AC 2011-899: ROLES IN THE DESIGN PROCESS: A SURVEY OF ENGINEERING AND INDUSTRIAL DESIGN EDUCATORS

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Introduction

In many industrial projects engineers and industrial designers work together. In such collaborative settings, individuals' perceptions of what skills are possessed by their colleagues can have an effect on how they approach the collaboration. Thus, we were interested in learning more about how professors/instructors of Mechanical Engineering and Industrial Design view the skills inherent to these fields. This data was collected through a combination of surveys and interviews.

A survey was conducted in order to gain insight into instructors' perceptions of these fields. The survey was created specifically for this project after conducting a brief introductory literature review. The purpose of the quantitative survey was to gain insight from professors in mechanical engineering and industrial design on certain topics pertaining to design education.

Methodology

A link to an online survey was sent out to professors who teach mechanical engineering or product/industrial design at the collegiate level. In the survey the term "product/industrial design" was used. Someone who practices industrial design is generally referred to as an industrial designer. However, due to confusion surrounding what an industrial designer does some industrial designers have started referring to their role as product designers[1]. This trend can also be found at design institutions, such as the University of Oregon in Portland, Oregon and Art Center College of Design in Pasadena, California, which offer "product design" as a major. The Industrial Design Society of America (IDSA) defines industrial design as, "the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both the user and manufacturer" [2]. For the purpose of this survey, questions contained in the survey the IDSA definition of industrial design will be referred to as product/industrial design, and someone who practices this discipline will be referred to as a product/industrial designer.

The survey was completed by 55 professors. Participants were subdivided into categories consisting of mechanical engineers (N=26), product/industrial designers (N=23) and, for clarity, responses that did not fit exclusively into one of the previous two areas (N=6) were not included in the results. This final category included responses from professors who taught general engineering, first-year engineering and multidisciplinary design.

The survey began with a list of 8 statements relating to perceptions of mechanical engineers and product/industrial designers which the respondents were asked to rate from "1" (strongly disagree) to "5" (strongly agree). The data obtained is shown below in Table 1.

		Mechanical Engineering Professors		Industrial Design Professors	
Question Number	**Statement**	**mean**	**std. dev.**	**mean**	**std. dev.**
1	Product/Industrial designers must understand mathematics and physics and how to apply them to the design process.	3.76	0.72	3.33	0.91
2	Mechanical engineers are creative in the same way that product designers are.	3.44	0.84	2.67	1.28
3	Mechanical engineers must be skilled at building models and prototyping.	4.16	0.85	3.9	0.89
4	Product/Industrial designers must be skilled at building models and prototyping	4.44	0.58	4.57	0.51
5	Mechanical engineers must have strong communication (oral, written and visual) skills.	4.48	0.65	4.33	0.86
6	Product/Industrial designers must have strong communication (oral, written and visual) skills.	4.64	0.49	4.86	0.36
7	Mechanical engineers are trained on the subjects of ergonomics and aesthetics.	2.24	0.88	2.38	0.8
8	Mechanical engineers and product/industrial designers would benefit from a better understanding of each other and their respective educational backgrounds.	4.28	0.79	4.71	0.46

Table 1

The results of this survey, for the most part, showed both sets of professors to be in agreement in their replies. Based on these results, it is reasonably safe to state that the professors feel:

- Both Product/Industrial Designers and Mechanical Engineers must be skilled at building models and prototyping
- Both Product/Industrial Designers and Mechanical Engineers must have strong communication skills
- There would be benefit to increasing Mechanical Engineers' and Product/Industrial Designers' understanding of each other and their respective educational backgrounds.

More neutral responses were found in terms of designers' understanding of mathematics and physics. According to the results of item number seven, the majority of respondents believed that mechanical engineers are not educated on the subjects of ergonomics and aesthetics (mean = 2.24). This is an area where engineers stereotypically lack education.

The question for which there was, based on the mean scores, the largest difference between how engineers and industrial designers replied was statement #2, "Mechanical engineers are creative in the same way that product designers are." The industrial design professor respondents had a mean that was 0.77 points below that of the mechanical engineers, resulting in a mean that was on the "disagree" side. Creativity is a challenging topic to define and understand. Differences in this area could stem from variation in the definition of what creativity is and how it is measured.

In addition to the Likert scale questions discussed above, professors were presented with an opportunity to submit opinions/comments on the survey topics. Specifically, two questions were offered for response:

- "What are the differences between how product/industrial designers and mechanical engineers approach the design process and why do you think these differences exist?"
- "Do you have any comments you would like to add on the subjects of product/industrial design, mechanical engineering, design processes, or design education?"

These questions were intentionally created to be very broad in hopes of eliciting a wide array of comments from the participants of the survey. From the responses received, from both disciplines, perceptions and insights were received regarding how each views the other.

One theme that emerged among the engineering professors who responded was an acknowledgement that many industrial designers take a more human-focused, holistic approach to design. One mechanical engineering professor stated that "[product/industrial designers are] *trained to be much more sensitive to the interactions between product and humans than mechanical engineers are."* Another mechanical engineering professor noted that in their opinion, *"product designers have been taught to derive the total product concept first and then address the details, whereas mechanical engineers have been taught to address the details of a given product concept."* The explanation goes on to further state that this is because, *"product designers emerged from an art background and mechanical engineering from a scientific background. Science is about analysis and art is mainly about synthesis."*
A product/industrial professor felt that, "*mechanical engineers … are trained to find solutions that are 'possible' to problems that are given to them".*

Understanding and appreciation for product/industrial design was encouraged by many of the comments from mechanical engineering faculty. Additionally it was felt that,*"an effective design 'team' includes both designers and engineers"* and that *"they [mechanical engineers and product/industrial designers] bring different, but very necessary, perspectives."*

Many professors weighed in on the differences that they see between the design approach taken by the two fields. One product/industrial design professor stated that, *"product designers must use a qualitative/quantitative approach*," whereas, "*engineering designers are familiar with a quantitative approach and often this is essential for the problems they deal with.*" A mechanical engineering professor believed, "*Engineers approach design logically, whether it works or not*

and that designers approach design aesthetically, whether it looks good or not and how user friendly it is. But they both should have both in mind."

On the topic of selecting a solution one product/industrial design professor stated that, "*engineers explore a few varieties to find an acceptable solution that is dependable*. *They like to know for sure something will work*." Additionally, this professor felt that, "*Industrial designers are trained to find the problems and then to find the solutions that are 'plausible' based on current and emerging technologies*." Likewise it was also stated by one participant, "*In my own 30+ years experience with both product designers and engineers, the former see the totality of the issue all the while ignoring details whereas the engineer focuses on details losing at times the overall perspective.*" One product/industrial design professor suggested, "*engineers should be taught to consider the experience as much as industrial designers are and industrial designers should be taught to think sometimes in more practical ways.*"

Interviews

One on one interviews were also conducted with five professors (two product/industrial design professors and three mechanical engineering professors) to try and capture any opinions or insights that the online survey may have missed.

The interviews were conducted by sending the five professors the same questions as from the online survey and asking them to comment on each question. Then after receiving their answers back a 30-minute phone interview was also conducted with each professor. The quotations that follow were taken from both the email correspondence and phone interviews. For anonymity the professors names will not be mentioned, but their respective backgrounds will be.

A point that was brought up by interviewees from both fields was that engineers are, "*more comfortable working within restraints*," *"experts at designing a technical solution"* and that they have "*a solid background in mathematics and science and the ability to apply this".* A product/industrial professor also noted that they felt that in his experience, "*engineering students…have been a bit rigid in their design approach with less desire or ability or focus on the blue sky but rather on more practical ideas."*

With product/industrial designers it was felt that they, *"are taught to think about who they are designing for and why a user has particular needs"* and have, *"more blue sky concepts which focus on user experience,"* in their work. One professor concisely summarized that, "*Designers are more often interested in what could be possible—imagining a unique, innovative, or interesting approach or outcome."*

As far as collaboration between the two groups, one engineering professor felt that,*"I think both disciplines…serve important roles on design teams."* And one product/industrial professor felt that it is important to, *"create curriculum and working situations for the product designers to focus on the engineering approach and vice versa. Otherwise, the students will focus on their natural strengths and prior education without gaining greater insights to the other's realm and responsibilities,"* when planning educational opportunities. These educational opportunities are important because the two groups, *"need to work together to foster and understanding of each others' strengths and weaknesses."* This type of interaction will lead to the most likely positive outcome, without possibly negatively affecting the rest of the student's educational experience.

Conclusion

The online survey itself yielded answers that were not surprising. Instead, the responses were more uniform than anticipated. The additional comments were more beneficial than the online survey because they revealed unique information that the survey results did not. Furthermore, the one on one interviews allowed professors to share their thoughts regarding their impressions/perceptions and those they read about, in regard to the other discipline.

Those surveyed felt that strong communication abilities, and the ability to create models/prototype were important skills for both areas to have. Those surveyed were overwhelmingly in agreement that there would be benefit to students in both fields gaining a better understanding of each other and their respective educational backgrounds. Finally, we found that the tendency was for the engineers to be described as quantitatively driven problem solvers and for the designers to be described in terms of innovation."

Acknowledgements

The authors would like to thank the University of St. Thomas Young Scholars program for funding this research, and all the professors who took the time to complete the surveys and interviews.

Bibliography

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