Collaborative Convergences in Research and Pedagogy: An Interdisciplinary Approach to Teaching Writing with Wikis

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Abstract

Collaboration has long been hailed as a critical key to success in industry, the sciences, and composition studies (Bruffee, 1984; Lunsford & Ede, 1994), and more recently wikis have earned a reputation as collaborative tools. For several years, composition (Moxley & Meehan, 2007; Carr et al., 2007; Garza & Hern, 2006) and science instructors (Chen et al., 2005; Hamilton, 2000; Kussmaul et al., 2006) alike have been exploring and writing about their experiences using wikis in the classroom. Although much has been written about attempts to integrate writing into hard science and engineering courses; surprisingly little addresses how wikis might be used to foster collaborative writing pedagogy across the disciplines. Moreover, the extant scholarship does not correlate wiki use with overall quality of student writing. As David Smit aptly points out, "we need to know more about exactly what produces effective writing in collaborative pedagogies--the structure, the amount and range of response, or the sheer time spent in practice" (1989, p. 55). Investigating how wikis might effectively harness collaborative potential to enable students to produce high quality essays, this article analyzes the incorporation of wiki-aided collaborative writing projects into two courses—a writing intensive Introduction to Engineering Design course and a junior level Product, Design, and Innovation course at Rensselaer Polytechnic Institute. Data was collected from student surveys distributed and wikis used during the Spring 2008 semester. They were analyzed by an interdisciplinary team of rhetoric, management information systems, environmental engineering, and science and technology studies scholars.

Our team investigated how wikis might be used to create what we have termed "deep collaboration" among writers working on multi-authored projects. Although students are often required to engage in group-work, when they are asked to provide one "group essay" they usually break the work into component parts and then assemble the pieces into one document just before it is submitted. We hoped, however, that wikis might enable students to engage one another about their writing process, from inception to delivery of the document, thus leading to deeper collaboration, more recursive revisions,

and higher quality essays. This article explores how we attempted to use wikis, with their ability to track a history of revisions, to facilitate what we term "deep collaboration" among students writing group-authored documents in engineering and design courses. Ultimately our research shows that when students are co-located, wikis ironically provide a tool for the assessment of individual contributions to group-authored projects.

Introduction

Calling attention to the social construction and collaborative production of knowledge, wikis have changed the way we think about authorship, the composing process, and the nature of collaboration. This article explores the strengths and limitations of using a wiki to foster what we have termed "deep collaboration," an iterative, recursive, process-based approach to writing where writers working on group-authored projects engage one another about their writing, from inception to delivery of the document.[1] Although this process might take place independent of any particular technology or software, building on the work of Tony Carr, Andrew Morrison, Glenda Cox, and Andrew Deacon (2007), we sought to use a wiki to help make our students' collaborative process "more transparent." Using the wiki's ability to preserve multiple revisions (highlighting the addition or subtraction of text and allowing for comparison across different versions), we employed the wiki would provide a "record" of the discussions needed to reach consensus around group-authored texts. By providing a structured environment in which discussions could take place (and be documented), we hoped that the wiki would

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[1] Deep Collaboration is a term we have coined to define and explain the highly iterative, recursive, and reflective interactions we hoped would take place among students involved in group-authored writing projects. Although the term is used here to describe an interactive process of ideation (known to rhetoricians as invention), arrangement, revision, and development that takes place within a writing context, deep collaboration is not limited to describing the interactions among writers involved in a shared writing task. Rather, the term is meant to highlight how ideas come into being and evolve in highly collaborative environments structured to create a singular document or text.

encourage more frequent and more reflective interactions among students and among students and instructors alike.

Our research team--comprised of instructors and students working in Rhetoric and Composition Studies; Engineering; the Program in Design and Innovation (PDI); Management Information Systems (MIS); Computer Science; Psychology, and Human Computer Interaction--introduced the deep collaboration concept along with a wiki-based collaborative writing task into two communication-intensive courses at Rensselaer Polytechnic Institute during the Spring term of 2008. The first one was a section of a required, first-year engineering course called Introduction to Engineering Design (IED). The second course, PDI Studio 6, was a junior-level PDI studio course, the sixth in a series of required studio courses, whose topic was design entrepreneurship and business planning. These courses were selected because they already included group-authored final writing projects as part of the required course assignments and because the instructors were willing to experiment with the wiki within the context of their overall course goals.

As a team, we wanted to investigate the following questions. Might wikis help students to better learn about and engage in "deep collaboration," and particularly recursive, process-based writing? Might collaboration be enhanced by using a wiki, even though all members of the groups were already co-located? Might wikis provide a way to better record and evaluate students' individual contributions to group work? Insofar as "deep collaboration" was to be achieved, might it improve the overall quality and sophistication of the jointly-authored prose produced? To answer these questions, data was collected from the class wikis, student assignment submissions, student surveys, and student interviews from the Spring 2008 semester. The course instructors also met several times with the rest of the research team to review and discuss the project as it progressed. The analysis and writing up of our findings was carried out through co-located meetings, individual writing, email exchanges, and perhaps most appropriately to the research project, through a wiki.

This wiki-article contains the components of a typical scholarly paper, which can be read linearly. However, we have also attempted to structure the document in a way that allows jumping around while still communicating each section's main points. Across the article, we seek to communicate:

- the wiki project's aims and the larger research agenda it grows out of;
- the project's local context, assignment design, and in-class implementation; and, finally,
- our assessment of the strengths and limitations of the study as a whole as well as the specific assignments based on student responses, our experiences, and the overall quality of the work they produced.

Background

RPI and Writing Across the Curriculum (WAC)

Rensselaer Polytechnic Institute (RPI), also referred to simply as Rensselaer, is a mid-sized polytechnic institute located in Troy, New York, 150 miles north of New York City. At RPI, there is no required first-year writing course. Rather, students are required to take two "communication-intensive courses" over the course of eight semesters; one needs to be in their discipline and one needs to be taken in the School of Humanities, Arts, and Social Sciences. Communication-intensive courses require that students write at least 16 pages (or present the equivalent orally) that are evaluated based on an individual's prose (or performance). In order for a course to be designated as communication intensive, an instructor must get his or her syllabus approved by a committee tasked with managing this requirement. The way the requirement is set up, students often first get exposed to writing by teachers who are not explicitly trained to teach it. While this model of teaching writing is worthy of its own discussion, we only mention this feature of our local context to help situate the collaborative writing experiment the rest of this article details.

STC Sponsorship and Background to the Wiki Component

This research is part of a larger project entitled, "Tech-mediated Communication: Innovating the User Experience in a Mediated World" (TMC), sponsored by the Society for Technical Communication. The TMC project includes five research teams working together to develop a set of paradigms for the analysis, design, and testing of communications in a technology-mediated world. The project combines formal and informal testing methods to answer the question: What makes tech-mediated communications usable? The TMC team at Rensselaer addresses this question in a way that is rooted in specific examples of tech-mediated communication, but also generalizes across them and extrapolates beyond them.

The individual teams working on the TMC project focus on sub-projects as varied as evaluating software for pedagogic needs in the distance-education classroom, designing effective cross-cultural graphics for AIDS education, developing effective narratives for cross-cultural communication, creating usable, educational websites that provide links to local resources for children and parents, and investigating wikis' capability to foster collaboration in group-authored writing assignments across the curriculum. As a whole, the TMC project aims to revise and supplement Nielson's initial design heuristics in order to better account for the multiple communication and community-building tasks that tech-mediated communication tools are expected to perform. More than simply developing a set of heuristics to help designers create more usable media, however, the team will also provide new usability testing methods for assessing and evaluating the new components of "usability" that tech-mediated communication tools introduce and require. The project as a whole seeks to develop criteria for designing and evaluating things such as "setting the context," "extending a welcome," and "creating opportunities for future engagement." Future publications are planned to discuss these new heuristics and assessment criteria in greater detail.

History of the Wiki Component of TMC

First introduced in the Fall semester of 2006, the wiki component of the project evolved significantly over the past two years. Initially, the wiki research team's efforts focused on choosing and modifying open-source freeware to meet the needs of the writing classroom. During the first two years, our team members experimented with different wiki platforms to try to find wikiware that would be easy and intuitive to use, while also providing optimum wiki functionality for course tasks. The questions that guided this part of the investigation included the following: How would students respond to the public, open access that wikis make possible? How can access privileges be applied and adapted to foster trust and enhance participation? How might students be encouraged to "populate" a wiki? And how might student writing produced on a wiki be best evaluated?

To begin to answer these questions, we began with a module developed in Mediawiki, the same software that powers Wikipedia and this wiki article. After two rounds of traditional usability testing, we discovered that students did not find the interface as intuitive as we had hoped, in part because it was not particularly “welcoming” and in part because they had difficulty using wiki code to manipulate and edit documents. Consequently, in the next phase of the project, we switched to Twiki, which enabled us to incorporate a what-you-see-is-what-you-get (WYSIWYG) text editor directly into the wiki interface. Round-two testing did not yield significantly improved results, and we realized that when prototypes intended to replicate class-use were designed and tested outside of the context of an actual class setting, the testers (referred to as “sample students”) had neither the community affinity nor the commitment to the task at hand to accurately test the collaborative potential of the tool. While this observation may seem like the ultimate “duh” moment to many rhetoricians, the protocols associated with traditional Human Computer Interaction (HCI) usability testing--protocols based on “time-to-task” measurements and an assumption that software should be so intuitive to the user that instructions are not necessary—-seemed a poor fit for “measuring” and documenting the complex pedagogical interactions among students, software, classroom community, and instructional materials. As any teacher who has tried to incorporate communications

technology already knows, all of the aforementioned elements are part of the "total user experience" in a teaching situation involving new technology.

Clearspace for Deep Collaboration

After completing usability testing with several different wiki systems, our team decided that Clearspace was the best candidate for carrying out our collaborative writing research because of several useful features.

First, content within Clearspace can be divided into groups termed "spaces" and "sub-spaces." Each space has its own user-base and contains sections for documents, discussion threads, blog posts, and announcements. Additionally, each space allows for a customized homepage. This makes it very easy to create individual wiki sites for different classes as well as sub-spaces for teams or groups working within those classes.

Second, Clearspace utilizes a rich-text editor, allowing users to author wiki content in a very familiar way, similar to standard desktop office applications. This feature is particularly helpful to novice users, who may be intimidated by the task of learning a new software interface or to users who are not interested in learning a new editing interface. In addition to the rich-text editor, Clearspace also includes a plain-text editor, which can be beneficial to users proficient with wiki code, allowing them to write and format text faster by using Clearspace's wiki syntax.

Third, changes made to documents created within Clearspace are tracked in a clear, concise manner through Clearpsace's intuitive version-history system. Whenever a document is edited and compared to the previous version, new text is highlighted green while text that was deleted is highlighted red. Furthermore, any version of a document can be compared with any other previous version of the document. Unlike many other wiki systems, Clearspace documents do not limit the viewer to comparing only the current version of the document to previous versions.

Lastly, Clearpsace allows comments to be posted by users at the end of each document. This gives students an opportunity to share with their team members, for example, what was recently changed in the document or how they feel the group should proceed with the assignment. Additionally, comment tracking allows professors to assess which team members have been actively contributing to the collaboration process, an important consideration when attempting to evaluate individual performance in a group setting.

Pilot Study Fall 2007--Wikis in Introduction to Air Quality

Based on what we learned in early pilot studies testing usability outside the classroom context in Fall 2006 and Spring 2007, we switched wikiware from the open-source Mediawiki platform to a proprietary platform, Clearspace, developed by Jive Software. Clearspace provided the following features: email notifications, RSS feed, search capabilities, blog capabilities, a discussion section with the ability to mark comments and questions, versions comparisons using revision and version history tools, as well as upload capability for Word documents, PDFs, and presentation software. Our hope was that by simplifying the design tasks, our testing efforts would be freed up to focus more specifically on the collaborative tasks the wiki assignments were designed to facilitate among the student teams. Although we chose Clearspace because it promised to combine several online communication features in a seamless platform, aspects of the interface led students to complain about its functionality and ease of use.

In Fall 2007, we conducted a pilot study with co-author, Dr. Lupita Montoya in Engineering. We worked together to develop a wiki-based collaborative writing assignment to be used in her Introduction to Air Quality Course. Although the course was not designated as writing intensive, she wanted to include a writing assignment that would help her students better understand the real-world applications of the air quality research they were conducting. The assignment prompt, co-authored by Drs. Fernheimer, Montoya, and Lewis, Director of the Center for Communication Practices at RPI, developed and introduced a collaborative writing assignment requiring student teams to research an air-quality problem of their choosing and then advocate for its solution. The groups focused on issues as diverse as reducing carbon emissions with fossil-fuel

alternatives such as biofuels, reducing toxic fumes from Katrina-relief mobile homes by incorporating air-cleaning plants within the homes, assessing acid rain deposition in the Adirondacks, improving indoor air quality in domestic dwellings in developing countries, and reducing vehicular emissions through more stringent standards.

To familiarize the students with the wiki and with process-based writing in general, Montoya, Fernheimer, and Lewis ran several workshops over the course of the semester. During the first session, Fernheimer and Lewis introduced the assignment and the rhetorical canons to help students think of their writing as process-based. In the next workshop Tom Kujala, the wiki administrator, conducted a hands-on workshop to introduce the students to the use of the wiki. Once the students had selected and researched their topics and begun drafting their reports, Fernheimer and Lewis conducted a third workshop on report organization and revision strategies.

Although the assignment explicitly asked students to track their discussion of the text using the wiki, there were no technical instructions for how to use the history/revision tool of the wiki, nor were there specific criteria according to which their "collaboration" would be evaluated. Students were told that five percent of their grade would be based on the extent of their collaboration and that they would play a role in determining how "collaboration" would be evaluated, but these criteria were not discussed until late in the semester. Not surprisingly, students were quite concerned about their grades and how their "collaboration" would be recognized and evaluated. Rather than encouraging the students to engage in deep collaboration, as we had hoped, under these circumstances the wiki seemed to many students to be a tool for "surveillance"--allowing the instructor to tally the number of posts made by each student. Students who made such complaints suggested that their face-to-face meetings made the wiki superfluous, and that they were only putting things on the wiki to make sure they "earned" their collaboration credit. In exit surveys, students complained both about specific technical glitches (e.g., that images did not display well, that the PDF converter did not allow them enough control over the final "look" of their documents, and that they were not able to work simultaneously on the wiki) as well as about the vague criteria for how collaboration would be assessed. We

learned from this experience that we needed to specify more clearly what we meant by deep collaboration and also to call attention to the benefits of such interactions more explicitly.

Theoretical Framework

Wikis, originally introduced by Ward Cunningham on March 25, 1995, are a web-based technology that provide a medium for multiple authors to contribute to and revise a given document or set of documents. As evidenced by the largest wiki to date, the English language Wikipedia, the value of wikis increases as more people use and contribute to them.[2] Since "Web 2.0" caught on as a descriptive term, the Web increasingly has been viewed as a social, collaborative space--where users create and contribute materials--not just one where they passively consume texts that others have created. Like other Web 2.0 applications, wikis harness "collective brain power" by encouraging authors to revise and contribute to their own and others' writing. Since wikis are collaborative writing spaces by nature, it would seem logical that they would be an effective way to facilitate greater collaboration among students. Composition scholars (e.g., Moxley and Meehan. 2007; Carr et al., 2007; Garza and Hern, 2006) and science instructors (e.g., Chen et al., 2005; Hamilton, 2000) alike have been exploring and writing about their experiences using wikis in the classroom. Nevertheless, surprisingly little scholarly work addresses how wikis might be used to foster collaborative writing across the curriculum. Carr et al. suggest that "the use of a wiki for collaborative writing can provide the transparency of process required to support the negotiation of meaning in shaping an emerging text"

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[2] Wikis have been shown to provide effective support for very large communities engaged in collaborative authoring and knowledge construction. As of April 2008, Wikipedia, the paradigmatic example, attracts 684 million visitors annually, who view over 10 million articles in 253 languages, comprising a combined total of over 1.74 billion words for all Wikipedians. Wikipedia's articles are written collaboratively by volunteers around the world, and nearly all of its articles can be edited by anyone with access to the Internet (www.Wikipedia.com). Each individual contribution to Wikipedia may be small, but collectively its environment produces a huge collaborative effort that leads to an impressive and original product (Shneiderman, 2007).

(2007, p. 271), but few scholars have explored how wikis might provide the social and technological glue to link writing, knowledge production, and collaborative teaching across the typical disciplinary divides. In this project we attempted to do just that.

Collaboration has long been hailed as a key to success in industry, the sciences, and composition studies (Bruffee, 1984; Lunsford & Ede, 1994). One of the basic assumptions behind such claims is that when students work together, they are likely to encounter and learn how to respond to "difference"--in the form of different students and different ideas, different approaches to problem solving, different values, and different sets of expertise. Those who support group work (and we're among them) believe that, ideally, students' encounters with others will be fruitful and productive, not just in terms of the scholarly work they produce (thus yielding more sophisticated and nuanced analyses, insights, prose), but also in terms of their growth and development as humans learning to recognize, respond to, and account for others through their social interactions. Those who are more critical of group work (e.g., Jarratt, 1991) argue that, rather than fostering careful consideration and inclusion of others, consensus sometimes comes at their expense. Worse still, quick consensus formation often fails to produce nuanced and sophisticated work or perspectives. While much has been written about attempts to introduce collaboration in writing and similar courses and attempts to integrate writing or group work into science and engineering courses, few scholars have explored how collaborative writing across the curriculum might affect both faculty and student interactions. Even less is written about how one might effectively evaluate and assess such group-authored pieces.

To better understand, and potentially measure, what composition scholars call "classroom community," we worked with colleagues in Management Information Systems (MIS) who also study collaboration, typically focusing not on interactions among students but those among corporate entities. According to social capital theory, social relations are often seen as the "invisible glue" that brings and holds communities together (Bourdieu, 1986; Cohen and Prusak, 2001). People engaged in collaboration derive value from their social relations where goodwill, mutual support, shared language, shared norms, social

trust, and a sense of mutual obligation are cultivated through interaction (Huysman and Wulf, 2005). To achieve successful collaboration, Gwendolyn Lee and Robert Cole (2003) point to the importance of establishing norms of trust, cooperation, and openness toward the sharing and critiquing of ideas. In communities with shared responsibility for and participation in knowledge construction, individuals with different perspectives and expertise are embedded in a highly dialogical network of relationships. The high degree of trust and the flow of communication and resources among these individuals enables them to openly convey their opinions and interests in order to influence others, while at the same time using others' insights and expertise to identify and solve their own problems. The close social relationships not only provide opportunities for individuals to identify new knowledge and expertise, but also serve as channels for mobilizing this knowledge and expertise (Nahapiet and Ghoshal, 1998). Thus Nahapiet and Ghoshal contend that "[t]he kind of personal relationships people have developed with each other through a history of interactions" (1998, p. 244) forms the normative basis that underpins cooperation and control in a community, such as trust and reciprocity. Accordingly, people who have stronger ties and connections are more capable of judging the quality of information provided by group members and are in better positions to engage in in-depth discussions online (Ellison et al., 2006).

Rhetoricians and compositionists may be more familiar with the term ethos, but the overall set of assumptions is similar--people who know each other better and interact more frequently are better equipped to make judgments about an individual, his or her expertise, and its potential contribution to achieving shared objectives. James Coleman (1988) also argues that individuals are more likely to respond to each other when their social relationships have established a sense of obligation, an expectation of reciprocity, and a degree of trust. Since trust and cooperation help to remove feelings of uncertainty and suspicion, they grease the wheels of communication and collective invention.

With this framing in mind, the project attempted to answer the following questions:

1. **Epistemology and social knowledge construction** - Might emphasizing deep collaboration, and using a wiki to foster it, improve the overall quality and sophistication of group-authored projects?
2. **Social relations and collaboration** - Might wikis help to strengthen social ties among group members, thus allowing them to build greater trust and more willingness to engage in the highly interactive process of deep collaboration?
3. **Assessment** - Might wikis allow greater transparency in students' collaborative writing processes, thus making their progress easier to discern, both for themselves and their instructor?

Skeptical of the high praise much collaborative pedagogy receives, David Smit points to the lack of supporting evidence for such claims: “Properly executed collaborative practices may constitute an effective pedagogy, but to be certain, we need a great deal more evidence--evidence clearly rooted in consistent theory, and tightly reasoned and documented by the methods best suited to test the hypotheses of that particular theory” (1989, p. 55). Smit thus calls attention to the important question of research methodology. In an attempt to answer the questions above, our team formulated several testable hypotheses:

1. Deep collaboration improves the overall quality of prose and thinking generated in group projects.
2. Wikis help students, especially those who might not know each other well, to develop trust and expectations for producing new knowledge by providing a forum for interaction to take place and for group writing to become public and thus available for critique and revision.
3. Wikis, because they make the writing process more transparent, help students to see writing more as a process--something that develops incrementally, recursively, and iteratively as well as something that benefits from revision.
4. Wikis, because they provide a structured mechanism for interaction, encourage students to interact more frequently and more "deeply", not simply by exchanging

parts, but by engaging one another about the development and evolution of the project (and their writing with respect to it) as a whole.

5. Wikis, because they provide a record of interaction, help instructors and group members alike assess and evaluate who contributed what and when.

As our reflections suggest, we initiated the wiki project without having resolved all the tensions surrounding the project's framing. On the one hand, we came to the technology with a certain set of assumptions about what it was supposed to do (e.g., wikis provide a medium for interaction, thereby fostering communication, thereby facilitating deep collaboration), and on the other hand, we had specific assumptions about what kinds of classroom communities are necessary to get the most benefit from the wiki technology. These assumptions led us to ask how the advantages associated with the tool could best be utilized to achieve specific classroom and learning goals, but what struck us was how social interaction and trust were at the heart of both sets of assumptions. In order for wikis to be populated with ideas and for groups to use them to create new knowledge, the people using the tool needed to establish effective patterns of interaction and trust. Of course, effective patterns of interaction and trust were necessary for the learning goals of deep collaboration to be achieved as well. So social interaction and trust were both what the wiki was supposed to facilitate (and what we hypothesized it would) and also what were necessary to have developed in order for deep collaboration to take place. This chicken-or-egg dilemma made it very difficult to measure precisely what role the wiki played in facilitating increased trust and interaction among group members, an increase which we hypothesized would, in turn, make students more willing and able to engage in deep collaboration. Obviously our research questions and aims were ambitious, perhaps overly so. In order to focus the project, the research team attended carefully to the various layers of methodology needed to answer our research questions.

Methods

The research team wrestled with the question of methods over much of the implementation phase of the project, striving to determine what would prove most useful

in the context of the classroom, in the context of the larger wiki research project, and in the context of the TechMediated research teams' attempts to improve usability heuristics. Our methods were developed to generate measurable data about what happens in the knowledge-construction process during collaborative writing. We hoped to measure to what extent the wiki influenced the degree and frequency of collaboration. As instructors, we also imagined that the wikis might provide a tool for the assessment of individual contributions when wiki-based collaborative writing tasks are introduced to Writing Across the Curriculum (WAC) courses.

To ensure our methodology was appropriate to the theoretical questions driving our work, the research team began by brainstorming ways wikis might help to solve two of the biggest challenges that group work presents, one concerning epistemology and the other assessment. Concerning epistemology, we identified a typical problem accompanying the incorporation of group projects into class assignments. When asked to provide one "group essay," students usually break the work into component parts and then assemble the pieces into one document just before it is submitted. Although this process seems "efficient" and sensible to students, it often circumvents the dialogue necessary to reach an engaged and critical consensus about a group-authored paper at every step of the writing process: determining key contributions or ideas (invention or ideation), strategizing organization (arrangement), choosing and writing with a unified tone or voice (style), and agreeing upon the overall format (arrangement & delivery). Instructors who introduce group-authored projects might implicitly hope that students will engage and learn from one another, collaboratively building the group's knowledge base in order to produce more sophisticated final projects. But students are usually more concerned about getting the job done quickly and painlessly, while ideally earning a good grade at its completion. This last part--grading--leads us to a second key problem faced by instructors in assigning group work: how to identify who wrote what and how to assess or evaluate individual students' contributions. Our team wanted to see if wikis' ability to track multiple versions of a document could be used to counter the "race to consensus," thus encouraging students to use a more iterative, reflective, and interactive process of

deep collaboration[1], while also providing a means to more fairly assess individual student contributions.

Learning from our experiences in the Fall 2007 Pilot Study, in the Spring 2008 semester we created a new assignment that better accounted for the technical shortcomings of the proprietary wiki software while also paying more explicit attention to the deep collaboration[1] we hoped to foster. This assignment defined deep collaboration and explained to students that the goal was to use the wiki, with its comment and revision/history features, to help them write a specific part of their project within a specified amount of time. The assignment in modified versions was introduced in two writing intensive courses: a required Introduction to Engineering Design course (IED) and a junior-level Product Design and Innovation (PDI) course (IED Assignment, PDI Assignment). Both courses already included a substantial writing component with semester-long group writing projects that culminated in a final group-authored project—a final prototype, presentation, and report for the engineering course and a final business proposal for a new concept or idea in the PDI course.

For the engineering course, students were asked to use the wiki to write their introduction and "benchmarking sections" (the section which summarized the extant literature on their problem and explained how their solution built upon or extended the current scholarly discourse and approaches). For the PDI course, students were asked to use the wiki as a place to select and modify a template and overall outline for the sections of their final business proposal.

To establish a framework for generating measurable data, we used three separate instruments. First, we distributed two paper surveys—one basic survey at the beginning of the class (before the students began work on the wiki) to determine how well the students knew each other and how much experience they had using wikis or other computer-mediated communication technologies (instant messaging, email, text, etc). A total of 54 surveys were distributed (24 in the PDI course and 30 in the IED course) and

44 returned (21 in the PDI course and 23 in the IED course), with a response rate of 81.5 percent (Survey 1).

Second, we distributed an additional paper survey after the students completed the "deep collaboration" task. The questionnaire asked 16 Likert-style (five-scale) questions, 3 yes-or-no questions, and 3 open-ended questions. The survey was distributed to 54 students. In the PDI course 19 students responded, and in the IED course 27 students responded, for a total of 46 responses, and a response rate of 85.2 percent (Survey 2).

Third and finally, at the end of the semester once the students had completed their final projects, two groups were selected (one from each class) and each member of the group was interviewed by telephone for 15 minutes to get more information about how they engaged in the task as well as what they found useful and less useful about the activity, the wiki, or both. Based on the results of the first set of surveys, we developed the phone questionnaire totaling 33 questions. This questionnaire was composed in Google Documents in collaboration with Dustin Kirk and Samantha Good (graduate students in Human Computer Interaction at RPI) and was then refined and revised after feedback from Drs. Montoya and Chi. The phone interviews were designed to solicit in-depth responses to open-ended questions, post-assignment. They were conducted with the members of two complete teams, one from PDI and from IED, for a total of 8 students interviewed (Phone Survey).

Case Studies

Case Study 1: PDI ENTREPRENEURSHIP AND BUSINESS PLANNING

Course Context

One of the cases of our wiki research involved a collaborative writing in a Product Design and Innovation (PDI) studio course. PDI is an interdisciplinary studio-based curriculum that integrates technical, social, and creative approaches to the design and analysis of innovative product concepts. The studio on business planning is the sixth in a

series of studio courses each emphasizing a different facet of design. PDI students are required to enroll in all of the studios in sequential order, so they travel through the curriculum as a cohort and, hence, know each other very well by the sixth studio.

Assignment Goals

The instructional goals of the wiki assignment for this course were twofold. First, the instructors hoped to foster deep collaboration among students, as discussed above. Specifically, the pedagogical goal was to encourage students to read and comment upon other team members' writing in process, rather than waiting for a formal, final "hand off" for review and revisions after the primary writing was "finished." Here, the goal was less to circumvent students' tendency to "divide and conquer" and more to promote earlier and more frequent peer review. Second, the instructors wanted to use the wiki as a tool for assessing "degree of participation" in the collaborative writing assignment, allowing us a more nuanced understanding of who contributed what than could be established by knowing only the primary student responsible for each section. In other words, we hoped to use the wiki to assess not only who took primary responsibility for each section, but also who contributed how much to other students' sections.

The Assignment

The wiki assignment was integrated into the studio's final project, which required two to three-person student teams to develop customized business plans for original product concepts. The business plans were to be 10-30 page documents, based on a common template provided by the instructors and adapted to individual projects by students employing the Clearspace wiki. The class was introduced to the wiki and the associated collaborative writing assignment immediately after the common business plan template was distributed, approximately four weeks prior to the final project due date. The wiki assignment required teams to adapt the common template to their individual projects by suggesting specific changes to the template and justifying those changes using the wiki. In order to initiate dialogue on the wiki, each team member was instructed to contribute at least one original idea to the template modification phase and to respond to at least two other contributions made by other team members. The outcome of the assignment was to

be both a working outline for the teams' business plans as well as documentation of the thinking that went into their customization of the template. Students were encouraged to continue using the wiki as a collaborative workspace upon completion of the first-stage assignment, but were not required to do so.

Student Engagement & Experiences

Student engagement with the assignment was highly variable, with some teams satisfying the bare minimum requirements and following the instructions to the letter and other teams using the wiki regularly from the initial assignment until near-completion of their business plans. Out of seven team projects, one team reviewed the wiki's capabilities and immediately requested permission to switch to Google Documents (which they already had been using since the beginning of the project); two teams satisfied only the minimum requirements of the week-long assignment; one team continued using the wiki for one week after completion of the initial assignment (discussing collaborative process and adding initial content and notes); one team used the wiki actively for two additional weeks before switching to Google Documents; and two teams used the wiki consistently over the entire course of the project. Level of engagement with the wiki spanned the spectrum, from simple updates as to work completed and pending on one end of the spectrum to meta conversations about business plan content on the other. Task-scheduling and team management postings occupied a middle spot along this spectrum.

Although student engagement with the assignment was variable, students' experience with the wiki, and particularly the chosen interface, was strikingly consistent: they didn't like it. As one student from one of the most engaged teams put it in a comment within her team's wiki space, "I feel like this interface will seriously inhibit our ability to collaborate [sic] and work together since only one person can be working on a section at the same time. The interface actually encourages us to divide up the work rather than work in a more collective manner." It seemed, the more students knew about collaborative authoring software, the more frustrated they were with the assignment requiring them to use a tool they otherwise would not have chosen.

Instructor Assessment of Project

From the perspective of the instructors, the assignment as carried out posed two serious problems and yet also provided valuable educational opportunities. The first major problem was students' perception that the assignment inhibited their progress in writing their business plans, not because they had to slow down and reflect upon others' contributions but because it added an administrative "make work" step to what was already — in their assessment — a highly collaborative process. Both of the course instructors encountered teams struggling with the assignment. These students seemed to think they had to project through the wiki a writing process that did not accurately represent how they worked. Their concerns were partly allayed when the instructors clarified that they did not have to prove to us a certain mode of working, but rather that they were to use the wiki to document how they were already working. The clarification helped, but students felt the assignment still entailed an extra and perhaps unnecessary step if the goal was to enhance collaboration.

The second major problem with the assignment was that, when completed, the wiki entailed far less reflection on business plan content than we hoped to achieve. Even students who used the wiki consistently over the four weeks (between the initial assignment and the final project due date) used it primarily as a document manager — a common space to hold the latest version of each section — and not as a tool for "deeply collaborative" writing. Whether this is due to limitations in the tool, as suggested by the student quoted above, limitations in how the project was assigned, or something else, the instructors could not surmise. At least in our studio course environment, where students already have considerable time to work together collaboratively on common assignments, the wiki's contribution to deep collaboration is not immediately apparent.

Nevertheless, the wiki and the wiki assignment did offer some clear benefits to the course. To the instructors, the wiki provided a tool for relatively easily assessing who contributed what and when, which was one of our instructional goals. At end of term, we can readily go back into the space and determine what each student contributed, both in terms of original document text and in terms of feedback to other team members. While

wikis tend to be celebrated for their contribution to more lofty goals, the ability to assess individual participation in team projects is not trivial in many educational contexts. Another clear benefit of the wiki assignment in the context of our course was that it encouraged students to face the reality of writing — that every document starts with a blank page — much earlier than they otherwise might have. By putting the (nearly) blank page in a public forum for everybody to see, students confronted their own contributions and those of their teammates in a material way: it was there or it wasn't. This probably helped students to work earlier and to contribute small pieces more often, which was another of our goals.

Case Study 2: INTRODUCTION TO ENGINEERING DESIGN

Course Context

The second case used in this research was a team-authored "Introduction" section to the final project report for an Introduction to Engineering Design (IED) course. IED is required for all sophomore engineering students at RPI. There were several writing assignments in this class, the most comprehensive of which was the final project report. This report included standardized sections, including Introduction, Methods, Results, and Conclusions. It also included appendices, usually containing technical drawings, pictures, and calculations. The final reports were 40 to 60-page documents that included graphics, pictures, calculations, programming code, and results data tables, in addition to standard textual descriptions. The Introduction section was selected for the wiki exercise because it usually involves background information that is gathered early in the project, and thus is not dependent on final results. Additionally, selecting the Introduction was meant to promote early discussion among team members regarding the effectiveness of the wiki in fostering collaborative writing without the complications of handling a lot of non-text components. Based on the previous effort to incorporate wikis in the Introduction to Air Quality course in Fall 2007, it became apparent that students experienced difficulty handling such files.

The use of wikis in the this class was promoted for several reasons. Major goals of the course were to encourage teamwork while learning the process of design and technical

writing. The teams that participated in this exercise consisted of five to six students from various engineering disciplines (primarily mechanical, civil, and environmental engineering). The wiki exercise was intended to contribute to meeting the course's major goals, as well as to increase the technical proficiency of the students in using novel communications tools. Each student was expected to contribute to the writing of his or her team's Introduction section and to participate in on-line discussions of their writing process. Although only the Introduction was required to be written using the wiki, the students had the option of using the tool to complete the entire writing assignment.

Assignment Goals

The instructional goals of the wiki assignment were similar to those of the first case described in this research. The first goal was to provide a forum for discussion, document sharing, and collaborative writing that would enable deep collaboration among team members. The second goal was to provide the instructor with a means to assess the amount and quality of student contributions to the final product. The third goal was to effectively force the students to start their writing early enough to receive and accommodate instructor feedback.

The extent to which each of these goals were achieved varied widely by team. One team, for example, seemed to engage in more regular and substantive discussions while another team barely used the wiki.There were a total of five teams.

The Assignment

The students were required to write the "Introduction" section, including a "Benchmarking" sub-section, of their Final Project Report using the wiki. The instructor selected the "Introduction" section for this exercise because it would minimize possible complications with the handling of graphic images and other non-Windows documents (e.g., Computer-Aided Design, or CAD, drawings) that are commonly present in other sections of the report. Students had a period of two weeks to work on this section and were expected to engage in group discussions in parallel to the building of a wiki document. The two-week time window was a guideline to encourage localized “traffic”

in the wiki website that could be used to assess the effectiveness of the tool for communication in a controlled manner. This concentrated composing period allowed the instructor to assist the students better with planning and to give the students earlier feedback on their written material.

The instructor provided the students with a detailed prompt describing the assignment. This document gave clear guidelines for the students to follow and to use as a reference. The assignment prompt also included some discussion on the research goals that the instructor and her collaborators had in mind. The intention was to enlist the participation and support of the students as active contributors to this research enterprise. For example, the governing hypotheses to be tested by the wiki exercise was explained to the students on the assignment prompt as follows:

"For this assignment, we ask that you help us test the following hypotheses:

1. The overall quality of writing improves with the input of more people.
2. Deep collaboration improves the quality of writing produced by groups.

You will experiment with this process by engaging in deep collaboration on the wiki itself."

The intricacies of the methodology are discussed elsewhere in this paper; however, the primary goal for including this information on our assignment description was to inform the students that the purpose of this exercise was not trivial and had the potential to impact future students. It is difficult to say whether this approach was as effective as leaving the underlying purpose unstated.

In order to facilitate the process and shorten the "learning curve," students received two short tutorials on how to use the wiki website, which were designed exclusively for this course. After the first tutorial "Writing Using Wikis," which occurred the day the wiki assignment was first introduced, a number of students were able to sign on and get

started; however, a glitch in the system prevented some students from successfully signing on at that time. Once that technical difficulty was resolved, all students were able to sign on and explore the wiki site. The second wiki tutorial occurred when the students received the wiki writing assignment, which was about a month after the first tutorial. By then, the technical problems with the wiki had been resolved and the students were free to start writing the required section of their final project report.

Student Engagement and Experiences

Working with information and communications technology is commonplace for our students and the majority of them managed to navigate and explore the wiki website fairly proficiently and quickly. While the initial deployment of the wiki website was not perfect, the technical difficulties were quickly resolved once they were identified. In this particular case, the initial glitch in the system was identified by the students but was not quickly brought to the attention of the instructor. (The problem entailed an inability to register as a user in the wiki website outside an initial window of time. Having a restricted time to register had not been part of the researchers' plan, so it was not anticipated.) Once the instructor and the researchers recognized the problem, it was resolved satisfactorily. The level of engagement varied from student to student and involved a wide spectrum of behavior. A few students did not participate in the exercise (as evidenced by their lack of entries in the document creation); however, the majority of the students participated actively in the exercise.

When asked to reflect on their experience, students shared a general view of dissatisfaction with the wiki, with few exceptions. The main concerns had to do with the less-than-optimum format for the chosen wiki in the given class conditions. For example, students often worked at the same location, making the use of a wiki almost unnecessary. Similarly, in some cases, teams designated one or two members to do all the uploading of documents on the wiki site. This behavior made it particularly difficult to assess the individual writing contribution of each member. This shortcoming was worked around using a peer-evaluation form where students provided feedback to the instructor on student participation/contribution within each team.

Instructor Assessment of Project

One of the advantages of using the wiki is that there was a record of usage to easily track who were the most assiduous users as well as the nature of their contributions to the document's content and discussion. The tool was useful to the instructor, allowing her to gain insight on the effectiveness and dynamics of the student teams as well as helping in assigning credit more fairly to individual team members. It was also a good way to always have access to the latest version of the document being generated and to have access to the background and behind-the-scenes discussions regarding the exercise. This accessibility enabled timely feedback and direct communication with students with specific problems (e.g., limited participation, focusing on the wrong issues, etc.). Overall, this exercise was helpful in achieving our initial goals; however, in order to reach its full potential as a pedagogical tool, the wiki would need to be tailored more precisely to our classroom requirements.

Overall, there was a lack of flexibility in document formatting that dissuaded students from using the wiki to generate complete reports. As this technology progresses, formatting flexibility should increase and user satisfaction should also increase. Another major problem was that some students did not follow the instructions regarding participation. Specifically, assigning one or two students to do all the uploading of documents onto the wiki subverted one of the assignment's main goals: to assess individual contributions. This problem could have been averted by connecting wiki contributions directly to individual student grades and outlining this correlation in the assignment prompt. Also, although the researchers provided two training sessions to the students so they could learn the basics of using and navigating the wiki, a more hands-on exercise would probably have been more effective.

Finally, having the team members meet regularly in a common location seemed to make use of the wiki less compelling. If the team participants were in different locations, they would have had a greater incentive to use the wiki to communicate and build their

documents. Using wikis for document generation using geographically disperse team members and/or asynchronous collaboration would probably best capitalize on this tool.

Results and Analysis

Both of the instructors who integrated the wiki assignment into their undergraduate courses sought to advance their course goals by achieving specific learning objectives, namely more reflective, more recursive, more deliberative writing and, as a result, higher-quality submissions. Additionally, both of the instructors saw opportunities to improve their assessment process using the wiki. Beyond the scope of the two courses and their associated objectives, the wiki research team sought to assess the wiki's ability to enhance group cohesion by increasing trust among student team members, or, in other words, to determine the extent to which the wiki facilitated "deep collaboration." This section reviews and analyzes the results achieved in meeting three sets of goals--learning, assessment, and social networking--associated with the wiki project.

Learning Goals

Congruent with the underlying motivation for the larger research project, both classes in which the wiki research was carried out sought to foster deep collaboration on writing assignments among student team members. Specifically, the instructors sought to encourage students to write early and then to read, reflect upon, and comment upon other team members' writing. This deliberation on other student's writing was to occur “in process,” rather than waiting for a formal, final “hand off” for review and revisions after the primary writing was “finished.” Effectively, the wiki assignment was intended to force students to start their writing early enough to receive and accommodate peer and instructor feedback, encouraging both early content generation and structured on-line discussion among team members regarding that content.

The extent to which the student teams engaged the wiki assignment varied widely, both in frequency and in depth of use. In the PDI Entrepreneurship course, some teams satisfied the bare minimum requirements of the assignment, following the instructions to

the letter. Other teams used the wiki regularly from the initial assignment until near-completion of their business plans. Out of seven team projects, one team reviewed the wiki's capabilities and immediately requested permission to switch to Google Documents[3]; two teams satisfied only the minimum requirements of the week-long assignment; one team continued using the wiki for one week after completion of the wiki component of the larger assignment[4]; one team used the wiki actively for two additional weeks before switching to Google Documents; and two teams used the wiki consistently over the entire course of the project. Similarly, PDI students' depth of engagement with the wiki spanned the spectrum, from simply distributing task assignments on one end of the spectrum to relatively high-level deliberation regarding business plan content on the other end. Task-scheduling and team management postings occupied a middle spot along this spectrum.

The majority of PDI students perceived the wiki as inhibiting their progress in writing, not because they had to slow down to reflect upon others' contributions but because the wiki assignment added an administrative "make work" step to what was already--in their assessment--a highly collaborative process. Both instructors in the course encountered teams that were struggling with the assignment, where students thought they had to project (through the wiki) a writing process that did not accurately represent how they worked. These concerns were partly allayed when the instructors clarified that the point of the assignment was not to convey a certain mode of working, but rather to document how teams were already working. The clarification helped, but, since students did not "deeply collaborate" when writing even jointly-authored documents, the requirement that students "reflect on other students' content" was, in fact, additional work. Worse, since the students had ample time in class to discuss the assignment and the work of their

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[3] This team already had been using Google Documents to coordinate their collaborative writing and had invested considerable time in that system. The instructor allowed them to continue using Google Documents provided they do their best to satisfy the spirit of the wiki assignment while using Google Documents. Despite differences in the interface and its capabilities, the instructor evaluated this team's on-ling collaboration in parallel with other teams' use of the wiki.

[4] This team discussed their collaborative process and added some initial content and notes, but then gave up using the wiki.

peers, the on-line exercise seemed unnecessary to them if the real goal was to foster collaboration.

Likewise, students in the Introduction to Engineering Design (IED) course engaged their wiki assignment to varying degrees. A few students did not participate in the exercise at all, making no contributions to their team's wiki document. Some teams failed to follow the assignment instructions and assigned one or two students to do all the uploading of content onto the wiki, regardless of who originally wrote that content. Obviously, this violated the spirit of the wiki assignment.[5] Despite these problems, however, a majority of the students participated more-or-less actively in the exercise.

Although student engagement with the assignment was variable, students' experience with the wiki, and particularly the chosen interface, was strikingly consistent: they didn't like it. As one student from one of the most engaged PDI teams stated in a comment within her team's wiki space, "I feel like this interface will seriously inhibit our ability to colaborate [sic] and work together since only one person can be working on a section at the same time. The interface actually encourages us to divide up the work rather than work in a more collective manner." When asked to reflect on their experience with the wiki assignment, IED students also shared a general view of dissatisfaction with the wiki interface. Their main concern had to do with lack of flexibility in document formatting--including difficulty in handling non-text content--which dissuaded them from using the wiki to generate complete reports. It seemed, the more students knew about collaborative authoring software, the more frustrated they were with the assignment requiring them to use a tool they otherwise would not have chosen.

In both classes, the learning goals of using the wiki were moderately achieved, at best. While the majority of students "participated actively" by contributing content to their respective writing assignments, there was considerably less discussion of the content, especially among team members. Even in the PDI course where "discussion"

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[5] It also made it difficult to assess individual contributions to the assignment, as discussed in the following section.

contributions were required, the majority of students tended only to "go through the motions," either discussing project management or offering superficial comments on other students' content contributions. Only rarely did we see elaborate reflections, suggestions, or critiques of one student's contribution by another student. Even students who used the wiki consistently over the assignment period used it primarily as a document manager--a common space to hold the latest version of each section--and not as a tool for writing that was “deeply collaborative.” On the other hand, having student contributions available to the course instructors did allow earlier feedback and direct communication with students having specific problems (e.g., non-participation, improper focus, etc.). Still, at least in our course environments, where students already have considerable time to work together collaboratively on common assignments, the wiki’s contribution to deep collaboration among students was not readily apparent.

Assessment Goals

Although both course wiki assignments proved unsatisfactory in fostering deep collaboration among students, they were surprisingly effective in enabling instructor assessment of individual students. As is typical in assessing group projects, the instructors needed methods for determining individual contributions to jointly authored submissions, and the wiki proved to be a useful tool for this. Instructors of both courses found that the wiki allowed a more nuanced understanding of who contributed what than could be established only by knowing the primary student responsible for each section. The wiki provided a clear record of usage, so the instructors could easily track who were the most assiduous users as well as the nature of their contributions, allowing insight on the effectiveness and dynamics of the student teams as well as helping in assigning credit more fairly to individual team members. In other words, the wiki provided a tool for relatively easily determining who contributed what and when, which allowed assessment of both amount and quality of individual contributions to team projects. It was also nice to always have access to the latest version of the document being generated and to have access to some of the background and behind-the-scenes discussions regarding the exercise.

Beyond the practicalities of assessment--determining who contributed what and when--the wiki provided new opportunities for instructor engagement in the students' writing process. Consistent with the logic of requiring multiple draft document submissions so that the instructor can provide input to student writing in-process, the wiki allowed the instructors to provide targeted input to individual students or teams based on the most-current version of the document available at the time of assessment. This real-time assessment opportunity removes the otherwise inevitable time lag accompanying the typical assessment cycle, where hard-copy documents are submitted then the instructor(s) review the documents (usually of the entire class) and then marked-up drafts are returned to students with comments. Although the same round of activities occurs with the wikis, the feedback occurs on the latest version of the document, at the point in time when the instructor is available to assess it, and the students have access to that feedback immediately.

Social Networking Goals

In addition to the specific learning and assessment goals within the PDI and IED courses, the larger wiki research team also sought to explore the role of wikis in mediating team dynamics and, specifically, facilitating cohesiveness among collaborators. To this end, the PDI and IED students were surveyed on their experiences with team dynamics both prior to and upon completion of the wiki exercise.

Survey 1 was sent out to students at the beginning of the semester. Our initial intention was to collect relational data about students in terms of whether or not they knew each other in person prior to class and how well they knew each other before using the wiki online. We had hoped to take this information and perform social network analysis to investigate and gain insights about how social relations among students and the structure of these social relations affected their collaboration using wiki. However, we were ultimately unable to complete this task because the wiki assignment was group-based and the student groups were too small to allow for meaningful social network analysis. Also, because it was difficult to establish a clear "base-line" for their initial networks, it was not

possible to directly link the wiki with any change that might have occurred as a result of collaboration on the wiki.

What follows below are the data culled from responses to the second survey, distributed and collected after students had completed the required collaboration on the wiki. Table 1 presents the descriptive statistics of the survey results, and Table 2 presents the correlation results. Consistent with our contention, our survey results showed the following correlations:

1. "Group cohesion" (which reflects the closeness of relationships among group members) is significantly correlated with "trust within the group" (r=.607, p=.000);
2. "Trust within the group" is highly correlated with "valued insight brought by peers to the project" (r=.538, p=.000);
3. "A high valuation of contributions from group members" is significantly correlated with "perceived equal contributions from group members" (r=.434, p=.003);
4. "Perceived equal contribution from group members" is correlated with "students' satisfaction with using wiki in the group project" (r=.409, p=.005); and
5. "Group members kept promises by fulfilling their expected tasks" is correlated with "group members reaching consensus easily" (r=.547, p=.000).

Together, these results suggest that facets of effective social networking, including relations of trust, reciprocity, and cooperative norms, are tightly bound with practices of deep collaboration, where interactions are satisfying and effective in achieving consensus in jointly-authored work. However, the survey results also corroborated the instructors' sense that students rarely engaged in debate or discussion on the wiki, and, instead, they tended to regularly engage in debates and discussions outside the wiki. Apparently, then, despite clear correlations between the quality of social networking and the degree to which deep collaboration was achieved, the wiki was not perceived by the students to be

important in facilitating collaboration within these courses. Worse, students' comments indicate that many perceived the wiki to hinder their collaboration. In students' words:

- "Deep collaboration has worked for previous projects (even ran our own wiki for it) but this software wasn't useful. We collaborated in class and divided the rest."
- "Essentially the requirements of the project and lack of decent interface and features removed any actual teamwork from the process."
- "[The wiki was] Not too effective [considering our team had] very few group members that met frequently."
- "The wiki delayed our work process."
- "Enjoyed working with Google docs before the wiki was required."

The correlations listed above are consistent with teams that achieve deep collaboration, yet it seems it was not the wiki that facilitated positive collaborative experiences in our courses. Instead, we assume that the collaborative relationships were either already well established or build around face-to-face interactions, including, perhaps ironically, those face-to-face interactions required to negotiate the wiki assignment! While wikis have been shown to enhance collaboration when participants are dispersed in time and space, in our studio courses--where students were working closely together and many had already established effective strategies for collaboration--the wiki was determined to be ineffective in promoting deeper collaboration, perhaps even inhibiting deep collaboration by reducing time available for direct, face-to-face negotiation of students' writing content and process among team members.

Challenges and Recommendations

Challenges

Overall, our experiences using the wiki were both mixed and surprising. While any new technology obviously brings with it limitations as well as benefits, what was most interesting to us was how--despite the common assumption that wikis enhance

collaboration--our students did not find the wiki helped to achieve deep collaboration given their existing situation. Rather, many saw it as an impediment to the deep collaboration they were (already) engaging in prior to the introduction of the wiki. There were several reasons for this tendency. While it became clear that the choice of Clearspace software inhibited student collaboration in specific ways, making the completion of the assignment more difficult than we or the students would have liked, some of the challenges we faced apply to wikiware more broadly. Many students, for example, complained that site hierarchy was challenging to understand and to navigate. Although the particulars of Clearspace's organization of spaces and subspaces may not have been self-evident for our students, wikiware in general typically suffers from a lack of clear navigation paths and a confusing overall hierarchical structure. Ironically, this lack of rigid hierarchy and the fact that users can create or manipulate their own hierarchies seems to be one of the characteristics that earn wikis their reputation for being "democratic." Regardless, and more fundamentally, our research team determined the application of wikiware in our courses to be disappointing in terms of deep collaboration because of three factors.

Co-locatedness

The first factor that worked against deepening collaboration through the wiki was an attribute of our courses: Our students were co-located and most had already formed more-or-less close-knit communities. In this context, students noted, meeting in person made it easier both to compile documents and to critique the work of peers. Although we had hoped that the transparency of the wiki would allow students to preserve and negotiate differences in the iterated revisions, they seemed to prefer not to make such critiques without the added communication tools of body language and facial expressions when face-to-face meetings were still an option. Admittedly some students--those who did not know each other well before forming a group or those in groups with conflicting schedules who found it difficult to set up face-to-face meetings--found the wiki to be an added benefit for engaging in group work. For some students, the particulars of the software we had chosen made writing on the wiki less appealing than writing in Word and exchanging documents or using Google Documents, and other students remarked that

they enjoyed having the wiki available as a common place to share all their documents. In fact, the most frequent users employed the wiki as a clearinghouse, a place to store documents or trade drafts which had been modified using other tools, such as Microsoft Word's track changes feature. These observations were first made in our 2007 pilot study, but were reinforced by remarks and usage patterns of students in the Spring 2008 PDI course. But this use of the wiki--as a clearinghouse--did not translate to more nuanced, more frequent interactions. Although we hoped having the wiki space available would encourage further contributions and interactions among group members, many students felt they already were collaborating "deeply" enough using other tools.

Synchronicity

The second factor that worked against wiki-enabled deep collaboration in our courses was an attribute of wikiware: the potential of one contributor to overwrite the work of another. Many of our students complained that if multiple students were editing their group's documents simultaneously, someone's work would be overwritten due to the way versions are saved, regardless of whether users were separated by a distance or co-located. To avoid the potential for overwriting, only one student would work on a wiki page at a time, thus making simultaneous engagement impossible. Hence, the wiki encouraged asynchronous contributions--i.e., turn taking--which was one of the primary practices the research team had hoped to improve upon. Such "slowing down" of the writing process had the potential of fostering deep collaboration, because it made each version's changes more transparent and open for feedback, which was exactly what we had hoped the wikispace would provide. In reality, however, the fear of "overwriting others' work" became a serious implementation challenge and one that may have undermined the very goal of deep collaboration as we envisioned it, with intimate negotiation over content at each stage of its generation. The risk of overwriting another's work by not knowing whether a team member was simultaneously working on the same section at a given time provided a strong incentive for students to break up the task into discrete sections, assigning each to a single person for a specified period of time (e.g., until the next class meeting). In other words, students iterated each section individually and then handed-off their work for modification by others. While we had hoped

wikiware's ability to update documents in real-time would encourage more back-and-forth exchanges among more individuals during the writing process, such exchanges were achieved only to a limited extent. Furthermore, regardless of the extent to which the quantity of interactions increased due to the fact that multiple contributions were required as part of the assignment, the quality of exchanges indicated that the wiki did not deepen the collaboration among student team members nor did it lead to improvements in their writing process or outcomes.

Time/Scope

Perhaps related to the two factors listed, above the third factor that seemed to work against students' use of the wiki for deep collaboration had to do with the overall length of time allotted to complete a relatively narrow and specifically delineated type of work. The wikis were introduced mid-semester and the time-to-task we specified in the assignments themselves was only two weeks. Although groups were encouraged to continue using the wiki to complete their final projects, and indeed some did, for most groups use trailed off after the requirements were fulfilled. Granted the instructors deliberately chose to force "wiki traffic" within a limited time-frame. However, given the complications of the interface, however, perhaps the learning curve involved with using Clearspace might have been more readily absorbed during a longer window of involvement or ironically, if the assignment had been more complex. In fact students' responses to the second paper survey support this analysis. One student wrote, "[t]here was little time to begin using the wiki for the assignment," while another student complained that the wiki was, "[o]bnoxious. Frustrating. It is useful to use a wiki when the project is the only thing you are doing. But, when the project is only a few hours a week, going online to chat with the group when you could just wait until class is relatively easier. Furthermore document sending is just as easy to do over email. If this project took 20 hours a week, and if it was difficult to get the team together to discuss, it would be very useful. But it is not really in this instance,"and a third student suggested that they would "[n]eed more time in order to fully experience it. The collaborative process was working at the same time on the same work."Perhaps larger projects that unfold over a longer time-period might benefit more from such wiki-aided use. In the

future, instructors may want to introduce the wiki earlier in the semester, even before the assignment is distributed to give students a chance to play around in the interface and thus become more familiar with it.

Recommendations

Our research suggests that the trust and respect necessary for deep collaboration is something that develops along with interaction, whether it is facilitated by a wiki or conducted face to face. Our goals of measuring and then correlating the degree of social networking and cohesiveness with (deep) collaboration on the wiki were difficult to achieve for several reasons. First, it was impossible to isolate the specific factors leading to deep collaboration. This difficulty was magnified by the fact that our wiki teams were small and that many of the team members already knew each other well. Second, the prerequisites for achieving deep collaboration--such as trust and respect among group members--could be developed independently of, and in parallel with, the wiki's usage, making it impossible to isolate the wiki's contributions to these factors. Third, while we hoped the wiki would increase the frequency and quality of interactions among group members who did not already know one another, the incentive to interact through the wiki was clearly much higher among group members who did not already know one another or who were not co-located.

Despite these limitations, however, both instructors were pleased with the way that the wiki assignment encouraged students to engage in the writing process earlier than they otherwise might have. Moreover, the wiki provided a public forum for student work to be displayed, so that students and instructors alike could see who was writing what and when. The wikis also made the evaluation of individual contributions easier to accomplish, especially in courses where students' writing grades were based on individual contributions. Although students complained mostly about specific technical limitations of the software, we and they are aware that all new technologies come with interface challenges and wikiware platforms will be improved in time and adjusted to the specific needs and goals of particular user communities. Setting these concerns aside, however, our students' analysis of their use of wikis suggests they could be potentially

powerful tools for harnessing collaboration in teams that are not geographically co-located. Additionally, for teams that are co-located, wikis might function best as a clearinghouse for document storage--a function that emerged from how our groups actually used the wiki. Wikis also allow distributed, process-based, iterative writing to be much more transparent for those who wish to understand (and evaluate) the evolution of a document and the contributions made by specific individuals. Thus, while we certainly do not recommend against using wikis on collaborative writing assignments--they provide valuable administrative and assessment opportunities--we do recommend against employing them as a substitute for other trust-building activities that develop team cohesion or collaborative-writing skills-building activities that facilitate peer-review and editing capacities.

Conclusions

Wikis are frequently celebrated for their role in achieving lofty goals surrounding collaboration. While we did not witness significantly-improved collaboration attributable to the use of wikis in our classrooms, we did find wikis to offer more pragmatic benefits in terms of assessment and coordination. Wikis enabled our instructors to assess individual contributions to group-writing projects, and we suspect such assessment tools would be appropriate in many educational contexts. Additionally, in the context or our courses, the wiki assignment encouraged students to face the reality of writing--that every document starts with a blank page--much earlier than they otherwise might have. By putting the (nearly) blank page in a public forum for everybody to see--students and instructors alike--students confronted their own contributions and those of their teammates in a direct and immediate way: it was there or it wasn't. This provided an incentive for students to work earlier and to contribute small pieces more often, which were also among our goals.

Although these courses were taught by instructors trained in disciplines other than rhetoric and composition (i.e., engineering and design/management), the faculty involved appreciated the iterative and recursive processes of writing, which closely parallels the

process of engineering design. The fact that wikis helped to make the creative processes involved in writing more transparent was thus a key benefit for our engineering and design faculty. The process-based approach to writing, long hailed as a successful pedagogical model in rhetoric and composition studies, can be easily and directly be connected to design pedagogy, to the benefit of engineering/design students and faculty. Both on our campus and on others where engineering and the sciences predominate, it is worth exploring the potential of drawing out this parallel--between processed-based writing and design--in a more explicit way, perhaps even drawing on the old rhetorical canons of memory, invention, arrangement, style, and delivery.

Regardless of diverse disciplinary training, the faculty involved in this project all wanted to create conditions that would foster deep collaboration and to identify methods for measuring it. What we found--which perhaps should come as no great surprise--is that collaboration, deep or otherwise, is a complex process that is difficult to measure, quantitatively or otherwise. In part, this is because it involves a multitude of interdependent factors that are hard to separate--establishing classroom community, forging bonds of trust and respect among group members, and, perhaps most important of all, creating a culture that values collaboration itself. Furthermore, the reality that institutions and instructors seek to disaggregate individual contributions from jointly-authored writing exists in tension with the goal of deep collaboration, which necessarily blurs lines of authorship. Given this context, wikis seem to offer a tool for negotiating this tension--for enabling individual assessment while still encouraging deep collaboration.

These observations beg larger questions about the values and assumptions that underlie (what often seems to be automatic) praise of the adoption of wiki-like technologies in the classroom. While the use of a wiki in our classrooms entailed only one application among many possibilities, and while we found educational and assessment benefits derived from our use of the wiki, it was also clear that the wiki was neither panacea nor short-cut to achieving deep collaboration. Deep collaboration is realized only over time and through continual or repeated cognitive engagement by participants. Wikis can enable such

investment of effort, but do not substitute for it. Our observations also bring to light the uneasy relationship that exists between the contemporary push for collaboration and the predominant way students are assessed. Organized as they are around the end product (the submitted document), instead of the writing process, typical assessment protocols are poorly matched to deeply engaged, iterative, recursive, and collaborative writing. Although the wiki provided a tool useful to the course instructors for negotiating the tension between collaboration and individual assessment, it certainly did not resolve or eliminate that tension. Ultimately the assessment protocol our instructors employed fell back upon a model that rewarded individual contributions that were documented. If educators are committed to collaborative writing (or collaborative design generally), if they believe that learning is improved when peers provide feedback on one another's work at each iteration, then rethinking the overall assessment process might be more effective than merely identifying tools that help cope with the existing tension.

At its completion, this project has addressed the questions it sought to answer only partially. Deep collaboration might well have been achieved, but the role of the wiki in fostering it is not straightforward and the extend to which group-authored writing was improved is impossible to determine. Insofar as the wiki assignment strengthened social ties, it did so through its role as an object of shared frustration, not because of the qualities of the wiki tool. And while the wiki increased transparency of individual contributions to the jointly-written document for the course instructors, this characteristic played no obvious role in improving the quality of the collaborative experience for students. Nevertheless, the role of the wiki in enhancing assessment for the instructors was not trivial--both course instructors agreed this was a positive outcome of the experiment. Similarly, the administrative effort required for exchanging feedback was drastically reduced (but only after the investment required to learn the software was made), which was another non-trivial achievement.

Hence, perhaps the difficulties we encountered in our attempts both to measure "deep collaboration" and to provide evidence for the claims that such collaboration improves writing were the result of flawed research design deriving from failure to account for this

tension and for the assumption that wikis can overcome it. Or perhaps our attempt to "measure" the intricate and interdependent processes of community formation and effective collaboration was wrong-headed from the get-go, especially as it directed our attention (and that of our students) to the quality of the final writing submission rather than the writing process. Probably, however, the research questions we originally sought to answer themselves were too ambitious, as are the expectations surrounding many a new educational technology. Had we moderated our expectations, we might well have been more successful in achieving our research objectives. At the end of the day, the wiki did not radically change our teaching or our students' learning. Instead, it was merely a tool that required investment of effort to learn, offered selective improvements in teaching and learning, and was experienced with a mix of annoyance and gratitude by its various users.

Reflections

Though not a formal part of our project's research methodology, the authors of this wiki-paper hoped our own writing process would achieve "deep collaboration," and that that collaboration would be enabled by the wiki we employed in our writing. When we first proposed this article, we had imagined that we would use the wiki as a way to generate and refine our ideas about what we learned from our experiences in different classroom implementations. We also hoped the wiki would provide a means of bringing together the authors whose roles in the research varied widely--instructors who assigned the wiki project, researchers in social networking and technology-mediated communication, and undergraduate student experts in wikiware. As with our students' experiences, it quickly became clear to us how hard it was to achieve deep collaboration using the wiki by itself. Like our students, we became frustrated with the tool, both in terms of its usability and in terms of communication bandwidth--we couldn't communicate enough information quickly enough to find its use satisfying. Despite having had our own training sessions and despite our intellectual curiosity underlying the use of wikis in collaborative projects, we found ourselves using the wiki little and late in our writing process.

There were many specific limitations that dissuaded us from using the wiki more consistently. For example, while the compare-versions feature of Mediawiki would have allowed us to see and compare our changes to the main document as it evolved, this feature was rarely deemed useful by the authors (again, consistent with student experience). Similarly, while we hoped the "discussion" feature would allow us to communicate with one another about the document's progress, we found that it was easier to bracket our notations within the document text itself. Especially earlier in the process when the overarching outline had not yet stabilized, we found ourselves composing text in Microsoft Word, commenting upon others' contributions using Word's comments feature, and emailing documents back and forth as attachments. We also chose to meet face-to-face on numerous occasions, and, as the document progressed, we found that we preferred to work on specific sections either singularly or in pairs. While some of the authors attempted to engage the others via the wiki, scheduling demands and inconsistent monitoring of the wiki for updates pushed us back to email as the primary tech-mediated communications tool for assessing our writing. Thus, not surprisingly, and as with our students, we found ourselves falling back upon old, reliable habits of communication and collaboration. To whatever extent we achieved deep collaboration in our research and writing processes, it was achieved through a combination of face-to-face meetings, frequent email exchanges, individual writing in Word, individual and small-group composing on the wiki, last minute phone calls from office to office, and the numerous updates and "water cooler" exchanges typical of robust social networks in professional settings.

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Appendix

Appendix A: The Wiki Text Editor

A wiki, in its most basic sense, is a website with pages editable by anyone at anytime. The main tool that facilitates user contributions is the text editor. Wiki text editors come in three main varieties: a plain-text editor, a text editor with shortcuts, and a rich-text editor, also known as a what-you-see-is-what-you-get (WYSIWYG) editor, which is similar to the common word processor. When wikis were first conceived, many used a plain-text editor, which required users to modify page content in a similar way to how a programmer would create an HTML document. However, the “wiki markup” language

was never standardized; users would need to learn different markup languages for different wiki software.

In order to make text editing easier, wiki software developers began to incorporate shortcut buttons that automatically inserted the wiki markup commands for selected text. For example, one button would inserts the markup command to make selected text boldface. The buttons were distinguish using common descriptive images, such as a boldface 'B' for boldface text. Although this method makes basic text editing easier, the content editor still appears as plain text regardless of the formatting applied, and the formatting commands are mixed in with the text, making it difficult to find content within the mix of content and markup commands. With the advancement of server technologies, web developers were able to extend to wikis features previously available only in word processors.

Recent advancements in dynamic server technologies, such as JavaScript (JS) and Java Server Pages (JSP), have allowed web applications to employ the WYSIWYG editors that most computer users are familiar with. However, many wiki software packages do not incorporate a visual editor by default. Some packages allow for visual editors to be added on, but this task can be a hassle for the administrator as well as the user. Adding on visual editors often creates inconsistencies between the software and the editor, sometimes even causing the software to fail, resulting in lost work. Although WYSIWYG editors simplify editing for most users, when selecting wiki software, it may be difficult to find packages that fit user needs as well as natively incorporating a visual editor.

Appendix B: Wikis in Higher Education

Obviously, wikis have been used elsewhere in higher education. Two noteworthy examples are the work of Dr. Joe Moxley at the University of South Florida (USF) and Texas A&M's First-Year Learning Community. TeachingWiki is one part of a two-part wiki community created by Moxley for USF's First-Year Composition courses. In 2006, 9500 students and 86 faculty members were part of the First-Year Composition program[6]. TeachingWiki is mainly used by USF faculty; however, it is open to all college-level faculty for sharing teaching practices, lesson plans, and references. In addition to sharing information, users are able to gain new insights into teaching practices from the contributions of other users. In order to use the wiki, users must contact Moxley for an account; Moxley moderates the site, which creates a more controlled atmosphere so irrelevant information is kept to a minimum. The platform used for this wiki is an open-source software package called FlexWiki. The user interface lacks a standardized navigation system, which makes it difficult to use.

The second part of this system is called WritingWiki and is the portal intended to encourage student-faculty interaction. It uses the same platform as TeachingWiki, FlexWiki, and is just as difficult to navigate. Instructors use this wiki mainly as a means of posting information for students, such as example papers. The wiki is broken down

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[6] http://teachingwiki.org. December 17, 2007.

into sections for classes and sections where professors can provide information for each section. Like TeachingWiki, WritingWiki also lacks standard navigation between its pages, creating confusion when browsing information located many "clicks" within the wiki.

Texas A&M's award winning First-Year Learning Community program has a wiki containing information pertinent to both first-year students and course instructors. The software powering this wiki is called PmWiki, a minimalist wiki platform. It provides breadcrumbs as navigation aids, but there is no standard navigation bar. The wiki is mainly used to organize information about the various courses that participate in the Learning Communities program. The wiki enables students to find information about their learning communities while also providing instructors a way to inform students about their courses. Again, this wiki is mainly used to publish information that students retrieve, rather than allowing for student input. There is also a teacher section on the wiki with a variety of types of information, including downloadable documents (documents not created for the wiki).

Appendix C: Documents

ENVE 4330 – Introduction to Air Quality Control

2006-2007 Catalog Data:
Quantitative introduction to the engineering methods for the study of air quality. Topics include: estimation procedures for air pollution emissions; indoor air quality problems, impacts and control strategies; sources, impacts and control strategies for greenhouse gases; dispersion modeling for point sources; pollutant acidification of lakes; urban source apportionment modeling; chemistry of stoichiometric and non-stoichiometric combustion; regulations for mobile and stationary pollution sources; control devices for motor vehicle and stationary source emissions; assessment methods for human exposure to air pollutants.
Prerequisites; CHEM-1300 and CHME-4010. Fall term annually. *3 credit hours*

Required Textbook: R.J. Heinsonhn and R.L. Kabel, *Sources and Control of Air Pollution*, Prentice Hall, © 1999.

Optional Textbook: John Harte, *Consider a Spherical Cow – A Course in Environmental Problem Solving*, University Science Books, © 1988.

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K. Wark, C.F. Warner and W.T. Davis, *Air Pollution – Its Origin and Control*, third edition, Prentice Hall, 1998.
John Harte, *Consider a Spherical Cow – A Course in Environmental Problem Solving*, University Science Books, © 1988.

Course Coordinator: Lupita D. Montoya, Assistant Professor,
MRC 315, X2532, lmontoya@rpi.edu
Civil & Environmental Engineering Department

Goals: By the end of this class, students will be able to:

1. Construct flow diagrams to represent the sources and sinks of air pollutants in steady-state and non-steady-state systems;
2. Write and analytically solve differential equations to predict air pollutant concentrations as a function of time;
3. Evaluate flows and timescales to determine which factors govern a system's pollution levels and equilibration processes; and
4. Identify and quantitatively assess the effectiveness of candidate control strategies for typical indoor, regional, and global-scale pollution problems.

Topics: Estimation procedures for air pollution emissions; indoor air quality problems, impacts and control strategies; sources, impacts and control strategies for greenhouse gases; dispersion modeling for point sources; pollutant acidification of lakes; urban source apportionment modeling; chemistry of stoichiometric and non-stoichiometric combustion; current regulations for mobile and stationary pollution

sources; control devices for motor vehicle and stationary source emissions; assessment methods for human exposure to air pollutants.

Grading: The grade will be based on 5 homework assignments, 1 quiz, 2 midterms, 1 (team) research paper, and a final examination.

- Homework: 5 will be assigned, due on the designated Friday (by 5:00pm).
- Formula for grade:
  - 20% HW, 5% Quiz, 15% Midterm 1, 15% Midterm 2, 15% research paper and 30% Final

Office Hours:

Tuesdays: 4:00-5:00 pm
Fridays 4:00-5:00 pm (or by appointment)

POLICY ON HOMEWORK

1. Collaboration

- You may work together in small groups (no more than 3 people) to discuss and compare approaches to the problem set.
- You may NOT copy line-by-line someone else's solution, and you may NOT allow someone else to copy line-by-line your solution.
- You must understand the problem solution you hand in well enough to be able to rework the problem completely on your own.

2. Format

Homework in this class will be graded not only on the solution of the problem, but also on the clarity (in terms of legibility and logic!) with which the solution is presented. General Rule: enough details should be included in your write-up so that, years from now, you could follow the assumptions, reasoning, and calculations you used to solve the problem. The following will give you an idea of what you might want to include in your write-up.

- State the Objective of the Problem. Make sure you have a clear understanding of what you are asked to do.
- Describe the Setup of the Problem. If appropriate, draw a picture. State what you are told to assume, as well as any other assumptions you may need to make.
- Show a Step-by-Step Solution of the Problem. State all assumptions, show your calculations, do not skip steps, and include comments. Circle all answers.
- Discuss Significance of Results. Is it what you intuitively expected? Does it seem low, high, wrong? Does it have any implications for health, policy, or the environment?

3. Penalties for Late Homework

Homeworks are due on the specified Fridays by 5:00pm in the mailbox outside MRC 319 (labeled ENVE 4330). Each homework assignment will have a total of 100 points possible.

(Please, note that the homework will be picked up promptly at 5:00pm; any homework placed in the box after 5:00pm will be considered late.) Penalties for late homework are:

- Less than 3 days late: 10% off
- 3 to 10 days late: 20% off
- More than 10 days late: 30% off (must be handed in before final exam)

Each student can receive one instant 3-day extension on any of the 5 homework assignments, just by writing "ONE-TIME WAIVER REQUESTED" on the top of that homework assignment.
Any student who manages to hand in all 5 assignments on time will be considered to have "Borderline Grade Insurance": if that student's final score for the class happens to fall *right* on the borderline between grades, she/he will automatically receive the higher of the two grades.

Course Content

1) Introduction to Basic Tools
- Important pollutants; introduction to mass balance (box modeling)
- Estimation procedures; pollutant removal mechanisms

2) Indoor Air Pollution Impacts
- Introduction; HCHO in mobile homes; cigarettes and CO
- Indoor control strategies; control of soiling in museums
- Timescales for pollutant buildup: “Smokeys” revisited

3) Global Air Pollution Impacts
- Relative importance of greenhouse gases
- Changes in the global carbon cycle
- Control strategies: CFCs as an example

4) Urban/Regional Air Pollution Impacts
- Shortcomings of box model approach; dispersion modeling
- Building downwash; tropospheric ozone chemistry
- Acid rain equilibrium chemistry
- Lake acidification example: Lake George
- Methods of identifying regional pollution sources

5) Gaseous Control Strategies: Mobile Sources
- Pollutant formation due to combustion chemistry
- Control devices for gasoline-powered cars; tampering

6) PM Control Strategies: Stationary Sources
- Overview of Federal Regulations
- Baghouses for PM control
- Industrial PM control: cyclones
- Combustion PM control: electrostatic precipitators
- Scrubbers for PM removal

7) Gaseous Control Strategies: Stationary Sources
- Methods for SO_2 control
- NO_x control devices
- VOC control devices
- Prioritizing control for multiple sources

8) Human Exposure to Air Pollutants
- Introduction; CO exposure/dose modeling
- Human uptake dynamics for airborne lead
- Human exposure to PM
- Human exposure to VOCs

ENVE 4330- Introduction to Air Quality Control *Fall 2007*
Instructor: L.D. Montoya
Assignment Creation: J.Fernheimer, L. Montoya, and B. Lewis

From the Classroom to Real Life: Writing About Air Quality Issues

Ability to communicate both in written and spoken forms is consistently mentioned as indispensable for conducting engineering work effectively. Technical writing, in particular, is a necessary skill that all engineers must possess in order to advance in the work place.

Results of a recent survey of Environmental Engineering RPI (2000-2006) alumni found that our graduates felt under-prepared in this area, considering its importance. Consequently, my overall goal as an instructor is to address this issue before you graduate and in a way that will bring you additional benefits and hopefully a new appreciation for air quality.

Assignment's Goals:
*To increase your knowledge of a specific application of Air Quality Principles.
* To provide an opportunity to work collaboratively to better understand a particular issue related to real-world applications of Air Quality Principles.
* To strengthen and improve your ability to communicate clearly and persuasively in writing.
* To enable you to advocate a position or specific policy concerning Air Quality.
*To develop your research skills and your ability to analyze, synthesize, and incorporate scholarly research into your own writing.
* To provide an opportunity to work with and learn from peers by working and writing collaboratively.
* To introduce you to innovative technology (wikis) to help you accomplish the aforementioned goals.

The Essay
To help you better understand and apply the conceptual models you have learned in our course, you will conduct research on how they apply to the real world. Through this assignment, you will have an opportunity to work with your colleagues to deeply investigate an Air Quality topic of your choosing. You will work in groups of your choice to both research the topic and develop a position that advocates a particular action. Some arguments might advocate that citizens vote or modify their daily behaviors in a particular way. Other arguments might encourage citizens to write letters to their representatives to introduce appropriate legislature. As a group, you will need to keep in mind the particular audience your essay will address and the specific action or position you will advocate. This assignment will enable you to sharpen your research, writing, and application skills. You will also learn to use innovative tools (i.e., Wikis) for writing this assignment as a collaborative effort.

I'm asking you to write an 8 page research paper that clearly synthesizes the current state of knowledge on your topic, but also moves further to make an argument about what is important for citizens to know about this issue — how should it be addressed? How might the research you've uncovered affect the way people vote? How should they

act? What bills might be introduced?

Research
In order to write an effective and persuasive argument, you will need to consult reputable, (e.g., peer-reviewed) scholarly sources. You will synthesize and cite them accurately using Chicago Style citations to support the position you advocate. You are expected to contextualize the material you include. In other words, you must first introduce the source in a way that demonstrates it is credible (i.e. "Biologist Joe Doe at the Institute for Environmental Preservation says in his four year study of air quality, that..."). You must also interpret the material/evidence in such a way that it is clear why you have selected the evidence to support the claim you are making.

Guidelines:

1. ***Audience.*** You should prepare this document for an audience with an engineering background at the undergraduate (BS) level. Use language that reflects your technical preparation and use terms that conform to scientific standards. You can assume your audience is 2006 graduates of the School of Engineering at RPI. You can further assume that they are familiar with basic air quality concepts, but you will have to educate them about the details of the particular issue you are researching.

2. ***References.*** You are expected to consult scholarly sources found both on and off-line. You need to cite at least ten (10) references and no more than 3 can be on-line references. No ".com" references are acceptable. Use Chicago style for your in-text references and the Works Cited (References), which should appear as a separate page at the end of your essay (not part of the 8 page minimum).

3. ***Format.*** The document format is pre-set by the wiki software we will be using in our class. You will be able to easily check the status of your paper by producing a pdf of your manuscript at any point. Our wiki has a handy tool that allows for this step to be quite straight-forward. This pdf should produce a single-spaced document with preset fonts and margins. The paper should be a minimum of 8 pages long (single-space) and no more than 20% of the total length can be made up of graphics (e.g., tables, figures, etc.).

4. ***Collaboration.*** You will work on this paper with two other people (i.e., teams should be 3 people total). You will have the option of selecting your collaborators or have the instructors assign them to your team. The goal would be to have teams of students interested in the same topic to maximize the benefits of this exercise.

5. ***Grading.*** This assignment constitutes 15% of your final grade. Five percent (5%) will be based on collaboration (see further description below) and the other 10% on the actual paper (i.e., the quality, depth, sophistication of the argument, the level of polish of the prose itself).

Since collaboration will be considered in the grading of the assignment, be a full participant in this exercise. We will consider, for example, the number of posts, revisions, discussion threads and the substance of your contributions. Using the Wiki, the instructor will be able to determine the true extent of your participation. Students will contribute to the grading of the collaboration component (details will be discussed in class).

6. ***Special Hints.*** You should take advantage of the writing resources RPI provides. Visit the Center for Communications Practices (CCP in the basement of Folsom library, http://www.ccp.rpi.edu/index.html) and work with a consultant who can help you at any stage of the writing process—from brainstorming to the final paper.

   Education research has shown that most students benefit from writing recursively, which means they write multiple drafts and the material is reorganized and developed significantly with each revision. In order for this process to work, however, it takes time. Allocate enough time for this exercise so that you can really benefit from what scholars term "process-based writing."

7. ***Schedule and Due date:*** The final assignment will be due ***Thursday, Dec. 6*** in class. Writing research has shown that students who use a process-based approach to writing understand the material better, develop more sophisticated ideas, and turn in more polished prose. To encourage you to work in the process-based model, I've outlined the following timeline for structuring your work.

Oct. 15	Assignment Distributed (start brainstorming on topics and groups). Workshop on Process-Based Writing; special guests Dr. Jan Fernheimer and Dr. Barbara Lewis.
Oct. 25	Introduction to Wikis (a hands-on workshop); special guests Dr. Fernheimer and Tom Kujala.
Nov. 1	Select topic and group members.
Nov. 15	Writing Workshop (revision, organization); special guests Dr. Lewis and Dr. Fernheimer.
Nov. 19	Full Draft of Final Essay to be completed. Your group will be required to provide feedback to another group to help them improve their essay.
Dec. 6	Final Essay Due to Professor Montoya.

PDI Studio 6

Spring 2008 Syllabus

ENGR 4961-01 (90560) engineering majors
STSH 4961-01 (91219) non-engineering majors
PDI Studio (SA 2211)
Monday and Thursday, 2-5pm

Instructors

Prof: Dean Nieusma | email: nieusma@rpi.edu | phone: 276-6381
office: Sage 5405 | office hours: Monday and Thursday 10-11am | mailbox: Sage 5508

Prof: Mark Hubbard | email: mhubbard2@verizon.net | phone: 413-329-7467
office: Sage 5408 | office hours: prior to class | mailbox: Sage 5508

TA: Michael Rapp | email: rappm@rpi.edu
office: | office hours: | mailbox:

Overview

This course is the sixth in the PDI studio series. It introduces students to entrepreneurship and business planning in service of advancing your skills as product designers and innovators. As with all PDI studios, assignments require students to synthesize social, technical, cultural, and formal concerns in the design of innovative objects, environments, or communications media.

As a studio course, class time is used for self-guided design investigations as well as structured group activities. Students are expected to participate in individual and group research, including hands-on exploration of design ideas; discussions with potential users, researchers, and business practitioners; project reviews; and formal presentations.

The course requires weekly reading from the course text and regularly assigned articles (available electronically).

Learning Outcomes

Upon completion of this course, you should have the following sets of skills:

1) Understanding of the core principles and major stages of the entrepreneurial process,
2) Ability to recognize, refine, and develop high-potential entrepreneurial opportunities, including product idea generation, screening, and financial feasibility assessment.
3) Ability to situate specific products and entrepreneurial ventures more broadly within larger social contexts, including cultural values (e.g., environmentalism); economic systems (e.g., market capitalism); legal requirements (e.g., product safety laws, incorporation regulations); market requirements (e.g., consumer expectations); etc.

Texts

req'd *Where Stuff Comes From* (2005) by Harvey Molotch [*Stuff*]

rec'd *Product Design and Development* (3rd Edition, 2003) by Ulrich and Eppinger [*PDD*]

Major Assignments & Grade Breakdown

Project 1: Idea Generation	due 4 Feb, 2:00pm sharp	10%
Project 2: Idea Screening	due 28 Feb, 2:00pm sharp	20%
Project 3: Business Planning	due 19 Apr, 5:00pm DN off.	30%
Pop Quizzes on Readings	throughout semester	20%
Class Participation	throughout semester	20%

Grading Scale

A+ 100	A 93-99	A- 90-92
B+ 87-89	B 83-86	B- 80-82
C+ 77-79	C 73-76	C- 70-72
D+ 67-69	D 60-66	F ≤ 59

Grading Notes

Individual project grades will be determined based on the quality of written submissions, interim reviews, final presentations, and peer evaluations by your team members. Assessment criteria include integration of course themes (including those from the readings) into project work, thoroughness, and persuasiveness. Handouts will provide detailed instructions for each project assignment. Project assignments 1 and 2 are due in class, Project 3 is due in Sage 5405. Being late for classes at which major assignments are due will count as absences, and project grades will be reduced by 10%.

Pop quizzes will be given on assigned readings to help you stay on top of the reading load. These quizzes will test for factual content as well as comprehension of argument.

The class participation portion of your grade will be based on active participation in classroom discussions and presentations, attentiveness, active engagement in group exercises, and your individual contribution to other classroom activities. Our theory of grading is to "defend the integrity of the A," so active participation throughout the course, in addition to high quality submissions, is required to get a high final grade. Participation in discussion can take many forms: responding to a question, commenting on what another student has said, illustrating a point with an example, connecting the discussion to a supplemental reading, another course, or to something you have seen or read in the popular press, etc.

The quality of participation is more important than the quantity, so only genuine engagement with the course material, rather than participation for its own sake, will be rewarded. Reading email or the newspaper or engaging in other non-course-related activities during class time will count heavily against your participation grade.

Session Preparation

Most class sessions will entail a reading assignment from the text or which will available electronically. All readings must be completed before the session for which they are assigned. Please bring your readings and your reading notes with you to class.

For each reading, you should be able to be able to outline the key argument, the main points raised, and the evidence marshaled. You should also be able to offer your own analysis of the strengths and weaknesses of the reading overall as well as its arguments.

Discussions will rely on both volunteer participation and "cold calls." We do not cold call to embarrass you or to "catch you out," but rather to help you learn to reason critically and to articulate your conclusions and arguments verbally in a convincing way.

Learning Partnership

Discussion-based learning relies upon a partnership—a collegial sharing of power, accountability, and tasks—between students and instructors. As instructors, our role is to plan, host, moderate, assess, be devil's advocates, and join students in learning. The student's role is to be profoundly and actively involved in your own learning in order to discover lessons for yourself and not merely accept the instructors' pronouncements.

Attendance Policy

Students are expected always to be present during studio time. Excellence in submitted work will not make up for delinquency in attendance. More than one unexcused absence will result in a lowering of your final grade. If you must miss a class, assignments are due before the class period begins. Excusable absences include illness, family emergencies, and scheduled sports games in which your team is away from Rensselaer.

Gender-fair Language

Students in this course are expected to use gender-fair language in their writing. When you use masculine-oriented words to refer to people in general, the implicit effect—even if unintended—is to imply *women don't count*. If you are unfamiliar with the practice of gender-fair writing, read the handout of the Center for Communication Practices (formerly the Writing Center) at <http://www.ccp.rpi.edu/genderfair.html>.

Academic Integrity & Appeal Process

Student-teacher relationships are built on trust. Students must trust that teachers have made responsible decisions about the structure and content of the courses they teach, and teachers must trust that the assignments students turn in are their own. Acts that violate this trust undermine the educational enterprise and contradict the very reason for being at Rensselaer. *The Rensselaer Handbook of Student Rights and Responsibilities* defines various forms of academic dishonesty and procedures for responding to them. The policies laid out in the *Handbook* help maintain a community of trust and will be strictly enforced. Review these policies, and see the course instructors if you have any questions.

For this course, the following penalties will apply:

- Willful acts of plagiarism:
  Failure of the course, with a permanent written judgment in the student's official record
- Unintended but substantial acts of plagiarism:
  Failure of the assignment, plus reduction of final course grade by one letter grade
- Other acts of academic dishonesty:
  Penalties range from a warning to reduction of final grade by one letter grade to failure of the course, depending on the severity of the violation as determined by the instructors

Students should note that penalties for plagiarism are significant. All direct use of another person's work must be placed inside quotation marks. You must also indicate where you paraphrase another's work and where you borrow another's specific ideas or interpretations. If you have questions regarding proper citation practices, see one of the instructors for clarification *before* the assignment is submitted.

While collaboration is encouraged throughout the course, others cannot do work for you. All assignment activities must be carried out by the individual or team members submitting the assignment for a grade. Other people may show you *how* to do something (say, when using computer software), but you must follow up by doing the work yourself.

The Rensselaer Handbook provides specific procedures by which a student may appeal a grade. Speak to one of the professors before initiating an appeal. If this does not lead to satisfactory resolution, you have the option of appealing your grade by writing to the head of the STS Department no later than 10 days after your grade has been posted.

Schedule

Key lecture topics and assignment milestones are provided in the table below. Readings will be assigned as we go. "Open studio time" means you will have at least half the class time to work on your projects.

	Monday	*Thursday*	
wk1	**14 Jan – Introduction** Entrepreneurship & management of risk E-ship: definitions and components	**17 Jan – Guest Presenters** David Hess, Rob Chernow, and Dan Dewine	
wk2	**21 Jan** **No Classes – MLK, Jr. Day**	**24 Jan – Context** Mega Trends, Population, Productivity How and Where Designed Objects Fit Historical Context	
wk3	**28 Jan – Idea Generation (1)** Identifying Needs Generating Ideas/Concepts/Objects The Fatal Flaw – Falling in love with the first idea.	**31 Jan – Idea Generation (2)** Marketing Theory applied to Idea Generation Case Studies Generating Multiple Ideas for a Single Opportunity	
wk4	**4 Feb** Project 1 due Project 1 – Presentations	**7 Feb – Screening & Evaluation (1)** Role of Screening External Environment Internal Environment	
wk5	**11 Feb – Screening & Evaluation (2)** Competition Scale SWAG Modeling	**14 Feb – Screening & Evaluation (3)** The 15 Questions to Answer Feasibility Studies Restarting from Scratch – "Do overs"	
wk6	**19 Feb** **(Tuesday, follows Monday class schedule)** Open Studio	**21 Feb** Open Studio	
wk7	**25 Feb** Project 2 – Presentations	**28 Feb** Project 2 due Project 2 – Presentations	
wk8	**3 Mar – The Business Plan (1)** Components of a Business Plan The Investors' Point of View Answering the Logical Questions	**6 Mar – The Business Plan (2)** Building a Business Model Format Assumptions	
	10 Mar **No Classes – Spring Break**	**13 Mar** **No Classes – Spring Break**	
wk9	**17 Mar – Guest Presenter** Bob King	**20 Mar – The Business Plan (3)** Review of Key Components Format Tips Presentation Tips	
wk10	**24 Mar – Financing & Funding (1)** Sources of Funds (the seven pools of capital) Terms and Conditions Managing Expectations, Rules of Thumb	**27 Mar – Financing & Funding (2)** Minimizing the Need for Outside Money Bootstrapping Techniques Case Studies	
wk11 GM wk	**31 Mar – Setting Up a Business or Enterprise** Organization and Personnel Legal Matters Accounting Matters	**3 Apr – Starting Up a Business or Enterprise** Minimizing Expenses to Buy Time Marketing and Selling Unexpected Challenges	
wk12	**7 Apr – Operating a Business or Enterprise** Cut Losses Sooner Be Innovative Preparations to Maximize Value or Exit	**10 Apr – Exit Strategies** Buy Out Merger Suspend Operations	
wk13	**14 Apr** Open Studio	**17 Apr** Open Studio	**19 Apr** **Saturday** Project 3 due 5pm
wk14	**21 Apr** Project 3 – Presentations	**24 Apr** Project 3 – Presentations	
wk15	**28 Apr – Wrap Up**		
finals	**5-9 May**		

"Deep Collaboration" on Group-authored Projects

Instructions for wiki collaboration for project 3, phase 1
PDI-6 (SP08) Instructors Nieusma and Hubbard
Grant researchers Dr. Fernheimer and Dr. Chi

Collaboration has long been hailed as a critical component of success in industry, the sciences, and composition studies, and recently wikis have earned a reputation as tools that enhance collaboration. Consequently, as you prepare your team-authored business plans for project 3, we ask that you do at least the initial drafting within a course wiki. Our goal is that you use the wiki to engage in a process of "deep collaboration."

What do we mean by deep collaboration? Simply that each member of your team participates in *every step* of the process—from generating ideas, to researching them, to evaluating the research and resources, to organizing the material, to drafting paragraphs within the business plan, to final editing of the text to ensure overall coherence. In other words, this assignment requires you to work against your first impulse to break the work into component parts and then assemble the pieces into one document just before it is submitted for a grade. Even though you may (correctly) perceive the division of labor process as "more efficient," what is gained in expediency is lost in sophistication and overall quality of the project and students' individual learning.

With deep collaboration, you are likely to disagree or even argue over which organizational structure is most effective, which sources are most trustworthy, or whose writing style is most appropriate to the assignment. Yet the very process of negotiating these disagreements helps each student to become more critically engaged with and aware of the material. Since each team member brings different knowledge, experiences, and expertise, such discussions help the group as a whole to gain a more complete sense of how other people (who are not in the group) might receive or react to the final document. Clearly this process is more deeply interactive and cooperative than the "divide and conquer" strategy.

To practice deep collaboration, you must complete this activity over the following week:
Identify a business plan template appropriate to your project and then determine how that template should be custom tailored to your project.

Each of you must use the wiki to contribute to the discussion: Which parts of the given templates are most appropriate and should be used? Which sections should be added? In what order should the sections appear? What other questions need to be addressed at this stage of the process? Be sure to *explain* and *justify* your positions. The wiki will not allow more than one person to contribute at the same time, so you should work individually according to your own schedule.

Technical Instructions

1. Go to your group's section of the wiki, and create a new document. Invite all of the following as "contributors": other group members, Dean Nieusma, Mark Hubbard, Jan Fernheimer, and Lei Chi. (While Professors Fernheimer and Chi will not make changes to your document, they will need access to your group's activities to complete the grant research.)

2. Name the document "Template Selection and Modification."

3. There are two parts to this new 'collaboratively' authored document:
   a) The **TEXT ["Document"]** itself is where you will add or delete parts of the template
   b) The **COMMENTS** section, which appears at the bottom of the document, is where you will identify who made the revision (e.g., Revision 4 by Jane Smith), and describe and explain the changes made. For example, if you moved a paragraph, you will articulate in writing why you moved it and where you put it. If you made a lot of small changes, you will need to describe why you made them (e.g., I corrected punctuation, clarified wording, and revised sentence style).

4. Each person will be required to make significant contributions to both the document and the discussion taking place in the comments section. You should post some of your own initial ideas as well as ideas that directly engage with some of the writing or choices your peers have made. You may make both types of changes in a single "revision," but be sure to document what you did in the comments section below.

5. You may find it helpful to use the history/revisions to look back at the different versions of the document, as some people may introduce changes that get erased or incorporated into later versions of the document. You should refer to the versions by number and author.

6. Over the next week, each group member should make at least 2 significant contributions. (You're welcome, of course, to make more.)

Good luck, and have fun!

Instructor: Lupita D. Montoya
MRC 315/JEC 5040; lmontoya@rpi.edu

Introduction to Engineering Design (ENGR 2050) with Professional Development I
Spring 2008 Syllabus

COURSE OBJECTIVES

The goal of this course is to introduce students to the engineering design process. While the steps involved in the design process may change depending upon a variety of factors, most design experts agree that the design process starts with a thorough understanding of the problem, followed by a thorough exploration of possible concept solutions. Since design problems are by nature open-ended (meaning that there are many possible solutions) and multi-faceted (meaning that there are multiple levels of complexity), the process of problem definition followed by formulation of system concept solution is an iterative process that usually continues until a complete and unambiguous system solution is identified. Because of the iterative stepwise nature of the design process, it is best learned by doing. Thus, this is a project-based course given in a studio format.

In the real world, resources are rarely considered infinite, so the best engineering designers learn how to implement the design process using the most efficient and effective methods available. This course will teach you some of these methods. The ultimate goal in the engineering design process is to satisfy customer wants and needs, while reducing cost and time. Factors that influence the efficiency and effectiveness of the design process include teamwork and communication. You will learn about teamwork and communication in Professional Development 1 (PD 1) and use it in the context of your course project this semester. Engineers who know how to communicate effectively and how to work effectively with others are also more effective designers. Learning how to communicate in the context of the design process and learning how to work in a team environment are integral elements to this course.

The objectives of the course are to:

1. Develop student capacity to solve engineering design problems, while instilling the importance of creativity in developing innovative solutions.
2. Learn how to identify customer needs, establish design objectives, and translate these into engineering design specifications.
3. Exercise and improve important design skills of visualization, calculation, experimentation, and modeling.
4. Build skills in organizing people and ideas for successful design. These include teamwork, project management, verbal and written communication, and documentation.

COURSE ORGANIZATION AND SCHEDULE

This course will consist of two major phases. The first phase will involve a short "warm-up" mini-design project that is intended to familiarize you with the major steps involved in the design process. Each student will work on this project as an individual. This phase will encompass the first four weeks of the semester and focus on the design of a device that performs a simple measurable function. The second phase will involve a more complex system design project that will encompass the remainder of the semester. For this second project, teams will be organized into groups of four to six students.

The instructional aspects of the course will typically start with a short discussion on topics pertaining to design, sustainable engineering and/or ethics. Students are encouraged to bring up topics of interest to them in this context. Next, there will be a brief mini-lecture followed by a design studio where students will engage in exercises pertinent to the assigned project. These sessions may also include formal meetings between the design team, individual students, and your instructor. Your instructor will work with the team on their projects and help guide the team in the design process. Team members should come to meetings prepared to discuss their design work and assignments. On a day to day basis, your instructor may assign specific tasks to be completed by the team or by individual team members. **Students are expected to keep a laboratory book**. More instructions about it will be given in class.

This course also includes a professional development segment (PD 1) that meets weekly for 1.5 - 2 hours. This

segment is taught by the staff of the Archer Center for Student Leadership Development. A separate syllabus will be provided for this segment.

Guest Speakers and Dates in lighter Text

Time	Topics, Activities, and Milestones
Week 1 1/14,17	**Topics**: course introduction, review syllabus, an overview of the engineering design process. **Activities:** Introduce first project, which involves *the design of a simple device to save energy, save water, enhance natural lighting or improve air quality.* Project selections will be approved by your IED instructor. Students will be expected to build a small prototype for milestone one. **Special lecture: Using Library Resources 1/14** **Guest Speaker: Dr. Steve Breyman, DSTS, Sustainability, Th 1/17**
Week 2 1/21*, 24 *no class	**Topics**: Translating customer needs into engineering specifications, exploration of past work, competitor benchmarking, functional analysis. **Activities**: Students should identify and define the primary functional attribute for their design. What is the one thing that it must do? Quantify a target value or specification for the design. Is there a mathematical formula that can be used to make a prediction? How will the target design specification be measured? **Mini Project Proposal (1 page memo) Due 1/24.** **Special lecture: Writing a Technical Memo**
Week 3 1/28 1/31	**Topics**: Concept generation and selection methods, design communication and documentation. **Activities:** Students should develop a CAD model, system schematic, circuit diagram, or flowchart that clearly and accurately communicates their design concept. Students should prepare a **technical memo (less than 5 pages)** and an **oral status report** (2-3 minutes) that describes their design. **Guest Speaker: Dr. David Borton, MANE, Alternative Energies, 1/28, 3pm** **Guest Speaker: Dr. Sim Komisar, ENVE, Water Quality and Use/Reuse, Th 1/31, 3pm**
Week 4 2/4,7	**Milestone One:** Project design review presentations and performance evaluations. Students are expected to give an oral presentation and demonstrate that their design meets the target design specification as predicted. Students are expected to serve as critical reviewers of each other's work and will learn how to give and accept constructive criticism. **Tech Memo and Presentations due 2/4.** **Russ Leslie (Lighting Institute) Topic: Passive Heating, day-lighting, simple lighting solutions, 2/7 @ 3pm.**
Week 5 2/11,14	**Activities:** Begin work on project 2. Teams will be formed. The purpose of the project is to *design or retrofit a house with simple and economical materials like adobe or wood for rural families who live in the high-altitude areas of Peru (4000m above the sea level), where the minimum temperature can reach -20°C. Efficient use of energy and lighting as well as air and water quality should be stressed. These solutions will be implemented in the context of enabling this community's sustainable development. (Specific details about the target community will be given in class).* Each team should clearly identify potential customers, conduct a customer needs analysis, and perform a study of past work. Students will be provided a list of acceptable materials to use for prototype construction.
Week 6 2/19*, 21 *Tuesday	**Activities:** Project teams should establish design specifications, perform competitive benchmarking, and generate alternate system concepts. A decision analysis matrix should be used to evaluate the best system concept(s). Each team should be able to clearly describe the science and technology concepts that their system design will use. **Guest Speakers: Dr. Jan Fernheimer and Andrew La Padula. Topic: Writing using Wikis.**
Week 7 2/25, 28	**Milestone Two**: At this stage, each project team should have a clear system design concept to pursue. They should perform a cost analysis and project plan. The goal is to develop a scale model or prototype to evaluate the system concept. All **project plans** should be approved by the IED instructor. **Project Proposal Presentation Due 2/28.** **Conduct web-based (Elluminate!) in-class communication test, 2/28.**
Week 8 3/3, 6	Conduct design reviews to evaluate safety, environmental impacts, reliability, life cycle issues, maintainability, durability, manufacturability and cost.

	Written Project Proposal Due Th, 3/3.
Week 9 3/17, 20	Refine detail design and prepare for prototype build.
Week 10 3/24, 27	System prototype build, test, and debug
Week 11 3/31, 4/3	System prototype build, test, and debug **Elluminate! session; each team gets individual time with Peru collaborators.**
Week 12 4/7, 10	System prototype build, test, and debug
Week 13 4/14,17	System prototype build, test, and debug
Week 14 4/21, 24	**Milestone Three:** Conduct final evaluations and demonstrations of system design concept prototypes. Reflect upon the design process. How does engineering design impact people? What are the strengths and weaknesses of your design? How would you improve the design process steps that your team took? What are your recommendations for improvement? **Prototypes demonstrations Due 4/24 or 4/28 (to be decided).**
Week 15 4/28	**Milestone Four:** Submit design documentation. **Oral Presentations and Technical Memo Due 4/28 or during Finals week (to be decided).**
Week 16	**Finals**

Materials and Supplies: Students are expected to provide their own materials and supplies for their projects as needed. $210 deposit per team will be supplied by instructor for loan of core materials (the kit).

Grading: Grades will be based upon a combination of:

1. The quality of system design responses to the challenges and objectives of the overall course and individual projects. This includes both the breadth and depth of understanding and development that communicates the technical, economic, social, and environmental impacts of engineering design.
2. Willingness and ability to work in a team environment to explore existing and new approaches that present innovative and practical solutions for engineering system design problems.

Project milestones and the professional development segment of the course will have the following weightings that will culminate in the final course grade:

Individual Project: 25%
Team Project: ICF * 50%
Professional Development: 25%

ICF is the individual contribution factor assigned to individual members of a team. ICF for an individual member of a team may be less than, equal to, or greater than 1, but will have an average value of 1 for the team.

A grade of "A" indicates excellent performance in all aspects of the course including problem solving, design skills, creativity, teamwork, initiative, communication, leadership, and professional behavior. "B" indicates good work and a thorough understanding of the coursework. A "C" indicates a satisfactory achievement level of the relevant coursework. "D" and "F" indicate two degrees of insufficiency, the latter, of less than a passing level. While time and effort expended toward work often reflects positively in the quality of project results, it cannot be, in itself, a guarantee of a high grade. Students will receive feedback at the end of every major assignment in the course. Those not doing satisfactory work will receive a written notice with an evaluation of what steps might be taken to improve. Grading for the Individual and Team Projects will include grades for the lab notebook.

Attendance, Class Policies, and Academic Integrity:

Attendance at all class sessions is mandatory. A student may miss part or all of a session only if prior notice and acceptable reason is given. If a student misses more than two sessions, grades will be affected accordingly. Class presentations, criticisms, and discussions are essential to the development of ideas in the context of the design process. Missing an assignment or design review without an authorized excuse will result in a grading penalty. All work submitted for grading should represent the student's own effort. Work that builds upon the prior work of others should be properly acknowledged. Collaboration with other students is expected within the context of design development and on designated team assignments. Student should be mindful that the work they submit truly represents their own efforts. Students found submitting work for a grade that is not their own will result in course failure. If students are at all confused about the application of this policy, they should seek clarification from their instructor.

"Deep Collaboration" on Group-authored Projects.

Collaboration has long been hailed as a critical key to success in industry, the sciences, and composition studies (Bruffee, 1984; Lunsford and Ede, 1994); more recently, wikis have earned a reputation as collaborative tools (O'reilly, 2005). In our attempt to enhance your learning environment and experience, we (Drs. Fernheimer and Montoya) have devised a unique opportunity for you to use this tool to improve your writing and collaboration skills.

In this course, you are required to write several collaboratively authored documents (i.e., your Project Proposal and presentation, your Final Project Report and presentation). These requirements are the same for all IED sections. In this section, however, you are being asked to do at least part of the Final Project Report in a wiki designed specifically for our IED section.

For this assignment, we ask that you help us test the following hypotheses:

1) The overall quality of writing improves with the input of more people.
2) Deep collaboration improves the quality of writing produced by groups.

You will experiment with this process by engaging in deep collaboration on the wiki itself.

You might be wondering, what exactly do we mean by deep collaboration? *We are so glad you asked*.

Ideally, when students are asked to collaborate, they should work together at *each step* of the process—from idea generation, to research, to evaluating the research and resources, to organization of the material, to reworking the actual paragraphs within an essay, and then reworking the sentences within a paragraph in order to ensure overall coherence. During this "deep collaboration," students might argue or disagree over which organizational structure is more appropriate, which sources are most trustworthy, or even whose style is most appropriate for the given assignment. Yet, the very process of arguing about these elements helps each student to become more critically engaged with and aware of the material. Since each member brings different knowledge, experiences, and expertise, such discussions help the group as a whole to gain a more complicated sense of how others (who are not in the group) might receive or react to the final document. Clearly, this process is more deeply interactive and cooperative than the typical "divide and conquer" strategy most students tend to employ.

In other words, *this assignment asks you to work against your first impulse* to break the work into component parts and then assemble the pieces into one document just before it is submitted for a grade. Even though students tend to deem this second process "more efficient," instructors often feel that what is gained in expediency is lost in nuance or sophistication and overall quality of the project.

To give you some practice in "deep collaboration," we are asking you to complete this activity over the course of the next 15 days.

Activity

*For this exercise, you will **write** and **revise** the **Introduction** and **Benchmarking sections** of the **Final Project Report**.*

In this wiki-based activity, your group will work in a deeply collaborative way to create and refine the Introduction and Benchmarking sections for the Final Project Report. Each of you will be asked to contribute to the discussion and justify your choices. You will use the wiki to help you flesh out your discussion. The wiki will not allow more than one person to contribute at the exact same time, so we expect that this discussion will unfold over the course of the next 15 days.

Writing Guidelines

Successful Introductions should introduce the rationale for the project. First, you need to state what is the problem and why it is important; you should use appropriate references to make your points. This section should also include a quick overview of the format and scope of the entire report (to guide the readers through what they are about to read).

Next, in the Benchmarking section (this could also be a subsection within the Introduction) you will need to describe what others have done to solve this problem, describe what you are doing about the problem, and explain how your approach is better than or different from what others have done. Successful benchmarking sections should not only refer to how others have approached the problem but also discuss how successful these approaches have been and how appropriate or inappropriate their approach would be for your specific case/project. In other words, you need to critically engage with the literature and interpret/explain how the choices you made for your prototype design grew out of this literature.

Technical Instructions

1. Go to your group's section of the wiki, and create a new document. Invite all your group members to be "contributors" as well as your instructor, Dr. Montoya. You should also ask Dr. Fernheimer and Dr. Chi to be contributors. (While Professors Fernheimer and Chi will not make changes to your document, they will need access to your group's activities to complete their research.)

2. Name the document ---"Introduction and Benchmarking" if you are in Dr. Montoya's class.

3. There are two parts to this new 'collaboratively' authored document.

   The first part is *the "document" itself*—this is where you will compose the actual Introduction and Benchmarking sections.

   The second part is *the comments section,* which appears at the bottom of the document--this is where you will identify who made the revision (ex. Revision 4 by Jane Smith), and describe and explain the changes made.

Example: If you moved a paragraph, you will articulate in writing why you moved it and where you put it. If you made a lot of small changes, you will need to briefly describe why you made them. Example: "I changed all the commas to semi-colons, because they were being used incorrectly."

4. Each person will be required to make a significant contribution to both the document and the discussions taking place in the comments section. You should post some of your own initial ideas as well as ideas that directly engage with some of the writing or choices your peers have made. You may make both types of changes in a single "revision," but be sure to document what you did in the comments section below.

5. You may find it helpful to use the history/revisions to look back at the different versions of the document, as some people may introduce changes that get erased or incorporated into later versions of the document. You should refer to the versions by number and author.

6. Over the next 15 days, each group member should make at least 2 contributions. (You are welcome to make more, of course).

Good luck and have fun! Get deep!

References

Bruffee, Kenneth A. "Collaborative Learning and the 'Conversation of Mankind'". *College English* 46.7 (November 1984): 635-52.

Lunsford, Andrea and Lisa Ede. "Collaborative Authorship and the Teaching of Writing." *Construction of Authorship: Textual Appropriation in Law and Literature*. Ed. Martha Woodmansee and Peter Jaszi. Durham, N.C.: Duke University Press, 1994.

O'reilly, Tim. "What is Web 2.0? Design Patterns and Business Models for the Next Generation of Software." 9 January 2008. <http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/03/what-is-web20.html>

Survey I

All your information will be kept confidential! Thank you!

I. Please provide your demographic information below:

1. Your name: _____
2. Age in years: _____
3. Previous fields of study (engineering, business, humanities (e.g. linguistics, philosophy), mathematics, physical sciences, social sciences (e.g. economics, history, political science, psychology), others): _____
4. Experience in using wiki or related technologies such as blogs, discussion forums: _____
5. Ethnicity (American Indian, Alaska Native, Asian, Black or African American, Hispanics, Middle Eastern, Native Hawaiian or Other Pacific Islander, White, etc.): _____

II. Please provide your relational information with others below:

Name		**Please mark "1" in the corresponding cell to indicate those with whom you have met *before taking this class (not including yourself)*. Otherwise, please leave the cell blank.**	**For those with whom you have met before, how long have you known this person (number of years and months)?**	**For those with whom you have met before, how often (daily, weekly, monthly, occasionally, etc.) do you exchange messages *socially* through face-to-face meetings, emails or phone calls, etc.?**	**Please indicate below *how close* you are with *each person*? (4=very close, 3=close, 2=not so close, 1=distant)**
Anderson	Carl				
Aust	Ashley				
Bender	Sean				
Bottzauw	Rune				
Burns	Shannon				
Clapp	Ryan				
Culen	Matthew				
Dan	Edward				
Dy	Juliene				
Gerbini	Sandro				
Gilbert	Emmy				
Gillaspie	Trent				
Linard	Jonathan				
Moise	Amy				
Perkins	Alexander				
Pradhan	Jolly				
Pulvino	Eric				
Rosen	Rachel				
Sarnataro	Devin				
Toyama	Anthony				
Vancor	Thomas				
Wang	Yangyang				
Zummo	Peter				

Survey 2

Please answer the following questions. It will take less than 15 minutes.

1. How often (e.g., several times a day, several times a week) did you use the following means to communicate with each of your group members for the wiki project?
Group member 1 name:_____
a. Face-to-face during class _____
b. E-mail _____
c. Phone_____
d. Instant messenger:_____
e. Wiki: _____
f. Other, please specify: _____

Group member 2 name:_____
a. Face-to-face during class _____
b. E-mail _____
c. Phone_____
d. Instant messenger:_____
e. Wiki: _____
f. Other, please specify: _____

Group member 3 name:_____
a. Face-to-face during class _____
b. E-mail _____
c. Phone_____
d. Instant messenger:_____
e. Wiki: _____
f. Other, please specify: _____

Group member 4 name:_____
a. Face-to-face during class _____
b. E-mail _____
c. Phone_____
d. Instant messenger:_____
e. Wiki: _____
f. Other, please specify: _____

2. Have you collaborated online in other teams or elsewhere?
Yes No

3. Have you ever edited a wiki page before?
Yes No

5. Based on your experiences of deep collaboration, would you use this method again?
Yes No

6. I felt that I could rely on my group members without any fear that they would take advantage of me in this project.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

7. My group members and I formed a cohesive team.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

8. I felt obligated to undertake some activities and tasks to fulfill the expectations of the group.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

9. My group members kept promises they made to our group.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

10. I am confident that my group members valued my contributions to our team project.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

11. I valued the insight that my peers brought to this project.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

12. My group members and I reached consensus on the final essay easily.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

13. All group members contributed to this project equally.
1=strongly disagree 2=disagree 3=neutral 4= agree 5=strongly agree

14. Did you send more or less time than you expected reviewing comments?
1=much more 2=somewhat more 3=about what I expected 4=somewhat less 5=much less

15. My group members and I engaged in debates and discussions using the wiki.
1=very regularly 2=somewhat regularly 3=neither regular or irregularly 4=somewhat irregularly 5=very irregularly

16. My group members and I engaged in debates and discussion outside of the wiki (e.g. face-to-face conversations, emails, chat, etc).
1=very regularly 2=somewhat regularly 3=neither regular or irregularly 4=somewhat irregularly 5=very irregularly

17. How satisfied or frustrated were you with the amount of effort needed to get the wiki running properly?
1=very satisfied 2=somewhat satisfied 3=neither satisfied or dissatisfied 4=somewhat dissatisfied 5=very dissatisfied

18. Overall, was your experience with this wiki positive or negative?
1=very positive 2=somewhat positive 3=neither positive or negative 4.somewhat negative 5=very negative

1. 19. How did your team divide group tasks and labor?

What was your role?

How did the wiki support you in this role?

20. Please list a few words that describe your overall experience using this wiki.

21. Please list a few words to describe the collaborative process.

Follow-Up Wiki Phone Survey

Purpose

This survey is part of a research grant by Janice Fernheimer PhD (Language Literature and Communications) and Lei Chi PhD (Lally School of Technology and Management). The objective is to improve the use of educational technologies in the classroom. Thank you for agreeing to help us with this research.

Script

Hi my name is _____. I am calling to ask questions for the follow-up wiki survey in _____ class. Your participation will be rewarded with a free lunch at the faculty/staff dining hall.

This survey will take only 15 to 20 minutes. We appreciate your time and willingness to answer these questions. Is this a good time to talk?

If yes, thank you for participating in this project.
If no, what time is better? _____

Was this wiki easy to use?	Yes No
Have you used wikis before?	Yes No
Did you personalize the wiki?	Yes No
Did you feel this software was effective?	Yes No
Did you edit other team member's work?	Yes No
Was your work edited?	Yes No
Did you know your group members before the project started?	Yes No
Did knowing team members affect the way you collaborated? How?	Yes No
Did (knowing, not knowing) group members make the group more or less productive?	Yes No
Would you recommend using this wiki for future projects?	Yes No
How do you think that using a wiki for collaborative projects could be made more effective for future students?	
How did the wiki help facilitate communication?	
What kept you from using the wiki?	
Describe your role in the project? (e.g. group leader, area expert) How did the wiki support you in this role?	
How did you negotiate project roles within your group?	
How did your group respond to your contributions in the comment section?	

How did the wiki make it easier or harder to justify your position?	
Do you think the wiki is a good place for deep collaboration? Why or why not? How did using the wiki affect your group's collaborative writing process?	Yes No
What types of group projects do you think the wiki is best suited for? Semester -long group research project? creating group presentations? short group essays? (short = 2 weeks)	Yes No Yes No Yes No
Do you think a wiki could be useful for group research?	Yes No
Would you recommend using deep collaboration for future projects?	Yes No
What type of projects do you think deep collaboration is best suited for? semester-long group research project? creating group presentations? short group essays? (short = 2 weeks)	 Yes No Yes No Yes No
Do you think the wiki would be better suited to distance students? If yes, why? If no, why?	Yes No
What other ways do you think distance students would use other ways to discuss collaborative class work and issues?	
Did you debate/ discuss the project outside of the wiki?	Yes No

If yes, what did you debate or discuss?	
The wiki was designed to support short statements and encourage on-going dialog amongst users. Did the wiki live up to this role?	Yes No
How does the final project reflect your abilities?	Very Well Poorly
How would you make this exercise (use of wiki for writing a report and for deep collaboration) more effective for the students in the future?"	