**A Collaborative Effort: Integrating Interaction Design Evaluation into Product Design Process**

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**Introduction**

Due to the incredible increase in both product and system complexity that the use of advanced technology enables today, it is more important than ever for industrial designers to engage more directly with interaction design. The Interaction Design (IXD) program, recommended and supported by our industrial partner, the Whirlpool Corporation, was established as the latest addition to our Industrial Design major in 2010. It is a graduate program where students study cognitive and social systems to inform their knowledge, employ research methodologies to improve the design, and adopt innovative technologies to better accommodate human experience [9].

In the fall semester 2010, GE Healthcare sponsored a design project of home-based health monitors for patients with Cerebral Palsy, Parkinson’s disease, Multiple Sclerosis, and Arthritis. Students from two courses were involved in the project: one at the senior level, A&D 405 “Industrial Design III”, and the other at the graduate level, A&D 590 “Interaction Design Evaluation”. It is our very first attempt to group Product Design students and IXD students together on the same project. Since the topic of the IXD course was “design evaluation”, IXD students were expected to act in two roles: firstly to create the interactive design components of the concepts and, secondly, to run iterative evaluations to improve the design outcome during the design process. This paper introduces our attempt to instruct students in interactive-product-design with a multi-disciplinary approach. Different from traditional product design or user interface design, we adopted formative evaluation methods to ensure design quality, and explored the collaborative creation in the studio environment.

**Literature Background**

**Formative vs. Summative Evaluation in Interaction Design**

In the domain of IXD design, evaluation should not be thought of as a single phase in the design process. Ideally, evaluation should occur throughout the design life cycle, with the results of the evaluation feeding back into modifications to the design [2]. Clearly, it is impossible to perform extensive experimental testing throughout the design cycle. Michael Scriven [10] coined the terms *formative* and *summative evaluation* and emphasized their differences both in terms of the goals of the information they seek and how the information is used. Robert Stakes is quoted as saying, “When the cook tastes the soup, that’s formative. When the guests taste the soup, that’s summative”[11]. Formative evaluation is often applied in design-testing lifecycles to identify usability problems. It can produce both qualitative (narrative) and quantitative (numeric) results. Summative evaluation is used for finalizing a design in order to obtain some statistical information. In the process of design, formative evaluation is the main approach used
since its execution and result analysis can lead to optimized designs with comparably lower costs [3]. In our evaluation course, we introduced six evaluation methods ranging from summative methods, such as controlled experiments, to formative methods, such as heuristic evaluation. For product designers, evaluating the design iteratively during the process is a new approach. In this collaborative design course, we used the evaluation as one of the channels for IXD and product design students to communicate and collaborate. We want to explore if such an approach can inspire and promote design.

Formative Evaluation Techniques

Formative evaluation encourages a process of reflective practice. First, it provides rapid feedback on how the design is working. Next, the evaluation process can document how problem solving is proceeding. Finally, the outcomes assist with the planning of the next design stage. Formative evaluation can take many forms. Within the range of formative evaluation approaches, there are four main goals for formative evaluation - planning, implementation, monitoring and progress - each of which may be more or less emphasized depending on the design requirements [11]. Considering the size and length of our design project, we focused on conducting implementation evaluation to assess design at different stages. Three formative evaluation techniques were selected, to be applied in this design project:

- **Interface criticism**: a method to turn the *aesthetics conceptual re-orientation* into handles for practical design. It consists of: perspectives such as analysing stylistic references in the physical and digital interface, identifying the use of standards and conformance to tradition, investigating materiality and remediation, considering various design genres, exploring representational techniques and discussing challenges to users’ expectations [1].

- **Heuristic evaluation**: a usability engineering method for finding the usability problems in an interaction design so that they can be attended to as part of an iterative design process. Heuristic evaluation involves having a small set of evaluators examine the interface and judge its compliance with recognized usability principles (the “heuristics”) [6, 8]. Some frequently used principles are “visibility of interaction status”, “recognition rather than recall” and “error prevention”. The evaluation designer has the freedom to customize his/her techniques to review the design projects.

- **Usability testing**: a technique used to evaluate a product by testing it on users, providing direct input on how real users use the system or device [7]. Usability testing generally involves measuring how well test subjects respond in four areas: efficiency, accuracy, recall and emotional response. The results of the first test can be treated as a baseline or control measurement; all subsequent tests can then be compared to the baseline to indicate improvement. This method is usually used on more mature designs, but can be used with low fidelity mockups to establish general directions and better understand user expectations.

Collaboration Enhances Creativity

Collaborations that result in innovation are those that lead to change in their domain’s dominant paradigms. The collaborations involved intense dialogue over a prolonged period of time, are motivated
by a desire to transform knowledge, and integrate knowledge from multiple disciplines. Much research on collaborative creativity has been focused on investigating collaboration-metaphors between partners from distinctive majors, such as artists and technologists [5], or developing technology supported environments (co-located or distanced) [12]. Our interest in this practice is to explore the partner-based collaboration between innovative designers from two different design majors. We believe that brainstorming, conflict, frustration and compromise lead to a true innovative process.

**Design Experience**

**Weeks 1-4: Design Research in Parallel**

IXD students began learning fundamental evaluation theories and practicing several different evaluation methods. Their first assignment was to investigate the functionalities of commercial monitors. Shown by Figure 1, they worked in teams to plan and conduct studies on four kinds of commercially available home-based health monitors (blood pressure monitor, body fat analyser, blood glucose monitor, and peak flow meter). These products are all very mature designs, so it is feasible to conduct usability testing [7] to understand the products’ efficiency, accuracy, recall and emotional response. Through testing these products with recruited subjects, they identified several crucial interaction design issues. For example, the blood pressure monitor team reported six interaction problems. In one situation, the “Day” and “Night” buttons confused users into recalling the previously read data instead of storing new data in the device properly.

![Figure 1. Interaction design students conduct usability tests upon commercial monitors](image)

At the same time, product design students began identifying issues to be monitored and opportunities to improve health management of individuals with chronic conditions. They tried to investigate the causes, symptoms and treatments of conditions by conducting literature review, patient interviews and empathetic research [4]. Assigned to four different disease groups, students actively contacted family and
friends who had the condition, visited hospitals and clinics and searched for second hand research, white papers and previous surveys. Empathetic design research [4] was introduced to this class. Students began with experiments, such as taping the knees (to emulate stiff joints), putting rocks in shoes (to simulate chronic pain) and covering one eye (to experience loss of depth perception) to understand users’ needs (Figure 2).

![Empathetic Studies](image)

**Figure 2. Conduct empathetic studies to understand chronic conditions.**

After conducting this research, some students realized that monitoring may not be the most important of user needs. The initial design challenge was to find ways to improve the quality of life for individuals with chronic conditions by monitoring them. Currently, most of these conditions are incurable and degenerative. For some diseases, such as Multiple Sclerosis, monitoring the progress of the condition is ineffective or impossible. Students’ design focus shifted from monitoring the chronic conditions to relieving daily pain and improving quality of life.

**Weeks 5-8: Concept Design**

Product design students divided into eight 2-member teams. They brainstormed ideas and used sketches to illustrate selected concepts. Each of the teams generated twelve distinct concepts and presented these to evaluators in the IXD class and corporate reviewers (Figure 3).

![Concept Design](image)

**Figure 3. Two concepts for patients with Parkinson’s’ Disease and two concepts for Arthritis patients.**

**Week 9-10: Early Stage Design Evaluation and Integration**

Based on the sponsors input and the evaluation student’s criticism of the 12 concepts, each team selected three concepts from which to develop physical mock-ups. Most mock-ups are useful for understanding the size and shape of the concepts. Some mock-ups were functional for user testing. These mock-ups assisted in the progression of the concept’s development. For example, the mock-up walker shown in
Figure 4 helped its designers to ensure comfort and fit while walking or sitting.

Figure 4. A walker mockup to support patients with Cerebral Palsy.

During week 8, IXD students began to create the interaction design to improve and refine their teammates’ product design work. For example, for a digital injection device, one student needed to determine how to map the screen and control buttons on a slim injection tube. This proved to be very challenging. In another group, focusing on a device for Arthritic individuals, team members agreed on integrating the physical interactions of pulling and twisting with the digital interactions of choosing functions.

**Weeks 11-14: Design Collaboration and Refinement**

After the physical mock-up presentations, teams narrowed their focus down to one design concept. Product design students revised the selected concept based upon evaluations from GE Healthcare, faculty and their IXD partner. Each team built computer models for the final design. IXD students actively analysed the product’s interface and created the interaction design. For some of the projects, the interaction design component became essential. For example (Figure 5), one IXD student attempted to provide intuitive interaction hints and contextual information when the user is making rental selections.

Figure 5. Interface design for a medical product rental system - Medbox.

At the final design stage, IXD students conducted a round of heuristic evaluations to review their design projects according to Nielsen’s interaction design principles [6] and created a list of pros and cons.
Weeks 15-16: Outcome Preparation and Presentation

All projects were presented with well-rendered digital models. Some teams created animations to illustrate the interaction design. Unlike traditional design presentations, students were able to address the need for additional improvement of their design based on their heuristic evaluation outcomes. Their final presentations, made at the GE Healthcare corporate headquarters in Wisconsin were very successful.

Design Outcomes

Because we were limited by the length of this paper, we were unable to illustrate all eight design-projects. However, we highlight two examples in order to demonstrate the outcomes of multi-disciplinary design collaborations.

Agilis: feed the evaluation results back to the design

Agilis aims to partially support CP patients while both sitting and walking. When the product designers finished the physical prototype (in Figure 4), they walked around with it and were very satisfied with the outcome. Their IXD partner conducted a round of heuristic evaluation and identified several severe design issues: for example, the size and lack of adjustability in the seat does not allow users to both sit and walk comfortably. Additionally, the slope of the armrests created risk of the user falling forward.

Figure 6. Agilis Walker a product that allows standing or sitting with adjustable support, to improve leg strength.

Critiques can be transformed into good design ideas. As demonstrated by Figure 6, handles with button controls were added at the end of armrests to adjust the seat’s sitting and walking positions and also provide extra security to help avoid falling forward. According to the reviews, these additions turned out to be critical components of this walker design.

Motivate-me: blur the boundary between physical and digital interactions

There are three forms of treatment for people with arthritis: medication, physiotherapy and exercise. Exercise is the only approach without any negative side effects. In order to encourage and enable patients to exercise actively and regularly, the team designed Motivate-me, an interactive device that can schedule, detect, remind and record patients’ mobility and communicate the information to doctors (Figure 7).
Touchscreens have been utilized in many interactive device designs, such as the successful designs of Apple family products. IXD and product designers of Motivate-me carefully considered their design context and decided to use purely physical interactions to navigate and control because their users have difficulty making complex or fine finger movements. The interaction can be as simple as using the thumb to turn the wheel to select and push the wheel to confirm. Complex navigation among different modes can be achieved with one thumb. In the presentation, the team used animations to demonstrate the simple and elegant interaction process.

**Student Reviews**

Students reviewed the design process and provided feedback at the end of the course. There were many encouraging comments, such as “GE project was awesome. I loved my group and our interactive design student was amazing!” or “the process of evaluating the specific needs of Parkinson’s patients forced us to closely examine the user’s tactile interaction with the product through every step. The interaction design mind set really helped our team consider the experience that our product would create.” However, not all student reviews were so flattering of the collaborative process:

- “Working with an evaluator was a new experience. I think it requires some ‘meet and greet’ before jumping into the project, otherwise collaboration seems forced at first. But in the end it resulted in a better project that I was confident with every detail.”
- “I enjoyed doing the collaboration with interaction student. It was hard to get meeting times coordinated, but they brought a fresh set of eyes and in our case someone who is not focused on product design.
- “It was difficult sometimes because our interaction design group member missed a lot of the design process. I feel like we sometimes wasted time having to explain the project to our interaction design group member each time we met. On the other hand, without the help of the interaction design member, we would not have been able to accomplish as much.”

The primary challenge we faced in this project was the power struggle between the evaluation students and the product design students in determining how to improve designs to overcome problems. As teachers, we struggled with communication because the two classes were scheduled at different times.
The most challenging aspect was scheduling the project so that both groups of students could be active on throughout the 16 weeks.

Conclusions

Collaboration between product design and IXD students improved the design from the early concept phase through the final design. At the recommendation of our sponsor GE Healthcare, all eight design projects were submitted to the 2011 International Design Excellence Awards (IDEA) competition and we are happy to report that three of them were selected as finalist. This project also contributed much from the educational perspective. First, students gained the experience of working in a multi-role team and listening to evaluation results. Secondly, teaching an evaluation class is difficult because there are few suitable projects for students to practice different evaluation methods. Students also have no passion for evaluation assignments that only criticize without the opportunity to improve the interaction design. This class collaboration demonstrated an elegant approach to combining evaluation with design development. For future research, we are interested in developing and adapting IXD evaluation methods into the design process, conducting more collaborative design activities from different perspectives and inspiring creativity through a multi-disciplinary approach.

Acknowledgement

GE Healthcare Inc., 8200 West Tower Avenue, Milwaukee, Wisconsin, USA.

And all our talented hard working students.

References


