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Key Learnings and Commitments from Mudd Design Workshop III*

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As the final two steps of Mudd Design Workshop III, a wrap-up session collected what participants believed to be the key learnings from the Workshop, and personal commitments were made, to take action based upon the things participants had learned during the Workshop. These commitments will be reviewed at the next Mudd Design Workshop.

THE SITUATION

AT MUDD DESIGN WORKSHOP III, *Social Dimensions of Engineering Design*, a variety of issues were surfaced relating to the teaching of engineering design, especially with regard to the interaction of engineering with the humanities and with societal issues. In order to send participants home with a sense of how the pieces all fit together, the final session was organized to collect and categorize what participants remembered as being the key issues. In addition, an attempt was made to follow the format of Mudd II, and send people home with action items based on the Workshop's key learnings.

IDENTIFYING KEY LEARNINGS

This was done in two parts. To start with Richard Phillips from Harvey Mudd reported on notes he had made throughout the Workshop, capturing what he perceived to be the important messages that he heard.

Following that, the participants who were still in attendance were asked to each list what they recalled as the three most important things they had heard. Twenty-nine people participated. These were collected, and organized using the *Affinity Diagramming* tool for making decisions with non-numeric data [1].

This organization was done by people who had chosen to sit at any of five tables in a grove outside the lunch venue. This resulted in five separate sets of clustered 'key learnings'. In order to bring these together into a single set of key learnings for the Workshop, people from Carnegie Mellon who had attended the Workshop and/or co-authored a Workshop paper were engaged to do a second round of affinity diagramming, using the group headings from the five first-round affinity exercise.

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RICH PHILLIPS' FEEDBACK

Overall, Rich noted that this group was very diverse, so that different people surely heard different things. He got a strong overall sense that: 'Design is a social activity, and takes place in a social context.'

He captured from Session 1 the *three threads* of design: social, symbolic, material. He had expected to hear, but did not, that since the graduates of the existing engineering programs do become leaders, graduates of 'new way' programs can be expected to create a climate more open to good design.

The shock to Rich in Session 2 was that as the participants representing the humanities and social sciences spoke, he became aware of a large body of literature with which he is at all familiar.

He missed hearing any discussion on who judges how good a design is.

From the third session, he got the sense that designers should *own* their designs, which may bring with it some responsibility for the outcome.

If you change the names of the roles of team members, could you perhaps change how people do design? Can science be done with a soul? Can engineering and design be done with a soul?

Beyond this Phillips noted mainly that all of the sessions provoked extended discussion.

COLLECTED KEY LEARNINGS

The output of the second round of affinity diagramming results in six topics

- How we teach engineering design.
- What we teach.
- What designers do.
- What we design—technical aspects.
- Good design requires diversity.
- Instances of diverse values.
- Need for a national infrastructure for design.

How we teach included such ideas as the need to recognize that design is a journey, not just results,

the need for more cross-disciplinary collaboration, and the potential value of teaching design in a studio environment. There are also needs for more understanding of how to evaluate students in design courses, more support for teaching design, and a better system of rewards for faculty who teach design—especially in the studio environment.

What we teach addressed farming design problems, and improving the functioning of student teams. There seems to be more need to teach students how to cope with complex systems.

Diversity in the next two topics refers to the main thrust of this Workshop: bringing the perspectives of humanities into design education and the practice of design. We heard the exciting new word *Techmanities*, referring most immediately to a program at Northwestern University where engineering and humanities faculty co-teach a freshman design course. People spoke of the interplay of design and politics and values. Environmental issues are important: Does this extend so far, as one participant suggested, as having designers take responsibility for reducing what some perceive to be a culture of over-consumption?

Finally, the idea of a National Engineering Foundation, which might hopefully better represent the engineering design community than the NSF does, was discussed.

(The complete set of key learnings appears as an Appendix to this report.)

COMMITMENTS FOR ACTION

Each of the people still present at the close of the Workshop was also asked to write on a piece of paper a commitment that they might be willing to make, for action based upon something they learned during the Workshop. People were seated at the final lunch according to similarities in their proposed commitments, and charged to discuss all the proposed commitments at their table, and to select one or two of the most promising for potential action by some or all of them at the table.

This resulted in fewer possible commitments than came from Mudd II, but with hopefully multiple owners for each.

Convince NSF to promote a more inclusive sense of socially responsible design

Owners of this potential commitment were Michael Black, Frances Bronet, Charles Gordon, Barry Hyman, Gordon Ross, and Ned Woodhouse.

Perhaps an important focus might be on design projects 'worth doing'. There might even be a series of short-term and longer-term projects (e.g., a bike powered multi-person transit unit) that might be promoted for use at multiple schools.

Continue the conversations between the principals begun here, perhaps via a threaded discussion forum in which others can participate

Owners: John C. Anderson, Todd Cherkasky, T. Govindaraj, Judith Gregory, Ulrick Jorgensen, Rich Phillips, T. L. Taylor, Bill Wood.

Some of the specific topics and interests we wish to explore include:

- gathering feedback from others on how to reform or expand particular courses and curricula;
- finding ways to help students recognize stakeholders;
- finding ways to help students integrate social context and stakeholders in our design projects.

Education-related potential commitments

Owners: Carl Baumgartner, Bruce Corson, Sarah Kuhn, John Lake, Pat Little, Joe Shaeiwitz, Eswaren Subramanian, Langdon Winner.

- Perhaps create a consortium on design studio education, which might lead an assessment of studio-based learning/project-based learning. Both physical space and learning environment seem to be important aspects of the studio.
- Establish a campus-wide design initiative to promote coaching rather than lecturing.
- Engagement of skills/increase of skills of potential faculty.
- Freshman course with studio focus. (How to obtain a proper studio facility?)
- Promote teaching values with design—especially related to over-consumption and social/societal impacts.

Plan 'Mudd IV'

Owners: Pete Counce, Richard Evans, John McMasters, Steve Lukasic, and Greg Olson.

'Design in/for a changing/growing world' focuses on

- change agents;
- paradigm change;
- politics.

Consider this at the department, institutional (national infrastructure), and global level. Enlarge the group of participants to perhaps include CEOs, National Academy of Engineering members, and Deans of Engineering.

Conduct an Assessment of Mudd III

Owner: Phil Doepker.

PERSONAL COMMITMENTS

I subsequently wrote to each 'owner' from this list, reminding them of the potential commitments identified at their table and asking to what they were personally prepared to commit. Nine people replied with personal commitments

1. To help other members of the HMC faculty to appreciate the advantages of coaching vs. lecturing. (Carl Baumgartner)
2. 'I will greatly step up using design criteria in my writing.' (Michael Black)
3. Convince NSF Program Managers concerned about design (and NSF in general) to redefine requests for proposals to include a more inclusive sense of socially responsible design. (France Bronet) (At the time of writing, Dr. Bronet had begun working on this, by meeting with George Hazelrigg of NSF.)
4. Further 'system design education' and the development of a system design curriculum, also considering system design theory, principles, and applications. (Richard Evans)
5. 'I should have the threaded discussion groups ready in a week or two. Only this afternoon (June 19, 2001) I received my new software from Apple after a few weeks of waiting. I wanted to install the discussion list on a Mac OSX server. I plan to work on one or two more items on the list as well.' (T. Govindaraj)
6. John McMasters had by July 1, 2001 already authored a letter from the Boeing President (Phil Condit) to the Chair of the NAE (William Wulf) about curriculum and faculty reward changes.
7. 'I'll explore options for change at the national infrastructure level.' (Greg Olson)
8. Joe Shaeiwitz signed up for: (a) implement a studio environment—space and learning; (b) press campus-wide design for more coaching versus lecturing (I already do this); (c) understand and communicate the relationship of social/societal impacts in design and education.
9. Conduct an assessment of Mudd III. (Phil Doepker) (This was already well under way by mid-July, 2001.)

These will be followed up for a report at the next Mudd Workshop on Design, tentatively scheduled for two 2003.

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APPENDIX

A. How we teach engineering design

A1. Pedagogy
A1.1. Design as a journey, not as an end
A1.2. Need for a design studio as physical and social space
A1.3. 'Studio methods' are more extensively used (successfully) than I had hoped
A1.4. Teaching by mentoring and coaching especially regarding participation in:
A1.4.1. Problem formulation
A1.4.2. Open ended exercises and simulations
A1.4.3. Design studio concepts
A2. Pedagogical Reform
A2.1. There is a profound need for reform in higher education
A2.2. Overall understanding of systematic issues and design potential
A2.3. One can use the curriculum to move from the artifact to the system
A3. Processes (for doing design)
A3.1. Design research must not work on abstractions, but on actual processes
A3.2. The tension between mathematical/structured methods and the needs of society can't be resolved
A3.3. Naming and framing is the only way to solve the problem and to set the social context
A4. Design Studios
A4.1. That the environment in which design activities are performed affects the product
A4.2. Design studios afford the most conducive environment for teaching design
A4.3. We need studios and they should be visually stimulating
A4.4. Individual vs. teams—team effectiveness and how it is affected by individual assignments
A4.5. What is the most efficient/effective way to promote teaming
A4.6. There are more dimensions to interpersonal communication than I have previously been aware of
A4.7. Do not use 'design teams' as design decision groups- rather, organize using the basic A, B, C model.

A5. Diversity and Cross-Disciplinary Collaboration
A5.1. Design is done in many disciplines
A5.2. Multidisciplinary education in design is a key part of a liberal arts education, not engineering alone
A5.3. The understandings of some social scientists and some engineers about design are actually very compatible
A5.4. Diverse group of participants worked in good train towards a common goal
A5.5. RPI has a wicked-cool set of projects for students to work on (and spaces to work in)
A5.6. Three systems to be designed, not just one
A6. Evaluation
A6.1. We need to spend more time thinking about how we define what the problem is, rather than what the solution to the problem is. ('why', not 'how')
A6.2. How do we amass 'good' design vs. 'bad' design? How do we design design processes
A6.3. Participatory design—involving other people with other perspectives in the design process
A6.4. Model of participatory design and benefits it can provide
A6.5. Role of coaches in design education
A6.6. Use time sheets as part of peer evaluation in design courses
A7. Rewards for Teachers
A7.1. Assessment of coaching and rewards
A7.2. Faculty reward issues including coaching incentives are no more advanced than they were circa 1995. Much progress needs to be made.
A8. Support for Design Education
A8.1. There is a general feeling in the public- supported universities that practice—based engineering professors may become extinct
A8.2. Desperately need NSF to support design education
A8.3. Be aware of particular social context of design

B + C, following, are both parts of What We Teach

B. What designers do

B1. Framing of the Design Problem
B1.1. Insisting on discussing this as 'engineering design' rather than design is a self-limiting perspective
B1.2. Balance tractability and missing the picture in defining the design problem
B1.3. Design is not always the solution to the problem
B1.4. Identify threads in design discussions
B1.4.1. Material
B1.4.2. Symbolic
B1.4.3. Social
B1.5. Set limits on complexity
B1.6. A common thread links complex system design in many disciplines
B1.7. Interplay of ethics and social responsibility
B1.8. There is a widespread thirst for broader perspective on the 'situation' on the act of naming and framing
B1.9. The idea of ecological systems as a domain for continuous system management and control
B2. Operation of Design Teams
B2.1. Importance of leadership in design teams
B2.2. The relationship between the physical learning space and what is taught. e.g. studios, offices, . . .
B2.3. Open problem settings giving room for discussions of use
B2.4. Three-dimensional thinking to enhance search—as looking for malice aspects etc. What might be at least three dimensions of this

C. What we design—technical aspects

C1. Complex Systems
C1.1. Logic is an organized way of going wrong with confidence
C1.2. Think about the drawbacks of consumption based student design projects
C1.3. Issues about design success and failure in complex systems should be an important focus of design education
C1.4. System design needs to include defense against attack and mediation of effects; I had previously thought about protection against non-malicious and random events
C1.5. When systems are connected, they inherit the flows of each other
C1.6. Maliciousness as a potential design criteria

C2. Enhance the Technical Framework
C2.1. Enhance the technical frame—work of 'design' may be in the context of semantics

D. Good design requires diversity

D1. Humanities and Engineering Integration
D1.1. 'Techmanities' integration is needed and doable
D1.2. Passion, spirituality, and personal identity are a basis for engineering design
D1.3. Engineers and engineering can benefit from interaction with social scientists
D1.4. Social and cultural issues are important in design, but it is not easy to integrate them into design education
D1.5. Under the right circumstances, conversation across the disciplines can be enormously fruitful
D2. Take Into Account Diverse Perspectives
D2.1. Teach design like debate: each student takes multiple roles, including anti-business, anti-innovation
D2.2. The importance of multiple views to feed into the engineers teacher—centric views
D2.3. Others are farther along than I am, but 'we' are all 'we'
D3. Interdisciplinary/Multidisciplinary Critiques
D3.1. Rehumanizing engineering
D3.2. The possible critical role of design as liberal art
D3.3. Ways undergraduate engineering education constructs particular tech. cultures and identities
D3.4. Alchemy science and source in relation to medicine and patient care in different social influence and cultural contents
D3.5. Future meetings such as this must include a humanities/social sciences component and participation. True whatever the focus of future meetings may be
D4. Anomalies
D4.1. Unconscious use of particular metaphors for projects/discussion
D4.1.1. Attack/espionage
D4.1.2. Dragonslayer
D4.1.3. Spores projects
D4.2. System vulnerability and the social construction of maliciousness
D4.3. The key idea/paper that spawned the internet was written by a psychologist

E. Instances of diverse values

E1. Design plus Values
E1.1. The concept of 'techmanities' and what it might subsume
E1.2. How to seamlessly embed ethics into curriculum, methods, and mentoring/models
E1.3. Design is a potential means to get to the spiritual (the soul) and to raise the ethical
E1.4. Students need to be reminded that they are not distinct from their solutions
E2. Design Driving Society
E2.1 Design against over consumption
E3. Politics plus Values
E3.1. Analyzing large-scale systems with an eye to exposing their unstated assumptions. Finding ways to think beyond homogeneous systems
E3.2. 'The design of risk'
E3.3. More explicit articulation of values and expose underlying assumptions
E3.4. Values in design and ethics in relationships. How to practice values and ways of working on design projects
E3.5. Role of professional societies in creating ethical considerations/frameworks
E3.6. The relationship between design and control deserves further exploration
E3.7 Infusing participation, wild diversity without narrow decision making structures
E4. Environmental Issues
E4.1. It is possible, or at least desirable, to integrate social and environmental values into all aspects of design
E4.2. What is the balance between utilizing resources for the benefit of mankind and environment? How should designers consider?
E4.3. Consumption—How do you include consumption as a design requirement or design criteria

F. Other

F1. National Infrastructure
F1.1. NEF or a clear and forceful charter for real engineering would be beneficial
F1.2. We need an NEF to provide the resources for our cause

John Wesner received his BS and his Ph.D. in Mechanical Engineering from Carnegie-Mellon University; in between he earned his MSME from Caltech. Recently retired from Lucent Technologies Bell Laboratories, Wesner's experience is in many aspects of engineering design, mainly doing and managing product design. Successful products include a shipping container for nuclear power reactor fuel assemblies, AT&T's first data terminal, and Lucent's MERLIN Small Business Communication System.

He has experience managing development projects using formal project management methods, and coordinating R&D quality improvement. He is co-author of the book *Winning with Quality: Applying Quality Principles to Product Development.* Currently Chairman of ASME's Committee on Technical Planning, which is charged with insuring that ASME's Council on Engineering stays abreast of the technologies important to Mechanical Engineers, Wesner served during 1996–1999 as ASME Vice President for Systems and Design. Previously he founded the Design for Manufacturability Committee, chaired the Design Engineering Division, and served on the Board on Engineering Education. Outside of his profession Wesner is a published model railroader, a strategy gamer and a 50-year Boy Scout—an Eagle Scout who has received the BSA Silver Beaver Award for distinguished service to youth.