

## Integrating Critical Thinking and Writing Curriculum into Freshman Engineering

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### Abstract

Being able to use critical and analytical skills, as well as the ability to communicate this thinking, are essential to people in engineering. At the University of Hartford, three faculty members from introductory engineering courses, and three faculty from the freshman writing program teamed for fall 2000 to develop engineering and writing classes that actively and deliberately overlapped. Classes were organized around a list of shared outcomes and shared activities developed during a series of workshops. Based on these shared outcomes, each team developed areas of specific content overlap and then developed shared, supporting activities.

This paper will discuss how shared outcomes and activities were developed, the progress of these classes through the semester, what we were able to achieve, and which elements looked good on paper but didn't work in practice.

### Introduction

Faculty teams at the University of Hartford have been developing Freshman Interest Group (FIG) classes since 1996. With funding from a National Science Foundation (NSF) grant, faculty in two departments, the College of Engineering and the Freshman Writing Program (Rhetoric, Language, and Culture, College of Arts and Sciences) undertook the challenge to more deliberately and creatively integrate the required freshman writing course and required introduction to engineering course. These faculty members began working together a little more than a year ago to integrate writing skills and engineering skills in the freshman curriculum.

Rhetoric, Language and Culture (RLC) 110, a required freshman course at the University of Hartford, teaches students critical thinking, reading, and writing skills. RLC 110 uses a three-part curriculum that helps students discern perspectives that are present in texts. The course also teaches students to analyze how these perspectives influence issues over time (historical analysis) as well as in a current context (culture analysis).

Engineering Science (ES) 141 is a freshman orientation course that introduces the engineering approach to solutions of problems of current interest. Students explore different fields of engineering through guest speakers, field trips, and research. They engage in basic design projects, report writing, and also learn relevant computer technology such as computer generated

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graphs and web pages. Both RLC 110 and ES 141 are three semester credit classes and meet either three times per week for an hour or twice a week for an hour and a half.

The RLC department faculty taught part-time and also worked as consultants, corporate writers, or technical writers. One faculty member was also serving as interim director of the department's professional and technical writing program. The engineering faculty consisted of three full-time faculty, one each from biomechanical, electrical, and civil engineering.

### **Integrating Introductory Courses**

At first glance these courses would seem to have relatively little in common. They do, however, have a shared desire for engineering students who can think critically and write at an appropriate level of literacy. Another area of shared concern is to have students understand the importance—especially in the workplace—of technically sophisticated people who can communicate effectively, not only with peers but with nonexperts.

To begin this effort, faculty from both departments met in a series of summer 1999 workshops funded by NSF to discuss course content and develop possible areas of intersection. We had the model of Integrative Learning Blocks<sup>1</sup> as well as excellent support and training from the University. Over the summer each faculty member developed a list of six desired outcomes shared by both classes. At the end of each course, students would demonstrate the ability to:

1. Communicate technical information in written and oral form in a professional manner appropriate to the workplace and the classroom
2. Manage and process information in a variety of contexts and situations
3. Gather, analyze, and evaluate data from a variety of sources, including interviews, library materials (books and journals), and on-line sources.
4. Organize and manage tasks regarding personal and professional development.
5. Be aware of university resources and use them.
6. Work independently as a member or leader of a small group that performs a variety of writing and analytical projects.

A few outcomes unique to either the writing and engineering courses were not shared. We agreed that each course could also support unique outcomes (for example, exploring professional engineering activities or completing a basic engineering design project) without endangering the shared curriculum.

From the above list of shared outcomes, the three faculty teams developed a worksheet, consisting of a four-column table: week of the semester, RLC 110 syllabus/agenda and required activities, ES 141 syllabus/agenda, with a blank column in the middle. As we listed our usual course content, we discussed what the activities and objectives had in common. Then we began filling in the middle column: Content Overlap and Possible Shared Assignments.

At this point we were still brainstorming, but we tried to think of overlap from every possible angle. From this list, we began narrowing our choices, and assigning them a number from the outcomes list. Our goal was to cover these objectives more than once during the semester, with

an eye toward shared activities that overlapped in numerous areas, thus deepening the integration. The table below shows plans for weeks two and twelve:

Week	RLC 110 activities	Content Overlap/Shared Assignments	ES 141 activities
2	Continue analyzing essay, “Why Should My Conscience Bother Me?”: analyze reasons for different perspectives in a conflict (cultural analysis)	<u>Shared activities:</u> group discussion of ethical dilemmas in engineering. Brief library exercise (getting familiar with library’s online catalog). <u>Shared outcomes:</u> appropriate professional communication (1); critical and analytical thinking (2); understand university resources (5)	“What’s engineering?” exploration of different engineering fields. Guest speaker: Cost vs. safety and ethics.
12	Prepare for town meeting exercise: stakeholder groups meet and share research results; practice presentations; set criteria for effective PowerPoint presentations and oral presentations	<u>Shared activities:</u> group discussion of waste management technologies available; research the pros and cons of each technology; generate bibliography; generate group profiles and revise “expert” resumes <u>Shared outcomes:</u> goal oriented writing and professional communication (1); critical and analytical thinking (2); gathering data and note taking (3); active class participation (4)	generating graphs on computer; using PowerPoint; researching technology on the Web; analyzing data

### Putting the Plan into Action

The semester got off to a rather slow start, due to a registration error that had students assigned to the wrong class sections and times. Once that was straightened out, the students in their appropriate classes, we began putting our plan into action.

What we quickly learned was that although students knew the classes were paired, they were not particularly proactive in making the connections—even when it was obvious to the faculty how much overlap we had created. We found that we needed to reinforce the connection constantly—if we didn’t, the students paid little or no attention. For example, even though most of the content in week 2 concerned ethical dilemmas faced by engineers, students did not transfer their analytical framework from RLC 110 to the issues raised by the guest speaker in ES 141.

This also held true for shared writing assignments. Students tend to see writing in a fairly compartmentalized way<sup>1</sup>. We noticed that our students were particularly adept at separating writing tasks into two mutually exclusive categories: real and not real. Real writing is anything clearly connected with “becoming an engineer.” Anything else (as in all “English” courses) falls into the “not real” category.

Because of this, students are somewhat resistant to connecting the writing skills required for an RLC 110 thinking/critical analysis paper—for example about the trial of Galileo—with the writing skills required for an engineering report. Both types of writing require assessment of data, problem-solving and analysis, and writing for a particular audience. However, even though we used more technical subjects, students often struggled to see the link.

Thus as the courses progressed through the semester, we realized we needed to emphasize the connections more than our original class plans had indicated. In most cases we added brief shared assignments (for example, writing a resume and cover letter for ES 141, then bringing the draft to RLC 110 class to evaluate and discuss). Faculty also tried to be more visible as a team, stopping by each other’s classes, asking students about what was going on in the paired class, and so forth. This and the shared projects helped break down the students’ compartmentalizing of their writing tasks, although the struggle is by no means over.

Another way we emphasized connections was through guest lectures by the RLC faculty. All ES 141 class met jointly each Friday to discuss a topic of current interest or to hear a guest speaker. For three of these sessions, the RLC faculty used case studies and examples to illustrate their technical writing work in various industries. In these lectures and accompanying student exercises, we emphasized how the skills students were learning in RLC and ES classes were also essential to success in the workplace.

We also learned that we had significantly underestimated the faculty time required to keep the classes moving along in sync. The three faculty teams used different methods but at an end-of-semester briefing, we all agreed that for best results, faculty most likely needed to meet weekly or every other week to achieve the best integration of these courses. We also feel that a number of classes need to meet jointly, with both instructors present in the classroom—something we were not able to do a lot this semester because of scheduling incompatibilities. One future goal might be to have a joint syllabus, which could resemble the shared activities worksheet that we developed during planning.

### **Discussion: Some Activities that Worked**

During the first few weeks of class, we realized that our initial worksheet of outcomes was rather ambitious and most likely not achievable with the current set-up. As we regrouped, we agreed that each team would focus on building a significant shared project. Following are brief discussions of representative integrated projects.

**Ader and Alnajjar.** The RLC 110 theme was “Defining America.” The final assignment for the semester was a group research project and presentation on an invention or structure that in some way was emblematic of American life. One group of students chose the computer. Each member

of the group then selected a particular facet of the invention, researched that aspect, then wrote a 4 to 5 page paper on it. One student, for example, focused on its history—from the punch card program of the Jacquard loom, to the room-sized Eniac, to the laptops and palm pilots of today. Another explored artificial intelligence.

Ten sources were required for the research paper, including at least one interview and one professional journal. The sources were divided into Works Cited and Works Consulted, and proper citation format was expected. Students were also required to balance on-line and hard-copy sources and to evaluate their reliability.

The group then created a group presentation that would enlighten the class on the importance of the larger topic—in this case, computers. Using a camcorder, the group interviewed staff and students across campus regarding their views on computers for work, recreation, and school assignments. The resulting film footage was then interspersed with clips from the movie *The Matrix* to contrast the convenience of computers with their dangers. In every group students were encouraged to evaluate an issue from a variety of perspectives, to support their conclusions with reliable evidence, and to develop a creative and persuasive method of communicating their findings.

**Richards and Adrezin.** The first assignment for the semester involved having students read an article about a young engineer's ethical dilemma—being asked by his employer to falsify test results about a crucial project. Students in the RLC class developed a series of written responses to this article, and the ES 141 class invited a guest speaker on ethics to discuss the dilemma in more detail. As noted above, students initially struggled to connect the ethics issue in the article and the ethics issue presented by the guest speaker. However, they did identify strongly with the article, which they saw as relevant (one of the article's protagonists was a just out of college engineer, pitted against the narrow minded senior engineer and other managers).

For the final project, students engaged in mock debate/town meeting. Students were assigned roles in OurTown, Connecticut (townspeople, business investors, government regulators, municipal officials) and were required to research the pros and cons of augmenting OurTown's nearly full landfill with a batch incinerator. Students were required to research text and online sources from varying perspectives and evaluate the sources' reliability. The exercise culminated in a town meeting in which each constituent group gave a PowerPoint presentation, explaining the group's "vote" about the incinerator and displaying the evidence the group had gathered. A number of students, in their final write up of this exercise, noted how the power and conflict dynamics were quite similar to the ethics discussions from the beginning of the semester—indicating that they perhaps made some deeper connections after all.

**Tempel and Isaacs.** In an effort to encourage students to actively work to overturn stereotypes of engineers, this team developed a final project that asked small groups of students to develop and present pilot episodes of a hypothetical television drama that would deal with engineering issues. Students were asked to develop plots that were grounded in former or likely engineering conflicts or challenges. In addition, the assignment asked them to create casts of characters consisting of different types of engineers from diverse backgrounds and to write a credits section

using library and online engineering resources. The projects were presented orally and accompanied by written treatments.

The presentations were quite interesting and students reported that they enjoyed the creative flexibility the project provided. The four pilots dealt with different areas of professional engineering: the first group addressed the ethical conflict of negligent product testing in an automotive environment; the second dealt with civil and environmental engineering conflicts when developers wish to build on wetlands; the third was about a narrow minded senior engineer who had difficulties dealing with woman and minorities in the workplace; and the fourth project concerned the heroics of biomedical engineers and their lifesaving creativity.

### **Student Evaluations of the Courses**

We surveyed students at the end of the semester, asking a series of open-ended questions about what students felt they had learned, their sense of how the classes worked together, and their evaluation of their skills as writers and thinkers.

The RLC survey responses were positive overall. Most students stated that they had found the class challenging and were more conscious than before of the overlap between thinking and problem solving done in engineering and thinking and problem solving as a component of good writing and communication. A number of students commented how for the first time, they could see how writing courses “fit” into their curriculum—and that the skills learned were applicable outside the writing classroom. Interestingly, when asked what could be done to improve the courses, about 75% of students asked for more shared projects and more shared class time.

The Engineering survey responses were very positive. Students indicated that the FIGs were successful as far as their progress in achieving the expected outcomes of the course and in doing well and enjoying the course. But what is most interesting is their view on the connections between the two courses. About 80% indicated that they see a strong connection, which is a large improvement from a year ago before the FIG. Also, about 75% reported that the FIG between the two courses helped them to learn and understand the material in each of the courses. (The survey was developed by the NSF-Grant Internal Assessment Officer, who is on the faculty in the Business School).

The only consistently negative response was that students dislike the perceived loss of control over their schedules. They know that students in sections that are not joined have more choices of class times.

### **Conclusion**

The shared writing and engineering classes are just beginning, and we have a number of areas that need increased coordination and connection, such as integrating a wider range of projects and allowing sufficient time not only to plan but to implement. We also feel that best integration may occur by scheduling class times back to back, so that both instructors could be present, and the entire block of time devoted to shared projects.

On the positive side, all the faculty members were pleasantly surprised at the students' responses and insights. While we allowed for a certain amount of end of term euphoria, our informal conversations corroborate the survey results—students enjoyed watching professors work together, and felt that their time spent in an “English” class was more clearly connected with their ultimate career goals.

These combined classes are a significant step forward in meeting our objectives: helping engineering students become flexible critical thinkers and effective communicators and writers.

### **Acknowledgement**

This work was supported by a grant from NSF, Grant # EEC-9872433, the University of Hartford and the Engineering Application Center at the College of Engineering.

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### **Biography**

Beth Richards, (M.A. Georgia State University) teaching in the University of Hartford's Rhetoric, Language and Culture program. She currently directs the University's Professional and Technical Writing program.

Hisham Alnajjar, Chairman, Associate Professor of Electrical & Computer Engineering & Assistant Dean, College of Engineering. B.S.E.E., Aleppo U., Syria; Diploma in Power Systems, Damascus U., Syria; M.S.E.E., Ohio U.; Ph.D., Vanderbilt U. Major interests: fault monitoring of power transformers, target detection & Estimation, DSP Software & Hardware & Speech recognition. Prof. Alnajjar is the director of the freshman year at the COE under an NSF Grant.

Andrea Brick Ader, (M.A.T. English/Teaching, Rhode Island College, B.A., Duquesne University) teaches Rhetoric, Language and Culture, focusing on defining America and technology. She has been writer, event, planner, and public relations consultant for the Quinebaug-Shetucket Heritage Corridor, Quiet Corner Tourism District, YWCA Camp Aya-Po and other non-profit organizations. She also served as Executive Director of Connecticut's Olde Towne Tourism District and Coordinator of Membership and Information Services for Hartford's Downtown Council.

Ronald Adrezin, Assistant Professor of Mechanical Engineering at the University of Hartford. He received his B.E. and M.E. in Mechanical Engineering from The Cooper Union in 1986 and 1987, and his Ph.D. from the Mechanical Engineering Department of Rutgers University in 1997. Dr. Adrezin has been teaching at the University of Hartford for three years, and prior to that he was managing director of a company performing medical research with NIH and various other facilities.

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Patricia C. Tempel, (M.A. University of Chicago, A.S. Wesleyan University) teaches in the University of Hartford's Rhetoric, Language and Culture program; her areas of concentration include technology and culture. She is the author of LEMON ICE (fiction) and has been a public relations consultant for 25 years.