

Multidisciplinary Courses: Facilitating Win-Win Opportunities Across Departments and Colleges

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“The advances in technology and changes in the organizational infrastructure put an increased emphasis on teamwork within the workforce. Workers need to be able to think creatively, solve problems, and make decisions as a team. Therefore, the development and enhancement of critical-thinking skills through collaborative learning is one of the primary goals of technology education.” — Gokhale (1995)

“All teachers think about what happens in the classroom, but these thoughts are largely undocumented and unreported.” — Myers (1985)

Introduction

For the past four years, the College of Engineering and the College of Arts and Sciences have participated in offering a multidisciplinary senior design course. The primary departments collaborating in this effort are the Departments of Industrial Engineering, Mechanical Engineering, and English. Secondary departments have included Computer Science, Business, Electrical Engineering and Engineering Technology. The course, as well as course design, have been positively recognized by a number of external sources. These sources include:

- ABET (Accreditation Board of Engineering and Technology)
- ASME (American Society of Mechanical Engineers)
- Industry advisory boards
- College and departmental academies
- Industrial grant awards
- Publications in journals and in conference proceedings
- Conference presentations by the course faculty.

From the students’ perspective, assessment of the class has been extremely positive. Many students point to a direct correlation between their work in this class and job or internship offers from employers. They also mention a new understanding and respect for the expertise of those outside as well as inside their own disciplines. In addition, three primary faculty coordinate and direct the class, yet in any given semester there may be up to twenty additional faculty or industry sponsors that ultimately work with student design

teams. In all of these cases once again, the response to the experience has been overwhelmingly positive.

Yet the mechanics of offering a multidisciplinary course, especially when different colleges on campus are involved, can be daunting. Institutional barriers involving everything from class scheduling to faculty course loads increase the complexity of offering this type of learning experience (Park, Riley, & Wojahn, 2002). In spite of the challenges of offering this course, our efforts have overcome many of the barriers outlined in earlier articles on the class (Park et al., 2002; Wojahn, Dyke, Riley, Hensel, & Brown, 2001; Dyke & Wojahn, 2000). In identifying and addressing challenges and assessing the course, we are even more convinced that our efforts—and our research focused on these efforts—add value, not just time, to the technical communication and engineering educational process.

To explore this value as well as identify areas to strengthen or improve, we have turned our attention to the classroom and the impact of decisions we have made to date. As Myers (1985) states in his book on teacher-researchers, “All teachers think about what happens in the classroom, but these thoughts are largely undocumented and unreported” (2). One of the primary reasons for this is that teacher-research does not seem to garner the same respect in the academy as do other types of research (Bissex & Bullock, 1987). As a result, according to Bosley (1992), “new curricula often come into existence haphazardly like the growth of cities” (41). However, the success of both curricula and cities is “contingent on understanding the needs of the community and assessing how those needs will be met” (41).

If we believe in the importance of educating our students, extensive assessment of our teaching processes and their results are required. Ochs, Watkins, & Boothe (2001) describe a three-tiered assessment process for reviewing a program such as ours. This process begins with descriptive evaluation “in which the planning process, project implementation, and outcomes are documented and reported on an annual basis” (582). We have documented the annual review of our course in presentations and publications in venues across our disciplines. In the next stage, the “operational evaluation,” we will document for and report to administrators the identified strengths and weaknesses of the program so that administrators can make informed decisions to help solve problems and to “provide continued support” (582). Finally, the “outcome evaluation” will assess the impact of our multidisciplinary effort on the university itself (582).

As faculty within a multidisciplinary collaboration, we have already made an immense effort not only to think about our pedagogy but to document, analyze, report, and improve it, taking the best from each of us as teachers and from research in our respective fields to create a new and positive type of learning environment. To continually improve, our learning environment has a research agenda immersed within it. We see the education of our students, engineers and technical communicators alike, as an important gap in widespread discussion of our fields. We turn our attention away from the practiced professional world and look instead to the education and development of learning in the professions.

We already know that students do not necessarily learn when we tell them “just do it.” Putting our diverse student populations in the same room at the same time is not the same as teaching them to work effectively on multidisciplinary teams. It is not teaching them to communicate effectively or to value what other disciplines and individuals can bring to the team effort. Committed to helping our students learn and actually benefit from the multidisciplinary situation they find themselves in, we share some of our initial analyses from the perspective of teacher-researchers.

Course Background

The class teams Industrial Engineering students, Mechanical Engineering students and Technical Communication students to work on a specific design project sponsored by a client or a competition. Based on a common focus on the design process and projects, we dubbed our course this year MULTI-SYDED, for “Multidisciplinary Synergy in Designing Disciplines.” In Spring 2002, we drew 91 students from six courses: ME 426 (Senior Engineering Lab I), ME 427 (Senior Engineering Lab II), IE 480 (Industrial Engineering Senior Design), ENGL 399 (undergraduate internship), as well as ENGL 449/549 (Publications Management/Practicum).

The overriding objective of the class is for students to participate fully in a multidisciplinary, team-oriented design project. This type of project is similar to those that are commonly found in industry, projects that are addressed by cross-functional employees working together to share the range of specializations (e.g., engineering, writing, managing, marketing) required to make given projects successful. In addition, the course specifically responds to employers’ and past NMSU engineering graduates’ feedback concerning the skill sets they consider necessary for success in today’s workplaces. In the College of Engineering ABET 2000 assessment, alumni indicated that our programs require more emphasis on: 1) multi-disciplinary design team experiences; 2) all forms of communication skills; 3) development of a global perspective of the design process; and 4) large-scale project planning and management (Riley & Pines, 2000; Riley et al., 2000). This course responds to that specific feedback.

Another course objective is to allow students to realize and apply various tools and skills they have learned over the course of their college careers. In entering this course, students should be nearing the end of their college education and should have been exposed to a number of topics and tools from their specific fields. The teamwork requires that students reflect on and tap the individual and disciplinary strengths they can bring to a project. We see the exposure to synthesizing and applying these tools and skills appropriately as just the beginning of a life-long learning process.

Other objectives include prompting students to do the following:

- to gain experience as an IE (Industrial Engineer), ME (Mechanical Engineer), or TC (Technical Communicator) within a design and development group
- to understand and then transform a client’s needs or competition goal into a tangible project design

- to understand the formal engineering design process with emphasis on concurrent engineering procedures and effective team and client communication during production, delivery, and sustenance of a product or system
- to become proficient in preparing and reviewing all components (including materials selection; notes & writings; sketches & drawings; simulations, tests & models) related to a completed project design
- to synthesize information and develop effective communications explaining the results of the design process in informal and formal reports and presentations
- to learn how to communicate specialized technical information *to* those with other expertise and to grasp the specialized information *from* those with other expertise
- to see value in alternative ways of approaching issues, thinking critically, and problem-solving
- to experience the value of early starts, careful planning, constant team interaction, and *positive* interpersonal communications under typical deadline standards
- to prepare for life as an Industrial Engineer, a Mechanical Engineer, or a Technical Communicator.

As anyone who has led a course knows, these objectives are easier said than done. Center stage in our efforts is the concept or process of design itself. In his text on engineering design, Dieter emphasizes that “the ability to design is both a science and an art” (1). As such, we believe it must include some combination of creativity, technical or specialized knowledge, ethics, marketing assessment, benchmarking, awareness of human factors and needs, and a range of capabilities that no single discipline can provide. As Dominick, Demel, Lawbaugh, Freuler, Kinzel, & Fromm (2001) state, “Design, as a motivator, [a] facilitator, as well as an area of study, has had an important impact” on achieving many of the educational goals in engineering (and, we would add, technical communication) education today, allowing

- “the supporting knowledge base of unified and connected science and math concurrently with engineering”
- “the integrative and professional aspects of the engineering process”
- “the importance of communication skills, teaming, and leadership skills with multidisciplinary emphasis”
- “the use of technologies to enhance the educational process” (vii-viii).

To see the value of attempting these objectives, it is the students’ performance and reflective comments that we turn to next. In our discussion below, we include our own assessment as well as the perspectives of students to consider the extent to which we are meeting our objectives along with these goals, aspects that we believe provide a “win-win” for all colleges and departments involved.

A Win for Mechanical Engineering

When Mechanical Engineering Academy (MEA) members visit our New Mexico State University campus, we ask them to review the multidisciplinary design projects in progress. The students give presentations on their early, interim products to the MEA, people who are accomplishing—or have accomplished—many of the professional goals

our students have set for themselves. The MEA committee usually suggests that we give students just two days' notice for presentation preparation. This is a typical industrial/government situation where unannounced briefings are often required. The MEA members typically report being impressed by students' presentations and projects; they offer suggestions along with critique for each student group. The MEA members recognize our multidisciplinary effort and achievements, with one member stating that the MEA now thinks that reviewing student presentations and speaking with our students has become "one of the best parts" of their annual campus visits.

Mechanical Engineering students themselves suggest that they are beginning to see the course as realistic and beneficial:

- "[It] felt like we were in a work environment."
- "This course is worthwhile. It created [a] fairly realistic environment in the engineering field."
- "Good course - very informative and beneficial to engineering experience."

Mechanical Engineering students also report learning through this course to work with others as a team in a reflective rather than haphazard way. Their comments reveal their understanding of the necessity of this type of collaboration:

- "It [this course] taught us to learn to work with others and work as a team."
- "Fun class[;] good group learning skills."
- "Good project/group management opportunity!"
- "Team cooperation is important."
- "It builds team work and presentation skills."

Many, though not all, students recognize the value of multidisciplinary work:

- "Keep course forever as requirement with IE, ME, and TCs."
- "... multidisciplinary work is very valuable for [the] real world."
- "It allowed students to experience real world group projects and working with other disciplines."
- "All types of knowledge allowed [us] to focus on what was important."
- "It gives us experience in the design process, and [in] dealing with other people outside our field."
- "This class modeled the real-world interaction between disciplines and clients."
- "It familiarizes one in working with multidisciplinary groups."

These positive perspectives exist even among students who acknowledge they would find it easier (though not necessarily better) to be left alone to work with their tools and to build the projects they are assigned. The multidisciplinary team- and client-based nature of the course allows for not only the hands-on, active learning approaches typical of engineering design courses (see, e.g., Finelli, Klinger, & Budny, 2001) but also the critical reflection required to create and make optimal decisions amidst people unfamiliar with mechanical engineering.

A Win for Industrial Engineering

Of all of the discipline specific areas of engineering, Industrial Engineering seems to be the least understood. In contrast to other engineering disciplines, Industrial Engineering is far broader in its application areas and possesses far more career paths for its graduates in comparison to other engineering areas. An Industrial Engineer may work for EPCOT in people flow modeling and traffic optimization, or work for a major airline in airplane network scheduling or work for Intel as a quality control engineering on a manufacturing line. Industrial Engineers are hired into all sectors of industry and government. Since this is the case, Industrial Engineers are trained in a number of engineering, mathematical and computer tools that are transferable across multiple work environments and engineering problems.

Comments from the Industrial Engineers on the benefit of the class generally involved two different threads. The first thread reported by the Industrial Engineering students highlighted the sense of new respect they felt when other engineers (document and mechanical) really understood what they did. The mystery surrounding the work of an Industrial Engineer was unveiled and comments such as the following were mentioned in assessment instruments:

“I really feel that I am more respected now after this class experience. Even though we have spent the past six years getting our degrees [only] 100 yards away from each other, the mechanical engineering students had no idea what Industrial Engineers do. The group design project showed them how valuable we are to designing a complex mechanical device. One of our group members even said that he wished he had majored in IE instead of ME after the course concluded.”

Another not so reverent student reported that she learned to value her own disciplinary expertise more:

“Finally, the Mechanical Engineers figured out that we had so much to add to the design process. If we had gone with their original design ideas, the product could never be manufactured, never be profitable, never meet quality specifications, and would probably seriously harm an individual using it because no safety measures were considered. Too bad they didn’t learn this earlier in their studies.”

The second thread of comments from Industrial Engineers focused on the benefit of having “Documentation Engineers” from the English Department on the design teams:

“It helped me so much in my own understanding of the process to have to explain it to the document designer. By the end of the semester we were all talking the same language. The English major was as well-versed in engineering speak as we were in discussing audience, purpose and style.”

“I don’t know who got more out of the class experience, the engineers or the document specialists. All I know is that collectively, we all benefited far more together than if this were a single discipline course. Working in teams, designing and writing together, it is exactly what I saw when I did my coop at Intel.”

Such students suggest that the course reflects some of the most positive aspects of organizational environments outside the academy, particularly the opportunity to learn from and share with those who have different educational backgrounds as well as to create something that would not otherwise be possible to produce.

A Win for Technical Communication

As Roger Grice (1997), formerly an IBM information developer and now an instructor of both electrical engineering and technical communication, explains, “I never knew a person who failed as a technical writer because of comma splices” (209). Grice lists a number of factors that may contribute to the failure of a technical writer (we would argue that the very same factors apply to engineers as well):

- (1) “Lack of understanding . . . products or processes . . . or . . . how audiences” will use those products or processes
- (2) Collaboration strategies not leading to the acquisition of “all needed information and perspective”
- (3) Attitude that their job is a “‘solo act’ rather than . . . a part of a team effort.” (210)

The multidisciplinary, team-based nature of our course demands that students begin to develop these less tangible aspects of success and satisfaction in their professional lives. At the point of the capstone design course, the question isn't so much whether students know how to communicate (or to engineer) but whether they know how to do so in a context with people with diverse backgrounds, motivational levels, and expertise. In other words, they can communicate or engineer, but can they communicate or engineer outside of a course text or simple classroom assignment? Do they have the mindset and attitudes to gain and maintain employment in their chosen field, communicating, working, and writing with people who know more—and who know less—than they do about the topic about which they are communicating?

On the first day that our course meets together as a multidisciplinary class, student reactions are sometimes unnerving. For one thing, students from the humanities fields are not used to being surrounded by an auditorium filled with many technically oriented male students. They are not used to working on technical design projects headed by faculty who are not from their discipline. They are not used to working on design projects for local and national clients with whom they must communicate. They are not used to being involved in national design competitions which require them to help build and sometimes train for running or even riding a new contraption.

On one first day, a young female English undergraduate came to the faculty after class with tears in her eyes, stating, “I have no idea what this is. I have no idea what we are doing.” We asked her to be patient and to trust that she would understand her project, her team, and her roles in time. We suggested that almost all students were feeling similarly apprehensive, though not all were showing it. We brought her to the student team leader and asked him to sit with her and spend some time discussing the Department of Energy

project they would be working on as well as how the team would be meeting weekly and what the nature of the meetings were likely to entail.

One main issue here is that in most of courses English students take, they are asked to write and communicate with their audience and purpose in mind as driving forces to their written and spoken correspondences. But addressing one's audience and purpose when they are imaginary is a whole other thing than meeting with a true audience, the client or the competition judge, and making a case for one's work. This opportunity to work with those with other expertise, to discover and apply one's own expertise, and to do so in the context of a project with a real audience is an immense benefit for students from the English Department. A few months after graduating, one alumni English MA student went so far as to argue in a follow-up email that the class is "the foundation of the current Technical Communicator program." He states, "Your class may be the only one like it in the country, and I think the class is ground breaking. . . . I am willing to argue that if one [were] comparing two technical communicator degrees (one which had your [multidisciplinary] class and one that did not have the class), the degree with the class would win without a contest."

Another English alumni, the former undergraduate who on the first day of class had been extremely troubled with the multidisciplinary nature of the course, sent an email over a year after she graduated, stating, "It took a while but I just wanted to let you know that I finally found a job with the largest engineering firm in the N[orth]W[est]. . . . The company is very well-organized and friendly. I wanted to thank you for putting in so much extra effort to help make my last semester at NMSU a wonderful learning experience. The . . . class not only offered me a chance to learn document design, but an even greater opportunity to learn how to work professionally with engineers in the workplace."

A Win for All

Many students across the disciplines report using their design packages and reports for job interviews. In the past, most of these students would never think of constructing a portfolio or bringing samples of their work to job interviews. However, after this class, more and more students relate that they start every interview for a co-op or with a potential position by displaying a copy of their design documents created from the class. Furthermore, a standard question in job interviews is: "What types of experiences have you had on multidisciplinary teams?" Our multidisciplinary design class provides a range of topics and material for addressing this question. Industrial/government people report being pleased with candidates' multidisciplinary experiences and having confidence in students' future success because of their cooperative attitudes.

Now in its fourth iteration, the multidisciplinary capstone design course continues to keep us locating new areas for research and innovative ways to improve upon past challenges. As Ochs et al. (2001) stress, "Change takes time, energy and demonstrated success to convince successive departments about the benefits of changing" (582). As a step toward

effective change, we expect to continue following the three-tiered evaluation pattern mentioned above.

One of our latest discoveries from an intense, descriptive evaluation process involving instructors, external reviewers, as well as students is that we need to add a new, central objective built not so much around tools so much as good design *attitudes* and *approaches*. In other words, we are now finding the need to focus on the less tangible (but more human) elements of the design process, a territory much less familiar to us than Bills of Materials, Purchase Requisitions, software applications, or statistical calculations. Engineering, engineering design, and technical communication can be all that and so much more.

Teaching the "so much more" is much less straightforward and so much more unpredictable. Experience and our assessment of our experience have taught us enough to jump in. Currently, we see a strong need to focus on team processes as well as the interim and final products in more depth. We hope this closer focus will help us to learn more about the following aspects that we hope to focus on next:

- Students can engineer, but how do they take a project from conception to solution?
- Students can communicate, but do they have the social awareness necessary for maximizing the benefits of team work?
- Students have worked on teams before, but how do they work on teams with individuals specialized in areas required to complete a project effectively?

In short, if we simply teach students in our own traditional, discipline-specific ways, we may not be optimizing students' ability to learn in multidisciplinary contexts. We want to move beyond this state. We want to understand and thoughtfully shape our course to provide students an arena in which to share and gain expertise. In carefully assessing what happens behind the scenes of our course; in the class itself; outside the class in team and mentor meetings; with clients and end users; and with students as and after they leave the course, we hope to make this not just a memorable high point but an exemplary learning environment, the best of what engineering education and technical communication education are all about.

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