# Comparing academic staff and student perspectives of an interdisciplinary design course

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***Abstract****: Since the turn of this century, engineering programs in Australia and the United States have been motivated by accrediting bodies such as IEAust and ABET to include multidisciplinary teaming in their curriculum. Yet, the reality of teaching interdisciplinary teaming requires both instructors and students to navigate institutional and social structures of engineering programs that are neither flexible nor adaptive. Drawing from multiple data sets, we present a case study of one interdisciplinary design course from the points of view of instructors and students. While the instructors prioritized flexibility to allow students to develop their own objectives for the project, many students desired more guidance. Nonetheless, many examples of successful interdisciplinary learning and appreciating the expertise of other disciplines occurred.*

## Introduction

Since the turn of this century, engineering programs in Australia and the United States have been motivated by accrediting bodies such as IEAust (Nafalski, McDermott, & Gol, 2001) and ABET (2005) to include multidisciplinary teaming in their curriculum. This requirement has been accompanied by forecasts such as *The Engineer of 2020* (National Academy of Engineering, 2004) and *The World is Flat* (Friedman, 2005) that predict a global workplace in which engineers must be flexible, adaptive and able to contribute in teams that cross a variety of boundaries. This shift is driven by both changes in the global economy and the ways in which industry has adapted to globalization.

While engineering educators have attempted to offer authentic learning experiences that mimic the cross-functional and cross-disciplinary team structure of industry, traditional disciplinary structures of higher education institutions stand as a barrier to interdisciplinary teaming at both student and faculty levels. Given the stark contrast between industry and academia, how can faculty effectively offer cross-disciplinary teaming experiences to their students? Drawing from multiple data sets, we present a case study of one interdisciplinary design course from both instructor and student perspectives. As role models, the professors of computer engineering, industrial design, and marketing conduct their scholarly work using the same interdisciplinary, self-managing work team features they strive to cultivate in their students. Our unique analysis comparing and contrasting the instructor team, their interdisciplinary pedagogy, and its impact on students provides insights into interdisciplinary and team pedagogy and its implications for engineering education.

## Literature Review

### Self-managing work teams

Self-managing work teams (SMWTs) are composed of members who "take responsibility for the team's work […], monitor their own work performance [… and] alter their performance strategies as needed" (Wageman, 1997, p 49). SMWTs work collectively (Kirkman & Rosen, 1999; Kirkman & Shapiro, 1997, 2001; Thoms, Moore, & Scott, 1996), with leadership coming from within the team rather than from supervisors in top-down models (Manz & Sims, 1993). SMWTs are cited as team designs that can enhance creativity (Williams & Yang, 1999) and lead to greater competitiveness (Cohen, Ledford, & Spreitzer, 1996). For these reasons, corporations are increasingly restructuring their work forces in ways that redistribute decision-making (Wageman, 1997). Inevitably, with these shifts have also come challenges. SMWTs require more complicated relationships and skills of employees, resulting in longer times for teams to form. Not all individuals are predisposed to embracing SMWTs, so various kinds of resistance are to be expected (Kirkman & Shapiro, 1997, 2001; Kirkman, Tesluk, & Rosen, 2004). Team and individual behaviours that are encouraged in SMWTs include autonomy, critical thinking, taking responsibility, and flexibility—all traits that are advantageous for 21st century professions.

### Institutional barriers to interdisciplinarity in higher education

While industry may have embraced cross-functional teaming and network-based knowledge management, the disciplinary departmental structure of higher education seems particularly resistant to change. The departmental structure is often identified as the most significant barrier to faculty interdisciplinary collaboration in higher education settings (Committee on Facilitating Interdisciplinary Research, 2004; Sa, 2008). Prior work (Author removed for blind review, in review-a) describes the institutional barriers experienced by two faculty teams at the same institution, including the one described in this paper. Barriers to interdisciplinary research were traced back to resource and reward structures based on disciplinary departments. Other authors echo our findings, frequently focusing on the implications for untenured faculty members (Payton & Zoback, 2007; Pfirman, Collins, Lowes, & Michaels, 2005). Given that both financial resources and promotion and tenure are so closely aligned with a hierarchical departmental structure, faculty members who wish to pursue interdisciplinary teaching or scholarship find themselves caught in the conflict between their career goals and academic tradition.

### Identities in interdisciplinary teams

Thus, in order to create and develop well-functioning project teams in a classroom setting, awareness is necessary of how institutional forces shape staff and students and how key experiences can alter student values and skills. As a framework for understanding the tension in an individual's identity development, we turn to Gee (2000, 2004), who proposes four types of identities that emerge in educational environments. This paper focuses on the tension between institutional (disciplinary) and affinity (interdisciplinary team) identities in an interdisciplinary higher education setting. Gee views construction of institutional-based identities as a process that authorizes. It is the endorsement of laws, rules, and traditions that defines a person's role in a larger institutional structure. This process "allows the authorities to 'author' the position" of a professor or student (2000). In a classroom setting, students are trained to think and otherwise conform to disciplinary norms that reinforce the basic underlying values of their chosen field (Donald, 2002). However, Gee also describes affinity-based identities that emerge in an educational environment based on experience, sharing, and participation. He remarks that an affinity group is "a focus on distinctive social practices that create and sustain group affiliations, rather than on institutions or discourse/dialogue directly" (2000, p 105). This process of creating a group based on interdisciplinary sharing and experiences is one means to weaken institutional restraints and empower interdisciplinary integration. The exchange between group or team members helps to construct and reinforce norms and attitudes. This interaction allows for certain flexible and changing identities to emerge that are not completely tied to an institutional (disciplinary) identity. Both types of identity are important to interdisciplinary work; Boix Mansilla and Duraising's (2007) framework for evaluation of interdisciplinary student work emphasizes both disciplinary grounding and integration.

## Methods

### Setting and participants

This study was set at a large public research university on the east coast of the United States. The three associate professors held tenured positions within computer engineering, industrial design, and marketing. Their team formed in 2004 to teach an interdisciplinary project course. When we began observing the faculty team in fall 2007, they began submitting proposals for external research funding.

The interdisciplinary team was awarded internal funding from the university's Office of Research for teaching release. We observed two-hour weekly research team meetings for two academic years. Twenty-one students enrolled in the fall 2008 course which was co-taught by these professors and focused on using smart technologies to build dorm rooms for students with special needs. There were seven engineers, eight marketing students, and six industrial design students, ranging from juniors to graduate students. We observed class meetings twice a week for 75 minutes.

### Data collection and analysis

The data collection for this study was approved through human subjects (IRB) review, and the participants signed informed consent forms. The primary data source for this analysis is observational field notes, supplemented by audio recordings which were selectively transcribed for exact quotations. Data analysis consisted of iterating between themes in the data and theories from the literature.

## Findings

### Instructor team identity

There are many ways in which this instructor team exhibited the features of a self-managed work team (SMWT) with strong affinity identity. As a SMWT, the group was co-led by all members at various times. Within the first few months, for example, the team had a running joke of leadership changing from week to week to whomever was unable to attend that week. As they worked on external funding proposals and other projects, leadership was distributed across the projects, usually to take advantage of disciplinary expertise or reputation. The workload was well-distributed, as all team members identified and pursued opportunities on behalf of the team. Overhead was also distributed evenly.

The group also remained flexible in terms of the problem domain. In previous versions of the course, they worked on products to help the elderly interact better with their pets, and on construction safety. For research funding, the group also sought out collaborators who are content experts. One member explained, "I view this group as we're kind of a core that can reach out in a bunch of different directions. …in order to be successful we're going to have to grab other people." Even the team's goals were widely distributed. Referring back to their original application for internal funding, one member described three aims: "an educational arm, a product development arm—sort of a business within the university, and then a scholarly grants writing arm." These varied goals allowed the team to stay focused on a shared vision, even when administrators pressured them to focus only on external research funding. The team members had a strong sense of these shared goals, which contributed to their empowerment and effectiveness as Alper et al. predicts (1998), but became competitive and detrimental to the team when it seemed the other two goals were being relegated in favour of research.

In terms of identity, these academic staff made several statements indicating they felt a stronger affinity identity to the team than institutional identity to their disciplines or departments. Team meetings were viewed as an escape from the bureaucracy of the university. Meetings nearly always included side conversations about other topics, and team members frequently socialized outside a professional setting, visiting each others' homes for social events. Team members felt they were doing something important, even if it wasn't being recognized by their departments.

### Interdisciplinary pedagogy

The pedagogy employed in this course is driven by the strong values of the instructor team. The engineering professor explained, "We set a good example in terms of, we come from the different disciplines and we value this and we're doing this, and talk about it from our own perspective." They felt that interdisciplinary teams are more creative and enable new solutions. The marketing professor explained, "What we're really trying to do is go beyond these different disciplines and say 'look, where creativity happens is in the cracks between these different areas.'"

The first day of class they outlined the concept of the course on a white board, explaining the concept of "T-shaped people" who are able to transcend divisions in order to increase collaboration between different disciplines. A T-shaped person is someone who possesses the core strength of disciplinary expertise (the vertical axis of the 'T') and also is able to see and work with a broad range of people and situations (the horizontal axis of the 'T').

An important step toward this was for students to learn about and respect the other disciplines involved in the course. The design professor emphasized, “We’ve got to get them respecting each other before they are working with each other and demanding things from each other.” Later, he asked, “What happens if all of the [design] students say ‘we know how to make something pretty,’ and all the [engineering] students say ‘we know how to make something work,’ and all the marketing students say ‘we know how to make people buy things?’ Then we’ve essentially screwed ourselves.” The engineering professor responded that this would be a “learning moment” to explain to students that their designs should have all three properties to be considered successful.

There were plenty of examples throughout the meetings where the instructors described their own disciplines to each other, often in relation to the other disciplines’ strengths and weaknesses. The engineering professor joked about lack of concern for aesthetics among engineering students: “They will give you a brick every time. If you had one of my students design the coffee cup for you, you’d have a brick. You’d be drinking out of the holes in the brick.” In a similar exchange, the engineering professor started describing engineering students, but then highlighted complementary strengths and weaknesses in design students:

> Engineering professor: [Problem exploration] is the part of the problem that the engineers have no experience with. It drives them nuts. They are so used to being given “here’s the specification for a problem.” They have no experience deriving a specification, going into a situation and finding a problem and coming up with a specification.
>
> Design professor: And that’s what our students do all the time.
>
> Engineering professor: On the back side, the industrial design students don’t have as much experience saying, “this is the reality of the situation, this thing has to fit in this…”

The key to achieving these competencies, according to this group of instructors, is flexibility. The pedagogy appears to be characteristic of the design professor (if not pedagogy in design studio classes more generally), as he most frequently offered direct explanations, such as:

> Not only is it different every time with every class. We’re going to have groups. I would fully expect and want to encourage a group that needed more time on its research to stay there and expect that not everybody gets to each point at the same time….The idea is that they take control of it and go where it needs to go.

Perhaps the most important aspect of flexibility was allowing students to construct their own objectives. The instructors stated that students should be innovative and open to learning and working with people from other disciplines. They provided only generally defined goals for students to interpret on their own and construct meaning with each other.

## Impact on student learning

### Valuing disciplinary diversity

Regardless of how their teams ultimately performed in the course, all students left with an appreciation for the value of diverse disciplinary perspectives. An engineering student said,

> I think it helps to have other people’s ideas to build upon. I think being able to go back and forth, have our ideas, have other points of view to your ideas allows you to see perspectives on what you are working on that you have never seen before...

Similarly, an industrial design student noted that “different perspectives, different way of seeing things, different disciplines” is critical and that “everyone brings an ingredient to the mix.” A marketing student said, “When I decide to invent something revolutionary, I will have engineers and designers around.”

Over the course of the semester, we observed that students on most teams began to look to each other for their traditional disciplinary expertise, but we also sought examples of students making assertions that might normally be attributed to another discipline as even deeper evidence of interdisciplinary learning. Examples included design and engineering students suggesting they use “word of mouth” marketing and asking, “How are we going to sell it?”

### Conflict and eventual integration

One particular student team exemplified how students were initially working separately towards conflicting goals, but eventually developed an integrated design. In their development of a robotic device, engineering team members were initially focusing on the inside of the device, while they expected the design students to work on the "covering." After many discussions reminiscent of the brick example described above, the student team realized that a better design would emerge from more integrated consideration of both technical and user aspects. In addition to attempts by the engineering students to soften their feasibility concerns, the group also had an internal discussion to resolve their differences. The design student explained the change, "It was just a different approach. We just talked about it. We talked and realized that we speak different languages and we talked about that. ...No one says dogmatically that 'this is the way things are supposed to be and everyone else is wrong.' We come to a group consensus, which is nice." With this consensus-based approach to group work, each member of the group took measures to ensure that the product was feasible, technically advanced, and user-centered. There was similar evidence of working in more integrated, face-to-face ways in several other teams. One design student remarked that the biggest creative force in class and in his group was "everyone playing off each other....It is the coordination." On the other hand, the teams that did not manage conflict exhibited a lack of curiosity and respect for the team's multiple perspectives. For example, one engineering student repeatedly said with force, "I don't have a clue *what* she does" about the work of a marketing team member. That team experienced sustained conflict and produced one of the less innovative designs.

In general, the students worked together, not separately, on questions of marketing, design, and engineering, moving beyond their expertise. Students were able to move beyond these entrenched identities and create affinity experiences. As the groups started to work in a more integrated fashion, the loose structure provided them the flexibility to generate creative and integrative solutions.

### Too much flexibility?

Teams that did not produce an innovative design were more critical of the lack of structure and tended to blame it, at least in part, for lack of project success. One industrial design student said, "If we had been more structured, if there had been deadlines...If you don't have things due by that date, then you get a bad grade. You need structure!" Another member of her group also expressed a similar frustration. This marketing student had not decided "whether or not [interdisciplinarity] is a good thing." He pointed out that "you need openness, clarity, and direction, and then ID groups work." However, he noted that this did not occur in his group. Nonetheless, an engineering student in the same group said, "We are free to sit down and work how we want to work, throw ideas back and forth to each other, plenty of space to collaborate with the group." His comments were similar to those of students in the groups with more successful prototypes. A marketing student from a successful group pointed out how less structure supports affinity identity. She said, "The whole point of the class was to not give structure from above. That was unique."

## Discussion and conclusion

Interdisciplinary collaboration within current academic structures will continue to pose challenges for both academic staff and students. Since there is little precedent for interdisciplinary teaching, instructors must approach such courses as reflective practitioners and role models. Students, especially in engineering, are used to working within well-defined, product-oriented learning environments that can stifle creativity. They may experience "culture shock" in open-ended course designs that require them to define their own objectives for a semester-long project. In order to create a setting that encourages students to create and to practice teaming behaviour, instructors could try to reduce ambiguity through other means than added structure. For example, they might follow the procedure laid out by Oberg (2009) for interdisciplinary groups to discuss a specific work product to create a common understanding of quality. Finally, instructors need to emphasize to students that they should expect conflict, and negotiate through it to gain multi-disciplinary perspective.

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