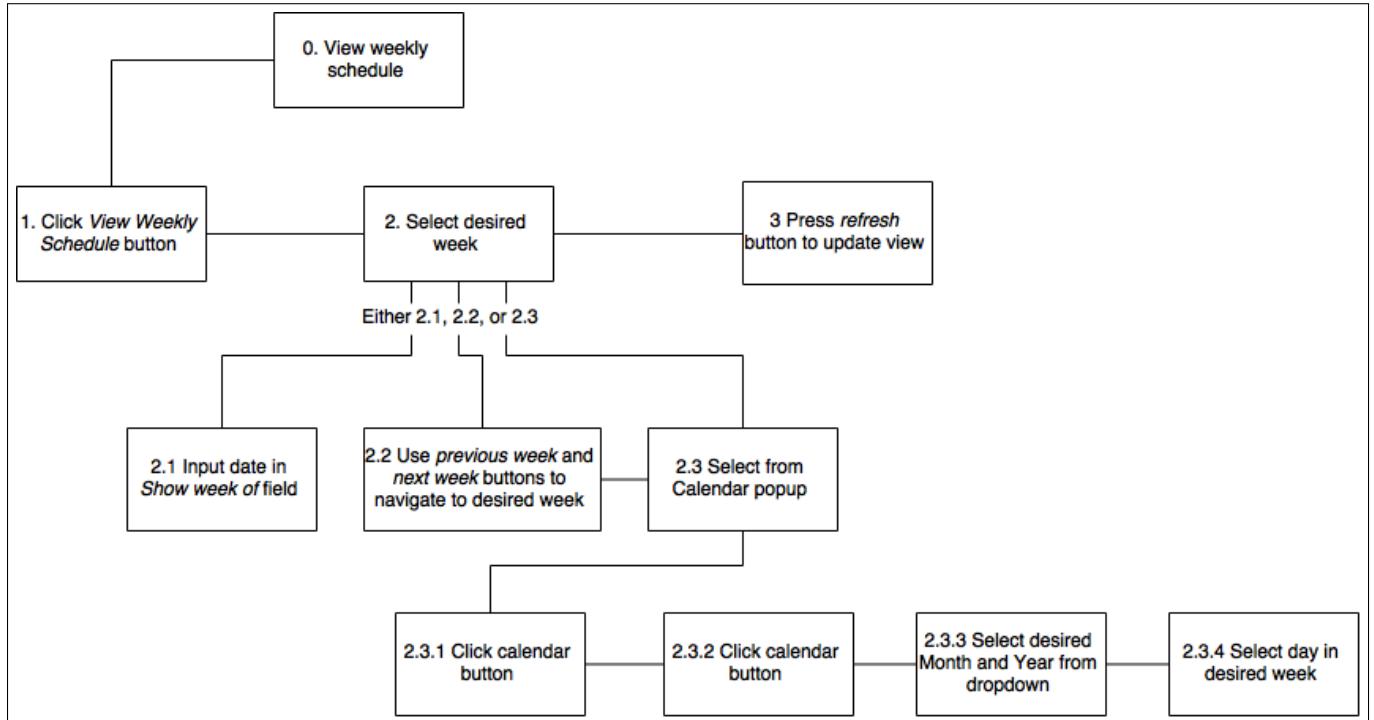


Figure 8: Mosaic HTA – Viewing Weekly Schedule

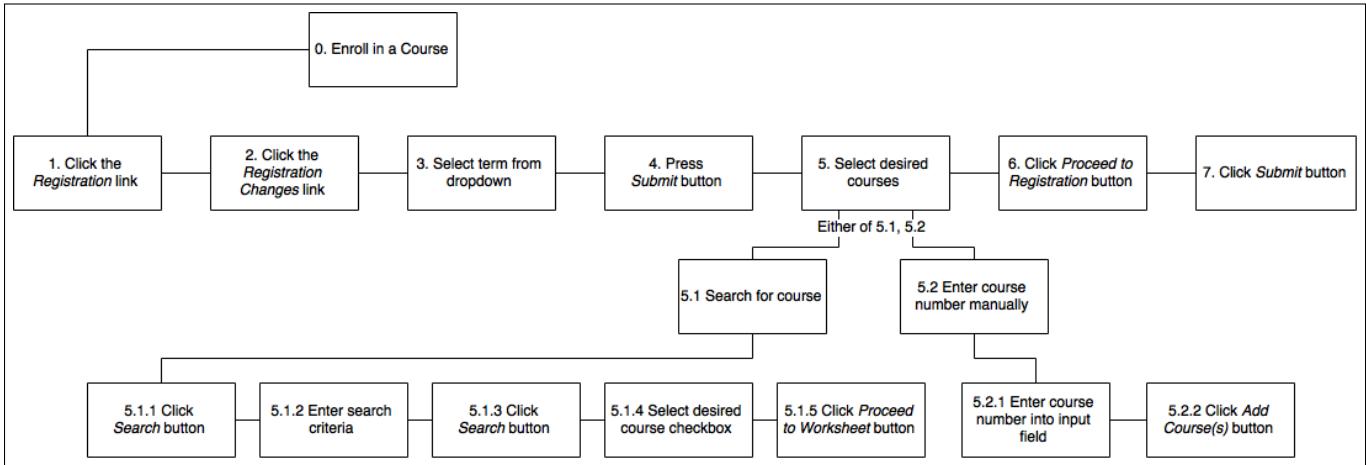


Figure 9: Carleton HTA – Enrolling in a Course

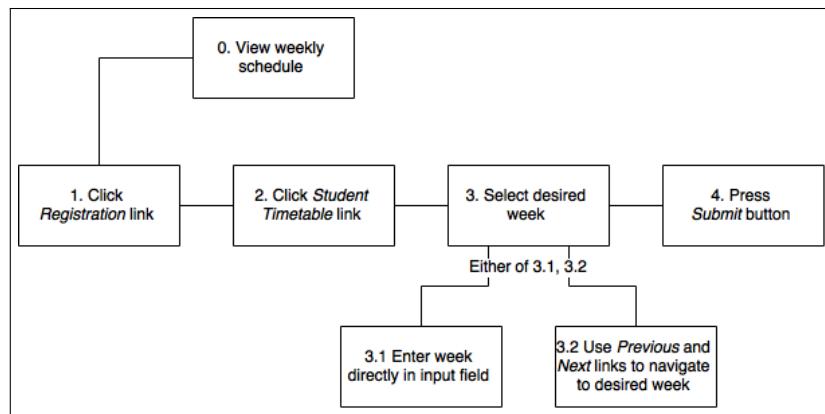


Figure 10: Carleton HTA – Viewing Weekly Schedule

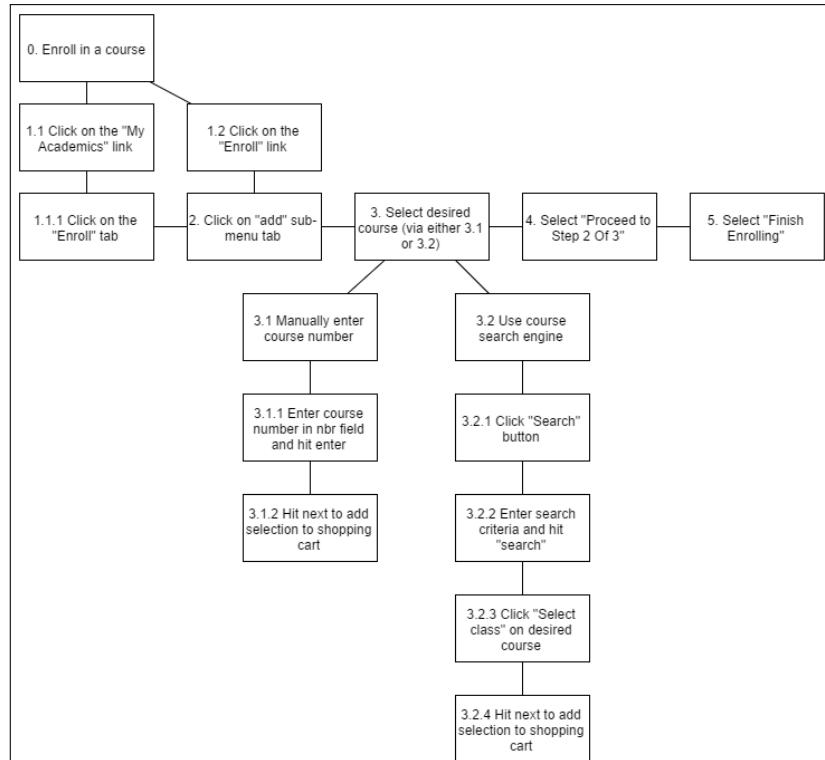


Figure 11: Quest HTA – Enrolling in a Course

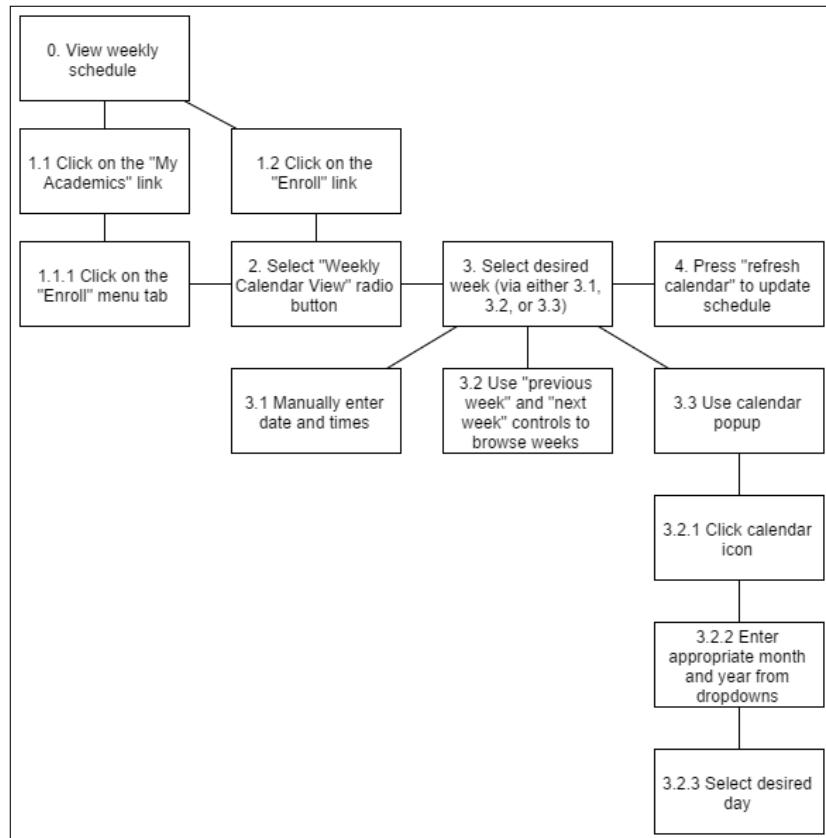


Figure 12: Quest HTA – Viewing Weekly Schedule

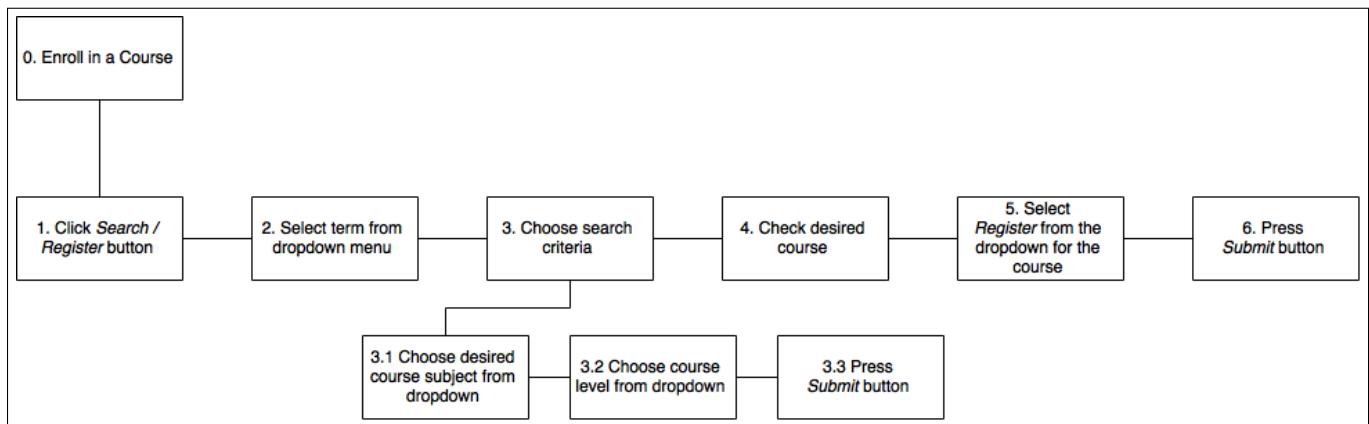


Figure 13: WebAdvisor HTA – Enrolling in a Course

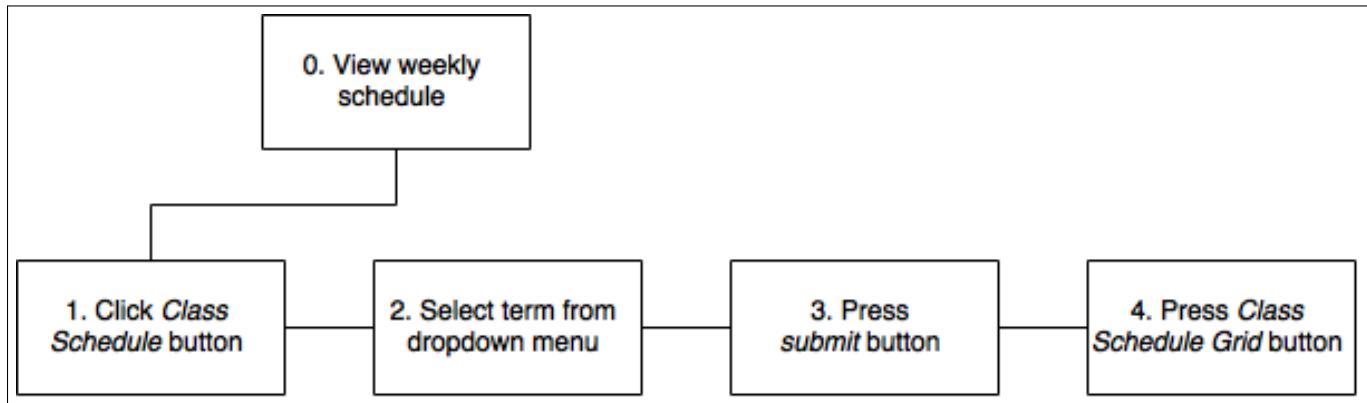


Figure 14: WebAdvisor HTA – Viewing Weekly Schedule

Other Systems – Screenshots

The screenshot shows the McMaster University Mosaic system. At the top, there's a navigation bar with links for Favorites, Main Menu, Welcome STUART, Home, and Sign out. Below the navigation is the McMaster University logo and the word "Mosaic". The main content area is titled "Add Classes". It has tabs for "Search", "Plan", "Enroll", and "My Academics". Under "My Academics", there are buttons for "my class schedule", "add", "drop", "swap", and "term information". A sub-section titled "1. Select classes to add" contains instructions: "To select classes for another term, select the term and click Change. When you are satisfied with your class selections, proceed to step 2 of 3." Below this is a "2016 Winter | Undergraduate | McMaster University" section with a "change term" button. The main form area is titled "Add to Cart" and shows a "2016 Winter Shopping Cart" which is currently empty. There are buttons for "Open", "Closed", and "Wait List". Below the cart are sections for "Find Classes" (Class Search, My Requirements, My Planner) and a "search" button.

Figure 15: Mosaic – Screenshot

The screenshot shows the Carleton University system. At the top, there are links for Personal Information, Student Services, Employee Services, and Financial Services. Below this is a red header bar with "Add or Drop Classes" and links for RETURN TO MENU, SITE MAP, and HELP. The main content area is titled "Add or Drop Classes". It includes a list of instructions: "To add a class, enter either the Course Reference Number (CRN) or the Course Subject/Number/Section (e.g. PSYC1001) in the Add Classes section.", "To drop a class, use the options available in the Action pull-down list.", "Courses from your draft worksheet will already be added at the bottom.", "After all changes have been made, press the Submit button.", and "For additional help with your registration, refer to the [registration website](#). Be sure to review your timetable after any registration changes to ensure that the changes have in fact taken effect." Below the instructions is a table titled "Current Schedule" with columns for Status, Action, CRN, Subj Crse Sec, Level, Cred, Grade Mode, and Title. One row is shown: "Registered on Sep 16, 2015" with "None" under Action, "14479 PSYC 5414 R" under CRN, "Graduate Studies and Research" under Subj Crse Sec, "0.500 Standard Letter Grade" under Cred, "Equation Modeling" under Grade Mode, and "Structural Modeling" under Title. Below the table are sections for "Total Credit Hours: 0.500", "Billing Hours: 0.500", "Minimum Hours: 0.000", "Maximum Hours: 99.000", and "Date: Nov 01, 2015 03:10 pm". A "Add Classes Worksheet" section follows, with a table for "CRNs (or SubjCrseSecs, e.g. ENGL1234A)". At the bottom are buttons for "Submit", "Class Search", "Reset", and "Return to Worksheet".

Figure 16: Carleton – Screenshot

The screenshot shows the University of Waterloo Quest system. At the top, there's a navigation bar with links for Menu, Student Center, and Lauren's Student Center. The main content area is titled "Lauren's Student Center". It has sections for "Academics" (My Academics, Course Selection (undergrad only), Academic Alerts, Go-Zero), "Finances" (My Account, Academic Integrity, Tax & Tuition, Promissory Note, Financial Aid, View Financial Aid, Scholarships and Awards), "Personal Information" (Demographic Data, Emergency Contact, Name/Address, Contact Information, Home Phone, 9059696220), and "Admissions" (You do not have any pending applications at this time). On the right side, there are sections for "Holds" (No holds), "Finance Information" (Student Assistance & Financial Aid, GSO Scholarships & Financial Student Accounts & Fees), "Academic Information" (Registrar's Office, Graduate Studies office, View Job Opportunities), and "Other Useful Links" (Co-op Ed & Career Action, QSAF).

Figure 17: Quest – Screenshot

The screenshot shows the WebAdvisor system. At the top, there's a dropdown menu for "Action for ALL Pref. Sections (or choose below)". Below it is a table titled "Preferred Sections" with columns for Action, Term, Section Name and Title, Location, Meeting Information, Faculty, and Available/Capacity. Four rows are listed: 1. RG - Register (Winter 2016, AHSS*3010*01 (3811), Guelph-Humber Campus, LEC Tues 06:05PM - 08:45PM GH, Room 324, TBA/TBA, 65 / 65). 2. RG - Register (Winter 2016, CIS*4110*0101 (1624), Guelph, LEC Mon, Wed, Fri 03:30PM - 04:20PM ALEX, Room 259, LAB Mon 12:30PM - 01:20PM JTP, Room 212, R. Dara, 8 / 50). 3. RG - Register (Fall 2015, EDRD*3500*DE (7474), Guelph, Recreation & Tourism Planning, M. Staempfli, 227 / 400). 4. RG - Register (Fall 2015, MGMT*3020*DE (8881), Guelph, Corp. Social Responsibility, D. Rezania, 18 / 150). Below this is a table titled "Current Registrations" with columns for Drop, Term, Pass/Audit, Section Name and Title, Location, Meeting Information, and Faculty. One row is shown: Drop (checkbox), Term (Fall 2015), Pass/Audit (checkbox), Section Name and Title (GEOG*3490*DE (8091) Tourism and Environment), Location (Guelph), Meeting Information (EXAM Mon 08:30AM - 10:30AM (2015/12/07) Room TBA Room TBA), Faculty (C. McCallum). At the bottom are buttons for "SUBMIT" and "If one of my choices is not available ALL don't process if any fail".

Figure 18: WebAdvisor – Screenshot

New System – Final Design Mockups

The Home page features the McMaster University logo at the top left. A user profile dropdown shows "John Smith". A navigation bar includes links for Home, View Schedule, Search Courses, Enroll/Drop, and Support. Below the navigation is a large banner with the text "Exam Season" and "Check your exam schedule here". A green button labeled "View Exam Schedule" is visible. To the right of the banner, two sections are shown: "Enroll/Drop" and "Schedule". The "Enroll/Drop" section contains a "Search for Courses" input and an "Enroll/Drop" button. The "Schedule" section has buttons for "Weekly Schedule" and "Exam Schedule". Under "Enrolled Courses", there are three items: COMP SCI 1X03 (Discrete Math and Logic), COMP SCI 1T83 (Introduction to Programming), and MATH 1A03 (Linear Algebra).

Figure 19: Final Mockup of Home Page

The Exam Schedule page header includes the McMaster University logo and user profile "John Smith". It features a navigation bar with Home, View Schedule, Search Courses, Enroll/Drop, and Support. Below the navigation is a breadcrumb trail: Home > View Schedule > Exam Schedule. The main content is titled "Exam Schedule: Fall 2015". A calendar grid from November 29 to December 5 is displayed. Specific events are highlighted: "Final Day of Classes: Fall 2015" on November 30, "Multiple Exams" on December 1, and "First Day of Classes: Winter 2016" on January 4. Detailed descriptions for COMP SCI 1X03 and COMP SCI 1AA3 are provided for their respective exam dates.

Figure 20: Final Mockup of Exam Schedule

The Weekly Schedule page header includes the McMaster University logo and user profile "John Smith". It features a navigation bar with Home, View Schedule, Search Courses, Enroll/Drop, and Support. Below the navigation is a breadcrumb trail: Home > View Schedule. The main content is titled "Class Schedule: November 22-28, 2015". A weekly grid from Sunday, Nov 22 to Saturday, Nov 28 shows class times and locations. For example, COMP SCI 1X03 (09:30-10:20, MCCL 1309) is listed for all days except Saturday. A green button labeled "View Exam Schedule" is located at the bottom.

Figure 21: Final Mockup of Weekly Schedule

The Search Criteria page header includes the McMaster University logo and user profile "John Smith". It features a navigation bar with Home, View Schedule, Search Courses, Enroll/Drop, and Support. Below the navigation is a breadcrumb trail: Home > Search for Courses. The main content is titled "Search for Courses". It includes two search fields: "Select Subject:" (set to COMP SCI) and "Select Level:" (set to Level 2). An "OR" button connects the two fields, followed by an "Enter Course Code:" input field (with "e.g. 1A03"). At the bottom are "View Wishlist" and "Search" buttons.

Figure 22: Final Mockup of Search Criteria Page

McMaster University

John Smith

Home View Schedule Search Courses Enroll/Drop Support

Search for Courses > Search Results

Search Results

Course Info	Times (final times selected when enrolling)					Enrolled	Action
	Monday	Tuesday	Wednesday	Thursday	Friday		
COMP SCI 1Z03 Intro to Programming Dr. S. Smith	Lecture 1 9:30-10:20			9:30-10:20	9:30-10:20	14/35	<button>Add to Wishlist</button>
	Lab 2 13:30-15:20						
COMP SCI 1A06 Computer Architecture and Logic Dr. R. Samavi	Lecture 1 19:00-22:00					48/50	<button>Add to Wishlist</button>
	Tutorial 1 12:30-13:20						
COMP SCI 1B03 Algorithms and Data Str. Professor TBD	Lecture 1 8:30-9:20	8:30-9:20		8:30-9:20		150/150	<button>Add to Wishlist</button>
	Lab 1 13:30-14:20						
COMP SCI 1T03 Code Analysis Dr. M. Dagg	Lecture 2 10:30-11:20	10:30-11:20				27/85	<button>✓ On Wishlist</button>
	Tutorial 1 14:30-15:20						
COMP SCI 1X03 Computer Architecture Dr. S. Polgo	Lecture 1 14:30-15:20	14:30-15:20	14:30-15:20			4/50	<button>Add to Wishlist</button>
	Tutorial 1 11:30-12:20						
COMP SCI 1XX3 Computer Graphics Professor TBD	Lecture 1 11:30-12:20	11:30-12:20	11:30-12:20			32/65	<button>✓ On Wishlist</button>
	Tutorial 3 15:30-16:20						
COMP SCI 1D03 Theory of Computation Dr. P. Church	Lecture 2 10:30-11:20	10:30-11:20				52/150	<button>✓ Enrolled</button>
	Tutorial 3 16:30-17:20						
	Lab 1 12:30-14:20						

Back to Search Continue to Enroll

Figure 23: Final Mockup of Search Results Page

McMaster University

John Smith

Home View Schedule Search Courses Enroll/Drop Support

Search for Courses > Search Results > Enroll from Wishlist

Wish List

Course Info	Times	Monday	Tuesday	Wednesday	Thursday	Friday	Enrolled	Action
COMP SCI 1Z03 Intro to Programming Dr. S. Smith	Lecture 1 9:30-10:20				9:30-10:20	9:30-10:20	14/35	<button>Remove</button> <button>Enroll</button>
	Tutorial 3 11:30-12:20							
COMP SCI 1A06 Computer Architecture and Logic Dr. R. Samavi	Select... 48/50							<button>Remove</button> <button>Enroll</button>
MATH 1ZZ3 Linear Algebra Professor TBD	Lecture 1 11:30-12:20	11:30-12:20	11:30-12:20				27/150	<button>Remove</button> <button>Enroll</button>
	Select... 27/150							

Enrolled Courses

Course Info	Times	Monday	Tuesday	Wednesday	Thursday	Friday	Enr.	Action
COMP SCI 1X03 What are computers? Dr. T. Murphy	Lecture 1 9:30-10:20				9:30-10:20	9:30-10:20	14/35	<button>Save Changes</button> <button>Drop</button>
	Tutorial 3 11:30-12:20							
ECON 1B03 Introduction to Macroeconomics Dr. R. Kressa	Lecture 2 13:30-16:20				19:30-22:20		48/50	<button>Save Changes</button> <button>Drop</button>
	Tutorial 1 11:30-12:20				11:30-12:20			

Figure 24: Final Mockup of Enroll from Wishlist Page

New System – HTA's

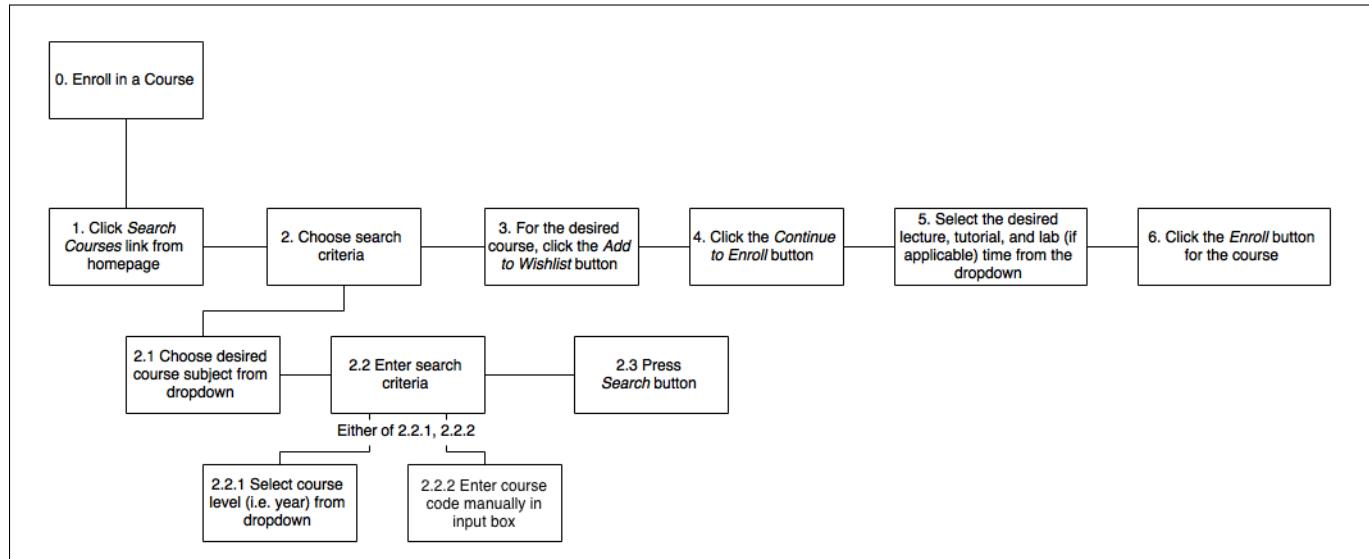


Figure 25: New System HTA - Enrolling in a Course

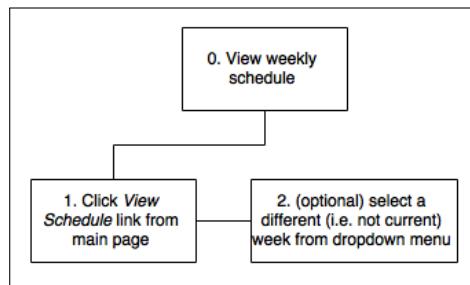


Figure 26: New System HTA - View Weekly Schedule

New System – Screenshots

The screenshot shows the homepage of the McMaster University new system. At the top left is the McMaster University logo. On the right is a user dropdown menu showing "John Smith" with options for Account Settings, My Profile, and Log Out. Below the header is a navigation bar with links for Home, View Schedule, Search Courses, and Enroll/Drop. The main content area features a large image of students taking an exam. Overlaid on the image is the text "Exam Season" and "Check your exam schedule here." A green button labeled "View Exam Schedule" is visible. Below this are two large boxes: "Enroll / Drop" containing "Search Courses" and "Enroll/Drop" buttons, and "Schedule" containing "Weekly Schedule" and "Exam Schedule" buttons. The "Enroll / Drop" box also shows a "Wishlist" section with course information for ANTHROP 1AB3 and COMP SCI 1TA3.

McMaster University

John Smith

Account Settings

My Profile

Log Out

Home

View Schedule

Search Courses

Enroll/Drop

Exam Season

Check your exam schedule here.

[View Exam Schedule](#)

Enroll / Drop

[Search Courses](#) [Enroll/Drop](#)

Wishlist:

ANTHROP 1AB3
Introduction to Anthropology: Race, Religion and Conflict

Schedule

[Weekly Schedule](#) [Exam Schedule](#)

Enrolled Courses:

COMP SCI 1TA3
Elementary Computing and Computer Use

ANTHROP 4M03
History of Anthropology

Figure 27: New System Screenshot – Home Page



John Smith

[Home](#)[View Schedule](#)[Search Courses](#)[Enroll/Drop](#)[Support ↗](#)[Weekly Schedule](#)[Exam Schedule](#)

Exam Schedule: Fall 2015

December 2015

29	30	1	2	3	4	5
		COMP SCI 1TA3 16:00 - 13:00 ITB AB102				
6		BIOLOGY 2SI3 13:00 - 16:00 JHE 303	9	10	11	12
13	14	15	16	17	18	19
20	21	ANTHROP 4M03 13:00 - 14:00 MDCL 1044	22	23	24	25
27	28	29	30	31	Jan 1	2
3	4	5	6	7	8	9

First Day of Classes: Winter 2016

[View Weekly Schedule](#)

Figure 28: New System Screenshot – Exam Schedule



Weekly Schedule

Exam Schedule

Weekly Schedule: Fall 2015

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8:30					
9:30	COMP SCI 1TA3 - T01 9:30 - 10:30 ITB AB102				
10:30					
11:30					
12:30	COMP SCI 1TA3 - C01 12:30 - 13:30 ITB AB102		ANTHROP 4M03 - C01 12:30 - 13:30 MDCL 1044	COMP SCI 1TA3 - C01 12:30 - 13:30 ITB AB102	ANTHROP 4M03 - C01 12:30 - 13:30 MDCL 1044
13:30	ANTHROP 4M03 - T05 13:30 - 14:30 MDCL 1044	COMP SCI 1TA3 - C01 13:30 - 14:30 ITB AB102			
14:30				BIOLOGY 2SI3 - C01 13:30 - 17:30 JHE 303	
15:30					
16:30					
17:30					
18:30					
19:30					
20:30					
21:30					

[View Exam Schedule](#)

Figure 29: New System Screenshot – Weekly Schedule



John Smith ▾

Home View Schedule Search Courses Enroll/Drop Support ↗

1. Search for Courses 2. Search Results 3. Enroll / Drop

Search for Courses

1 Select Subject:
BIOLOGY

2 Course Level
1 OR Course Code
Select Course Code...

Back to Home Search

Figure 30: New System Screenshot – Search Criteria Page

The screenshot shows the McMaster University website interface. At the top left is the McMaster University logo. To its right is a dropdown menu showing "John Smith". Below the header is a dark red navigation bar with five items: "Home", "View Schedule", "Search Courses", "Enroll/Drop", and "Support". Underneath the navigation bar are three grey buttons labeled "1. Search for Courses", "2. Search Results", and "3. Enroll / Drop". The main content area has a light grey background and features a heading "Search Results". Below the heading is a table titled "Course Info". The table lists two courses: "BIOLOGY 1BB3" and "BIOLOGY 1A03". For each course, it shows the course name, professor, and lecture/lab details. The "Action" column contains buttons: "Add to Wishlist" for BIOLOGY 1BB3 and "✓ On Wishlist" for BIOLOGY 1A03. At the bottom of the table are two buttons: "Back to Search" and "Continue to Enroll".

Course Info	Times	Monday	Tuesday	Wednesday	Thursday	Friday	Enr.	Action
BIOLOGY 1BB3 Argumentation <i>Matthew Grellette</i>	Lecture 1		15:30 - 16:30	15:30 - 16:30		15:30 - 16:30	30/100	Add to Wishlist
BIOLOGY 1A03 Cellular and Mole... <i>Alastair Tracy</i>	Lecture 1			8:30 - 9:30	8:30 - 9:30		16/100	✓ On Wishlist
	Lab 15		13:30 - 15:30					

[Back to Search](#) [Continue to Enroll](#)

Figure 31: New System Screenshot – Search Results Page


John Smith

[Home](#) [View Schedule](#) [Search Courses](#) [Enroll/Drop](#) [Support ↗](#)

1. Search for Courses 2. Search Results 3. Enroll / Drop

Wishlist

Course Info	Times	Monday	Tuesday	Wednesday	Thursday	Friday	Enr.	Action
ANTHROP 1AB3	Lecture 1				19:00 - 22:00		38/100	Remove
Introduction to Ant...	Tutorial 1			9:30 - 10:30				Enroll
<i>Karen McGarry</i>								
BIOLOGY 1A03	Lecture 1				8:30 - 9:30	8:30 - 9:30	16/100	Remove
Cellular and Molecu...								Enroll
<i>Alastair Tracy</i>	Lab 1		8:30 - 10:30					

Enrolled Courses

Course Info	Times	Monday	Tuesday	Wednesday	Thursday	Friday	Enr.	Action
COMP SCI 1TA3	Lecture 1	12:30 - 13:30	13:30 - 14:30		12:30 - 13:30		24/100	Save Changes
Elementary Comp...	Tutorial 2	11:30 - 12:30						Drop
<i>TBD</i>								
ANTHROP 4M03	Lecture 1			12:30 - 13:30		12:30 - 13:30	24/100	Save Changes
History of Anthro...	Tutorial 19	9:30 - 10:30						Drop
<i>Sean Corner</i>								
BIOLOGY 2SI3	Lecture 1				13:30 - 17:30		13/50	Save Changes
Studio Investigati...								Drop
<i>Christopher Myhr</i>								

[Back to Home](#)

Figure 32: New System Screenshot – Enroll from Wishlist Page