

AC 2010-1723: USING WIKIS IN A SOPHOMORE ENGINEERING DESIGN COURSE

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Using Wikis in a Sophomore Engineering Design Course

Introduction

With the launch of Wikipedia in 2001, the nature of creating content and gathering information on the internet began to change dramatically. Initially introduced as a free online encyclopedia¹, it has become a single source of information on nearly any subject and one of most visited sites on the internet, consistently ranking in the top ten. It can be used as a starting point for research on almost any topic. A wiki, according to Wikipedia², “is a website that allows the easy creation and editing of any number of interlinked web pages via a web browser using a simplified markup language or a WYSIWYG [what you see is what you get] text editor.”

An important feature of a wiki is that users themselves can edit the content of the page. In the case of Wikipedia, anyone with access to the internet can update nearly any entry at any time. While this has been a controversial feature of Wikipedia, due to fact that false or erroneous content can be anonymously inserted in an article, wikis can be useful in other contexts. One example is corporations that have been using wikis for knowledge sharing and project management³. Another example is the use of wikis in education^{4,5}, since it is an ideal tool to use for collaborative learning. In such situations where editing access is controlled, a wiki may be effectively used as a central location in which information pertaining to a particular topic or project may be found.

As wikis have increased in popularity, they have become more prominent in academic settings as a learning tool. The education community has initiated studies on the effectiveness of these web-based collaborative learning tools. See Aharony⁶ and Parker and Chao⁷ for a review of wiki use in general and how they fit into different learning paradigms. These researchers see wikis as enablers of deep learning and their use within an academic setting teaches students to effectively use the technology in a professional setting.

Within engineering education, wikis have been used in several ways at several different levels. One example is the creation of ePortfolios in a freshman engineering design course⁸. The students were given writing assignments in which they reflected on the human implications of design. Another example can be found in a team-based capstone design project in which the wiki was used to document social knowledge and assess group performance⁹. A third example is a student-written online textbook⁵. In a senior level chemical engineering process controls course, an open-source text was written, edited, and reviewed by the students to allow them to learn the course content through teaching it.

This paper describes the use of a wiki in a project-based engineering design course at the University of Hartford. The inspiration for this application came from an article describing how students in a computer engineering course at the University of Alabama, Huntsville used a wiki combined with version control software to manage a programming project¹⁰. The wiki gave them a central location to store project files while the version control software allowed them to easily keep track of file revisions, an important aspect of programming projects.

The intent of incorporating a wiki into the engineering design course was to improve the students' skills in two areas: organization/project management and technical writing. The course consisted of a semester-long project, with several groups working on different parts of the system. It was important for them to keep track of progress and maintain an understanding of the overall project. Also, the students were required to submit a formal written report at the end of the semester and another goal of using the wiki was to have students documenting their work as they went along so that the entire report was not left until the last minute.

In the following sections, this paper provides the following:

1. A brief description of the project-based engineering design course.
2. A description of how the wiki was used in the course.
3. A demonstration of the wiki software used and possible alternatives.
4. Assessment results and discussion of successes and failures.
5. Lessons learned and suggestions for how to incorporate wikis into project courses.

The wiki created for this course can be found at <http://es242-digitalhealth-s09.wikispaces.com/>.

Sophomore Engineering Design Course

A wiki was used in spring 2009 in a design course taken by sophomore level biomedical, civil, computer, electrical, and mechanical engineering students at the University of Hartford. The course is offered each spring and meets once per week for three hours. Three or four projects are offered that are related to the different engineering disciplines. Recent projects have been offered that relate to digital health, solar heating, water purification, and architectural acoustics. Students are divided into projects so that each section enrolls approximately 15. Each project section has its own instructor. For the first two hours of class, each section meets in its own classroom/lab to work on the project. This is followed by a ten minute break and then a common lecture for the last hour.

During the project section, individual design steps are discussed and applied to the project. Students are also able to work with each other on their project during this time. In the common lecture, presentations are made by faculty and guest speakers about topics such as engineering design tools, technical writing, intellectual property, and ethics. Details of the course, and the digital health project specifically, have been previously published^{11,12}.

A wiki was used in the project section related to digital health, which involved designing, building, and testing a system to remotely monitor the health of an individual in the home environment. There were three major components to the system: footwear, walker, and data acquisition. The footwear component consisted of force sensors, accelerometers, and their associated circuitry incorporated into an insole of a shoe to monitor the quality of the patient's strides. The walker component consisted of force sensors and optical encoders to determine how much the patient relied on the walker. The data acquisition component consisted of hardware and software to wirelessly collect data from the footwear and walker sensors, display the data in real-time, and save it to a file for future use. The class separated into three groups with each focusing on one component. The groups were responsible for building and testing their

component and integrating it into the overall design.

Wiki Use

The layout of the course and the project made using a wiki especially appropriate. One goal of using the wiki was to enhance the students' organizational and project management skills. In a project of this scale, with several groups working on different parts of the system, it was important for each group to keep track of progress and maintain an understanding of the overall system. With the wiki, the groups and the instructor were able to follow progress easily. Using the technology in this way was particularly important since the class met only once per week.

Another goal was to improve the students' technical writing abilities. At the end of the course, each group was required to submit a formal written report. These reports were complete documentation of a group's work and consisted of an overview of the whole project, description of their particular subsystem and how it fits into the overall design, and schematics, drawings, or pictures of what they built. The intent was to make the final report easier to write by requiring each group to keep the wiki up to date throughout the semester as they were working on the project.

The wiki was introduced to the class during the second meeting of the semester. A simple webpage was set up by the instructor as a starting point that contained a brief text description of the course and the project. A demonstration was given on how to use and edit the wiki (discussed in the next section). A semester-long wiki assignment was given and the students were provided with guidelines about how to use the wiki, but they were instructed to develop the wiki as they thought appropriate for the project. The assignment is shown below. Wiki writing assignments were worth 10% of the overall grade while the final report was worth 20%.

Each group (data acquisition, walker, footwear) is to update the wiki *on a weekly basis* to provide details of their project plan and work done to date. Each group should create a page containing the following information.

Background	<ul style="list-style-type: none">- What is your group doing? Describe what your subsystem is.- What is your group contributing and how does your design fit into the overall project?
Technical Information	<ul style="list-style-type: none">- Provide schematics, drawings, code, pictures, etc. of you design.- Describe the information contained in these items.
Schedule	<ul style="list-style-type: none">- Provide a timeline for your progress.- How is the project progressing against the schedule?- Be specific about what has been accomplished and what tasks remain.- Be sure to include:<ul style="list-style-type: none">• How much of the work is complete• What part of the work is currently in progress• What work remains to be done
Budget	<ul style="list-style-type: none">- How is the project progressing against the budget you defined in your project plan?

	<ul style="list-style-type: none"> - Be sure to include: <ul style="list-style-type: none"> • Budget to date • Expenditure to date • Accrued expenditure • Expected total expenditure including scope changes or variations • Explanation of how this varies from the total budget
Issues	<ul style="list-style-type: none"> - What problems or unexpected issues have arisen and how are they being managed? - Have there been any changes to your project specifications?
Resources	<ul style="list-style-type: none"> - Provide external links to resources that are useful for your group. - Describe what the external link is and how it helps the project. - Be sure to give credit where credit is due on our wiki page (i.e. provide information about the link and where you found it).
Other Information	<ul style="list-style-type: none"> - Provide any information not listed above that you feel is relevant to the project.

Groups will be expected to keep their information up to date. The wiki will be assessed **every Thursday at 5PM** and grades will be assigned.

Grading:

This is a collaborative effort on the part of each group. Each member must play a role in creating this documentation. Individual students will be assessed on a scale of 1-10 based on the quality and extensiveness of their contributions.

The students immediately began editing the webpage and made it their own. Some students showed their artistic abilities by creating logos and figures. The home page, shown in Figure 1, was edited to include a logo for the project. Each of the three groups created their own page that showed information about their schedule and progress. Figure 2 shows the page created by the footwear group. The instructor created a parts page to keep track of components that were ordered, when they arrived, and information such as part numbers, vendors, cost, and links to datasheets, as shown in Figure 3.

Editing and maintaining the wiki page was trouble-free. Each student was able to monitor who was modifying information. Editing the page helped improve their skills by providing an active learning environment that helped the students communicate with the other designers in the class. It was also a powerful tool to correspond with each other without being in the classroom. Designers were able to share and improve the design at anytime and from anywhere. Anyone on the team could edit and it was easy to follow and track the changes. It also helped the designers to be inspired by each other's work.



Figure 1: The home page for the project's wiki.

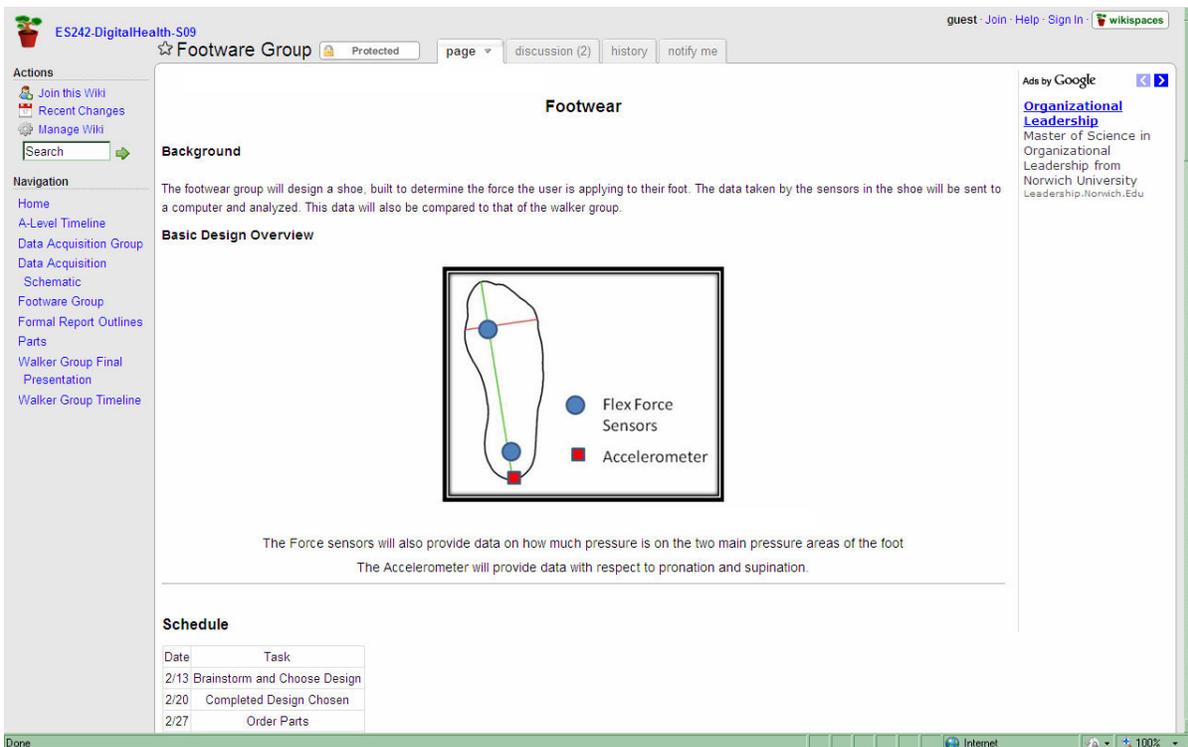


Figure 2: The working page for one of the groups.

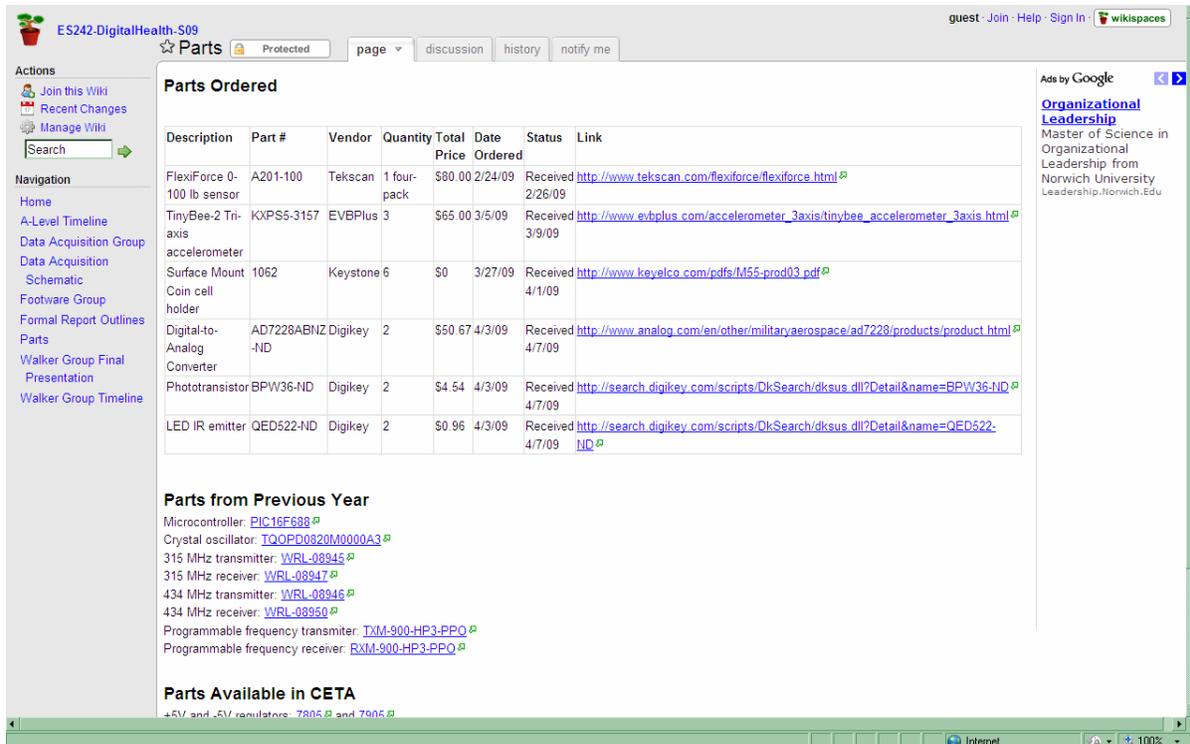


Figure 3: The parts page showing the status of components ordered for the project. Links connect to manufacturer websites for datasheets.

The wiki helped the students put their plan together, then go back and fix it when necessary. For example, the wiki provided everyone with an opportunity to contribute to the page created for each team. Then the other team members provided input on a weekly basis on what had been achieved on behalf of the team and what was still needed for the project to be completed.

Communicating through the wiki was an excellent process for transferring information between teams. Designers could also upload files and documents to their page, which made the collaboration more practical. Everyone had access to them, in addition to the ability to modify them. By using the wiki in this project, the students were able to stay on the top of the project and have more sense of organization. It helped the groups stay organized by having the ability to modify their work quickly, which made it easier to maintain their momentum throughout the week.

Wiki Software

The wiki used for this course was Wikispaces¹³, a service provided by Tangient that claims to be one of the easiest to use wikis available. Based on experience with their service, the wiki is easy to use, but as with any product, there are some downsides as well.

Wikispaces provides a free basic wiki which was used for this course. The free version of their wiki provides unlimited users and unlimited pages with a storage limit of 2 GB. The editing

interface is WYSIWYG and other features include discussion areas, file uploads, email notification, RSS feeds, and detailed usage statistics. Another feature of the free version is ads, as can be seen on the right side of figures shown above. While the ads were mostly inconspicuous and related to project, there were a few instances of inappropriate ads being displayed. The ads can be turned off by upgrading to the “Plus” version of the wiki for a small fee per month.

As an administrator, the wiki was easy to set up and use. The free version can be configured as public or protected. A public wiki can be edited by anyone, including anonymous visitors, while a protected wiki can viewed by anyone, but edited only by members. Upgraded versions of the wiki include a private configuration in which only members can view and edit the pages. The free protected version was used for this course. Administrators can invite people to be members by entering their email addresses and typing a welcome message. An email is then sent to the invited users with a link to the wiki. However, a copy of the email is not sent to the administrator, so there is no record of who was invited or what message was sent. To become a member of the wiki, the invited users need to set up an account with Wikispaces if they don't already have one.

Editing the wiki was straightforward. The editor is WYSIWYG and quite similar to other wiki editors. Clicking the “Edit This Page” button located at the top of each page allows the users to edit the text on the page and brings up a toolbar. The toolbar has buttons for inserting various elements such as tables, hyperlinks, files, and special characters, as well as buttons for basic text formatting. Unfortunately, there is no obvious way to enter mathematical formulas. It must be done using LaTeX commands, which few undergraduates know.

Other features of the wiki used were the discussion page and the history page. The students used the discussion page as a way to have focused communication related to the project that everyone could see. The instructor used the history page to track changes. Each week the students were graded on their contribution and it was fairly easy to see who made the various changes. By clicking on a version of a page in the history list, the changes made by a particular user were highlighted to show their insertions and deletions. However, these highlights only gave text modifications and did not identify if the user, for example, inserted an image.

One of the disadvantages of using this wiki is that students were not able to edit an uploaded document in the same way as text. Users first had to download the document, modify it, and then upload it again. Students found the process to be tedious because of the fact that there they had to deal with many documents for the project. Another disadvantage appeared when multiple users tried to modify the same page simultaneously. Multiple edits were not allowed and messages would appear indicating that the page was not available for modification because another user was editing. Students had to edit the wiki once every week, which meant that many of them were trying to make changes at the same time. It seemed that when there was a lot of simultaneous editing, there were formatting issues with text type, table of contents, etc.

There are many alternatives to Wikispaces for hosting a wiki and two were considered for this course. One is PBworks (formerly known as Pbwiki), which has many of the same features as Wikispaces, but the user interface is not as intuitive or seamless. Google Sites is another

alternative. Although not described as a wiki, it has many of the same features. Editing and navigation is quite intuitive and are similar to Wikispaces. It does not contain the discussion feature, but users can easily see revision histories and create different types of webpages. Additionally, there are no ads and sites can be made private without paying for an upgrade.

Assessment Results and Discussion

The effectiveness of using the wiki was assessed primarily in two ways:

1. Surveying students about their opinions of the usefulness of the technology and their attitudes towards it, both at the beginning and end of the semester.
2. Comparing the final reports to those of the previous semester when wikis were not used.

The students were asked to fill out an anonymous online survey at the beginning of the semester. Response to this initial survey was low, with only 7 of the 16 students answering the questions. Based on this feedback, it was determined that prior to the course, many of the students had experience with accessing information on wikis and about half had experience with editing them. As a result, the students felt comfortable with using the technology at the beginning of the semester and found it easy to use. Also, the initial response from the students indicated that they were comfortable with the collaborative nature of the technology. Most responded that they didn't mind that other students could see or modify their contributions.

At the end of the semester, the students were surveyed after they had completed their final presentation. The students were asked to fill out written anonymous surveys during the last class meeting. A total of 16 surveys were given and 15 responses were received. The students seemed to agree that the wiki was useful for the class, as can be seen from the results in Figure 4. Most felt that it helped with project organization and writing the final report. Results also indicate that they understood the purpose of using this web-based tool and thought that it was beneficial to the project.

Each of the three groups was required to submit a report to document the project at the end of the semester. The final reports from the spring 2009 course were more complete than those received in spring 2008 (when students worked on the same project, but did not use a wiki). Although this provides only one data point and there may be other factors influencing the students' work on the reports, it is important to note that in spring 2009, each group submitted a completed report on time. This is in contrast to the previous semester in which one group submitted only a partial report and one group submitted several days late. This may be due to the fact that with the wiki, students were given an assignment that encouraged them to document their work throughout the semester and not leave all the writing to the last minute. Additionally, they received weekly feedback from the instructor regarding their wiki content by discussing what was appropriate and what needed to be added.

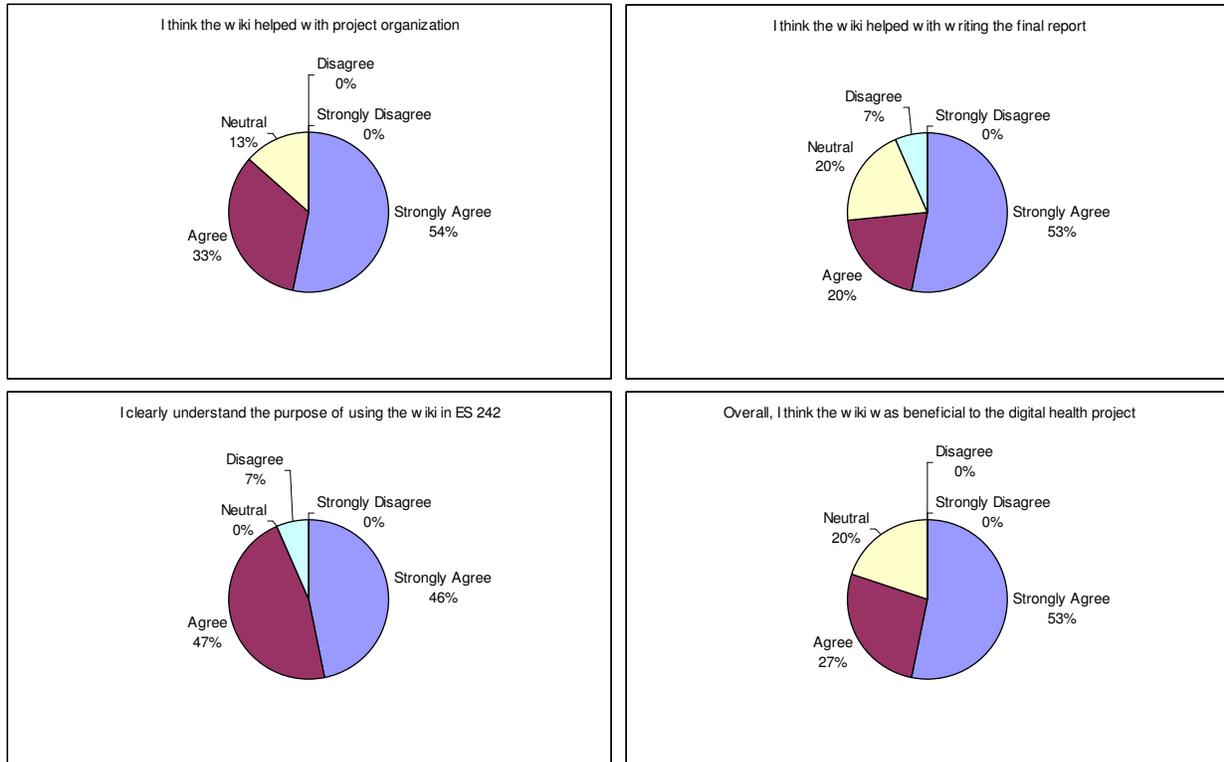


Figure 4: Results of the end-of-semester survey.

Lessons Learned and Suggestions

The goal of using wiki technology was to improve the students' abilities in organization/project management and technical writing and it proved useful in achieving these goals. Overall, it was a great tool to use in this type of course and it will be used in future semesters. Many of the students used the wiki quite effectively to record their progress and were able to see what the other groups were doing. The quality of the submitted reports was good and incorporated many of the items from the posted material, but they were not just copies of it. The students seemed to understand the difference between the wiki content format and that of a formal report.

It was beneficial to the students to create web-based technical content. Many of them did not have experience editing wikis before this course and their technical writing was most likely in the form of traditional laboratory reports. Many companies are now using this type of tool internally for project management, so it is helpful that the students be exposed to collaborative writing and understand the differences between the different types of technical communication.

The biggest highlight of using this technology was seeing the creativity of the students. The wiki assignments were loosely structured and the students were given the opportunity to develop the website as they thought appropriate. It allowed their imagination and inspiration to be displayed. There were no limits on where or how to express thoughts and ideas; therefore, it pushed the students to participate and collaborate with each other. Through the wiki, they were able to promote their work to anyone, including friends, parents, etc. The instructor also contributed to

the content, which allowed communication with the students in a different way. For example, the instructor created the page to list components that were ordered and in doing so, demonstrated what should be included (price, part number, vendor, etc.) and the way that kind of content should be organized and formatted.

One disadvantage of this technology was that Wikispaces was independent of the University of Hartford. While this website worked without any significant problems, the instructor had to invite the students to join and they had to create an account if they didn't already have one. Then, they had to inform the instructor what their usernames were because they didn't necessarily use their university username. While this was not a huge burden, it was an extra task for the students and additional administrative load for the instructor that could have been avoided if the wiki were part of the university and linked to the course roster.

Finally, for faculty members interested in using wikis in their courses, the following suggestions are provided:

- Make sure the students understand up front what the purpose of the wiki is and how they will be evaluated in its use. Set expectations about what should go on the site and provide a template to help them with content, but don't be overly restrictive or stifle their creativity.
- Since the students seemed to easily grasp how to use the wiki, minimize the amount of class time spent teaching its use. In this course, the Wikispaces site was briefly introduced and 15-20 minutes were spent demonstrating how to navigate and edit. This was sufficient for most students and the few who had problems received individual help.
- First determine if the wiki is appropriate for the course (it was quite appropriate for this project-based engineering design course). If it is, be certain that it is not an extraneous assignment. It should be fully incorporated into the course's structure.

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