Leveraging Visualization Skills
The need for integration of design disciplines

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Abstract: We live in a complex world that is interconnected in many ways. The interactions between products, markets, cultures, organizations and multiple sets of users play an important role in the success of a product over time. Design education however, has not been as expeditious in its adoption of this new paradigm. Design curricula is typically structured with a focus on teaching a process toward the creation of a single form. We believe that there is a need for integration between the traditional disciplines. It is our position that designers and design educators must expand their focus from design as a form-giving process, to design as a process of visualization of actions and interactions in context. This paper discusses visual narratives as a means to leverage visualization skills among design disciplines and presents examples of successful student’s work. Each project demonstrates the benefits of system level interactions between individuals, products, cultures and information from a synthesized approach between visual communication and industrial design. The authors conclude that this strategy establishes a foundation for more meaningful learning outcomes and applications in design education practice.

Key words: design disciplines, storytelling, interdisciplinary, visualization, systems approach.

1. Introduction
Currently, students are educated in a single design space, and are more or less proficient in the design language that describes that space [1]. Recent graduates generally define themselves in terms of their academic major, since this is how they have been taught to see the world; their knowledge of and experience with other disciplines is likely to be quite limited. The academic majors themselves, are defined in terms of the “object” deliverable e.g. department of graphic design, architecture, photography, industrial design and the like. Undergraduate design education is also compartmentalized according to discipline. This current arrangement limits the opportunities for cross-pollination and interdisciplinary collaboration. The global economy and information age has given rise to a variety of challenges for the design professional. To adequately prepare students for the challenges they will face, we believe they will require a strong level of expertise in a particular design space as well as a broader area of competence through basic levels of expertise in the design languages of related fields [2]. It is our assertion that highly effective design professionals must extract appropriate ideology
and skills from a range of disciplines. Visual communication students must look to semantic issues to facilitate the design of functionality and experience (as required in web and multimedia communication). Conversely, industrial design students must adopt richer communication methods to visualize their products within a complex system of use. With the rise of technology driven products and sophisticated consumers seeking value-added experiences, the physical characteristics of the artifact are increasingly becoming secondary to the characteristics of the interactions the product system enables. For product designers the challenge lies in the conception of products as part of complex systems where information and information technology play a key role. For visual communication designers, more consideration must be given to the use and usability of their project outcomes as well as to their role as translators of complex visual information within the context of products, services and organizational systems. Today’s expanding range of applications such as wayfinding systems, web sites, motion graphics and information design are much more about interaction and experiences than they are about form and aesthetics.

As the body of knowledge and breadth of applications continue to expand in our various disciplines, how do we appropriately integrate the instruction of these multifaceted problems into design curriculum that is presently compartmentalized. Our strategy has been to leverage the expertise of our companion disciplines for structure, process, skills and principle. An examination of the relationships between industrial and visual communication design activity may prove useful in structuring a process for understanding and teaching design from a more systematic perspective. We believe of primary concern is a refocusing of instruction centering on the visualization and communication of interactions between users systems, and technology, through all areas of design practice.

2. Visualization and communication skills

The development of visualization skills is a predominant issue in traditional industrial design education. Students go through rigorous training in sketching techniques, prototyping and computer modeling. They become proficient at visualizing and communicating the form and function of a product. Along with these skills, they learn to consider the user in the design development process. Representing the product use and the product’s user is another important skill they acquire. While these skills will continue to be necessary, we believe they are no longer sufficient. Given the evolving map of design practice and design research we believe there is a need to expand the visualization and communication skills of our students to levels beyond the scope of the product and product user in order to consider the entire system in which the product-user interaction resides (political, economic, social, manufacture, etc). For VC students, traditional typography layout and skills will continue to be valuable assets but with the many opportunities generated by rapidly growing information technologies, students need to understand their ability to translate complex visual information into usable information within the context of products, services and organizational systems. “It is now becoming apparent that the traditional user-centered design approach cannot address the scale or the complexity of the challenges we face today. We are no longer simply designing products for users. We are designing for the future experiences of people, communities and cultures who now are connected and informed in ways that were unimaginable even 10 years ago” [3].
2.1 Visualizing users within systems

User representations or user visualizations in the context of product, software and marketing systems are not something new. Designers from many different fields have long used a range of methods to translate user information into product requirements. Product design engineers have used matrices and graphs such as the Quality Function Deployment QDF, which help transform customer needs into engineering characteristics, these representations have been implemented in many industries and advocates claim its use leads to better product designs, lower product costs, and shorter development times. Marketing experts have used the concept of market definitions to describe groups of customers that share common characteristics. Market definitions and market segmentations have provided a foundation for market research. Software designers have implemented use cases to describe, “a special sequence of transactions, performed by a system in a dialogue”, [4]. Use cases were critical in the development of software design as they captured functional requirements within a system. HCI experts have used the term *scenarios* to describe “stories about people and their activities” [5]. According to Carroll, a scenario “provides a concrete envisionment of a design solution, but can be couched at many levels of detail. They define a system design by specifying the tasks users can or must carry out, but without committing to the lower-level details”. Both Jacobsen and Carroll refer to the user as “actors” or “agents” and little attention is placed on the actual characteristics of the users. For Jacobsen the primary actors or agents are the initiators of the interaction, so they can be individuals or things. Within systems engineering, use cases are used at a higher level than within software engineering, often representing missions or stakeholder’s goals. Also in the context of HCI, Alan Cooper introduced the idea of *personas* as “hypothetical archetypes of actual users…defined with significant rigor and precision”[6]. Cooper’s personas are aimed to describe these hypothetical users in detail in order to give them value. The main difference between the traditional market segmentation and *personas* is that the market segmentation data is primarily quantitative in nature and doesn’t describe the user’s context of use and behavior. The demographic perspective remains important but it doesn’t include qualitative information such as the one gathered from field techniques such as observational studies, task analysis or participatory techniques.

While all of these different representations of users and systems have become valuable ways of infusing user data into the design process within each one of the contexts described, these representations often come in the form of static documents. According to Pruitt, personas and scenarios are dynamic in nature and designers need to “embrace the challenge of communicating information about users through narratives and storytelling” [7]. When taken in combination with the systems engineering approach, personas, scenarios and storytelling can be powerful tools for designers in the context of the increasing complexity of our design space.

2.2 Visual Storytelling: A Holistic Approach

An important shift in our teaching has been the way we ask students to understand their problem space from a wider perspective, to visualize the users in context and to communicate the process and their project results in effective dynamic ways. “Stories can be highly effective tools for communicating to others problems with current work processes and the value of new functionalities being proposed. Stories are useful with multidisciplinary or cross-organizational teams because they tend to serve as a “common language” that spans differences in background and organizational status and focuses attention on the people who will use the system.” [8]. Technology allows for presentations that include rich media and facilitate easier collaboration, co-creation, and
dissemination. Students use visual narratives to capture and describe the context in which new products and new technology will be used, these stories determine which functions will be important, how they should be presented, and what interactions with other products, people and information will be relevant. These stories also promote a way of thinking about how information is organized. Storytelling also conveys emotion and utility and allows the user to build a sense of empathy or ownership with the design solution. “The reader can experience the visualized interactions by empathizing with the user or the situation, like he or she would while reading a (comic) book or watching a movie”[9].

The benefit of storytelling is that it influences a more holistic approach to design and a clearer, more persuasive communication of outcomes. The three projects illustrated in this paper frame their problem and solution through storytelling.

3. Results of Teaching

We believe we must extend ourselves beyond the confines of our individual disciplines to develop pedagogy that addresses the unique characteristics of user interactions with products, spaces and communication. We propose interdisciplinary activity and conceptual convergence to achieve this. The Design Department at The University is unique in that Industrial, Interior and Visual Communication design are structured under one department.

The intent of this research is to present new directions to teaching design, in order to define a context for growth in professional education, and improve the user experience. Our results of teaching at The University have yielded a variety of solutions that are intriguing in their interaction, structured in their communication, and demonstrative of the value of interdisciplinary activity. Student projects highlighted in this paper are complex in nature, and place their focus on design as a process of facilitating interaction and experiences rather than design as simply a form-giving process. We present three examples that describe collaboration between industrial design students and visual communication students where their combined skills in visualization and communication allowed for a much richer understanding of the design space and more effective conveyance of results.

3.1 Designing for the aging consumer

Our first example is taken from an undergraduate project sponsored by a very large global manufacturer of household products. The primary objective for the sponsor company was to support and inform the design education community by encouraging the adoption of truly multidisciplinary projects in university design curricula. The focus of the program was “The Aging Consumer”, a particular area of interest for this company, given the global reach of their markets. This project aimed to identify and develop product experiences that can assist and support both the aging individual and their caregiver’s wellbeing in the context of ethnic households in the United States. The disciplines represented in the project were industrial design (twenty students, two faculty), visual communication design (five students, one faculty), mechanical engineering (three students, one faculty) and systems engineering (two students).
Critical to the success of the project was the students’ ability to empathize with a population unfamiliar to many of them. Some of the insights acquired during the research phase included diverse definitions of family, definitions of marriage and the role of women; status of the elder in the family unit; direct vs. indirect communication channels and patterns; language barriers; and mistrust of the American health-care system. The primary challenges throughout the course were visualizing the users in context and communicating findings to classmates, faculty and sponsors in effective ways.

The students used visual narratives in order to gain insights, understanding, and empathy with their subjects as well as to communicate research data and final results. Based on their research data, student teams built sets of personas that illustrated many of the cultural, physical and emotional needs of their target audience. After group discussions and feedback from faculty and sponsors, two defining characteristics of the population were identified: linguistic isolation and mutual assistance and dependence between family members. Once this conclusion was reached, the students were able to develop a more “mature” set of personas by visualizing them within a multi-generation family household (Figure 1). Once the “characters” and the “setting” were established, a narrative was developed and the students created visualizations through videos, animations, and sketches in order to convey the emotional needs and the physical challenges many individuals and caregivers in this market segment experience on a day–to–day basis.

The goal of the initial visualizations (Figure 2) was to illustrate a current undesired user experience in order to “set the stage” for the future desired scenario. The desired scenario conveyed the emotional effects of successful product interactions between users and not the details of the product’s physical characteristics.

This technique proved to be successful due to the fact that the sponsor company was not looking for final solutions but rather novel product opportunities. During the weeks that followed the students worked on
detailing the interactions with the product and the product brand utilizing different strategies, media and technology. One group videotaped “actors” who portrayed the characters in their scenarios (Figure 3) illustrating a sequence of desired activities. Another group used flash animations that included 3D renderings of their product line as well as the brand attributes of the proposed product “direction”.

The final presentation was given at the sponsor’s headquarters’ facility and was very positively received. The students were able to utilize a wide range of visual strategies and techniques that are typical in each of their disciplines but they were able to learn new skills and augmented by their collaboration.

3.2 Sustainable computing

Our second example is a senior level studio aimed at developing the students’ ability to understand the challenges of designing sustainable products and sustainable systems for a global economy. This project was part of a student design competition sponsored by a large computer manufacturing company. The primary goal of the competition was to explore new directions in green computer technology products. The project was centered on educational settings, specifically a college campus.

The initial phase focused on researching the computing environment, the user experience, and the business constraints of the current computers and computer systems in the university. The design research team was comprised of ten senior industrial design students and two engineering graduate students and one visual communication graduate student. During this phase, a variety of user research techniques were employed. They included several rounds of user observation, interviews, surveys, and questionnaires from which the team gained a more thorough understanding of computer use by students, faculty and staff members. Secondary research included library and Internet searches in the areas of product sustainability as well as the problems faced by the computer industry in its attempts to attain a more sustainable profile. At the conclusion of research phase, presentations were held in which the findings were reported, and the copious notes of all researchers were combined to form a master list of research findings.

The data was organized and analyzed in terms of the categories and the master list of research findings from the research phase was screened and the data was fit into broad meta-clusters. Initial and emergent research questions guided the formation of these meta-clusters. The meta-clusters identified included: System Issues, Adaptability, Transparency, Centralization and Design Issues. These categories were used by the faculty member and a visual communication graduate student to develop a set of cards. These cards summarized a set of personas and scenarios as well as system level constraints and product level requirements. They provided a starting point.
for the subsequent transformation and design phase (Figure 4) and were critical to the success of the project.

Figure 4: User profiles and design requirements cards

The students developed storyboards through illustrations, photographs videos and cartoons in order to explain the interconnectivity of a sustainable scenario. The primary objective of using these methods in the course was to reduce the complexity of the subject by providing the students with more comprehensive research data and to allow for visualization of the user and context within a more manageable “system”. Usage of these methods proved successful in developing good system level solutions (Figure 5).

Figure 5. Storyboards

3.3 Tractor Combine Thesis Project

This project was developed to satisfy the requirements of the 4th year senior thesis requirement. It was a collaborative effort between a visual communication major and an industrial design major. Both had experience with interdisciplinary collaboration through prior classroom activities. The two found common interest in interface and interaction design as well as agriculture, so the analysis and redesign of a farming tractor (combine) control system was a logical choice. The design challenge was to examine how interaction design would facilitate and improve the harvesting experience for the driver (farmer). Consideration of the entire user process from start to finish had to be investigated and a pragmatic set of deliverables had to be determined. The student’s initial research revealed that although the design of this farming equipment was physically impressive (Figure 6),
very little thought was put into the needs of the driver (Figure 7). Thus, the project became less about the design of physical controls, but more about addressing the needs of the tractor driver and how these individuals interacted with the system. The goal became about improving driver experiences, rather than focusing on object solutions such as seating, dashboard configurations, or ergonomics, as seen in the past.

Through general observations and analysis, the student designers had initial assumptions of what was needed in a redesign. Although some of their assumptions were true, we do not allow the students to approach a solution from a self-defined point of orientation. The students must go through a problem seeking activity prior to any type of problem solution undertaking. We make the distinction in that problem seeking identifies the appropriate issues that necessitate resolution. Central to this is to gain a thorough understanding of user needs and expectations. Several personal interviews were conducted with farmers, drivers, and equipment owners. This in turn led to the creation of personas and scenarios that aid in the visualization of the context of use (Figure 8). Personas were used to create representations of the range and experience level of users. These personas were then placed in scenarios to understand usage patterns and prioritize driver needs. This technique enabled the student designers to develop a multifaceted, holistic solution, focused on the machine’s interface.

Once the students had a good understanding of user needs they began with the development of the interface. They examined several different organizational models, visual languages, control configurations, and interaction levels. Each design decision referenced the personas and scenarios, enabling more objectivity and placed their designs in context. They concluded that a heads-up display (Figure 9) would be the most useful interface solution for the driver. The heads up display enabled a clear line of sight for the driver as well as flexibility and customization of interface position, size, and hierarchy. The number of functions was reduced and the menu structure was organized into driver modes (Figure 10). Depending on the driver and which mode he or she was in (plan, drive, harvest, or close), they would only be presented with menu options pertinent to that mode of operation. This made the menu structure much more approachable and easier to navigate.

Most notable was the form in which the project results were delivered. The depth of the project presented a unique set of communication challenges. It had to convey the student’s research, problem definition, process of discovery, design methodology, and results, which were interactive and time-based. The solution was to produce a 6-minute long narrative as an Adobe Flash movie, rather than the typical 3-dimensional model or presentation boards with schematics and annotated drawings. The narrated movie richly describes their research and design process, and puts the viewer in the position of a tractor combine driver (Figure 11). The viewer quickly gains
empathy for the driver and will see how the proposed design solution resolves many of the problems at hand. There is very little discussion about color, type choices, or form. The focus is placed on the interactions between the machine (system) and the user throughout an entire day of harvesting.

The collaborative activity on both the student and faculty’s part facilitated the success of this project. Faculty from both visual communication and industrial design advised and critiqued the work simultaneously. This transparency enabled faculty from visual communication and industrial design see the work from multiple perspectives. Their willingness to work together changed their typical view of a “thesis deliverable” and was crucial to the student’s success. For the students, the territorial boundaries sometimes seen in collaboration, for example, the visual communication designer will work on all the components that have type, were not evident because the project was about an experience, rather than an application. The students worked to their individual strengths while maintaining a strong sense of sharing, knowledge transfer, and teamwork. Each brought different skills to the table but at no time did the students work in isolation. The visual communication designer had a strong ability to create narrative, organizational menu structures, and design the visual form of interface controls. Complementary to this, the industrial designer had a strong sense of interaction design, systems engineering, research, and script writing. We believe their approach yielded a more robust solution and richer student experience and the result is unlikely to have been attained by an individual. As a point of reflection, one of the students stated the following:

“I felt it appropriate to collaborate with [my colleague] on my final project because I wanted to work in the same manner that professional designers work. The reality is a single designer does not know everything. The more focused eyes on a project the stronger and more appropriate the final output. [my colleague] was a hard worker. I valued his perspective as a visual communication student and as a friend with completely different life experiences. His past experiences allowed him to think about each design issue with different sensitivities and ultimately allowed us to craft a stronger design argument.”

4. Conclusions

The previously described projects were developed in a collaborative multidisciplinary environment. The authors supported the projects’ instruction, one with a formal background in industrial design, the other in visual communication. Each project was recognized as meritorious by internal and external sources, and the results were due in large part by the integration of disciplines and the teaching methods applied. Unique to these projects was the strategy of teaching that applied several new ideals in our curriculum. The first was the
utilization of personas and scenarios as a means to gain a deeper understanding of one’s user or target audience and the system in which they operate. This strategy allowed the student designer to gain empathy for their user and in turn promoted much more insightful results. As each project solution evolved, attention was given to the way the projects results were presented. We promoted the use of visual narratives or storytelling as a way to deliver a more holistic result. A result that was more descriptive of the solution and the context in which it resides. This was inclusive of all the activities that surround the product. Lastly, focus was placed on the experiences and interactions the project solution would elicit, rather than the characteristics of an object solution. We conclude that this approach yielded much more robust solutions and created richer learning experience for the students that transcend the framework of their respective disciplines.

With design’s increasing levels of complexity compounded with the demands of more discriminating consumers, we must begin to look at new ways to prepare our students for the professional environment they will enter. A rigid disciplinary approach to teaching will merely prepare students to work in a very narrow framework and limit their possibilities and potential. We believe design curriculum needs to change to adequately and responsibly prepare students for an environment that is dynamic, collaborative, and global.

5. Acknowledgements
The authors gratefully acknowledge the work of our graduate and undergraduate students presented in this paper.

6. References