

## **PROMPT VERSUS PROBLEM: HELPING STUDENTS LEARN TO FRAME PROBLEMS AND THINK CREATIVELY**

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**Abstract.** Currently engineering students are given opportunities to apply knowledge learned in the classroom to hands-on design projects. While being trained to solve problems, are creativity skills also developed as part of that experience? According to a recent study, surveys found that students do not feel that creativity is part of that experience (Kazerounian and Foley 2007). Two questions are posed to frame discussion: how does current curriculum shape the way students approach problems? What can be done to create assignments that encourage creative thinking? Four observations are made from a class that focuses on creativity and design.

### **1. Introduction**

In a world full of complex problems, from socio-political to technological issues, new and innovative ideas are necessary to tackle problems of intricacy and magnitude. Creative thinking is needed to approach such problems. What about creative thinking in the engineering curriculum, particularly with respect to design thinking? It is not surprising that in engineering education students feel that creativity is not explicitly encouraged in their experience (Kazerounian and Foley 2007). Students in engineering programs graduate perhaps having gone through design courses with a good deal of learning-by-doing, where they see the principles they have learned in the classroom come to life. Does this approach teach creative thinking?

We pose two broad questions to frame the discussion for this workshop. First, how does the time spent in engineering and design education "practice" (that is, how long students have been taking design courses at the university level) relate to the way students perform in different types of design tasks? Often, projects provide situations with familiar design scenarios and it becomes convenient for students to attach and constrain themselves to a certain solution space. Awkward or unfamiliar design

situations forces an individual or group of people to think divergently (Patton and Bannerot 2002). Second, how can assignments be designed to create environments where students are put in foreign or “awkward circumstances”, thus giving them an opportunity to gain experience in creative thinking within “an unfamiliar situation that demands ingenuity to overcome” (Stouffer, et al. 2004)?

In our paper, we discuss four observations made from a month-long design class that consider elements of the above questions.

## **2. Motivation**

### 2.1 Design-a-Palooza

"Design-a-Palooza" was a month-long design course open to all majors and years taught by our research group and sponsored by MIT's Mechanical Engineering Department. The class gave students six relatively brief, very different design challenges, as opposed to traditional courses with one, longer term project. We wanted to examine how students' performance changed as they grew in design experience over the course. Some challenges were typical, such as the “egg drop”, but many were foreign to students, such as creating an imaginary sport or creating chindogu. The chindogu exercise will be detailed later in the paper. The core of the class was designed to emphasize creativity rather than building skills or analytical abilities.

### 2.2 Key Questions

Does engineering education curriculum focus enough on giving exercises to students that force them to confront underdetermined and ill-defined problems? In our observations of the class, older students did better than younger students at less creative or more typical design problems, which were already well-defined for them, when the solution generation and evaluation process was linear and straightforward. In contrast, when faced with an open-ended, less defined design problem, younger students did better.

Can curriculum and assignments be framed in such a way to ease students into becoming comfortable with divergent and creative thinking, thus giving them an opportunity to learn how to formulate and frame the problem? We hypothesize that by combining this aspect with the convergent and analytical skills already taught, engineering students will be able to successfully approach more problems they face in the future.

### 3. Previous Work

At the University of Houston, the departments of Mechanical Engineering and Art collaborated to integrate students from both schools in classes “aimed at strengthening problem solving skills” (Patton and Bannerot 2002). They wanted to give the students the opportunity to face problems that exhibited characteristics like they had never seen before. This is important since often engineering design problems can refer to or be based off of known solutions. With an open-ended problem, there are fewer constraints within which to work and therefore decreased likelihood for rote problem solving from existing solutions. In their initiative, chindogu was one of the assignments used.

Chindogu is a form of Japanese design art originally developed by Kenji Kawakami. Kawakami describes chindogu as is the art of “unuseless” invention. Although the adjective “unuseless” implies that a chindogu is not useless, it cannot be considered useful in an absolute sense either. The art of chindogu lies in building within this paradox. Chindogu are simple devices that solve real, everyday problems but are somehow logistically or socially unacceptable. For example, there is the “hay fever hat” which is essentially wearing a roll of toilet paper on your head. While the hat would provide easy access every time your allergies bother you, you probably wouldn’t want to wear it in public. The University of Houston study concluded with the argument that “learning to process through an awkward set of circumstances cultivates instinct and confidence”, thus teaching students how to solve problems without necessarily knowing any previous solutions (Patton and Bannerot 2002).

### 4. Methods

The final project for Design-a-Palooza, the “Chindogu Challenge”, was quite atypical, especially for those who had never heard of chindogu before. The assignment focused on concept generation and the communication of the chindogu design through a photograph of the chindogu each pair of students made. Each student had to make 4 total chindogu with 4 different partners. Though the chindogu may not be in accord with the standard definition of a creative product as “something novel and useful,” we contend that the functional requirement of “unuselessness” fulfills this definition in chindogu space. A panel of 12 external reviewers scored each chindogu on problem solving, transparency, simplicity, unuselessness, and hilarity. Since this exercise was intended to be a creative task, those 5 categories were selected as a measure related to creativity. All of these factors differentiated the Chindogu Challenge from the previous design tasks in the course.

### 5. Discussions

### 5.1 The Role of a Student's Previous Design Experience

In our study, "experience" was a function of age or time spent in school. Out of a class of 11 students, there were 7 engineering students. The ages were evenly spread from 18-23 years old. We assume that the students, regardless of major, had done some number of hands-on building projects throughout middle and high school, in addition to whatever they had done in college thus far.

The first design task showed a statistically significant correlation between experience and performance on the assignment. There was a confidence value of 95% with a  $\rho$  value of 0.60 between the two variables, using Spearman's correlation. This "egg structure" challenge, which involved creating a structure out of limited materials, with minimal weight, maximum height and strength, could be approached in a straightforward fashion. The older students had more experience in handling problems in a process that is more linear and formulaic. These logical skills are important to solving problems and not trivial. However, the lack of training in more divergent thinking approaches throughout the additional engineering courses, as shown by Kazerounian and Foley (2007), for the older students had no effect on their creative ability for the chindogu task, which was a more open-ended problem.

For the chindogu exercise, there was a statistically significant negative correlation between age, or experience, and how well the student ranked, with 98% confidence value and a  $\rho$  value of -0.69, using Spearman's correlation. The implication of this is that additional education may not do an adequate job of developing creative thinking and possibly has a negative effect since there is a lack of attention on creativity, as younger students seemed more likely to be able to think outside the proverbial box. Once the younger students understood that in Design-a-Palooza crazy ideas were encouraged, they were more likely to think creatively as opposed to those who needed to change from their normal problem solving approaches.

### 5.2 Problem vs. Prompt – Where do I start from?

Pahl and Beitz (1996) describes the activities in the first phase of design as "product planning" and "clarifying the task." Often in engineering and design courses, this first phase is already specified for students in the form of a well defined problem statement. In contrast to typical design assignments, the chindogu assignment only gave a prompt with the definition of chindogu. The students needed to first search within the problem space and properly frame an everyday problem that they wanted to tackle. Along the way to building the chindogu, they might have needed to step back, reframe the

problem, and thus go back and forth between problem framing and solution generation (Cross 2006).

### 5.3 Practice Makes Perfect – Immediate Action After Reflection

In many engineering design classes, smaller milestones are assigned that build up to one, integrated product in the end. In contrast, in Design-a-Palooza a large number of disparate projects were given in order to stimulate design creativity and productivity. Also, a typical design course is over a semester or longer whereas this class lasted a month.

We parallel this to when a pitcher practices, he throws thousands of balls with slight variations to improve; when ballroom dancers practices a routine, they run through the steps over and over again – ideally improving each time. Similarly, design students may be able to extend creative abilities by experiencing the design process more than once, trying out more than one method, and leaving time for mistakes and refinement. Several participants in this study said they gained a better understanding of their tendencies, strengths, and weaknesses as a designer by being able to participate in several projects within the short amount of time.

While some mistakes and failures are etched in the memories of students, we have found from our own experiences that often we would make the same sorts of mistakes in our design classes in subsequent courses. Giving students an opportunity to "throw some more pitches" and immediately apply new lessons learned will help develop their design and creative skills.

### 5.4 Acclimation via Creative Camaraderie

In the post-course assessment, one student gave very helpful insights into his experience. When asked about the order of the six design assignments, he made an interesting comment: having the more typical design problems at the beginning helped him ease into the creative demands of the course. If the Chindogu Challenge had come first, he would not have approached it in the same, open-minded fashion. Over the period of the class as the creative demand of each assignment increased, he became more comfortable with thinking creatively.

Also, he mentioned how working with other students on the projects building up to the "capstone" of the class (chindogu) helped to create an environment with creative camaraderie where they learned about the working styles of their colleagues. Also, everyone had a shared understanding about the creative expectations and thus were less likely to hesitate to suggest crazy or radical ideas during final project.

## 6. Conclusions

In the paper, we initially suggest two questions to frame discussion: is there something about the engineering design curriculum that focuses more on one aspect of design thinking, neglecting other aspects? Second, how can we shape the design tasks to create an environment that fosters creativity?

Based on our experience and observations of the Design-a-Palooza class, we gained insight into the nature of creativity within the realm of design. First, older students who have been through more design and engineering classes are trained to think in a certain way, which may not emphasize divergent and creative thinking enough. Second, the level of definition of the problem will affect the type of design thinking necessary to complete the posed challenge. Third, often classes do not provide an opportunity for the students to act upon the reflections and lessons learned from a design task. Finally, the structure of the class can be shaped in a way to ease students into creative thinking and that the social aspects of design can help to nurture these skills.

We suggest that our findings provide departure points for further discussion on how creativity is important in design and, perhaps more importantly, how we can foster creativity in students. In a time when traditional engineering and design skills have become increasingly computerized or outsourced, educational institutions can gain value in being able to cultivate skills that are indispensable, equipping students to approach any problem they will face.

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