The Interdisciplinary Workshop: Immersion Into the Pedagogy of Team-based Design

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INTRODUCTION

This paper will describe the need, context, development, implementation and first results assessment of a set of interdisciplinary design workshops/charettes over a period of three years in six different university contexts.

This project, developing interdisciplinary pedagogical workshops, was part of a response to the mounting concern for the future of professional education. Traditional professional educational practices have intensified the insularity of the professional disciplines through barriers of language, values, prestige, and proprietary interest, as each discipline seeks to protect its information in order to remain indispensable.[1] This has happened at a time when our world is changing and growing at an unparalleled rate. Specialized knowledge coupled with many of the social and environmental problems that we face in modern society have fueled the rapid growth of technological innovation. The problem with the narrowness of much contemporary education is that problems exist that do not fit into the artificial boundaries that have been marked out by the individual disciplines. This hampers students' abilities to call a range of tools into play, and leaves college graduates unprepared to solve the complex problems of the 21st century.

Current educational practices tend to isolate the professions in order to impart specialized knowledge to the students. We propose, instead, to focus on the similarities between the disciplines. Herbert Simon writes that, "Everyone designs who devises courses of action aimed at changing existing conditions into preferred ones."[2] By looking at design in this light it is possible to see that architects, engineers, nurses, lawyers, comparative literature scholars, and musicians are at some level all doing the same thing and effecting similar change. It is possible, then, for specialists from different disciplines to learn from each others' methodologies and have fruitful conversation about design. This is not to say that specialized knowledge should be forsaken; but, in order for design to be effective, specialized disciplinary knowledge must be combined with an understanding, knit across disciplines, of the social and cultural context in which it is situated. This synthetic approach has further potential to draw diverse and underrepresented people, previously not attracted to technical education, to enlist in a more interdisciplinary environment that may have more political authority to address social issues, as well as the technical and aesthetic.[3]

LOCAL INTERDISCIPLINARY LEARNING

Throughout the past decade at our institution, the Schools of Architecture, Engineering and Humanities and Social Sciences have developed an interdisciplinary design program that takes into account the changing natures of technology and education. Based on a survey that we conducted of industrial and product design programs around the country, we saw that they fell into two categories: one stressing technical or engineering expertise (housed in an engineering school), and the second stressing aesthetic or arts expertise (housed in an arts and/or architecture school). Since there is little, if any, overlap, they fail to integrate the insights and expertise of each other. Moreover, neither incorporates into the curriculum an adequate expertise in how products shape social and cultural relationships and how in turn these relationships shape products.

We believe that in order for designers to have a positive impact on society they need to have an understanding of the technical issues of design, as well as the social-cultural and aesthetic implications of those designs. Until there are people who can navigate these complex issues we will continue to either have thinkers who understand what needs to be done in society, and yet are powerless to do anything, or engineers who have the ability to change society through their designs, but lack the intentionality to create real change.

Over a period of four years, and with generous institutional and national support, we created an integrated program linking our institution's Schools of Architecture, Engineering and Humanities and Social Sciences. The Product Design and Innovation (PDI) curriculum combines emphases on design, innovation, and society. The PDI program has now been in place for six years with over ninety students enrolled and over a dozen faculty involved. Faculty in the senior level engineering design courses indicate that PDI students are the "only students who can think with of both sides of their brains." The social science faculty continually remark on PDI students' quality of work, indicating that they seem to possess far better critical thinking skills than other students and can quickly connect issues from one course to another. The results from quantitative and qualitative assessments done in 2002 and 2003 for the National Science Foundation by Barbara Seruya and Associates of our PDI program suggest that the PDI students are indeed developing into future technology professionals. The PDI students are innovative and creative; demonstrate social and psychological sensitivity; can define design problems in a more systematic and articulate way than their non-PDI engineering counterparts; are more comfortable working in a group setting as a team; and are more likely to develop positions of leadership.[4]

LESSONS FROM THE STUDENTS

One of the most important lessons we have learned, however, is that these interdisciplinary studios can be good learning experiences for faculty as well as students. The studios also have the potential to inform faculty research.

For the social sciences faculty, working with students in an interdisciplinary setting has greatly facilitated both the teaching and research of the faculty involved. When teaching in an engineering context, typically social relations constitute a brief "front end" in the design process, and engineers will quickly ask for a list of "relevant parameters" so that they can remove any social complexities and reduce the problem to a purely technical domain. By teaching in a multidisciplinary setting we can pay attention to social issues throughout the design process. Participation in the PDI program has enabled social sciences faculty to communicate with engineering students about social issues in ways that are applicable to their disciplinary practice.

For the engineering faculty, there has been a realization that engineering education, and even engineering design education, is so problem oriented that there has been very little time allocated for allowing students to be creative. The studios have provided a means for building a student's creative capacities and skills. They offer a very different approach to the structured process taught in most engineering design courses. Additionally, integration of social sciences material with design work has led to critical discussions about the role technology plays in everyday life, and the impact a designer can have on society. The ways that a social scientist looks at the world can also lead to very innovative solution paths that are not considered if one is thinking only in technical terms.

For the architecture faculty, there has been an opportunity to share our studio design experience and to receive transformative critiques from our colleagues in engineering and social sciences. Challenges to our models of team definition and building, time management, clear assignments with stated outcomes have been resolved through discussion and exercise redefinition. Design has become much broader.[5]

EVOLUTION OF INTERDISCIPLINARY DESIGN EXPERIENCES AIMED AT FACULTY

During the summer semesters of 2000 and 2001, we developed an exercise designed to involve our own institution's faculty in an interdisciplinary design experience aimed at educating them about the benefits of the studio approach to design education. The exercise was modeled after our architectural design charrette. When eight faculty from diverse backgrounds are shut in a room for a week and charged to design something, something incredible

happens. In this case, the faculty designed a product for a 90-year old senior housing resident who called her 40-year old nephew on a regular basis to help her get stuff off the top shelf in her kitchen. The social scientists began by pointing out that asking for specific help was more socially acceptable than nagging for a visit. Engineers looked at ease of access and adaptability. Architects considered contemporary kitchens and whether the room itself should be re-evaluated. By the third day, the disciplinary boundaries and areas of insight were not so clear, and the groups coalesced to become informed teams.

TYPICAL INTERDISCIPLINARY DESIGN WORKSHOP

In 2002, with funding from NSF, educators from universities across the country were informed about a similarly structured workshop through a variety of media; the Internet, seminars, presentations and announcements at professional association meetings, e mail, etc. They were invited to attend a weeklong workshop during the summer where they would become part of an interdisciplinary group to learn innovative ways of teaching engineering/ design courses. The group would also be given a stipend whose distribution was determined by the lead contact from the institution.

Faculty and graduate students from Hampton University [HU] and the University of Colorado [UC] participated in the first two workshops in the summer of 2003 and were part of the initial investigating teams listed on the NSF proposal.

Applications were solicited for the next set of workshops. One of the strongest indicators of the relevance of this type of learning was the amount of interest that the workshops generated across the country. Twenty two institutions inquired about the application and indicated intent to submit and thirteen major national colleges and universities applied to take part in the interdisciplinary design workshops. Participants applied from programs including architecture, physics, theater, chemistry, math, economics, computer science, information technology, systems and a range of engineering disciplines including industrial, mechanical, aerospace, electrical and civil. The University of Michigan [UM] and University of Virginia [UV] were successful in their applications for the summer of 2004.

Content, facilitators and delivery of the workshop were slightly modified each time in response to the participants' experience of the workshop. Participants at the 4 institutions consisted mostly of educators from the engineering and architecture departments but also included faculty from comparative literature, ethnic studies, ceramics, science and technology studies, urban planning, industrial design and geography.

Our independent assessor summarizes:

"Throughout the week the facilitators helped develop the participants into a working team. The group had one major assignment over the span of several days, that is, to come up with solutions to a design problem, a problem that had societal dimensions to it. In contrast to other didactic workshops, the structure of this workshop was deliberately modest and fluid. Participants would have a good deal of hands-on learning in a group setting, centering on a "deep dive" experience. At points during the week workshop facilitators would explicate some of the group process to the participants, extrapolate the concepts from what the participants were doing and point to how they might be applied in the real world. Participants were also given materials and resources to assist their work." They had impromptu lectures on innovative strategies for implementation, alternative models for interdisciplinary practice, administrative structures for successful interdisciplinarity, etc.

"At the end of the workshop the team's design solutions were presented to the group. The workshop ended with a "reflection period" meant to help consolidate what they learned, to debrief them, and to obtain feedback on how the program was experienced. The Principal Investigators of this project, requested that external evaluation be undertaken of the *Design as a Creative Model for Technical Inquiry* program to be assessed from the perspective of the workshop participants."[6]

The workshops were designed and presented as a typical design studio lasting five days. Participants were given a simple, but open-ended problem chosen specifically to have multiple interpretations. The participating faculty from various institutions were invited with the expectation that they would become mentors in the future, to continuously build

a network of interdisciplinary professionals who will pass their knowledge of interdisciplinary design to colleagues and, by course design and implementation, to students. Facilitators for the workshops were faculty who believe in the promise and future of interdisciplinary cooperation and were joined for the last 2 workshops, based on need identified by the HU and UC experiences, by a professional leadership expert. The projects were conceived of and critiqued by an interdisciplinary team of faculty, undergraduate and graduate students.

The general schedule for the five days included: Understanding the Problem and Team Formation; Conceptualization; Concept Selection and Iteration; Building the Prototype; and Presentation. The workshop opened with an inaugural dinner and some ice-breaking design exercises. The first day of the studio began with an introduction to interdisciplinary design. Host faculty lectured on existing models of interdisciplinary design education. Lectures concentrated on how and why this program could be implemented as a successful institutional tool. The long term intent was for seminar participants to apply their knowledge to develop similar programs for students at their home institution. The workshop's major hurdle was to convince participants that this way of learning is valid and better than traditional teaching styles. By working in a design studio based in the same principle, it was hoped that participants would discover the overreaching benefits firsthand.

Days one, two, three and four were studio working days. During the first afternoon, participants were charged with identifying the problem, and asked to write up processes by which they would independently and discipline-specifically solve the problem. Participants were then split into cross-disciplinary teams with coaches with whom they worked directly for the remainder of the workshop. Each team had access to the Internet, appropriate software and machine and wood shops.

On the fifth day, teams presented their final scheme. The designs were critiqued by seminar leaders, other participants, and the team's own invited guests. Teams were then asked to reflect on their experience. The emphasis of both the critique and reflection period was the process, which included delivery of the final product. Teams were also asked to critique the program itself and to give their own opinions on the benefits and disadvantages to interdisciplinary teams. Success was not defined necessarily by the product's effectiveness, but as a combination of team partnering, reflection and design.

INTERDISCIPLINARY DESIGN WORKSHOPS CONDUCTED

The following are focused descriptions of elements of the workshops. They are not parallel evaluations, but as a group may reveal some of the observations that will become the basis of a more detailed and projective set of assessments.

HAMPTON UNIVERSITY

UNIVERSITY OF COLORADO, DENVER

Design a device for kitchen waste and recyclables

Summer 2003

Workshops funded by the National Science Foundation were held in the summer of 2003 at Hampton University and the University of Colorado, Denver. Each school had one team comprised of faculty members invited from the schools of architecture, engineering and humanities. Both were assigned to "Design A Device For Kitchen Waste And Recyclables," which included building a working prototype within five days. This very incomplete comparison identifies factors in the different approaches to interdisciplinary design employed by the University of Colorado, Denver and Hampton University.

Hampton University

The team was composed of a Professor and Chair of Architecture, Associate Professor of Architecture, two Assistant Professors of Chemical Engineering, and a Professor of Fine and Performing Arts.

The team at Hampton University began by deconstructing and redefining the problem. They spent most of their time exploring all dimensions and potential applications which led them on interesting tangents and informed the complexity of their final solution. Intermediate ideas ranged from redesigning the entire trash collection culture by removing the garbage truck and having home processing centers, to designing a landfill net which chemically breaks down trash. They brainstormed

concepts from policy to chutes that move garbage from kitchen to removal trucks. The facilitators were aware of some of their frustrations in moving forward and midweek, the facilitator, an artist, showed them slides of artwork made of trash. This turned out to have a great deal of influence on the outcome of the project.

On the final night before the deadline, the team agreed to do a project which centered on crushing glass. This direction chosen, the team split up into smaller groups which each researched different components pertaining to glass crushing. After physical testing, they became interested in sound which eventually led to a device for recycling which was also a musical instrument. Shaped like an oblong pyramid (a giant metronome), the prototype had a slot for bottles towards the top of its 4' in height. A system of weights and pulleys crushed the bottles and the broken pieces fell through the core striking pieces of wood generating different sounds and were collected in the bottom. From here, the shards were removed and ready for recycling. After the problem was determined, the group was successful in designing and building the prototype as a functional team project. Each person had a hand in all of the steps nearing completion.

Four members of the team are developing a cross-listed interdisciplinary design course for engineers and architects to be offered this Spring.

University of Colorado

The team was composed of an Associate Professor and Chair of Architecture, a Professor of Architecture, an Associate Professor of Mechanical Engineering, a Professor and Chair of Mechanical Engineering, an Assistant Professor of Architecture, and an Associate Professor of English and Director of Ethnic Studies.

From the start, at least one member of the team reinterpreted the problem as "designing and building a prototype for a kitchen waste basket." The only female, also the only non-designer became the "accidental client." The group deferred to her lead. Focused on a specific problem from the onset, this team solved the problem at hand with little exploration into alternative solutions. By moving quickly to a concept, they were able to focus on utilizing their noted team strengths, including shop ability, to develop a precise and finely executed cabinet.

To start, leadership positions in this team were taken by those accustomed to roles of authority (the chair and associate dean of the group). As the project progressed, alternative leaders emerged who came up with ideas and convinced others that their ideas were valid.

The workshop at Colorado has lead to a new course cross-listed between architecture and engineering called "Prototyping Techniques."

For both Colorado and Hampton teams, personality conflicts and outside constraints seemed to be the largest problems that the groups faced. In professional realms, the teams worked well together although the individual members came from different backgrounds. In many ways, the participants did not originally know how to work as a design team. The assessment prepared for NSF indicates that "interviews with participants have been positive. One of the participants said, "I discovered my art and engineering colleagues knowledge had more areas of intersection than what I originally thought. This reinforced my suspicion we don't know how to work collaboratively." As teachers, they have become intrigued by group dynamics and leadership qualities. They are also keen to apply varying degrees of interdisciplinary communication in their own studies. They were surprised to realize how much another opinion or expertise can widen the horizons and now seek help from unlikely sources." Hampton University invited the lead investigator back to hold abbreviated workshops with the entire institution's (350) faculty.

Both of these teams had multiple sets of diverse communities. For example, "at UC, we had 6 Latino/as, and one Caucasian, 6 men, 1 woman; 2 mechanical engineers, 1 civil engineer, 3 architects, 1 comparative literature and ethnic studies faculty member."[7]

UNIVERSITY OF MICHIGAN

UNIVERSITY OF VIRGINIA

Design a device to increase the fitness of unlikely exercisers

Summer 2004

University of Michigan

The team was composed of a Professor of Practice of Architecture in Structures and Design Construction, a Lecturer in Architecture, Design and Construction, University of Michigan), an Associate Professor of Architecture and Urban Design, an Assistant Professor of Architecture, History and Design - all in the school of architecture, a Professor in Art and Industrial Design and a Professor in Civil Engineering. The team was extremely well traveled, having taught and worked in Switzerland, Germany, Britain, India, Pakistan, South Africa, Egypt and Norway.

Most were familiar with the studio method of teaching and learning. A few had participated in experimental studios in the past which merged the fields of architecture, materials engineering and industrial design. Team members knew each other to some degree, and were all dedicated to making the studio work, aspects which they believed would make them a successful team both in the workshop and in teaching together.

This team was the most frustrated. The faculty member from the engineering school who had little knowledge of the design process and the most likely learner from this experience had sporadic attendance. The team was all male. In general, they were all only too familiar with the charrette process and didn't see how this workshop would add value. How they would be remunerated was also opaque.

The outcome of the Michigan workshop is the proposed course, "Contextual Engineering - Design Studio," to be run by the School of Civil Engineering and intended to expand beyond the boundaries of traditional civil engineering design studios. Students will be primarily engineers, but will be assigned to teams with architects, industrial designers and urban designers. Ideal teams would each have two engineers, one architect and one urban designer. By including students from different backgrounds, the course aims to promote understanding of design as a multi-disciplinary responsibility. Projects will address the aesthetic, social, historical and urban context. Potential projects for the course are re-informing urban blight of major US cities, development of artificial shorelines and floating infrastructures, planning of a sustainable city, personal transport redefinition and its urban implications, sustainable building project, alternative energy sources, and projects involving designing infrastructure by comparison. The studio will culminate in a proposal and prototype.[8]

University of Virginia

The team was composed of a Professor of Architecture, Professor of Mechanical Engineering, Professor of Technology, Culture and Communication, Professor of Material Science and Engineering, Professor of Electrical and Computer Engineering, Assistant Professor of Landscape Architecture, and Assistant Professor of Urban and Environmental planning.

Almost all the faculty had degrees in areas outside their field of practice, from Asian studies to environmental science. This gave the group a substantial breadth of knowledge that stood to benefit the team as they reached beyond traditional disciplinary boundaries of their practices. Having faculty already skilled at interdisciplinary work promises a huge advantage in their teaching interdisciplinary design. They also recruited students and other faculty to consult for parts of the workshop. This team moved easily through the process, and although there was a lot of erratic scheduling, they developed a process and remunerative scheme that positively engaged this as a time and financial management strategy.

One of two courses proposed by Virginia is titled "ECO-MOD**:** an ecologically based modular house proto-typing project." Its goal is to produce low-cost, high-value sustainable housing. These goals will be accomplished through rethinking modular home design in the context of a three year project. The first year will involve research into both the local housing market and the building industry in general. The second year will be dedicated to the design and construction of an actual modular building, with input from manufactured house companies. The final year will be a second iteration of the project that will build on what was learned in the first project.[9] The other course will cross urban, landscape and

public policy students.

OVERALL ASSESSMENT

The assessment reported that:

"the workshops were successful; that participants found it a productive experience to work as part of a group; that while most of these professionals espoused interdisciplinary values, working with other disciplines in this intense model was illuminating and challenging as well as productive and creative. Participants found it quite useful though challenging to engage in hands-on, experiential learning with perceived minimal external structure provided by this studio design model, and obtained a better understanding of what their students experience in their learning environment. The majority of the participants enjoyed the workshop process, which increased the likelihood that they will try to apply this approach in their own course setting."

Recommendations from the assessment included the possibility of "a shorter length workshop [A recent day long workshop with all faculty at Hampton has been completed]. The cornerstone of this approach is to provide experiential, hands-on learning. However, facilitators should assess the group's need for structure and consider adjusting the degree of structure provided. This way, anxiety reactions to the fluid boundaries in this situation may not transform into resistance to engaging in this process. Preliminary evaluation of this Interdisciplinary workshop initiative is encouraging for future efforts in this direction."

SUMMARY

The need to increase the number of faculty qualified to teach in an interdisciplinary way is what prompted our series of NSF-funded workshops, "Design as a Creative Model for Technical Inquiry." The project was aimed at faculty and graduate students, and we feel that the project has been successful thus far. We look forward to the outcomes of the courses designed by the workshop schools.

A university is a rich resource. Professors and students need to be aware of one another and the potential for sharing of knowledge and expertise both within departments and across disciplines. The Interdisciplinary Design Workshops conducted have opened up lines of communication amongst faculty of various schools that previously co-existed, but did not draw on each other. This networking potential between professionals can lead to intense learning environments, able to address the complex problems of the 21st century.

In the design studio, one is faced with an undefined problem. The task is to at once define and solve the problem. This requires one to "educate themselves to a new competence when they don't yet know what it is they need to learn."[10] In studio courses, students are asked jump into an undefined problem, realizing that it is only through grappling with the problem that they are able to understand and define it. This "learning through doing" is the heart of the architectural studio. For a studio to function as it is supposed to, agile instructors are needed who can facilitate the process. Donald Schön asserts that,

> The instructor is called upon to display a coach's artistry, a capacity for reflection-in-action on the task of figuring out how what is to be learned can best be linked to a student's present understandings and difficulties... She must be able to function as on-the-spot researcher into the student's understanding of the phenomena, and have on the tip of her tongue - or be able to invent - a method suited to this particular student.[11]

Just as there is no ready-made solution to a design problem, there is no ready-made way of teaching design. What our experience has taught us is that successful multidisciplinary experiences for the students require a faculty that are themselves multidisciplinary and understand the associated issues. Because these qualities are not always cultivated in a research university where accomplishments and recognition in one's own discipline are what are often most prized,[12] our next project addresses the opportunities of an agile curricular and reward structure that facilitates a pedagogy and research strategy for interdisciplinary investigations.

ENDNOTES

1 Cheryl Geisler, 'Forum for Integrated Design,' excerpted from work done for NSF proposal (1996), 2.

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3 Ernest Boyer and Lee Mitgang, Building *Community: a New Future for Architectural Education and Practice*, (Princeton: The Carnegie Foundation for the Advancement of Teaching 1996), 101.

4 Barbara Seruya, 'Evaluation PDI Program Evaluation Report,' (BBS&A 2001)

5 Frances Bronet and Gary Gabriele, 'Product Design and Innovation: Combining the Social Sciences, Design and Engineering,' (ASME CIA Submission 2003).

6 Barbara Seruya 'Evaluation Study of the Workshop Design as a Creative Model for Technical Inquiry,' (BBS&A 2004)

7 Garcia, Notebook

8 Harry Giles, Application for NSF workshop funding, 2004

9 Paxton Marshall, Application for NSF workshop funding, 2004

10 Donald Schön, *The Design Studio: An Exploration of its Traditions and Potentials,* London (RIBA Publications Limited 1985), 88.

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