Making Industry Meaningful In College: A Multi-Disciplinary Entrepreneurial Project for Teaching Reengineering

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An entrepreneurial project at Illinois Valley Community College immerses engineering design and electronics students in reengineering and entrepreneurship throughout their two-year programs. Making Industry Meaningful In College (MIMIC) pioneered at IVCC as a one-semester multi-disciplinary project with technical and business students teamed into "companies" to select, design, prototype, manufacture, market and sell products. Now, with support from a National Science Foundation grant, elements of the entrepreneurial project are being incorporated throughout the students' two-year programs.

The four-semester program brings freshmen engineering and electronics students into the continuous quality improvement loop and reengineering in their first semester courses where they recommend improvements on products previously designed by student teams. In their second and third semesters, students continue to design and redesign products, build and redesign prototypes. The fourth semester is the entrepreneurial MIMIC semester; "companies" are formed including engineering design, electronics, and business students, to manufacture, market and sell the redesigned products.

The hands-on, learning-centered nature of MIMIC is utilized in recruiting. High school students are brought to campus to participate in project-related activities and experience the technology available to the college teams. To improve retention, a leadership track has been created for promising technical students; they are being trained and paid to provide peer support to other technical students.

MIMIC not only exposes students to the world of industry within the classroom, it is a replicable, cost-effective model that can be integrated into various programs and college settings.

ENTREPRENEURIAL PROJECTS AT OTHER INSTITUTIONS

Entrepreneurial team projects are relatively common in university engineering programs. The projects vary in focus, participants, and length, but none appear to exactly match the MIMIC model. Some university projects emerge from university programs encouraging entrepreneurship, like Pennsylvania State (Bilen *et al*., 2005). Some projects, like the University of Maryland (Barbe, *et al*., 2001), are a part of incubator-like environments where prospective entrepreneurs live together. Some universities facilitate start-up ventures: Florida Institute of Technology (Ports, *et al*., 2005) and Stanford University (Stanford Technology Ventures

Program, n.d.), for example. A business plan competition is the focal point at the Massachusetts Institute of Technology (MIT $50k Entrepreneurship Competition, n.d.) In other programs, a high tech manufacturing facility is available for the student teams to produce a product, for example, at the University of Missouri-Columbia (Zayas-Castro, *et al*., 2002).

At some universities, the student teams work with industry partners: Lehigh University (Ochs, *et al*., 2001) and Michigan Technological University (Raber and Moore, 2005), for example. At some universities, multi-disciplinary project teams include MBA students: University of Nevada-Reno (Wang and Kleppe, 2001) and University of Florida (Stanfill, *et al*., 2004), for example. Other projects include undergraduate business students: University of Missouri-Columbia (Zayas-Castro, *et al*., 2002) and Lehigh University (Ochs, *et al*., 2001), for example. Some team projects are capstones: at the University of Nevada-Reno (Wang and Kleppe, 2001), for example. Other teams exist over three or four years; for example, at Rowan University (Engineering Clinics, n.d.) and Michigan Technological University (The Enterprise Program, n.d.).

At community colleges, multi-disciplinary entrepreneurial projects, which include business students, are either rare or not well publicized. Engineering team projects are relative common (Mott, 2002; Gordy and Ezzell, 2004). Cooperative agreements with universities also allow some community college students to participate in projects at a university (Liou, *et al*, 2003).

ORIGIN OF THE MIMIC CONCEPT

In 1995, the engineering design instructor and a business instructor at Illinois Valley Community College developed a creative plan to provide their students with workplace experience. As a project in one of their courses, the instructors integrated their students into teams to develop, produce and sell a product. The design and business courses were scheduled to allow the student teams a common meeting time and to facilitate special training in such areas as group dynamics. The student teams simulated an industrial environment not only by designing and marketing a product, but also by participating in the types of communication situations required in the workplace. The project was named Making Industry Meaningful In College or MIMIC. In its first year, MIMIC received an Innovative Curriculum Award from the State Board of Education.

Since MIMIC's successful debut, both the technical side and business side of the project have expanded, bringing membership on the student teams closer to an industrial setting. On the technical side, electronics students have joined the student companies, and product specifications have been revised to require electronic components. On the business side, a MIMIC business course has been developed as a capstone for students in Associate in Applied Science degree programs in marketing, accounting, management, computer systems and information systems.

THE REENGINEERING OF MIMIC

Today, with support from National Science Foundation Grant #0501885, the one-semester MIMIC project is being used as a catalyst to embed continuous quality improvement methodology (CQI) throughout the two-year engineering design and electronics curricula.

For the first ten years of MIMIC, the entire process was completed in one semester, including team assignments, product decisions and designs, training in teamwork and other skills, prototyping, production, marketing and sales. The one-semester time frame successfully provided teamwork, problem solving, entrepreneurship and communication experiences, but it limited the design experience of the technical students and the viability of the products. Expanding the program to introduce engineering design and electronics students to CQI in their first semester courses solves those problems.

In the first semester of their two-year programs, students learn CQI principles and receive hands-on experience with reengineering in Computer Aided Drafting I, which is required of both engineering design and electronics students. The students begin by breaking down and analyzing products built by MIMIC teams in previous semesters, and the students make recommendations for improvements on those products. In their second and third semester courses, the technical students continue to study the CQI loop, and they design products, build prototypes, analyze the prototypes, redesign, and so on. The engineering design students also receive training in project management during their third semester. Before the start of the fourth semester, the instructors of engineering design, electronics and business select the products for the MIMIC project from the redesigned products. The instructors evaluate the quality of the design, ease of production on campus, cost and marketability.

The fourth semester is the MIMIC project semester, when products are manufactured and sold. Students enrolled in the following courses participate:

- Design Projects, a capstone engineering design course,
- Digital Microprocessor, a sophomore level electronics course, and
- Integrated Business Operations, a capstone business course.

The three courses are scheduled at a common time to allow for company meetings and training sessions as needed.

At the beginning of the MIMIC semester, the three instructors assign students to companies and assign a product to each company. Enrollment determines the number of companies and number of students from each discipline assigned to each company. Typically, a company includes two engineering design students, two electronics students, and a mix of students from the various business fields.

Companies meet immediately for orientation and training and continue to meet at least once a week throughout the semester. Instructors from other disciplines are brought into company meetings or into the individual courses to teach workplace skills such as teamwork, goal setting, and problem solving, as consultants would be hired to provide training in a business or industry. Communication channels, including e-mail and an electronic discussion board, are established to allow students to conduct their company business realistically.

In their early meetings, the student teams decide how to produce and market their product, and they decide on a product and corporate name. The engineering design students act as project managers, and the other students assume responsibility for a portion of the project based on their

discipline. For example, marketing students conduct a marketing survey and recommend a marketing strategy, and accounting students work on production budgets. Students also assume responsibility for facilitating company meetings on a rotating basis.

The student teams research and purchase materials and determine the final selling price. A minimum of one week is devoted to producing the products with the students in all of the disciplines participating. The number of units to be produced is set by the instructors. Marketing students design packaging, and work with students in a technical writing class to prepare the instructions for assembly and/or operation of the products.

Business students plan and promote an on-campus fair where the products are sold. All students are required to assist in the sale of their product. After the fair, accounting students prepare a cost analysis and make a recommendation on the commercial viability of the products. A celebration dinner for all participants wraps up the project.

The student guidebook and current timeline for the project are available on the MIMIC web site at http://www.ivcc.edu/mimic

MIMIC PRODUCTS

Products created by student teams have included security devices, desktop water fountains, electronic games, lamps, clocks and lighted picture frames.

The flashing drink holder, Figure 1 and Figure 2 below, is an example of a student designed product. Marketed under the name Kan Kuzzie, this drink holder incorporates fiber optics with a tri-color LED and a printed circuit board. The top, bottom and battery holder were produced in a rapid prototyping machine. This product was produced from the original design and sold a few years ago; it has yet to undergo reengineering.

Figure 1: Flashing drink holder exterior view

Figure 2: Flashing drink holder interior view

The strobe light, in Figures 3 and 4 below, clearly illustrates how reengineering is improving the quality of the products. Figure 3, on the left, shows the side and top view of the original product that was designed, produced and sold a few years ago. Given the limited time the technical students had from concept to production, the original is relatively well designed. The original light also predates the students' access to rapid prototyping and mold making capability. Newer technology and reengineering allowed students to create the more commercially viable and professional product in Figure 4.

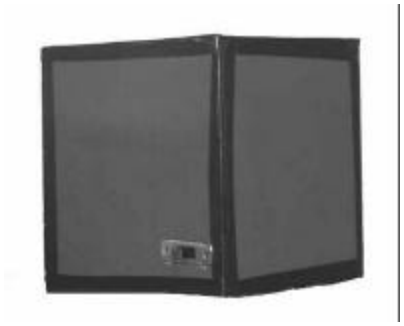

Figure 3: Strobe light original design, side and top views

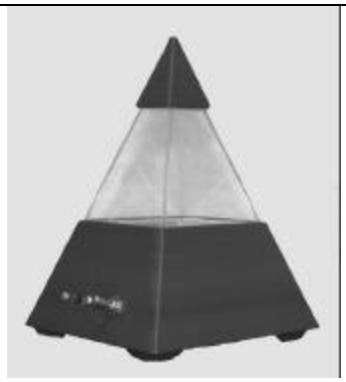

Figure 4: Strobe light reengineered design, side and top views

The new design is also more effective. The original design concentrated light in one direction, upward from the box. The new design distributes light more evenly throughout a room because the entire upper section is made of clear plastic. The RC time constant in the new design was also altered to affect the time charge rates, affecting the flash rates.

The lamp, Figures 5 and 6 below, is a product being reengineered. Intended to provide storage for CDs in the base, the original lamp is on the left and the first redesign is on the right. In the original, CDs are stored in slots designed in the wooden base. The reengineered lamp utilizes a canvas and mesh CD holder designed for use on an automobile visor; the CD holder is attached

to the wooden base with Velcro. The original product has a much wider base and stores only 10 CDs; the redesigned lamp, with a much slimmer profile, stores 20 CDs. The lamp is still undergoing reengineering to improve its stability, proportions, and access to the CD slots near the shade.

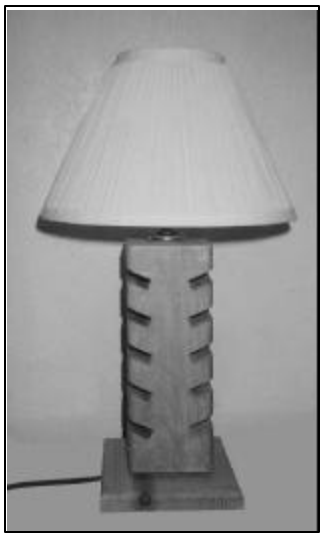

Figure 5: CD lamp original design

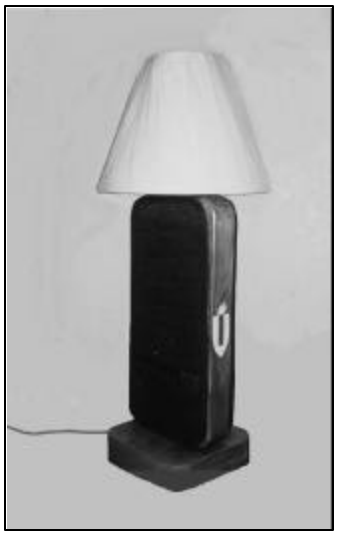

Figure 6: CD lamp first redesign

LEARNING IN THE MIMIC PROJECT

MIMIC is a learning-centered project, which provides students with training and practice in leadership, teamwork, problem solving and critical thinking, in addition to requiring students to apply their career field skills. MIMIC also provides students with opportunities to learn about and experience:

- the entire process of manufacturing,
- technologies outside of their discipline,
- thinking and communication styles of other disciples,
- scheduling and time management,
- oral and written communication modes appropriate to their discipline.

At every stage in the process, all team members participate in making company decisions, such as purchasing of components, pricing, producing, and selling the product. That participation helps them to understand how their role fits into the entire process.

Throughout their two year programs, the technical students have extensive experience with technology they will encounter in the workplace including: AutoCAD, Solid Works, Auto CAD Inventor, 3D Studio Max, Catalyst, Multi Sim, and a Dimension Rapid Prototyping Machine. The capstone MIMIC project exposes all of the students to technology outside of their fields. For example, engineering design students become familiar with Electronic Workbench and Excel

while the business students are introduced to rapid prototyping, CNC technology and Auto CAD. Understanding the technology outside of their disciplines helps them to work together productively.

The students also encounter different thinking and communication styles as they interact in their companies, and, with the assistance of training in group dynamics and communication, they interact more productively. Past experiences with MIMIC indicate the need for training and practice to improve the interaction especially between technical students and business students. Samples of student feedback illustrate the problems:

- An electronics student: "We can't get money out of the accountants to buy parts for a prototype."
- An accounting student: "The engineering and electronics students won't give me any numbers."
- A business student: "The electronics and CAD students had their minds already made up about what they're going to do. They wouldn't listen to us."
- An electronics student: "I kind of understand the CAD students, but I don't know what those business students are thinking with. Instead of worrying about whether we can do it or if it will work, they just think about price and the schedule."
- An engineering design student: "Those business students are hard to work with. Marketing students said we'd never be able to sell it. Two days later our instructor found something like it selling for 40 bucks. The accountants said our idea was no good – to complicated. We work okay with the electronics guys."

Obviously, these issues are typical of the workplace.

In their MIMIC companies, students receive training in goal setting and time management. Their hands-on teamwork throughout the project is designed to make the students aware of deadline responsibilities in a way that their individual classroom assignments do not. In interviews at the conclusion of the project, students routinely advise future MIMIC participants not to relax even if they are on schedule.

A number of communication exercises are integrated into MIMIC. In addition to the small group communication skills required for the student companies to function successfully, the students participate in other types of communication situations that would be required of them on the job. All of the students give oral presentations in a 120-seat, multi-screen, electronic lecture hall where the audience includes members of the faculty and administration in addition to members of the student teams. The presentations are scheduled throughout the semester with students from each discipline explaining their portions of the project; engineering design students, for example, defend their product designs early in the semester, and accounting students present their product viability recommendations at the end of the semester. The types of written materials produced by the students are also determined by their discipline; engineering students detail their product designs in formal, technical reports, and marketing students write sales materials.

UTILIZING MIMIC FOR RECRUITING

The hands-on, learning-centered nature of the MIMIC project is being utilized in recruiting students for the engineering design and electronics programs. Technical teachers and small groups of students from area high schools are being brought to campus to observe and participate in MIMIC project-related activities. In their visits, the high school students experience the technology available to the college teams, including rapid prototyping.

To enhance recruitment and retention, a leadership track has been created for technical students. This year, engineering design and electronics instructors at IVCC have identified promising technical students and encouraged them to enroll in a college strategies course, free of charge. The students who successfully completed that course in the fall of 2005 are being paid a stipend to provide peer support to other technical students. For next year, high school instructors will identify students or recent graduates as potential leadership track students. Prior to their admission at IVCC, those students will be contacted about participating in the leadership track.

UNIQUE BENEFITS OF THE MIMIC MODEL IN RURAL AREAS

While the MIMIC model can provide valuable workplace experience in a variety of college settings, it offers unique benefits for colleges in rural areas. Illinois Valley Community College, which has an enrollment of approximately 4,000 students, is centrally located in a 2,200 square mile district in north central Illinois. In this rural, primarily agricultural district, the largest community has a population of 18,000. As a result of the limited industrial base in the district, internships and industry partnerships can be problematic. Technical jobs, however, are readily available just outside of the district; Chicago, Peoria and Rockford are all within 60 to 100 miles of the campus. MIMIC provides a solution to the dilemma faced by the college's technical programs since it allows students to experience a simulated industrial workplace. The MIMIC model not only prepares students for internships, it can be a viable alternative for college students in geographic areas where internships are in short supply.

COST FOR A MIMIC-LIKE PROJECT

MIMIC has been a very cost effective project at Illinois Valley Community College, illustrating that a similar project can be established with minimal funding. In Spring 2005, the MIMIC budget was approximately $3,000:

- $1,200 for the three instructors ($400 stipend each),
- $1,000 for product supplies, divided equally among the student companies,
- Under $1,000 for stipends to instructors for training in teamwork and other workplace skills.

The MIMIC project is sponsored by the college's Tech Prep team, and for ten years, the funding has come from a mini-grant provided through Carl D. Perkins federal legislation. MIMIC students have helped to control costs by locating low-cost supplies and soliciting donations from lumberyards and hardware suppliers. Product sales, from previous years, have covered some additional expenses for supplies and end-of-project recognition for the students. A grant from the

National Science Foundation is currently providing funds for some of the MIMIC project, but the project has been offered for ten years with a budget of $3,000 or less each year.

ASSESSMENT OF THE MIMIC PROJECT

Since its inception, the MIMIC project, participating students, and student products have been evaluated from a number of perspectives and by a number of people. Evaluations of plans, designs, prototypes, products, written materials, oral presentations, teamwork, and student participation are completed by the MIMIC instructors, consulting instructors, student participants, buyers and potential buyers of products, and business/industry leaders. A full assessment of the four-semester reengineering focus will not be possible until the first students complete their two-year programs, but past assessments of the MIMIC project have been very positive. Business and industry leaders have been supportive because MIMIC gives students hands-on experience dealing with workplace problems. Student feedback has also been very positive. Typically, students are skeptical about the benefits of the project as they begin the project and frustrated during the project. By the end, they recognize the value of the experience in preparing them for the world of work.

An advisory committee of business and industry representatives has been formed to provide guidance as the technical programs incorporate reengineering. The committee will also provide an ongoing formal structure for feedback on the MIMIC project itself.

ADAPTABILITY OF THE MIMIC MODEL

MIMIC is an adaptable model for integrating students from diverse disciplines, as illustrated by a spin-off project at Illinois Valley Community College. Four years ago, students in engineering design, electronics, theatre, English, art, graphic design and business designed and built a portable puppet theatre and puppets; developed and administered a budget; and wrote, promoted and produced a play. The project required the engineering and electronics students to work with theatre students to learn about theatre materials, design elements and stage lighting effects and zones. Integrating technical students with liberal arts students provided even more teamwork and communication challenges than the original MIMIC project. As the theatre instructor said, "Design and electronics students approach a project differently compared to theatre students."

Integrating teams of students from diverse areas to produce products can also be accomplished at various educational levels and can involve industry partners. The MIMIC model can be adapted to various college settings, including university programs, by adjusting the complexity of the products to match student backgrounds and expectations/standards of the instructor, course or program. A number of universities offer projects that incorporate aspects of the MIMIC model, as the literature review (above) illustrates.

At IVCC, MIMIC has truly made industry meaningful. The MIMIC model can make industry meaningful at other colleges.

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