# Enduring Design: Examining the Relationship Between Art, Engineering, and Creativity

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## Abstract

This paper describes the development of an arts and humanities course entitled "Enduring Design: The Art of Engineering." The course was co-developed by faculty members in the humanities and engineering departments. The intent of the course was to help students better appreciate the importance of the arts and humanities by creating an art course that provides a bridge between engineering and an appreciation of the arts. While the course had a variety of outcomes, the focus of this paper is on the effect of the course on student creativity. Results suggest that enrollment in the course increased the ability of students to recommend improvements in both the form and function of common objects. Further study is required to verify this preliminary outcome.

## Keywords

Art, Creativity, Humanities, Engineering

## Introduction

Engineering curricula tend to be full to overflowing in their course requirements for students. ABET minimums require a full year of math and science courses and a year and a half of engineering courses. Most engineering curricula go well beyond these minimums, with math, science and engineering courses occupying 75% or more of the required course load for a student's four years of study. This leaves little room for studies outside of these areas, which may be to the significant detriment of the engineering student. Lichtenstein et al.[1] demonstrated that engineering majors gain the least benefit from their liberal arts education when compared to all other majors. One possible cause is the need for engineering students to make effective time management decisions related to their studies, with the result of liberal arts courses being shuffled to a lower level of importance. This unfortunate process creates engineers who are obtaining reduced value from their educational experiences with a potential handicap in their ability to see opportunities from a broader perspective. One potential method to resolve this problem is through the creation of courses in the arts and humanities that provide more intentional links to engineering. This paper presents the creation of one such course and evaluates the short term impact of the course on the creativity of the students in the course.

This paper examines the development of a liberal arts course entitled "Enduring Design: The Art of Engineering." The course was developed with the intent of providing students with an exposure to the world of art based on a multidisciplinary approach that ties art to various ideas in engineering. This is not a new idea, as one of the guiding principles of the course is derived

from the ancient Greek word, "tekhnē," which is a word that indicates a combination of art and craft, and from which our modern word "technology" is derived. The ancient approach to art was best understood in a combination of form and function, rather than the separation of the two that is often seen in the modern engineering curriculum. As such, one objective of the "Enduring Design" course was to provide a modern forum for students to ponder this classical approach to art.

The understanding of the creative arts has a potential for significant positive benefits to the engineering student. A number of authors[2-5] have studied the relationship between scientific success and engagement in ancillary hobbies. The studies indicate a strong correlation between scientific success and participation in one or more of the arts (art, music, etc). As such, one should not be surprised at the growing popularity of the "STEAM" (Science, Technology, Engineering, Art, Mathematics) movement[6], nor with efforts to mix the topics of art and engineering in a variety of courses[7-13]. These mixes range from engineering courses with an art component[7-10] to interdisciplinary courses that enroll combinations of art and engineering majors[11-13].

One course that is typically missing from the above mix is a course that begins with the liberal arts and uses that as the mechanism to build connections between art and engineering, between form and function. The "Enduring Design" course described in this paper provides an example of the possibilities for such a course. This paper focuses on one specific outcome of this course, which is an evaluation of creativity gains evidenced by students enrolled in the course. More compete evaluations of other aspects of the course are still being processed and will be presented in a future paper.

The "Enduring Design" course was developed for the 2014-15 school year. The course enrolled a total of 39 students, so the results reported in this paper indicate student trends rather than statistically significant results. Yet even with this, the trends show promise, with students displaying an improved ability to generate ideas between the start and the end of the course.

The following sections describe the course and the outcomes that relate to the changes in the creativity of the enrolled students.

## Enduring Design: The Course Format and Topics

The course entitled, "Enduring Design: The Art of Engineering," was created in the summer of 2014 and taught during the Winter quarter, 2014-15. The overarching objective of the course development was to create a course to better enable students to see the opportunities that arise from the effective combination of form and function. The method for pursuing this objective was grounded in the idea that the more we can get engineering students to see the integration of art and engineering, the more creative those students will become.

The course was open to all students. Because Rose-Hulman is an Institute of Technology, all students are enrolled in STEM majors, with the majority of these being engineers. Course enrollment included students from all grade levels (freshman-senior).

One important aspect of the course is that the course was offered from an art perspective, pulling in examples of engineering to reinforce topics in art, rather than creating an engineering course

with examples of art pulled in. This is an important distinction as the intent of the course is to help students build a better arts perspective and engage those students in the arts, rather than using art to reinforce an existing engineering perspective.

The course was broken into weekly topics, with each week focusing on a particular facet of the relationship between art and one or more fields of engineering. The topics included:

1. Building the framework – defining art and engineering
2. Portable but site specific objects – Connecting topics such as sculpture and household appliances.
3. Static and stationary objects – Buildings and architecture
4. The art of kinetics – The illusion of motion as well as the study of moving objects.
5. The inspiration of the natural world.
6. Urban design – Displays that exist in public space.
7. Homes – Home design ranging from mobile homes to Frank Lloyd Wright.
8. Virtual Art – Website design, computer graphics and solid modeling.
9. Industrialization – Mass produced art and the management of art.
10. Failures, Fiascos, and Fantasies – The Pontiac Aztek, hoverboards and other topics.

The above topics were supplemented by a variety of guest speakers. The course also included a day-long field trip to GE Appliances in Louisville, KY to visit the GE rapid-prototyping facility and to interact with the GE industrial design staff.

The course contained a number of assignments that included weekly writings and five larger projects. The focus of this paper is on the first and last of the longer assignments as these reveal some of the growth of the students over the course.

The first assignment given to the students was to write a paper that addressed ways by which a common item might be improved. The list of items provided to the students included: a pen, a key, a mug, a stapler, a hammer, and a laundry basket.

At the end of the term, the above assignment was repeated, with the stipulation that students did not have to choose the same object as they used in their original paper. Approximately one-third of the students continued with the same object, while two-thirds of the students chose a new object for their second paper. The choice of students to continue with the same object or to examine a different object does not seem to have affected the results presented below.

The purpose of the above student papers was to compare the changes in student perspective from the start to the end of the course. The following section describes the analysis of these papers and the trends indicated by the results.

## Measuring Creativity and Ideas

One of the basic objectives of the course was to enable students to improve their ability to define "value-added". The starting assumption was that engineers tend to think of value-added in terms of added functionality, commonly overlooking the value that can be added by improving the form and aesthetics of an object. The primary purpose of the assignments described above was to track whether the course caused a change in student perception of "value-added". And while

this seems to be the case, a second outcome that suggests an increase in student creativity is perhaps an equally important result.

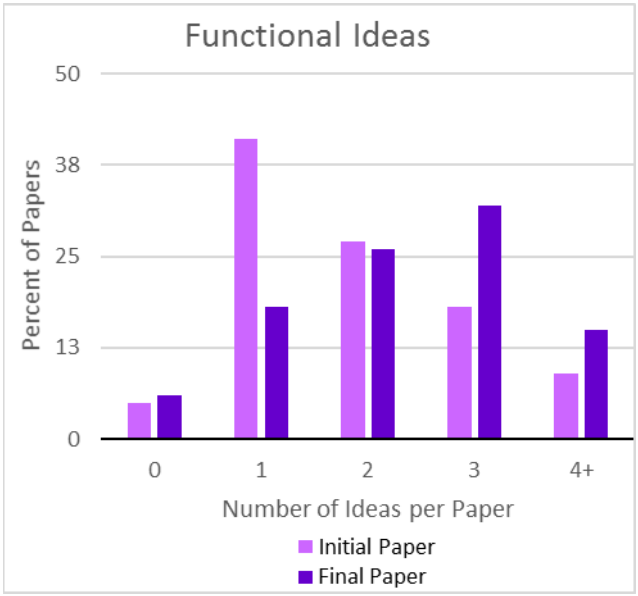
The student papers for the assignments described above were analyzed to determine the percent of each paper devoted to product improvements. Improvements were broken into 3 types:

1. Ideas related to the functionality of the product.
2. Ideas related to the form of the product.
3. Ideas that integrated improvements of both form and function so the improvements were not clearly separable into either "form" or "function" categories.

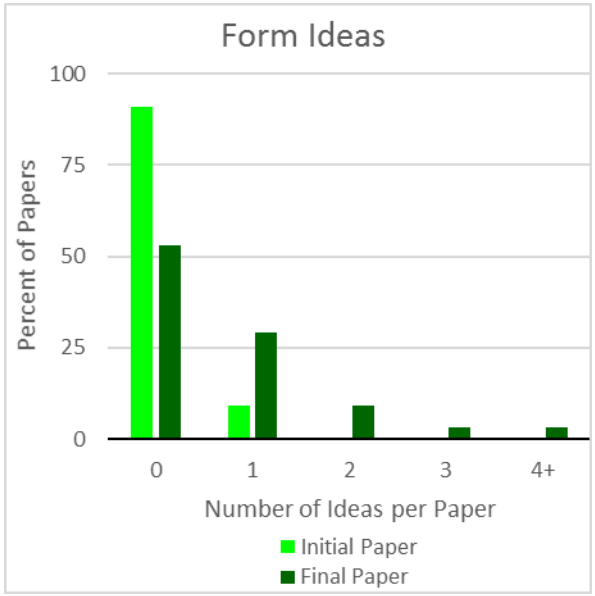
For each of these categories, the papers were analyzed to determine the number of ideas in each category, and the average number of words dedicated to each idea.

The results of the analysis are shown in Figures 1-4 below. Figure 1 shows strong support for the hypothesis that engineering students tend to focus on improvements to function rather than form as a means to add value to an object. Approximately 95% of students suggested improvement to function on each of the assignments. Less than 10% suggested improvements to form on the initial assignment. This number grew to around 50% for the second assignment which indicates some success in getting students to shift perspective. This result is encouraging but not as dramatic as desired.

The more interesting results that provide the basis for this paper are shown in Fig. 2. Here we see the number of ideas generated by each type: function, form, or combined. As expected, the number of ideas related to form increased. Since the course topics were built around an appreciation of art and form, this result was anticipated.




(a) Ideas related to function




(b) Ideas related to form

**Figure 1: A comparison of the number of ideas generated on initial and final papers.**

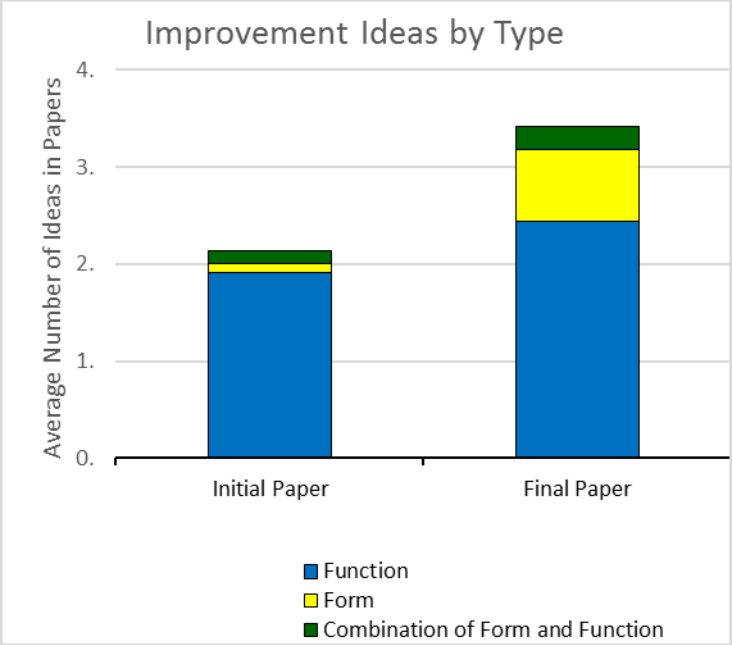



**Figure 2: Average number of ideas generated**

An unanticipated result shown in both Figs. 1 and 2 is the increase in ideas related to function from the beginning to the end of the course. The course developers anticipated a better balance between function and form ideas, but assumed this would occur due to an increase in form related ideas (as happened) with a corresponding decrease in function related ideas. Instead, the function related ideas increased by approximately 25%. The results suggest the course increased the ability of students to appreciate form as a value-added proposition with the added benefit of increasing the overall creativity of the students. As previously noted, the statistical numbers are too small to draw definitive conclusions, but the trends are compelling.

Additional analysis focused on the percent of each paper dedicated to the ideas presented. Figure 3 shows the percent of writing (by word count) that students used in their discussion of ideas related to function, form, and combined ideas. Figure 4 shows the average number of words used for each idea.

Figure 3 provides some additional support for increased student creativity with the results showing students increased the creative content in their papers from 35% of the total paper to approximately 40% of the total paper.

The distribution of creative content is shown in Fig. 4. Students had an increase in improvement ideas for both form and function. Figure 4 shows that students decreased the number of words used to describe each function related idea, while increasing the number of words used to describe each form related idea. This suggests a more balanced use of the creative endeavor with students being better able to develop and articulate their improvements related to form.

On the whole, the analysis of the student responses shows some positive trends related to the impact of the presented course on the overall creativity of students enrolled in the course. The improvements in aesthetic creativity were expected, while the improvements in ideas related to function provide an interesting topic for further investigation.

## Conclusions and Future Directions

This paper has presented a summary evaluation of some of the outcomes from a first offering of the course "Enduring Design: The Art of Engineering." The primary focus of this paper has been on the changes in student creativity that are suggested by a review of initial and final assignments in the course. Learning about the connections between art and engineering has the expected result that students are more creative in their suggestions for improving the form of objects. The course also seems to have increased the ability of students to suggest improvements for the function of an object.

The course results raise a number of interesting questions related to the engagement of engineering students with their arts and humanities courses. The foremost of these is that of how such courses can best be used to effectively supplement the technical education of engineering students. Results from the "Enduring Design" course suggest one possible method is to provide engineering students with liberal arts courses that make deliberate connections between engineering and topics in the arts and humanities. Further investigations are needed to fully determine the type and extent of these connections and in what type of courses such connections might provide the greatest benefits.

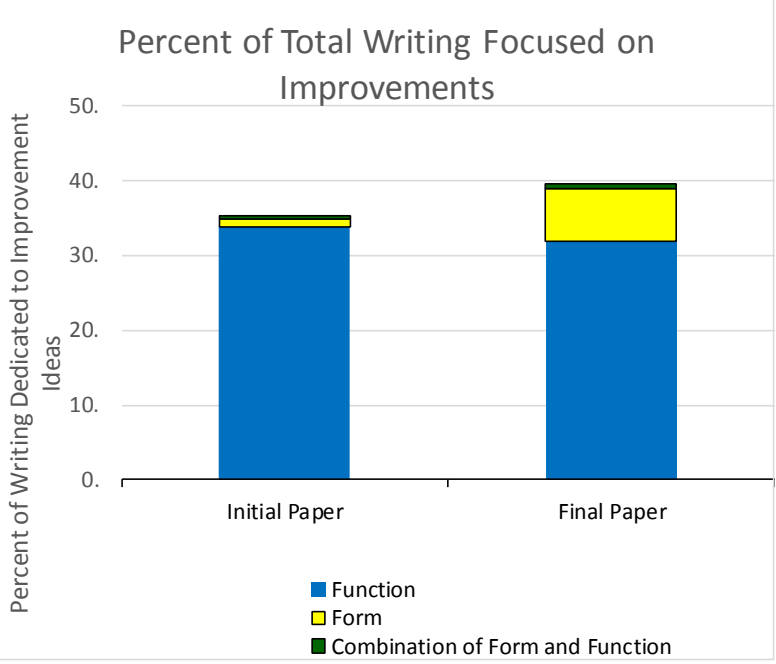



**Figure 3: Percent of Total Writing Focused on Product Improvements**

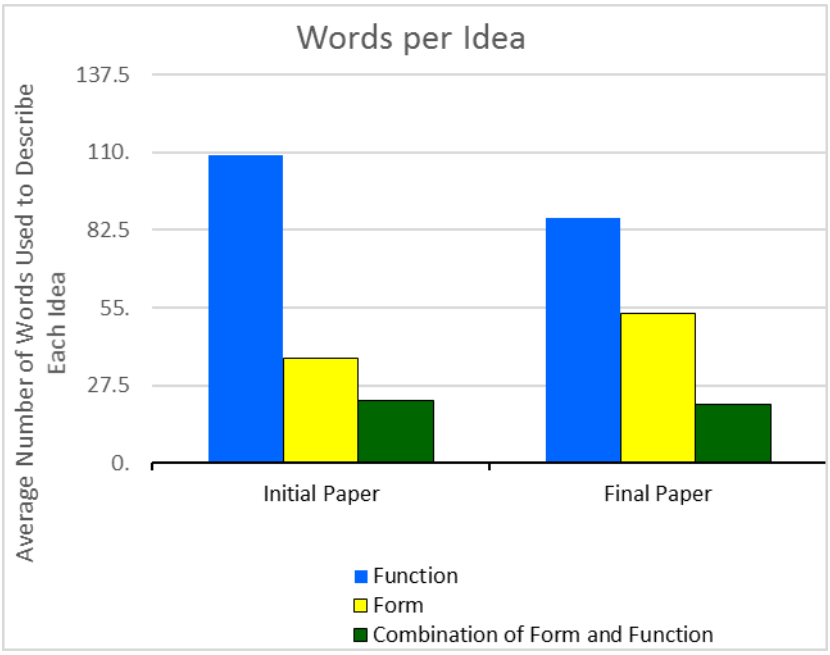



**Figure 4: Average Number of Words used to Describe Each Product Improvement Idea.**

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