Education and Teamwork Across Disciplines: A First Experience with an Interdisciplinary Course In Human-Centered Design

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Introduction

As we approach the 21st Century, significant demographic and ideological changes suggest that a design approach to make products, spaces, and environments more usable is warranted. Dramatic declines in mortality rates associated with a variety of illnesses, injuries, and age-related conditions have enabled an unprecedented number of people with disabilities to live longer and more independently. People also are growing older in record numbers and those aging into disability represent an ever-increasing proportion of the population. In addition, the disability movement that began in the 1970's has changed attitudes regarding the participation of individuals with disabilities in society. However, community living also has brought exposure to the barriers imposed by a world designed to be used (at best) by people without disabilities. As a result, handicaps imposed by unforgiving products and environments designed and built irrespective of the needs of individuals with different abilities are significant and often unrecognized[1].

Changes in who we are, what we can do, and where we live require a world that is more accommodating to variances in mobility, vision, hearing, cognition, and manual dexterity. All aspects of the physical environment including building layout and elements, signage, signal and alarm systems, telecommunications, and other user interfaces provide opportunities for improved designs that accommodate the needs of an increasing number of people with varying abilities. In fact, the magnitude of the population shift suggests that it would make more sense to design products and environments for *everyone* rather than creating different designs specifically for individuals who have limitations.

Universal design is an approach to creating everyday environments and products that are usable by all people to the greatest extent possible, regardless of age or ability[2]. Universal design involves a fundamental shift in thinking away from the practice of removing or overcoming environmental barriers for an individual or particular group of people (i.e., those with

disabilities) to a way of meeting the environmental needs of all users. Specialized design is predicated on the notion that people with functional limitations are different from people without such limitations and therefore require special products or unique solutions. Universal design, on the other hand, makes no such assumptions. On the contrary, universal design is *inclusive design*. It eliminates the distinction between people with disabilities and the rest of society. Universal design promotes design for children, older people and people with disabilities without considering each as a separate group of users; it presumes that people comprise a continuum of needs and abilities. By increasing the number of people whose needs are being addressed, universal design presumes that one good solution that meets the needs of a broad range of users is more desirable, convenient, and economical as well as less stigmatizing than multiple solutions for a myriad of subpopulations. This design strategy is particularly important for improving employment opportunities and options for people with temporary or permanent disabilities and older workers experiencing changes in their abilities.

A consequence of traditional design strategies is the requirement of people to adapt to the world, often while blaming themselves for their inability to function well within a poorly designed environment. This is echoed in comments such as, "My hands are just too small", or "I just don't have the strength to...", or I'm just not smart enough to program that VCR". The objective of universal design is the creation of products and environments that do not require users to make those adaptations. However, in order to make the world more user-friendly, it must be responsive to the needs of diverse users. To accomplish this, information about users, their needs, preferences, and abilities must be available to engineers and designers. In the absence of either valid and reliable data or direct input from people with disabilities and older individuals, those who design specialized products and environments have typically relied on traditional design strategies, including their own insights, personal experiences, and interactions, to develop new designs for this population[3,4]. However, in a human-centered model, design for differences becomes a key strategy[5]. In such a model, information about people with disabilities and older people is not only important, it also must be integrated with data for the general population. Therefore, the design process cannot be so reliant on personal experiences and insights of the designer, but rather must be based on input from people with varying needs and abilities. It is this perspective that provided the basis for this course.

Background

During the 1997-98 academic year, engineers and designers, faculty and researchers at North Carolina State University, planned and offered a new one semester course, entitled *Introduction To Human-Centered Design*. The course was designed to attract upper level undergraduates and graduate students in design, engineering, psychology, textiles, and business with interest in learning about inclusive design. The main objective of the course was to introduce an interdisciplinary group of students, through reading, research, discussion, and observation, to the concepts of *user-centered design* and *universal design*. Students learned about the spectrum of human capabilities, which make application of these concepts so important to society and individuals. They also learned to develop solutions to design elements in products, spaces, and workplace designs that create barriers to human function. Specifically, during the semester, students:

- Learned how to identify barriers faced by people as a result of poor environmental or product design.
- Were exposed to daily living and work activities from perspectives that were new to them, through direct interaction with people with disabilities, rehabilitation professionals, employers, and designers.
- Used appropriate user models in design and evaluation of products, work spaces, and public spaces.
- Identified and described different research methods for gathering data in product design or evaluation.
- Developed strategies for overcoming barriers to function.
- Learned about the continuum of design solution approaches (from design-for-one to universal design), and were able to recognize in which situations particular solutions or approaches are appropriate.
- Employed several design strategies in the design of products for daily living.
- Completed design projects and presented those projects to the other members of the class.

The faculty began to design the course by searching for and reviewing materials from other, similar courses. These materials were few in number and most often courses were aimed either at students of engineering or, more often, at students of design. Relevant work was found in proceedings of annual meetings of RESNA (The Rehabilitation Engineering and Assistive Technology Society of North America), ASEE, the Human Factors and Ergonomics Society, and SUCCEED[6, 7, 8].

Additionally, *Strategies for Teaching Universal Design*[9] documented the experiences of over 60 faculty from design schools across the USA who participated in the Universal Design Education Project (UDEP). Faculty and students together developed creative approaches to integrating a universal design philosophy into design instruction. According to Welch[9], the one teaching strategy that stood out as being more effective in raising students' awareness of the value of universal design was their involvement with consultants, or user/experts. UDEP faculty and students cite the involvement of persons with disabilities and other diverse users in the teaching and learning process as one of their most significant learning experiences. Design studios and classes with design assignments offered opportunities for students to engage the user/expert and to incorporate this new awareness into their design thinking. This underlying value, that students learn as much from users of design as they do from formal design teaching, was a guiding principle in our course development.

Approach

Phase One: Human Capabilities. The course was designed in three phases. During the first phase, students learned about a number of human capabilities from lecture and discussion with local experts – people with disabilities as well as professionals who work in the disability community. Topics included gross and fine motor control, speech, hearing, vision, cognition, and aging. In addition to classroom exposure, students used a design research tool called "A Day's Journey Through Life," developed at Eastern Michigan University[9], to conduct structured interviews with volunteers from The Center for Universal Design's consultant pool. Consultants

are people with disabilities or older individuals who through their lived experience are able to provide input and critical review throughout the design process. Students also researched the disability of their consultant using relevant literature and the Internet. This phase concluded with students making presentations to the class which were designed to inform the class about health and functional aspects of a particular disability or age-related condition from both a general and a personal perspective.

The faculty spent considerable time arranging for local consultants/user experts to assist students in class and with outside assignments. Students were provided with a list of people who agreed to participate and from whom they could call on. This included personal interviews for the "A Day's Journey..." project, and in some cases carried over to ongoing involvement with their final design projects.

Throughout the semester, and starting with the first class, students were asked to record design problems they encountered daily, or observed others encountering, in individual observation journals. Discussion of these observations occurred periodically during the semester, and included brainstorming as a means of searching for solutions to observed problems.

Phase Two: Design Primer. During the second phase of the course, students were introduced to some specific design methods, strategies, and tools. These included *House of Quality*[10] and Stuart Pugh's *Total Design* analysis[11]. These techniques, widely used in professional design development situations, gave the students a framework for developing and refining ideas based on input from users. To facilitate and structure the gathering of user input, students were introduced to some research tools and methods, including use of focus groups. Students also received an overview of the continuously evolving and improving on-line research tools of the campus library system, through a hands-on lecture/demonstration conducted by the engineering librarian.

Phase Three: Workplace and Public Space Design. Workplace and public space design was the focus of the third phase of the course, with students learning about the Americans with Disabilities Act, learning about workplace modifications that facilitate employment of individuals with developmental disabilities or brain injury, and touring a local manufacturing company whose facility was built based on universal design principles. Additionally, during the third phase of the course, students were asked to draw upon their experiences for a final design project, in which they could choose to address a particular design problem they had encountered during the semester. Most students opted to solve a specific problem that they identified when interviewing their consultants earlier in the semester, while some selected a problem from their observation journals. Throughout the third phase of the semester, students informally presented their evolving projects to the class in order to receive feedback, suggestions, or other comments from the students and faculty. The form of the final presentation and product was left up to the student, allowing them to summarize their ideas in formats with which they were most comfortable. In general, design students opted for visual presentation board displays while psychology and engineering students prepared written reports. Some students made functional or form models. All students made oral presentations to the class. Final project topics included an adjustable desk for use in classroom settings; a checklist for older adults to assist them in

identifying cars with appropriate design features; recommendations for design of an exterior courtyard for an assisted living residence; design of an assistive bathroom stall door closure device; a design concept for a yard and garden materials transport system; an oven mitt with improvements that included the ability to don and doff with one hand, reduced conductivity, and improved friction properties; an alerting system for people with hearing impairment; and guidelines for design of appliance controls.

Reference materials used throughout the course included works by Covington and Hannah[12] and Norman[4].

Evaluation

As hoped, the course attracted a diverse group of students: graduate students in industrial engineering, psychology, and liberal studies, and undergraduates in industrial design and biological & agricultural engineering. At the beginning of the semester, students were asked about their expectations for the course. Their interests included learning about designing for older adults, transportation design issues, design of graphical/telephony interfaces, product development, design evaluation, industrial applications of user-centered design, residential design for special populations, ADA interpretations, and incorporating adjustability into design.

Students evaluated the course using standard course evaluations, as well as a pre- & post-course evaluation designed by the faculty specifically for this course. Standard evaluations showed students rated this course as 3.7/5, which equaled the department average. Based on their beginning expectations for the course, for the most part, students felt their first-hand experience and level of comfort with specific topics about which they wanted to learn had improved over the semester. They also felt their experience and level of comfort with most of the topics specifically identified by the faculty had improved during the semester. Students reported enjoying the variety of people they met throughout the course, and reported experiencing a greater comfort level with people who have disabilities.

Based on student feedback and internal discussions, the faculty targeted several areas of the course for improvement, including 1) increasing consultant involvement throughout the course; 2) broadening the consultant pool to a greater variety of people, in terms of ethnicity, culture, age, and race; 3) improved use of selected readings to supplement classroom experiences; 4) providing more experiences outside the classroom to enhance observation of the impact of design on human-environment interaction; and 5) refining the student project experience including project conceptualization, teaming across disciplines, review and feedback of ideas, presentation format and grading criteria.

It is important that as future engineers and designers, students learn to view the world from the perspective of others, who are often unlike themselves. A critical part of the course was exposing students to people with disabilities from the community, including individuals with mobility, vision, hearing, and dexterity limitations. The faculty expects to increase the students' opportunities for interactions with the Center's consultants by inviting consultants to critique

student project presentations, increasing the number of consultants who participate as guest speakers for class lectures, and inviting consultants to accompany students on off-site visits.

Conclusions

The faculty feels this initial course offering was successful, having met its objectives to broaden students' views of the built world around them, while providing an enjoyable learning experience for the students themselves. We feel more design education needs to occur in a real-world context, and that includes engaging people who ultimately use and benefit from our designs. Our expectation is to refine and offer the course again, and in time develop a two-course sequence that includes the overview class presented here, followed by a more intensive project-based course where students conceptualize, build, and evaluate design solutions against human-centered and universal design values.

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