Design Collaboration

University-Industry Partnerships in New Product Development

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Abstract: Industrial design typically interacts with diverse organizations ranging from local companies to government agencies, as well as various and distinct disciplines such as engineering, business, sociology, and psychology. In educational environments, such collaboration can serve as an excellent pedagogical tool and a structure for maintaining the relevance (and future viability) of industrial design programs in large research universities.

This paper begins with a brief definition of design collaboration. It will then discusses the mutual benefits for the disciplines involved, the nature of their relationships, opportunities for education and research, and the difficulties faced as well. In addition, this paper will also show how these collaborations within a university structure can be a significant tool in the generation of socially conscious and innovative ideas as well as great learning environments.

Collaborative design will be described by the attention devoted to various case studies, in which the author is involved as well. Special attention will be devoted to these case studies for they are a part of an ongoing relationship between industrial design and mechanical engineering on a major university campus along with a local company and U.S. government agency. This paper will also demonstrate how expertise in a wide range of disciplines is necessary when developing products and provide broader implications for anyone interested in leveraging collaboration to spark new forms of education and faculty research in industrial design.

Key words: Industrial design, collaboration, transdisciplinary, design education.

1. Introduction

The product development process typically involves the active participation of individuals from a wide range of distinct disciplines such as engineering, business, sociology, and psychology, among others. The development process also requires infrastructural facilities for the purposes of marketing, research, manufacturing, and prototyping, to be provided by a diverse range of organizations. Large research universities with a wide range of disciplinary expertise and infrastructural facilities provide a fertile ground for experimental and innovative collaboration. This collaboration offers an excellent pedagogical apparatus and model for shaping the future of design education, and through the case studies, the apparatus proved to be very effective.

2. Design collaboration

The definition of design collaboration is a group activity in which design professionals or design teams work collaboratively with different disciplines and areas of study by sharing their expertise and responsibilities through the design process to reach a goal of obtaining a successful design solution together. Large-scale projects typically involve experts from multiple disciplines or groups related to the project [1]. Industrial design is not generated in fine arts and concerned principally with aesthetics, but rather a product-development process requiring many different perspectives and the expertise of various disciplines. Industrial design works in collaboration when individuals from different areas of study work collaboratively toward a design solution that is agreeable to all of those involved with the project.

2.1 What makes a successful collaboration?

With many different disciplines involved, a successful collaboration requires trust, mutual respect, shared vision, frequent communication, and flexibility [2]. It also claims a significant amount of time to develop and deliver [3].

- Values and qualities of each group or member are the most important requirements for a successful collaboration. Finding the right individuals or groups from different disciplines to participate opens more doors and enables possibilities for a successful collaboration [3]. To foster integrative thinking among the different disciplines and to encourage successful collaboration, the participants must have a sense of partnership for the team while contributing their individual expertise and knowledge of their area of study.
- Brainstorming allows participants to evoke a lot of diverse ideas and suggestions with different points of view. The project leader must provide these opportunities to everyone without any bias. All of the ideas and suggestions must be recorded and organized to collect all possible scenarios and directions for the project. There should be no argument and no friction. The team members must respect each other and listen, no matter what is suggested during the brainstorming.
- Communication is an important skill required for collaboration between different disciplines. It is necessary that team members communicate consistently and honestly with each other with mutual respect and open minds. All members must exercise active listening skills in order to “learn to listen and listen to learn” [3]. Though each discipline uses particular terms, they must be explained by common or intuitive words to enable others to understand. It is important to understand and communicate among the different areas.
- Teamwork and leadership are also essential requirements for making a collaboration successful. The leader of the collaborative team must set the vision, goals, roles, tasks, and responsibilities for each member or small group. The other participating team members must develop mutual respect, cooperation and respect to create an environment of truthful and innovative communication. The challenges of leadership are membership continuity, cultivation of a common language and method, facilitation of member growth, effective coordination of work and active engagement of members’ knowledge bases [3].
- Ownership and partnership are key elements to each team member. There should not be an employee-employer relationship. If this relationship is broken among the team members, the success of the collaborative work is threatened. A team member who takes on the role of employer may acknowledge responsibility for the project overall, but may divert his/her focus and energy from the workings of the project itself. This is an example of one of the general mistakes that can cause failure in a team.

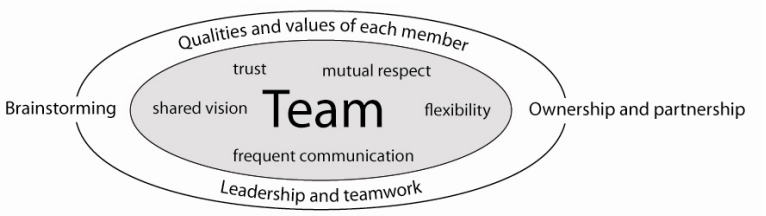

Figure.1 The requirements for a successful collaboration

2.2 The role of each discipline

- Industrial design

One of the roles of an industrial designer is to shape the interactions between users and objects by considering diverse questions. Industrial design is not just a simple activity dealing only with visual styling [4]. Once the proposal for the project is initiated within a business or marketing division, industrial design starts by identifying the user, the relationship between the user and the product, the uses of the product, the important interactions between the product and user, the opportunities to make the product successful, the technology required to understand the product, and the possible design solutions that will appeal and satisfy both the user and the company identity.

- Engineering and science

Engineers and scientists provide appropriate mechanisms and technology to make products work efficiently and are responsible to determine the reliability of the product. They approach tasks logically and scientifically in order to acquire accurate facts and data. They use prototypes to conduct a number of tests and experiments to find out the most suitable mechanisms and structures for the product. Their contributions in product development are significant and deal with issues such as material investigation, rapid prototyping, engineering drawing, cost-effective assembly, and manufacturing process. Typically, mechanical engineering and bioengineering work closely with industrial design.

- Human factors engineering

Human factors experts provide statistical data and information to designers in approaching the physical interaction between products and users and enable designers to shape more precise and universal outcomes. They have specialties in cognitive psychology, anthropology, human factors engineering, and ergonomics. The roles and responsibilities of human factors specialists are to keep the focus on the users by dealing with physical, cognitive, social, emotional, and cultural issues that have significant bearing on the success of the design. They also conduct ergonomic evaluations and anthropometric studies to gauge human dimensions and their impact on products [4].

- Interaction design

Interaction design collects the information relating to user experience, envisions new opportunities for the product, and explores the relationship between the object and user, such as intuitiveness and responsibility of design, graphic elements, and emotional effects caused by the product. As an extension of interface design and graphic design, interaction design concerns not only physical devices but also intangible things such as software and services. The role of interaction design is to provide not only visual graphical user interface but also a better communication between product and user.

- Business

Business and marketing plays a critical role in coming up with marketable ideas and proposals at the design conceptualization stage. The primary roles and responsibilities of business and marketing are to determine the appropriate database and collect corresponding information for new product development, such as product cost and value, consumer needs and user preferences, marketing strategy and management, sales strategy, public relations, and brand naming and advertising. Business and marketing experts investigate the product's value and the possibilities of success in creating proposals with other disciplines. Typically, business experts contribute to the development of a new product by analyzing the accessibility of the market and determining the possibilities of a product's success in the market.

- Social Sciences

In design, the role of social sciences is to analyze the relationships between people and things, such as material desires, social status, symbolic meanings, and other cultural issues relating to objects. Anthropologists typically conduct participant observation, perform interviews, and take photographs and videos in their data collection [5]. In collaborative design, people coming from psychology, sociology, and anthropology identify the social meanings of products, cultural constructions, and issues of ritual and routine.

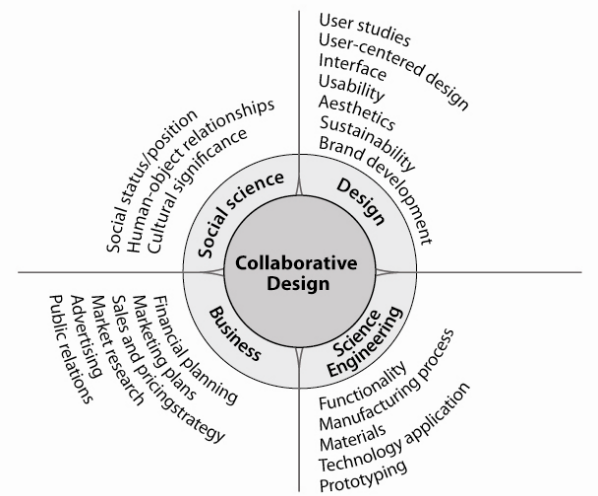

Figure.2 The role of individual disciplines in collaborative design

2.3 The role of participants in university collaborative projects

- Students

Typically, faculty in each discipline involved in the project chooses approximately the same number of students from each discipline for balance in performing the physical research and presentation. Participating students must be very skilled and qualified in their disciplines and they must be enthusiastic about of the project. Students will conduct the majority of the research. Therefore, they must recognize the project goals and their individual responsibilities from the first meeting with all participants. Once the responsibilities for each discipline are clearly identified, students typically divide the tasks into assignments for each individual, and they arrange their own flexible small-group meetings. Regardless of the nature of the material, presentations of work are made collaboratively, by the whole group. The students' primary responsibilities are to find information, analyze the data, and convey the findings to other team members using acceptable communication tools. Many different inputs and responses are generated during the presentations. Students must try to incorporate all opinions

generated by members from other disciplines and accept the facts without having to escalate to serious argument. Heated arguments among students can arise unexpectedly because of the multiple perspectives resulting from different fields of study. Attending faculty must manage this situation effectively to avoid any project-threatening conflicts. All participants must use common vocabularies in delivering and transmitting their knowledge and information. Particular languages or special terms used in each discipline can create confusions and frustration among the team members, and this can harm the teamwork and the established relationship between the members of the team. It is important that students learn from other disciplines and inform their own knowledge of product design and try to find common ground.

- Faculty

The most important roles of the faculty are finding opportunities for interdisciplinary collaboration and help developing the community. The faculty initiating the project contact other faculty or representatives in other disciplines relevant to the project and introduce the proposal respectfully. Once availability and interest are expressed by the representatives, a certain number of qualified students who are interested in the collaborative project are recruited, by several means, from the faculty in each discipline. Before the project begins, an informal conversation among representatives from the each discipline will be required. During the course of this conversation, participants will identify the goal of the project, the timeline, the deliverables, and the accountability of each discipline. Faculty members are responsible for advising and facilitating students, coordinating the project schedule, instructing the students by providing directions and guidance for them [6]. It is desirable that the faculty representatives attend all meetings with students, thereby making it possible to determine which disciplines are contributing effectively, what other input is needed from other disciplines, and how to transition to the next stage. Another important role of the faculty is to distribute the group's successful accomplishments through public presentations or papers. These activities can bring about more opportunities for collaboration and can help the community to develop subsequent projects and education programs.

- Sponsors

A sponsor's role is to provide professional feedback, criticism and technical support such as technology and to function, not as a client, but a partner. The presence of the sponsors will help lead to quality research from very skilled students coming from different educational backgrounds. New methods of approach in conceptualization and creative outcomes can be expected through the collaboration of these various areas of study. It is favored that sponsors do not force students in the directions that they want to see the research go, but should try to make students more flexible in doing research to produce diverse variations of the result. They do not necessarily need to attend all meetings with other teams but they are invited in major presentations to offer criticism and professional feedback.

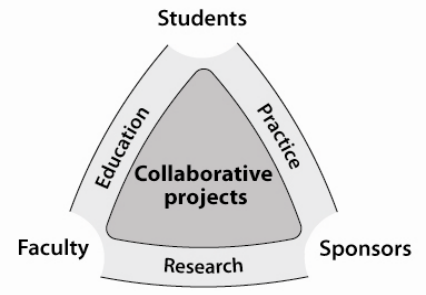

Figure.3 The relationship between participants in university collaborative project

2.4 Difficulties facing current practices

The difficulties in collaboration are communication, compromise, and coordination (CCC).

- Communication

Communication is a tool by which one person influences the cognition of another consciously or unconsciously using any kind of visual or verbal materials [1]. However, communication in design collaboration is one of the most common problems, since the team members are from multiple disciplines working together. Another common problem is precisely conveying knowledge and expertise through communication without losing the original meaning, and effectively accepting and understanding the information of the other participants. The vocabularies and symbols used in disciplines such as business, engineering, sociology and psychology can be extremely different. Cognitive ability to understand communication materials also varies widely among individuals. Design disciplines rely mainly on visual communication skills. On the other hand, engineers are most comfortable when presenting their data and expertise using calculated figures and intricate graphs. Social scientists often communicate in a more theoretical manner, which can cause misinterpretation among other team members. A common language and method must be used for optimum communication among the team members, and the communication channel must be open at all times [6].

- Compromise

Another problem faced in design collaboration is that each discipline will have different opinions and interpretations of the problem, and therefore have different methods in approaching them. This can possibly lead to arguments or conflicts among the team members. Engineers are mainly focused on developing the most appropriate mechanisms and trying to determine the cost-effective manufacturing techniques and materials. Industrial designers approach design with the considerations of aesthetic and functional hierarchies. These disciplines have different priorities in the process and are required to make certain compromises through exchange of views in order to gain maximum benefit from the collaborative design attempt.

- Coordination

One of the most difficult jobs in collaborative design is organizing and coordinating the program for the diverse disciplinary teams. Who will be team leader depends on the origination of the project. In the case of product design and development in collaboration, industrial design typically becomes the core coordinator and leads the project. Managing team members, coordinating meeting schedules, establishing time frames, attaining funding, and conducting research are the primary roles of the coordinator, and require a high degree of skill and experience.

2.5 Advantages and values of design collaboration

The advantages of design collaboration are:

1) Accurate research and results from different disciplines
2) Mutual responsibilities and roles
3) Extensive opinion and input
4) Qualitative research and opportunities
5) Professional practice and anticipation

There are several issues that must be addressed and resolved precisely in the process of process development, and this work should be conducted by skilled professionals. It is impossible for industrial designers to obtain all

of the knowledge that individuals in other disciplines possess. Furthermore, it is not necessary that an industrial designer master the knowledge to do thorough ethnographic research. Finding right the people from the right discipline and requesting the inquiries is a much smarter strategy than searching reference resources alone. This approach will also save a lot of time and effort, and will yield accurate information and materials.

3. Collaboration as a design pedagogical tool

The distinct advantages of this practice for design education and specifically students of design are:

1) Opportunity to work and learn in a multidisciplinary environment
2) Training to prepare for the real world situation/scenario
3) Hands-on learning and training in complete product development process
4) Learning and exposure to teamwork, knowledge, organization, responsibility, communication, and professional practice

4. Large research universities as fertile ground for collaborative design

Research-based universities provide an ideal environment for work with other disciplines for industrial design faculty who seek the opportunities, as industrial design programs strive to apply design collaboration as a pedagogical tool in design education. The methodologies of design collaboration have been created in industrial design programs and interdisciplinary design collaboration labs have been established at many universities in the U.S. New teaching and research methodologies are applied to industrial design for collaborative work and undergraduate and graduate students from other disciplines have the opportunity to register for these collaborative courses. They learn teamwork, gain knowledge and organization skills, improve communication, learn responsibility, and professional practice through the courses, which can be the best model and practice in design education.

5. How to bridge the opportunities in the university environment?

To make design collaboration happen, a university environment is very ideal. There are a number of different disciplines and programs to which industrial design can contribute for research and many are also interested in collaboration. The faculty's first assignment is to identify ways to bridge the opportunity within universities.

- Grant opportunities

Design collaboration has advantages such as grant opportunities, whether from local industries or government agencies. Funding resources affect a lot of issues in design process, deciding such factors as the number of participants and the depth of research quality. Working with other disciplines collaboratively in the university environment can create more opportunities to apply for grants from government organizations such as NSF, NIH, NASA, and SBIR. Although industrial design is rarely the main contractor, the exposure to and participation in funded projects as a subcontractor is still hugely beneficial. It is a great prospect for industrial design programs and faculty achievement. It is very unlikely to find funded research projects in industrial design programs but many industrial design programs in the U.S. are striving to find funded projects in collaboration regardless of the amount of money. This opportunity provides huge mutual benefits in design education and enables the participants to achieve qualitative, research-based solutions. Science and engineering departments have proficient experience in and capability of submitting government proposals, as compared to departments in the

design discipline. Therefore, working closely with them can increase the opportunities for funded research projects. Industry-sponsored collaborative projects supported by local companies and large-scale corporations have been coming through the industrial design programs at universities and creating successful academic research among students and faculty.

- Building networks

Typically, it takes a certain period of time for a junior faculty to build a network with other departments or programs within a university. The project cannot begin without faculty interest, and can occur by contacting each other. This is how relationships between different disciplines happen. Calling or e-mailing individuals working in other disciplines or organizations in order to introduce the project and requesting an informal conversation over lunch can be a great start toward building a university network. If colleagues already have connections with other disciplines, they can help to build new relationships as a bridge. Once the relationship is built with other disciplines or organizations, the university networking has already started and a lot of invisible opportunities to meet diverse experts who have connections with the individual or programs begin to surface. Many opportunities for sponsored projects from industries are offered from alumni or personal relationships. Therefore, keeping in touch with former students is also advantageous. Meeting individuals working at various areas through any kind of social or commercial gatherings – such as conferences, forums, exhibitions, and workshops – is a good way to build networks.

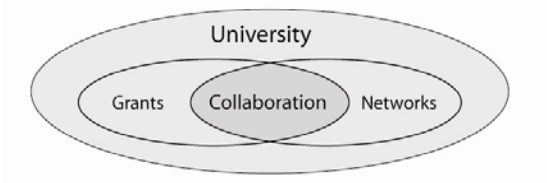

Figure.4 Opportunities in the university

6. A case study of collaborative design in an institutional context

A collaborative project to design a safety seat product for children that would be used in emergency vehicles such as ambulances and fire trucks was conducted by a group of local entrepreneurs and the department of Industrial Design at Arizona State University in the U.S. The industrial design team was composed of a faculty and two senior level industrial design students. The entrepreneur partners included an independent business consultant, the head of Emergency Medical Equipment Research and Development for the City of Phoenix Fire Department and a Captain on the Community Involvement Division of the Phoenix Fire Department. In assembling this team, our goal was to ensure that all stakeholder needs were addressed throughout the design process, making the product manufacturable, safe, aesthetically appealing, and ergonomically comfortable.

6.1 The role of team members

- Industrial designers

The design team focused on exploring possible design solutions that would satisfy the problem statement and meet the safety requirements of transporting passengers in emergency vehicles. Delivering fresh concept ideas, 2D illustration and renderings, 3D CAD models, and 3D appearance models were the primary roles of the design team.

- Fire fighters

With their many years of first hand experiences addressing the realities of using existing child restraint systems, the fire fighters played a significant role in bringing their concerns about safety and regulations to this critical project. They also provided context-specific research access to ambulances and potential users of the proposed seat. Interviews, site visits, and product observations were one of the most significant research activities undertaken when crafting the problem statement for the development of the new product. In addition, the participating experts were an integral part of the process of identifying user needs and safety concerns.

- Engineers

ESG Engineering, a local engineering company familiar with the requirements and regulations for seating products, was contacted to help develop the mechanism required for the infant seat. The engineers collaborated with the project leader and stakeholders to evolve the concept presented by the original design team to meet safety specifications and provide ease-of-use for the first responders. Other important tests, such as impact analysis and material test, were conducted with the CAD engineering drawings from the group. After the simulation test, the engineers made a full size working prototype to demonstrate the concept mechanism and function.

- Business consultant

The independent business consultant on the team undertook the appropriate database, collected relevant information for the new product development and provided the team with a concise executive summary. Based on this summary, the business expert and firefighters on the team acknowledged that this product offered a valuable opportunity to form a new company that would come to be known as Serenity Safety Products (SSP).

6. 2 Timeline and deliverables for design phases

It was a big challenge for the design team to develop a new product which has strict regulations directly relating to a life-saving product within 15 weeks, assuming 10 hours a week for each of the three designers. The implementation timeline for design process and design deliverables were outlined by the faculty and approved by the entrepreneurs in the contract document. The project was conducted in 4 main phases: 1) understanding the context, 2) concept exploration, 3) concept development, and 4) rapid prototype and documentation.

Figure.5 Final design solution of the safety seat for children on the ambulance

7. Conclusions

This project demonstrates that in situations where design is called on to solve very complex problems, it is imperative that a transdisciplinary team comprised of design, engineering, business and research is involved in the project. It is evident that no single discipline can tackle the intricacies involved in finding the most appropriate solutions to such complex problems. Teams that involve corporations, faculty, students, and local research groups need creative environments where multiple disciplines can exercise their unique knowledge in finding appropriate solutions. The university provides exactly this type of an environment for collaboration. The results of such collaborations not only provide excellent educational opportunities for students, but serve as great research explorations for faculty as well as viable product ideas for entrepreneurs.

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