Last edited by CLD at 4:20 PM on 3/11/03.

Social Dimensions of Engineering Design: Observations from Mudd Design Workshop III

(An Educational Brief)

Clive L. Dym
Department of Engineering
HARVEY MUDD COLLEGE

John W. Wesner
Department of Mechanical Engineering
CARNEGIE MELLON UNIVERSITY

Langdon Winner
Department of Science and Technology Studies
RENSSELAER POLYTECHNIC INSTITUTE

Abstract

This paper reports on a design education workshop held at Harvey Mudd College (HMC) in May 2001. Mudd Design Workshop III provided a forum for engineers, social scientists, designers, researchers, and educators to explore social and societal issues in and for engineering design education. Sessions were devoted to social and systems issues and themes in design; collaboration in design; and pedagogical and institutional issues in design education. Major emergent themes included the need for dialogue about the social dimensions of engineering design to extend across entire college and university faculties, the use of design to enhance the study of values and ethics in undergraduate curricula. the importance of the framing of design problems, and of pedagogical choices made in design courses. Before leaving, participants made commitments to bring about change at least in their own environments.

Also Hixon-Riggs Visiting Professor, Department of Humanities and Social Sciences, Harvey Mudd College, Spring 2001.

I. Introduction

We have been repeatedly warned about the gulf that exists between the technical world and the humanist world, and the difficulties and risks of trying to bridge that gulf. In May of 2001, thirty eight (38) engineers and nineteen (19) colleagues from the arts, humanities and social sciences faced those risks by coming together at Mudd Design Workshop (III), the third in an ongoing series of workshops on engineering design education organized by the Center for Design Education at Harvey Mudd College. For three days they declaimed and listened and discussed — occasionally confrontationally —how engineering design might be both taught and practiced better if the two groups maintained regular intercourse.

II. Structure and Themes of MDW III

MDW III was organized much like its predecessors [1–3]. All participants took part in seven topical workshop sessions over two and one-half days, covering various views of design and design education. Session format featured brief presentations by three or four panelists, followed by open, moderated, general discussion.

An eighth session looked backward to commitments made at MDW II in May 1999 [2], and a ninth looked forward (tying everything together and making new commitments).

Discussion was further stimulated by several keynote talks:

- The challenge was cast at the opening lunch by C. L. Dym and L. Winner, providing perspectives from, respectively, engineering and the humanities and social sciences, on the social dimensions of design;
- Larry J. Bucciarelli, Jr., introduced and conducted the playing of his Delta Design Game, "Engineering as a Social Activity";
- The "Recent Boeing Experience" was described at the second luncheon, by John H. McMasters; and
- Stephen J. Lukasik described his experiences while "present at the creation" of the Internet in his former role as Director of the Advanced Research Projects Agency (ARPA).

III. The People

A majority of MDW III's fifty-seven (57) participants represented the technology side—four from industry, one from government (NSF), and thirty three from educational institutions. Their backgrounds included several engineering disciplines plus "general engineers" and administrators. Twelve were from an interesting middle ground between arts and humanities, on the one hand, and technology, on the other, including some architecture professors and a larger number from "technology and society" programs. Only seven appear to have been "pure" humanities professors. This mix rather diminished the likelihood of open conflict between extreme views on the two sides. We can, in fact, remember one only

instance where a gut-level argument began to develop; it petered out after a few rounds.

IV. The Sessions

The seven working sessions addressed:

- Social Issues and Themes in Design;
- Collaboration in Design;
- The Many Meanings of Design;
- Product and Process Design;
- Design in and for a Complex World;
- Institutional Issues; and,
- Engineering Design Education.

Faculty from arts and humanities were presenters in only the second, third and sixth of these sessions. Those with "feet in both worlds" presented in all of the sessions except for the one on Product and Process Development, in which all of those who gave papers were engineers.

This seemed most odd for the first session, which consisted mostly of engineers presenting their views of how well the technical world is paying attention to social issues. On the other hand, three *threads* of design emerged from this session: *social*, *symbolic*, and *material*. However, we never did reach a conclusion as to whether (or not) we can expect graduates of "new way" programs will be able to create a climate more open to good design.

V. The Learnings

There were several interesting and important lessons or "learnings" that we took away from this workshop. They are:

V.1. *Good design requires diversity*.

Diversity in this context refers to this conference's main thrust of bringing the perspectives of humanities and social sciences into design education and the practice of design. Can engineering be "re-humanized"? To what extent is design itself a *liberal art*? Social, cultural, and political values are important in design, as are matters of personal passion, spirituality, and identity. Environmental issues are important, but the question was left unanswered whether or not this means that designers should take responsibility for reducing what some perceive to be a culture of over-consumption?

Engineers (indeed, the entire engineering community) can benefit from interaction with social scientists.

Design is done in many disciplines. Thus, multidisciplinary education in design is a key part of a liberal arts education, not just of an engineering or fine arts

education. The *weltanschauung* of some social scientists and some engineers about design are actually very compatible.

We heard an exciting new word, "techmanities," referring most immediately to a program at Northwestern in which Engineering and Writing faculty co-teach a freshman design course.

V.2. *What we teach in engineering design.*

Much of design education is done via *projects*. We need to address the *framing* of design projects, because there is a widespread thirst for broader perspective, including addressing the interplay of ethics and social responsibility. In addition, we need to improve the functioning of the student design teams who carry out the projects.

We need to spend more time thinking about how we *define* what the problem is, rather than just what the solution to the problem is.

We need to teach students how to cope with complex systems; too often we revert to over-simplified versions. Once advantage to be gained here is that the examination of complex systems virtually demands a multi-disciplinary approach and a multi-disciplinary team.

Design is a potential path to get to the *spiritual side*, the *soul*, and to raise ethical concerns. Students need to understand that they are not distinct from their design solutions. How might we seamlessly embed ethics into curricula, methods, models and mentoring? What could (or should) be the role of professional societies in creating frameworks for ethical considerations?

The question asked, Do design projects consider the vulnerabilities of complex systems to malicious forces unanticipated in their design? (And recall that MDW III was held long before 9/11/2001□.□.□.)

V.3. *How we teach engineering design.*

We need to recognize that:

- design is a *journey*, so design classes are not just about results; and
- there is a need for more interdisciplinary collaboration.

Design education abounds with opportunities in which to address *values and ethics*, as well as the impacts of design work on society.

Design education could be (is??) at the forefront of pedagogical reform because it stresses cross-disciplinary collaboration, team interaction, and the pedagogical potential of teaching engineering design in a studio environment. The studio concept was discussed at length. Our colleagues from the fine arts side, who use studios extensively, emphasized an important relationship between the physical learning space and what is taught. Their experience reinforces their belief that design studios afford the most conducive environment for teaching design.

In what ways does undergraduate engineering education construct particular technical cultures and identities? How might we affect this to move in the directions identified here?

How can we ensure that teachers of engineering design bring multiple views into the classroom and projects? A concern was expressed here that practice-based engineering professors may become extinct in the public- supported universities.

We need to better understand how to evaluate students in design courses, provide more support for those who teach design, and a provide a better reward system for faculty teaching design, especially in the studio environment.

V.4. *There is a need for a national infrastructure for engineering and for design.*

An minor, yet rather interesting point surfaced several times, namely, that a *National **Engineering** Foundation* that might better represent the values of the engineering community than does the National *Science* Foundation. In addition, might not an existing body such as the National Academy of Engineering play a greater role in engineering education, especially to influence faculty reward systems in ways which will enhance design education?

VI. The (Expected?) Impact

We can manage a snapshot view of the potential impact of MDW III by considering the action items that some of the participants committed to taking in the next two years:

- To keep the discussions begun at MDW III alive, by setting up threaded discussion groups for the participant community.
- To:
  - implement a studio environment: space and learning;
  - understand and communicate the relationship of social/societal impacts in design and education; and to
  - press campus-wide design for more coaching versus lecturing (which he was also doing already).
- To help other members of their institution's faculty to appreciate the advantages of coaching over lecturing.
- To press 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.
- To further "system design education" and the development of a system design curriculum by considering system design theory, principles, and applications.
- "To author a letter on behalf of my CEO, a member of the NAE, to the President of the NAE about curriculum and faculty reward changes."

VII. Conclusions

The participants generally agreed that bringing the "two sides" together, even so unevenly, had made this workshop a special experience. They recommended that more meetings be held that include active participation of colleagues from the humanities and social sciences.

VIII. Acknowledgments

The authors would like to acknowledge once more the support of the remaining members of MDW III's Advisory Committee, a "mixed bag" of engineers and social scientists who worked hard to make MDW III bigger, more stimulating, and more challenging than its predecessors: L. L. ("Larry") Bucciarelli, Jr., Massachusetts Institute of Technology; Todd Cherkasky, Sapient; Sarah Kuhn, University of Massachusetts–Lowell; Larry J. Leifer, Stanford University; Patrick Little, Harvey Mudd College; Gregory B. Olson, Northwestern University; and John W. Prados, University of Tennessee–Knoxville.

IX. References

1. C. L. Dym (Editor), *Computing Futures in Engineering Design*, Proceedings of a Workshop, Harvey Mudd College, Claremont, California, 2–3 May 1997. See also Special Issue, *Artificial Intelligence for Engineering Design, Analysis, and Manufacturing*, *12* (1), January 1998.
2. C. L. Dym (Editor), *Designing Design Education for the 21st Century*, Proceedings of a Workshop, Harvey Mudd College, Claremont, California, 19–21 May 1999. See also C. L. Dym and S. D. Sheppard (Guest Editors), Special Double Issue, *International Journal of Engineering Education*, *17* (4, 5), 2001.
3. C. L. Dym and L. Winner (Editors), *Social Dimensions of Engineering Design*, Proceedings of a Workshop, Harvey Mudd College, Claremont, California, 17–19 May 2001. See also C. L. Dym and L. Winner (Guest Editors), Special Double Issue, *International Journal of Engineering Education*, *18* (6, 7), 2002.