

PIRL: INNOVATION AND RESEARCH OPPORTUNITIES FOR INTERACTIVE EDUCATION

William Bullock / Joyce Thomas / Kevin Reeder

University of Illinois at Urbana-Champaign / University of Illinois at Urbana-Champaign
wbullock@illinois.edu / jkthomas@illinois.edu / kreeder@illinois.edu

ABSTRACT

The new product development trend in corporate America is increasingly toward market focused, human-centered research and development. The government is increasingly interested in applying research for a return on investment. Fundamental research and applied research are being blended in an effort to speed the delivery of highly innovative new designs to the marketplace. Given the diversity of expertise required to nurture and guide this process, this is by necessity a team approach involving many stakeholders.

The interest in product design and development research across college campuses is widespread. Interdisciplinary collaboration is critical to attaining a competitive edge. This reality requires that academic institutions integrate multiple disciplines in the learning process to prepare students for the complex dynamics of the collaborative product development process.

1. WHY INTERACTIVE EDUCATION?

"The world and the world of business are changing. Individualism is out, teamwork is in. Specialization is out, a now-style generalism is in. Rigid organizational lines are out, fluid collaboration is in. Power is out, empowerment is in. Hierarchical organizations are out, replaced by network organizations, adaptive organizations, informal organizations, and horizontal organizations. Right smack in the middle of all this sit cross-functional teams composed of experts ready to move quickly and flexibly to adapt to changing business needs." (Parker 2003)

A survey conducted by the Corporate Design Foundation points out the need for interactive learning:

"Increasingly, successful corporations are adopting some form of multi-disciplinary team process for developing new products. It may be called concurrent engineering, simultaneous development, tiger teams, innovation cells or project management, but the essential idea is the same: to achieve competitive advantage by bringing new and better products to market faster. Traditional product development involved different functions sequentially; by bringing design, engineering, manufacturing, marketing and field service together from the outset, companies can create better product in less time." (Hypes 1994)

Dr. Stucky, Associate Director of the Institute for Research on Learning (IRL), believes that teaching interactive product development will also reinforce learning as a social process (Hypes 1994). Stucky suggests that if collaborative product development produces better products and brings them to market faster, collaborative education will result in better-educated employees that will support this process. While education has historically encouraged individuality, 'collaboration' in this setting can be considered plagiarism. However, the classroom setting and learning is essentially a social activity, which is much closer to collaboration than individual activity.

"When I was a kid, there was no collaboration, it's you with a camera bossing your friends around. But as an adult, filmmaking is all about appreciating the talents of the people you surround yourself with and knowing you could never have made any of these films by yourself." Steve Spielberg (Murphy 2011)

Schrage has studied some of the world's greatest collaborators: Wozniak and Jobs, Picasso and Braue, Watson and Crick. He found that rather than relying on charisma in their collaboration, they all created 'shared spaces' where they could play with their ideas. He tells us that it takes the collaborative efforts of people with different skill

sets to create innovative product solutions to problems. Individual creativity isn't enough anymore – people need to be in collaborative relationships where they have the knowledge and tools for building these relationships in order to be successful in the offices of today and especially in a growing trend toward "virtual" offices (Mattessich & Monsey 1995).

A 2014 Gallup survey assessed the happiness of graduates of all ages from 30,000 colleges and universities across 50 states (Gallup 2014). About 3% reported having had the types of campus experiences that other studies suggest can lead to successful careers and personal well-being. This speaks to the need for increased opportunities for collaborative learning. McKeachie reports that in a 2010 study by Roehling and colleagues that 'Millennials' born between 1980 and mid-2000 value active learning, having "grown up surround by fast-paced, interactive and constantly changing media-based activities. To sit just listening is not their style. Discussion allows them to be active" (McKeachie & Svinicki 2013, p46).

"Most industrial designers have never received the training to become integrated members of cross-functional product design teams" Gerard Furbershaw (Ulrich & Eppinger 2011)

"Effective change is almost impossible without industry-wide collaboration, cooperation and consensus" (Mainwaring 2011)

Real-world practice is integrating backward into professional education. From experimental courses introduced into isolated engineering or business school curricula less than a decade ago, the movement has already produced full-fledged programs involving students and faculty from two or more different disciplines. Collaborative education programs involving industrial design, business and engineering disciplines are spreading across the country:

- Art Center College of Design/University of Southern California
- Auburn University
- Carnegie Mellon University
- Massachusetts Institute of Technology/Rhode Island School of Design
- Ohio State University
- Stanford University
- Syracuse University
- Virginia Commonwealth University da Vinci Center
- University of California at Berkeley
- University of Michigan
- University of Oregon at Eugene
- University of Texas at San Antonio
- University of Vermont

Industry research clients serve as external advisors on matters related to professional development and the curriculum, promote industry experience and capstone opportunities, sponsor collaborative research projects and provide financial support. Experiences at research universities indicate that this model is highly successful in generating interactive, innovative research and is an effective educational model.

Some are calling this the beginning of a transformation in how America educates its business, design and engineering professionals.

2. RESEARCH PROJECT APPROACH: PRODUCT INNOVATION RESEARCH LABORATORY (PIRL)

"Good design begins with honesty, asks tough questions, comes from collaboration and from trusting your intuition." —Freeman Thomas, Director of Strategic Design, Ford

The Product Innovation Research Laboratory (PIRL) at the University of Illinois in Urbana-Champaign brings together faculty and students from design, marketing, business and engineering to solve product development problems for industry. Reacting to the current agile and concurrent climate in new product development, the PIRL product innovation research effort is directed at bringing together experts in various disciplines early in the

process, using technology to facilitate interaction and envision concepts. PIRL links user-centered, customer-focused, and technology-driven disciplines to work toward common goals and solutions, by integrating research and instruction to create innovative solutions and prepare students for leadership positions in collaborative product development.

Begun in 2002, PIRL has evolved into a successful design research laboratory that for over a decade has created an interdisciplinary environment in a university setting that integrates existing faculty and research capabilities into a project-based graduate interdisciplinary course sponsored by industry and government. Advanced students in industrial design, business and engineering receive course credit for work on a project specified by a company contracted by the University. Industry research funding has been provided by international companies such as Samsung, Dell, Kimberly-Clark, Aero Products (Coleman), HON Industries, Whirlpool, S. C. Johnson and Son, MCS, World Kitchen and private entrepreneurs.

This interdisciplinary partnership between industry, government and academia focuses research on strategic, user-driven projects. Industrial design is the constant integrating discipline of the laboratory with a user-centered approach, and includes marketing and engineering to support the integration of business, technology and manufacturing innovation. Students are exposed to tools that support interdisciplinary problem solving and decision making such as identifying customer needs, establishing target specifications, analyzing competitive products, generating and selecting product concepts, and performing economic analysis (Ulrich & Eppinger 2011).

Examples of sponsored Product Innovation Research Laboratory interdisciplinary research projects include: smart product development through transfer of technology into commercial product concepts and prototypes; user needs research methodologies; assistance to start-up technology commercialization ventures; envisioning strategic product and systems concepts; and the study of rapid prototyping processes.

PIRL attracts highly qualified technically oriented students from engineering, business and industrial design, many of whom have prior industry design experience. Graduate and senior undergraduates (12-21 students with 4-6 per discipline) are invited to participate under the guidance of faculty researchers to work in multi-disciplinary teams depending on project needs. Normally this is a 16-week semester research and product development study. One of the benefits of this program is that student participants develop key leadership skills relating to self-awareness, self-management, interpersonal relationships and organizational guidance.

PIRL's design process methodology combines customer, technology, business and marketing research with structured analysis, interdisciplinary brainstorming, rapid prototyping and evaluation. Research deliverables include strategic product and systems concepts, sustainable product development, ethnographic studies, trends forecasting, ergonomic verification and envisioning new products and systems. Research guides companies in articulating the future or addressing immediate needs through a fresh independent perspective.

Projects typically involve two or three disciplines: industrial design plus engineering and/or business. Sponsors contract with the University and PIRL to support the projects. Normal project costs are \$15,000 per discipline with a two disciplines minimum. Typical research funding is in the \$30,000-\$45,000 range for a 16 week semester long research project.

Projects are proprietary with faculty and student researchers signing non-disclosure agreements. As the goal of research is to provide clients with the best information and insights to inform and drive knowledge, students sign intellectual property waivers giving client rights to the work. This is covered in a signed agreement negotiated between the University Office of Sponsored Programs Administration (OSPRA) and the company. Non-exclusive royalty free of use of intellectual property may be granted for publications or portfolios. The majority of work is completed and meetings are held in the PIRL laboratory, an 800 square foot on-campus facility.

Benefits of PIRL research to the University are wide-ranging:

- PIRL provides leadership in securing project-based research to inspire creativity and innovation among students and faculty.
- Highly qualified faculty and students are invited to conduct research.

- Research funding comes from major corporations, not-profit organizations and entrepreneurial start-ups.
- PIRL assists with College industry outreach and development activities; the lab provides opportunity for corporations and alumni to “give back” to the university.

2.1. PROJECT PHASES

A typical project can range from one to two semesters and will be conducted in three phases:

Phase	Milestones	Deliverables
I. Research	Audit marketplace/suppliers Develop guiding principles Interview/observe users Gather secondary research Identify emerging technologies Analyze current products/systems Competitive analysis	Emerging technology road-map Results of audit Consumer issues/needs Sequence of use diagrams Interaction matrices
II. Development	Conduct brainstorming sessions Develop concept sketch/prototype Measure against guiding principles Build prototypes Conduct consumer testing Test technical feasibility Update guiding principles Refine concepts/build prototypes Iterative testing	Concept sketches/prototypes Recommendation for testing Test results Recommendation for final prototype
III. Finalization	Build final prototypes Conduct business analysis - Financial - Risks Prepare final specs/drawings Prepare final report	Final prototypes Written/visual report Presentation of results

2.2. PROJECT CRITERIA

Potential new projects must meet certain basic criteria. Among these are the opportunity for a challenging collaborative research and development experience involving two or more disciplines. Projects must be user-centric with the potential of prototyping and represent a novel idea and fit. Projects requiring only technical expertise with minimum user interaction are referred elsewhere. Feasibility of a real outcome should be apparent with the possibility of innovative problem solving and realization in a design prototype. Theoretical and hypothetical futuristic projects and project concentration on style alone are not undertaken. Projects that offer strategic economic advantage to the state of Illinois and the region are welcomed. Companies are reviewed for references and integrity.

Although the PIRL process and even deliverables may be similar from project to project, each project soon reveals its individual nature as the research and development process unfolds. Not only do team members differ in their skill set, abilities and experiences, clients frequently change their minds and redirect project goals as new knowledge, insights and new design possibilities are revealed. This is normal and to be expected. While project results vary, the emphasis is on providing the client with the best possible information to help them achieve the goal that was set out.

3. UNIVERSITY RESEARCH PROJECT APPROACH: DISCUSSION



Figure 1. PIRL projects.

Sponsored research that PIRL teams work on are typically projects that the company might have otherwise hired an outside agency to explore (refer to figure 1). These projects performed by PIRL teams and faculty have primarily factored into helping companies develop strategy for new business plans and derive solid design directions. PIRL is excellent at providing leading edge knowledge pertaining the project brief that helps guide the company's important product development and business goals.

PIRL visualizes research by illustrating potential design directions (refer to figure 2) and themes based on current and developing technology and materials, and analyzes potential new markets for companies to enter. If even one direction proves fruitful for the company, the intellectual property developed results in PIRL participants being named as inventors on patents, and the project has paid for itself for the client. PIRL projects do not result in turnkey deliverables; ultimately the design and business development is performed by the company. The important vision and insight provided gives a valuable return on investment for the company.



Figure 2. Product prototype, usage storyboard and Chooser profiles.

Approximately \$600,000 in external funding has been brought to the University over the course of the past decade through these research projects. With an average of about 20 students per year on each of the projects, more than 200 graduate and undergraduate students have participated and received course credit. Each project typically involves three expert faculty with approximately 35 faculty having participated. Students must be recommended by a PIRL professor and provide their current resume. Their course load is assessed to make sure that they have enough time to devote to this project. Amazingly, even among the most advanced students, this is the first opportunity for students to work in an interdisciplinary sponsored project.

The project briefs provide general deliverable guidelines which become more focused as the research unfolds. The initial core research phase is typically discipline specific. The marketing team bench marks and assesses the company, comparing it to parallel companies, existing markets, and assessing market potential. Industrial design students follow a similar path in their research, looking more closely at the products (or services) the company and its competitors produce while beginning to understand the user. Engineering students review materials, processes, patents, technical standards, UL requirements, government regulations and standards. They also

assess the current level of technology pertinent to the project brief. The entire team frequently participates in user and chooser interviews, as well as existing product use observations.

In the development phase (refer to figure 3) all of the disciplines work together to produce a large quantity of ideas. The designers typically take the lead in illustrating concepts but the entire team is responsible for developing ideas. Ideas are discussed and assessed and then presented to the client for review and direction narrowing. Often the design brief takes a right turn at this point as the client discovers new areas of opportunities and the project brief can be changed. The remaining ideas are used as a basis for forming three micro interdisciplinary teams (each including marketing, industrial design and engineering students) to champion specific projects.



Figure 3. Phase 1 Idea generation and client presentation.

The three teams are in parallel competition with each other to advance product ideas into more refined and believable concepts. Once the client reviews these ideas and based upon their guidance, the teams produce sketch models and refined illustrations. The client reviews once again and then finalizes the direction.

In the final phase, marketing separates to develop a marketing plan and to finalize the business concept. Engineering and design tend to continue together to finalize the chosen concept(s). PIRL's mission is not to provide turnkey product designs but to envision multiple options for future outcomes based on the research and development of new knowledge and insights.

Each project happens differently. Typical teams consist of 2-3 faculty and 20 or so students. Industrial design and marketing tend to be graduate students (marketing recruited from both business and advertising). The engineering students frequently are advanced undergraduates because the Masters level students often have course requirements that prevent them from participating.

Faculty researchers take on a role of general management, initially providing more hands on guidance at the beginning of the project, and encouraging students to take lead roles as the projects progress.

Team management is often like juggling elephants. One of the biggest snags on these projects is lack of effective communication. This seems odd because of the current electronic communication capabilities. The failure to show up for meetings with no explanation and/or complete deliverables on time is a nagging problem with some of the student population. This is partially a maturity issue and happens more frequently with the undergraduate team members. They tend to not recognize the seriousness of the applied research opportunity and have difficulty putting this as high priority. Business and engineering students generally arrive on time and get good seats at the table. Industrial design students are less business-like and often arrive late. However, there are often key team members from all disciplines who demonstrate great leadership and keep the teams focused on project deliverables.

PIRL participants at the project onset sometimes have exaggerated notions or preconceived ideas of their own capabilities. For example, when asked at a round table at the beginning of the project, a marketing student thought they would bring product design aesthetics to the team. The natural overlaps between marketing, engineering, and design can give some confusion about which discipline should take the lead at times. Through

working in this collaborative environment and with reminders from the faculty, the students begin to develop awareness of the contributions of the other disciplines in the product development process.

These sponsored projects are not easy to do. Finding and forming collaborative partners in industry takes extensive time and requires faculty commitment and dedication. Project participation is done beyond their typical course commitments. Students more often than not need to devote more time and energy to these projects than other courses with similar credit hours.

4. CONCLUSION

PIRL offers a unique learning environment for students and faculty alike. It is where teaching and research come together. Students learn about collaboration between disciplines and the methodologies and procedures necessary for the product development process. The value of theoretical knowledge from coursework is learned when it is applied. Faculty fulfill their research obligations to the University. The client gets an applied research deliverable and new insights and knowledge are developed. The University benefits through research funding from major corporations, not-profit organizations and entrepreneurial start-ups. It fosters a synergistic relationship between the academy and industry. This decade of collaborative interactive projects in PIRL has driven home the importance of teamwork for learning and research.

5. ACKNOWLEDGMENTS

We would like to acknowledge the early contributions of Tom Hardy, design strategist, who along with Bill Bullock helped to create the first iteration of the PIRL program – CoLab at Georgia Tech.

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