Chapter 12
Engineering and Art:
Putting the EA in STEAM

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EXECUTIVE SUMMARY

This chapter discusses challenges faced by first year pre-engineering students. Also discussed are several topics taught within the curriculum including: the engineering design process, sketching, measurement, the elements and principles of design, and three-dimensional modeling. The chapter proposes a design project for engineering students that would tie all of these concepts together to provide an additional learning opportunity for students and more relevant practice of skills like isometric sketching, creating three-dimensional computer-aided design models, and measurement. Samples of student work from the project are included.

LITERATURE REVIEW

I became a teacher after working in industry as an engineer. I chose to enter a teacher education program to become certified through a traditional route. Once I entered the classroom, aspects about my prior life became more known, and I was given the opportunity to teach classes such as engineering and energy in high school. To me, engineering is the application of math and science concepts to solve problems. This definition parallels that of the Next Generation Science Standards (NGSS, 2013). While contemplating the differences between teaching engineering and chemistry, I discovered a few notable distinctions. One of those distinctions is that engineering solutions to problems could be an invention, an innovation, or a more efficient process. Engineers design, build, conduct tests, market, and communicate

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with others in the pursuit of solutions. Engineering requires creativity and ingenuity. Art is an important and integral part of the creativity involved in engineering. It lends a hand to the engineer's process of developing solutions. John Maeda does a great job of demonstrating this. Maeda is former president of the Rhode Island School of Design where he was very involved in adding art to the STEM (science, technology, engineering, and mathematics) education movement. He holds degrees in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology as well as a Ph.D. in design from Tsukuba University in Japan. In his piece for Scientific American in 2013, Maeda said that "STEAM and arts integration are crucial in K-12 education, engaging students in the STEM subjects and ensuring that creativity doesn't fall by the wayside as we chase innovation..." (Para. 5).

Integration is also important at the college level, so much so that multiple colleges and universities have designed courses that blend art and engineering into one. "Enduring Design: The Art of Engineering" is one such course being offered at the Rose-Hulman Institute of Technology in Terre Haute, Indiana. The course was described by Mirth and Findley (2015) as being designed by both humanities and engineering faculty. The faculty members saw that the school's engineering students did not take many liberal arts courses and felt that this caused a "potential handicap in their ability to see opportunities from a broader perspective" (p. 1). While the course is open to all students, a majority of those enrolled in the first offering were engineering students. The course is an art course that incorporates examples of engineering. This course is still new, and data is still being collected, but initial data show that the art and engineering connections taught throughout the course helped students to become more creative in their ideas for improving both form and function of objects.

At the University of South Florida in Tampa, an engineering professor created a course that "merges his research world with the world of fine art" (National Science Foundation, 2006, Para. 1). The course itself teaches concepts like electromagnetism and optics; lab activities incorporate lessons including everything from examining works of fine art to using pinhole cameras and learning how to spot a forgery.

As these schools created courses to strengthen the minds and creativity of engineering students by incorporating art, the project described in this chapter is an attempt to do the same for high school students enrolled in pre-engineering programs, most specifically the Project Lead the Way (PLTW) students that I teach.

Project Lead the Way

PLTW began at Shenendehowa High School in upstate New York in 1987. There was a decrease in engineering program enrollment, creating a predicted shortfall of over 600,000 engineers in the United States by the year 2000. Many engineering

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