

Teaching Professors: A How-To Guide to Reduce Paper Printing

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I. Executive Summary: Paper Reduction

The University of Michigan (U-M) produces approximately 3.5 million pounds of waste entirely from printing paper. Therefore, it can be instrumental in creating a more sustainable campus by lessening the paper usage of students and professors. An innovative strategy to eliminate copy paper is through the reduction of hard copy assignment submissions by students. Our group from Environment 391: Campus and Sustainability class determined that educating faculty and Graduate Student Instructors (GSIs) of the benefits of accepting, grading, and returning assignments electronically was the best strategy. Professors accepting electronic submissions can give students feedback in a legible and easily accessible format. Consequently, professors can substantially decrease the amount of paper that is used at the University of Michigan.

Large college campuses, like U-M, are some of the largest consumers of paper. Despite 70 percent of students printing less than their 400 sheets per semester allotment, U-M still printed over 30 million sheets of paper in 2009. This amount of paper translates to the use of over 36 thousand trees, 1.8 million gallons of water, 5.8 million kilowatt hours of energy, 6,900 tons of solid waste resulting in pollution that degrades the surrounding ecosystem. After the production process, different toners and inks used for printing are often made with petroleum-based chemicals that do emit harmful particulates into the air. Discarded printers, ink cartridges, and paper create a large amount of waste that occupies landfills. Unfortunately, paper consumption is increasing by four to eight percent a year, which corresponds to more resource depletion and pollution.

Our project group decided that if professors required hard copies, asking students to decrease usage would not be feasible. For this reason, we created a survey to assess professors' electronic submissions habits. By E-mailing 600 professors from various disciplines, we received a 10 percent response rate that provided information about professors' practices. We discovered 80 percent of professors accepted assignments on CTools, but 79 percent of professors always or sometimes printed assignments to grade. They expressed that printing is done by habit and because of the difficulty of reading from a monitor for an extended period of time. Furthermore, they believed students received the best feedback from hand written notes. With our findings, we developed our plan to educate professors on sustainable habits with respect to printing and grading.

Knowing that 95 percent of professors from our survey sample were comfortable with CTools and accepted electronic submissions, we focused on enhancing electronic grading. We educated professors about the benefits of electronic submission and how to grade Microsoft Word documents with Track Changes tools. With the aid of our project, professors would make the decision to reduce paper usage. We created a website called "Green Printing" with a professor tutorial about CTools applications, information about using Track Changes, and a concise report of our findings. Having these materials easily accessible through the ITS website will allow for public use, and spread the knowledge about reducing printing on campus.

Our charge was to improve sustainability on campus. The method was to inform professors of the environmental impacts of paper production and use, resources about reducing printing, and benefits of electronic submission and Track Changes. There can be long-term improvements to the environment by providing useful literature about paper impacts, ways to reduce usage, and subsequent benefits.

II. Statement of Problem

Paper products are integrated into every part of our lives and most everyone uses office paper on a daily basis. There are countless needs for paper and it has become an essential aspect of our society. As the world population continues to grow and people in other countries become more modernized, the demand for printed-paper will continue to exponentially increase¹. Paper production and printing activities are significant contributors to greenhouse gas concentrations. Moreover, a significant amount of paper is wasted every day due to excess use by people⁸.

The first aspect of paper and printing that causes environmental problems is the processes involved in paper production. This process begins with the cutting of trees to make pulp. To make the pulp into paper includes multiple steps such as mechanical, heat, and chemical treatment⁶. Pulp and paper mills consume many resources like forests and fresh water while releasing industrial pollutants to the air, land and water. The massive amounts of water required by the pulp mills can have devastating effects on local ecosystems because of the wastewater degradation⁸. For every sheet of paper produced, at least one liter of freshwater is required⁹.

Paper production consumes a large number of trees in order to supply our country's paper demands. For example, one ton of office paper requires approximately 19 trees, and the United States alone uses 85 million tons of paper and paperboard each year^{7,9}. The clear cutting forest is a problem because forests act as a major land sink for carbon, helping to sequester substantial amounts of carbon dioxide. That is just one problem with cutting down trees; of course, you should at least mention the many others. The utilization of trees and water in the paper and pulp mills creates hazardous air and water pollution. The mills produce large quantities of sulfur dioxide and nitrous oxide (NOx), which are some of the compounds responsible for smog and acid rain development¹⁰. Freshwater and salt-water sources can become polluted with various chemicals and can cause anoxic zones because of eutrophication. The anoxic zones can eventually ruin local ecosystems¹¹.

After paper is produced, it is shipped all over the world and nearly all paper is printed on in some form or another. Printing activities bring about another series of environmental problems. The first major problem associated with computer printers is related to the ink or toner they use to produce the image or text on paper. When paper is discarded, the toner is not readily degradable and makes it more difficult to recycle the paper¹⁶. Another problem with printing and the toner is the emission of ultra-fine particles from the printers. In addition to being a source of air pollution, these particles can also be harmful when inhaled and can produce severe lung problems¹⁸. As more people spend a greater amount of time in close proximities to printers, this problem could become a significant health problem. On average, most ink jet printers last for just about three years adding to our limited landfill space⁵. While printers can last for a couple of years, the ink and toner cartridges last for significantly shorter durations. Almost fifty percent of people automatically discard the cartridges after the ink/toner runs out even though they are recyclable¹⁷. Over 350 million ink cartridges discarded every year and each unit takes nearly 450 years to completely decompose¹⁷.

College campuses are some of the largest consumers of paper in the world. There are 41,674 students at the University of Michigan. Every undergraduate student has four hundred pages allocated to them through U-M's budget. Although 70 percent of students print less than four-hundred sheets per semester, the University still printed approximately 23 million sheets of paper in 2009, and that number has been increasing by four to eight percent each year³. The

University needs to do a great deal of work to make progress in paper reduction. Many professors require hard copies of completed assignments, and students often must bring printed notes to lectures. Students and faculty need to be educated and motivated in a manner that makes them feel involved and part of the solution.

III. Campus Options for Reducing the Impact of Paper and Printing

Reducing paper usage at any college or university is a daunting task. Colleges require enormous amounts of paper for a number of different purposes. The motivations for places of higher education to reduce paper range from helping the environment to the recognition of the high costs of paper and printing. The University of Michigan is no exception when it comes to needing to reduce paper. Several paper reduction efforts are currently underway with the support of many campus leaders and organizations. Despite U-M wanting to make changes to become a more sustainable campus, when attempting to change the practices of more than 41,000 students and faculty there are bound to be problems.

One of the most talked about ways to reduce the environmental impact of paper and printing is to reduce paper usage through duplex, also known as double-sided, printing. Utilizing both sides of a sheet of paper can cut the amount of paper consumed by half. By reducing the amount of paper used by almost fifty-percent, the amount of pollutants, resources consumed, and landfill usage is drastically reduced.

Other efforts to reduce the impact of paper on campuses include starting at the source and decreasing paper usage by encouraging increased online communication by students and faculty and only printing when necessary. Students should be able to submit assignments online where professors can grade the homework without printing each student's assignment. There are programs available online, such as Lecture Notes, which allow the professor to upload their slides to a program, and students can take notes in an area adjacent to the slide. In a similar fashion, other programs have been created for online homework for classes like math and physics. The note-taking and homework programs can have numerous benefits for the professor, beyond just decreasing the need for printed assignments. For example, many of the homework programs can instantaneously tell students how they performed on assignments and note-taking programs can alert professors of student attendance at lecture or discussion.

U-M is also doing a number of other smaller activities to reduce the impact of paper and printing on campus. U-M buys and uses paper that is 50-100 percent recycled content¹⁷. The University of Michigan has also decided to purchase remanufactured toner³. In addition to purchasing green computing and printing objects, the university has educational efforts to help teach people about environmentally friendly options for green computing.

IV. Duplex Printing and the University of Michigan

While duplex printing has many advantages and sounds like the easiest solution to reduce paper usage it is not popular among ITS staff. Unfortunately, a common belief among ITS staff is that duplex printing is detrimental at U-M. First, not all printers are capable of duplex printing. Special equipment must be present for the printer to be able to reverse the paper. ITS staff members, Steve Sarzna and Robert Joyes, observed that most of the calls received by ITS regarding campus printers are linked to duplex. They believe that the duplex printing capability available on many campus printers, including the printers in Angell Hall where 20 percent of all

ITS computer sites paper is printed, is to blame for jammed printers. One of the reasons that the duplex printers jam is because people do not allow enough time for the printers to make impressions on both sides of the paper. Students become impatient waiting for the printer and repeatedly press the print button, causing a malfunction in the printer. According to Sarzna and Joyes, many ITS employees at U-M are not in favor of duplex printers because of the frequent jams and the environmental costs of constantly maintaining the printers, which need to be replaced every five to seven years¹⁹. Based on Sarzna and Joyes comments, it was clear that duplex printing would not be the preferred solution for ITS staff. More solutions had to be considered in order to satisfy the staff responsible for maintaining the campus computing sites.

There are several reasons to explain why the availability of duplex printing has not had a major increase in people independently choosing to print double-sided. These reasons include: printing machines without an automatic duplex mode, people not knowing how to duplex print, or people just choosing not to use duplex¹. In addition, people choose not to print in duplex because of the slow machine speeds during duplex printing or the increased jam rate from duplex printing¹. As companies enhance printing technologies in the future, duplex printing may increase.

V. Project Objectives

Our group was tasked with decreasing paper consumption on campus. After deciding to focus specifically on reducing paper printing among students and faculty, we considered several paper saving strategies, including: encouraging duplex printing, changing the student printing allocation, and increasing the price of printing. Ultimately, our group decided to start at the source of many paper-printing requirements, faculty. It is unreasonable to ask students not to print assignments if their professors require them to hand in hard copies of their work. Therefore, we wanted to decrease the amount of printing done on the campus by influencing professors to accept more electronic submissions through the available Course Tools (CTools) methods.

To gauge how faculty uses CTools, we created a survey and sent it to six hundred professors with ITS (Information and Technology Services) and Graham Environmental Sustainability Institute sponsorship²¹. The faculty members included in the survey population is from different departments throughout the school of LS&A. The goals of the survey were to learn the percentage of faculty that allow electronic submissions, the types of submissions they accept, the difficulties they perceive with CTools, and their consideration of the environment.

We heard back from sixty-eight professors, which was roughly ten-percent of our survey sample size. After analyzing the responses, we saw a similar trend in CTools use between Graham and non-Graham Institute affiliated professors. With this information we wanted to create literature to better educate the professors and graduated student instructors (GSIs) about using CTools and electronic grading. We wanted to create a report to send out to all faculties that detailed the environmental impact of paper printing, why it was important to allow for electronic submissions, and how to grade electronically. The other literature included a professor/GSI tutorial teaching them how to use track changes on Microsoft Word and grade electronically. Creating a website, hosted on University of Michigan's Green IT website, will allow for this literature to be made available to everyone on campus²¹.

VI. Summary of Findings

To achieve our project goal, we created a twelve question survey to send to professors on campus to gauge how long they had been at the University of Michigan, the extent to which they used CTools, how many assignments they printed and why²¹. We wanted to see what the professors were currently doing to understand if we could create valuable resources for them. The responses helped us tailor the literature we made. Listed below are the important findings with some translated into graph form as part of Appendix 1.

- 1) Faculty at U-M for more than 10 years (64%)
- 2) Professors who are generally comfortable using CTools for electronic submission (95%)
- 3) Professors allowing electronic submissions (78%)
- 4) Professors who then print out the electronic submissions (68% of the 78%)
- 5) Why professors print off electronic submissions
- 6) Faculty who believe a CTools tutorial would be helpful (50%)
- 7) Faculty that consider themselves comfortable or experts at using CTools (95%)
- 8) Faculty with a pre-existing knowledge of the environmental impact of printing (82%)
- 9) Faculty with an understanding the environmental effects of printing which did not affect decisions to print assignments (50%)
- 10) Faculty at U-M for more than 10 years (64%)

Even though professors accepted electronic submitted assignments, they printed their students' work to grade. Faculty members were only switching the printing burden from the students to themselves. The results also showed that CTools is a valuable resource in reducing paper printing for students. The problem we realized we had to tackle however was getting professors to reduce their assignment printing. Therefore, we decided to include information about tools to increase electronic grading as well as statistics about the effects of paper printing on the environment to educate the professors and eventually their GSIs.

VII. Constraints and Enabling Forces

We were concerned that faculty would not respond to the survey because undergraduate students conducted it. To create a more professional appearance, we approached the Graham Environmental Sustainability Institute. The Graham Institute agreed to approve the survey. A list of faculty affiliated with the Graham Institute was also provided. It was predicted that these faculty members would be more willing to complete the survey because of the Graham Institute's support.

In addition to the Graham Institute, the support of ITS was helpful as well. The Climate Savers Computing Initiative program, within ITS, also sponsored the survey. Climate Savers Computing Initiative promotes sustainable printing practices at the University. Furthermore, Climate Savers also agreed to create a website explaining the survey's findings and offering suggestions to reduce paper use.

As undergraduate students in a one semester course, conducting such a major survey was intimidating. Without the support and guidance of ITS, the Graham Environmental

Sustainability Institute, and Climate Savers it would have been near impossible to develop an effective survey.

VIII. Assessment of Project Outcome

The overall goal of our project was to educate the professors on campus about electronic submissions to decrease printing. We had four steps for achieving this goal, including a survey, professor tutorial, GSI orientation presentation, and report. We successfully created this literature and impacted the intended audience in a variety of ways.

Initially, we needed to understand the way professors accepted their assignments. Therefore, we created a survey that asked them if they accepted electronic submissions on CTools, if they preferred e-mail over CTools, what types of assignments they wanted electronically, and if they printed their results. We successfully heard back from 68 professors. By answering the survey we made the faculty think about their printing practices, and gauged what kind of tools would be helpful.

Even though the majority of professors understood how to use CTools, we thought it would be valuable to go over the logistics of electronic grading on the website to make sure everyone understood the basics. We also wanted to educate the professors about the environmental effects of printing off assignments to grade, as well as, how to use electronic grading resources like Microsoft Word's track changes options. With these things in mind, as well as the results of the survey, we successfully created:

1. Report: A one-page document describing the environmental effects of printing, printing practices currently used at U-M, how to decrease paper printing requirements, and what natural resources would be saved.
2. Instructor Information: A PowerPoint presentation detailing how to create a CTools website, accept assignments electronically, use Microsoft Word's track change options for grading, etc. This can be a stand-alone presentation or included in GSI Orientation.
3. Website: MaryBeth Stuenkel, our project sponsor, granted us web space on the Information and Technology website to host these files for future reference, use, and distribution.

We believed that if both GSIs and professors were successfully taught the effects of paper printing and how they could help contribute to the sustainability initiative on campus that printing would decrease. This material is hosted and can be viewed on the website²¹.

IX. Recommendations for Future Students

The CTools survey was the most significant part of the project. Writing and sending out the survey via e-mail was a challenge. The survey was a success, but some faculty did have criticisms. One faculty member criticized the survey for being biased. Future surveys should not lead faculty to a particular response. In an attempt to make the survey shorter, it is possible that the questions were directed to produce the answers we anticipated. In the future, there

should be more effort to ensure that the survey is not biased. Depending on how the questions are worded, it is possible to target for specific answers.

Also determining what faculty to ask to complete the survey was difficult. The survey was based on CTools submission. In some courses, it is not practical for students to submit assignments electronically through CTools. Determining, if it was feasible for faculty to require online submissions was difficult. In the future, a better understanding of the coursework in different departments, such as engineering and mathematics would be beneficial.

In addition, suggesting ways for students to submit assignments by using less paper in general could be an area of focus for future projects. For instance, in classes that require hard-copy submissions, it could be possible for students to use both sides of the paper, therefore, reducing the paper usage by fifty percent.

It is also important to factor in students preference for assignment submissions and feedback. A survey for students could provide information regarding electronic submissions and could also encourage instructors to increase electronic submission opportunities. The role of instructor feedback is an important aspect of electronic submissions. It is possible that students would prefer electronic feedback. Instructors would not be responsible for legible handwriting and would not have to worry about miscommunications with students. This could convince faculty of the other benefits of electronic submission, besides paper use reduction.

Future teams can examine several different areas. Understanding online submissions and feedback preferences for both students and instructors is crucial in generating ways to reduce paper use in the classroom. Conducting surveys for both faculty and students may prove challenging in the future. Our survey was a success, but there is room for future improvement.

X. Recommendations for U-M

Based on the work our group has done, we have several recommendations for how the University should proceed to decrease paper and printing activities on campus. The first would be to set the precedent of instructing the professors about electronic grading tools and procedures. This can be done by sending our Instructor Information PowerPoint, developing instructional seminars, and creating supportive services to answer any professor questions. If professors understand how to use tools like Microsoft Word Track Changes, then they can reduce the amount of assignments they print for grading purposes.

We also recommend creating an ITS Checklist point called "Paperless Classroom Attributes." It can only be achieved after reducing the amount of paper generated from assignments by a professor, and this achievement can be hosted on the Green Printing website that our project group created. The current checklist highlights green computing activities, but does not include a paperless component.

Furthermore, U-M has established resources for professors such as CTools support, ITS staff, and computing seminars to spread green computing knowledge on campus. While these resources exist, professors do not always recognize them. Through better information publicity, U-M can save money by not having to create new computing resources. For example, if a Green Computing Campaign was implemented to share the existing computing services and state the benefits of going paperless, then everyone on campus would be made aware.

XI. Lessons Learned

The main lesson learned regarded the dissemination of our project literature. We created an interactive website that hosts the one page report, instructor information PowerPoint presentation, survey, sustainable website links, and tips on how to reduce paper printing in general. To share this literature we were granted ITS web space to host the website. Additionally, we contacted the administrative assistants of various University departments to deliver our report to professors. We were successful in sharing our information with faculty.

Overall, our group believes the greatest way to address sustainability in relation to paper and printing activities is to try to reduce paper that students need to use on campus. U-M can work to increase the amount of recycling, duplex printing, environmentally friendly toner usage, etc., but all of those activities still require the use of energy and resources. Decreasing the need for printing, however, is the best way to help the University of Michigan become a greener computing campus. By not using the energy and resources required our campus can become a greener campus than compared to just using cleaner more efficient processes.

Our group decided to target professors to decrease the amount of printing they require from their students. Ultimately, professors make the decisions whether students will be required to print homework, papers, and projects. Students can still play an important part though if they advocate for paperless learning and urge their professors to accept more online submissions. Hopefully, professors may see the value in decreasing paper and printing in their classrooms because of our report.

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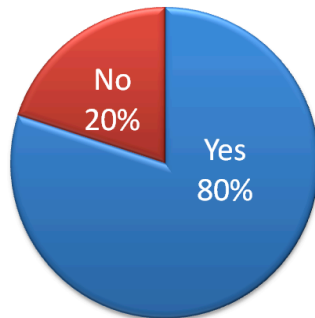
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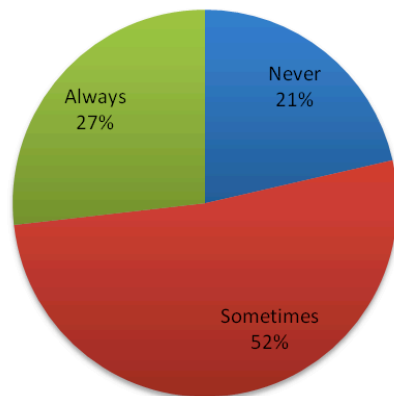
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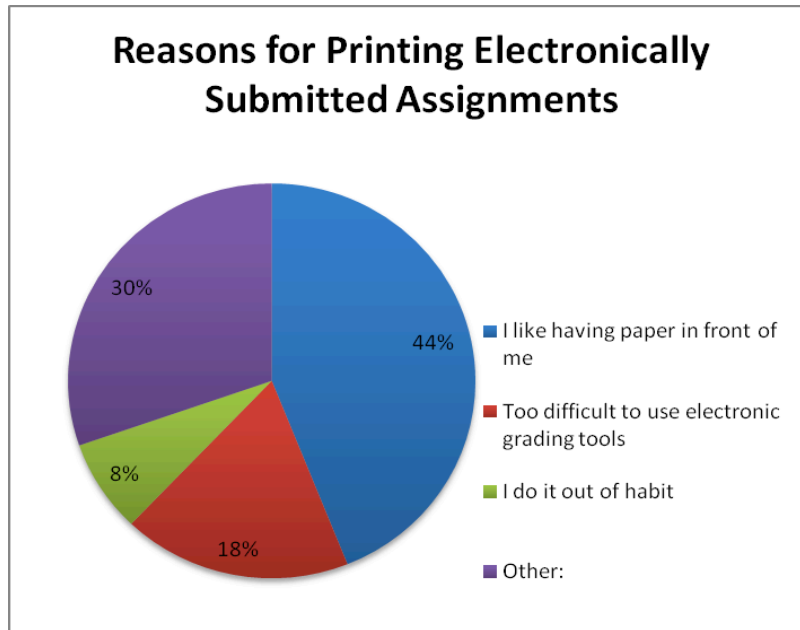
20. Appendix 1
Graphs

Professors Who Accept Electronic Submissions



Professors Who Print Off Electronically Submitted Assignments





21. Appendix 2

Website <http://climatesavers.umich.edu/greenprinting/> leads PDF files of the:

1. Report: <http://climatesavers.umich.edu/greenprinting/Report.pdf>
2. Survey: <http://climatesavers.umich.edu/greenprinting/Survey.pdf>
3. Instructor Information: <http://climatesavers.umich.edu/greenprinting/InstructorInformation.pdf>

22. Appendix 3

Process Taken to Achieve Goals

The following timeline describes the process we took to achieve all of our goals:

1. 2/12/2010: Meeting 1- We met with MaryBeth Stuenkel, our project sponsor and Climate Savers Computing Initiative Coordinator, and two computing sites staff members, Steve Sarzna and Robert Joyes, to discuss the scope of the project and decided to concentrate on electronic submissions via CTools.
2. 2/18/2010: Meeting 2- Stuenkel gave us access to UMLessons to create a survey because this website was more professional than our first idea of www.SurveyMonkey.com. We edited our survey to eliminate certain questions and thought about how to discover how professors are using CTools. After contacting the Information Review Board (IRB), we decided that it would be in our interest to avoid waiting four to six weeks for survey approval and asked for Graham Institute sponsorship to give legitimacy to our survey. We decided to include a GSI Orientation presentation into the project, in addition to, the Report and Professor Tutorial.
3. 2/21/2010: The Project Group Midterm Survey was completed and after we met with Carol Anderson, the project facilitator, we all agreed on an action plan for the rest of the project.

4. 2/24/2010: Meeting 3- After hearing back from Drew Horning, the Deputy Director of the Graham Institute, that our group would have Graham Institute sponsorship so we used a listing of Graham Institute affiliated professors, as well as, non-Graham Institute affiliated professors. We created e-mail lists for each group; containing roughly three hundred professors in each list in preparation for sending the survey. This way we were able to obtain credibility and sponsorship without waiting four to six weeks for IRB approval.
5. 3/09/2010: Meeting 4- We completed our Project Outline and Update, incorporated all corrections to the UMLessons survey, created an e-mail group to administer our survey so no single group member would be responsible for responding to questions or comments from survey participants, and decided to send the survey out on March 15 and close the survey by March 22.
6. 3/10/2010: We submitted our Project Outline and Update and contacted the head of the GSI orientation to see if we can collaborate with their program.
7. 3/10/2010 to 3/15/2010: With the outline completed, we submitted our last draft of the survey for review to Mike Shriberg, the course instructor, Julian Dautremont-Smith, the course GSI, and MaryBeth Stuenkel for revisions before sending it to professors. After changing the format of the survey to make it look more professional, and taking into consideration all of the comments made, we finalized the survey and prepared to send it.
8. 3/16/2010: Meeting 5- Due to unforeseen difficulties with the survey, we decided to e-mail the survey on March 17. We then divided the final paper assignment requirements for all us to work on as we waited for survey responses. At this meeting we finalized the survey, which was sent out on March 17 by Stuenkel.
9. 3/23/2010: Meeting 6- We decided that although we only received sixty-six survey responses we would not re-send our survey because of the lack of time. Therefore, it was agreed upon to analyze the information we received. Based on this analysis we decided what to include in the final report, professor tutorials, and GSI orientation.
10. 3/30/2010: Meeting 7- We presented to the group our finalized paper parts, the report, the professor tutorial, and GSI orientation. After receiving comments from MaryBeth about our format, we decided to put everything together to create our final draft. Then we completed an outline for the in-class PowerPoint presentation.
11. 4/04/2010: We finished and submitted the project rough draft on April 3.
12. 4/06/2010: Meeting 8- Finalized the PowerPoint presentation, received final feedback from MaryBeth, and finished the paper draft.
13. 4/19/2010: Final Presentation
14. 4/18/2010: Meeting 9- Completed the final version of the paper

15. 4/20/2010: Final Project Paper and Assessment of Group Members completed
