Drafting with Design in Mind

By i ae aug er y an in n ar er

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ntroduction

Design and drafting are subjects long taught in technology education, and subjects that retain high status in the profession. Admittedly, since the initial publication of *Standards for Technological Literacy* in 2000, design has taken on a larger role and meaning in the technology education profession. However, design continues to be delivered primarily within drafting and computer-aided drafting (CAD) classes in many technology education programs across the nation. And, in many cases, that design component taught in drafting class may be unnecessarily restrictive. As an initial step in overcoming this inherent restriction, the authors of er an alternative approach to teaching design in CAD classes.

In *The Art of Innovation,* Tom elley (2001) writes that while many in our society believe that truly creative individuals are few and far between, he believes the opposite. elley contends that we all have a creative side that can flourish if we spawn a culture that encourages it, one that embraces risks and wild ideas as well as the occasional failure. One could easily make the case that the "design" taught in many technology education courses includes very few opportunities for true creativity, includes little risk, and is almost never accepting of failure. Conversely, the design component of most drafting classes includes students making exacting copies of the imaginative designs created by others in the distant past.

The historical roots of drafting and design in technology education are rooted in the interpretation of drafting as a fundamental tool for technical and graphic communication. Anyone who has sat in a drafting class for more than a few minutes has heard an instructor note that drafting is "the universal language of industry." In 1953, William Ivins (CITE) stated that:

> *The tool maker wants not a verbal description of the thing he is asked to make but a careful picture of it without pictures most of our modern highly developed technology would not exist.* (p. 160)

Others have noted that, beyond teaching technical communication, drafting classes help students apply mathematics, specifically geometry. French and Helsel (2003) noted that, in addition to solving drafting problems using geometric constructions, drafters often need to be able to calculate various aspects of geometric constructions. Similarly, Computer-aided Drafting (CAD) has been noted as a class that prepares students with the computer skills needed to be successful in modern business and industry. Now that many CAD classes use software incorporating three-dimensional design, students have additional opportunities to understand the parts they are learning to draw. While the visualization that is enhanced by 3D CAD software allows for more creativity as students conceptualize their designs, the actual classroom exercises continue to be dominated by activities that cause students to replicate preexisting designs.

The Problem with Traditional CAD

Many computer-aided drafting (CAD) classes are taught in a manner similar to the traditional board drafting classes they replaced. Students complete the same prescriptive set of drawings that have been published in textbooks for the past generation or two. Gear blanks, T-blocks, industrial sprockets, and outdated machine parts are the daily grind. Clemons (2006) noted that, while teaching materials require frequent updating, the illustrations used in many texts appear to be a step behind. Further, Clemons noted that many students cannot relate to these drawings and become disinterested in the classroom routine. Bhavnani, et. al. (1996) noted that an analysis of CAD usage indicates that, even after many years of experience, users tend to use suboptimal strategies to perform complex tasks. Bhavnani suggested that many of these suboptimal strategies are based in manual drafting technique. He attributed this problem to the textbooks and teaching techniques used to deliver content to CAD students—noting that most textbooks are still dominated by learning activities and drawings generated for manual drafting. He noted that, if we understand that a new technology often requires reformulating the way we approach old tasks, we must reformulate the way we deliver instruction in CAD and design. Most technology teachers would agree that students crave practical, real-world activities in all of their classes—and CAD classes are no exception.

Hill and Wicklein (2000) noted that the very content of technology education is rapidly changing, requiring teachers to continually upgrade their knowledge and expertise. Given this rapid change in the technology education profession, teachers must find the hook to both engage students and deliver design in a more creative and even risky manner. A CAD Design Survey of 9[illegible] middle, junior high, and high school students from Oklahoma and Arkansas indicated that, of those students who have completed or are enrolled in a CAD class, 65 percent noted that the primary teaching methodology is through teacher-led demonstration and individual drawing exercises (Carter and Daugherty, 2009). Additionally, this same group of students noted that more than 30 percent of all primary design/drawing assignments came directly from the textbook. It is interesting to note that only 18 percent of these same students indicated that this was a preferred method of learning technical material such as CAD. Further, only 6 percent indicated that they prefer to learn technical subject matter, such as CAD, through teacher demonstrations. Overwhelmingly, the 9[illegible] students who completed this purposive survey listed hands-on/discovery projects as their preferred method of learning technical subject matter.

This suggests that members of the technology education profession should question the manner through which CAD and other design instruction is delivered to middle school and high school students. Jordan, et. al. (199[illegible]) recommended that, to enhance student engagement and understanding, educators must create learning experiences and subject matter with which the students can relate. Given the fact that most of the technological products that we take advantage of daily were shaped in the minds of designers (Ferguson 199[illegible]), technology education must find ways to incorporate design in a more robust and engaging manner.

A Proposal

How can technology educators engage students in authentic and creative design? What can provide the “design” hook for our students? Additional student choice in design exercises and a subsequent decrease in the use of prescriptive work assignments may be the answer to both questions. Student choice leads to student engagement. Stipek (1996) writes in the *Handbook of Educational Psychology* that engaged students are more likely to approach tasks eagerly and to persist in the face of difficulty. They are also more likely than disengaged students to continue learning after formal schooling has been completed. When a student is given choices and the opportunity to find value in creative design activity, the result is purposeful learning. All of this is not to suggest that standards or rigor should be lowered, or that students should determine the curriculum. Rather, this is to suggest that design activities should include opportunities for students to explore and experiment in a creative environment. Sheldon and Biddle (1998) observe the impact of student engagement on learning:

> … *if students are challenged, if their interests in the subject matter are encouraged, if they are given autonomy support, then their intrinsic interests, their motivation for learning, and their test scores will all grow more effectively.* (p. 1[illegible]6)

Although maximum achievement may be the technology teacher's goal, if student attention is focused on completing prescriptive assignments, growth will likely not be maximized. In contrast, if the students are provided with some measure of choice and design challenges that support their individual interests, their performance and retention will grow accordingly.

An Application

Close your eyes for a moment and enter the world of the middle school or high school technology education student. This is a world of few personal spaces and still fewer individual choices. In fact, as you travel down the hallway, you will note that your student locker is one of the few private spaces that you have in the public school. Now open your eyes and consider the student lockers that you have seen during your own school visits. Students' deep ownership is apparent when walking down a school hallway, as students tend to personalize, decorate, and enshrine their locker spaces. For these reasons we have

selected the activity of package design, more specifically the package design of a locker organizer, to invigorate the traditional drafting classroom and infuse more design and creativity into student CAD drawings.

oc er Design Challenge

Overview

Students will plan, draw, and produce a cardboard prototype of a school locker organizer that can be produced in one dimension and then creased, folded, and assembled into a working prototype.

Challenge

Create and produce a full-scale school locker organizer that will store textbooks, notebooks, writing utensils, mobile phones, and various other items commonly found in public schools.

Time Limits

The time to complete this assignment will vary between classrooms based on class period length, but generally this would work as a one-month-long school project.

Parameters

A. The Locker Design Challenge is an individual assignment. However, collaborative problem solving is encouraged. No two locker organizers should be alike.
B. The locker organizer must be designed in such a way as to allow for the final product to be designed using CAD software, printed or plotted using a printer, affixed to card stock, and then cut, creased, folded, and formed into a finished prototype.
C. The locker organizer must be comprised of no more than three (3) components (each affixed to card stock), with the overall dimensions of the organizer being:
    1. 30” height
    2. 11[illegible]”width
    3. 10[illegible]” depth
D. The drawings for each component must contain an accurately dimensioned orthographic projection, and an isometric view of the parts.
E. No fasteners, glue, or other types of adhesives may be used in the design. Each component must be self-standing or interlock together with the other components.
F. Prototypes must be constructed of 1/8” or smaller corrugated cardboard, card stock, railroad board, or a like material.

Evaluation

Designs are evaluated for design creativity and the effectiveness of the prototype. Additionally, the design will be judged on accuracy, functionality, strength, neatness, and technical quality of the drawings and the prototype. Design teams will be evaluated on this project using the following criteria:

1. *Functionality*: (30 points) Does the prototype device perform the intended function?
2. *Accuracy*: (20 points) Does the prototype meet the stated criteria (i.e., store textbooks, notebooks, writing utensils, mobile phones, and various other items)?
3. *Strength and Durability*: (20 points) Is the prototype strong and durable, and will it stand up to hard and constant use in a school?
4. *Technical Quality*: (20 points) Is the original drawing of high quality, and was the prototype produced in a neat and clean manner?
5. *Originality*: (10 points) Is the prototype an original idea, and does it incorporate innovations?
6. *Extra credit*: (up to 5 points) Points will be awarded for the efficiency of the student's work or "time on task."

Summary

The Locker Design Challenge is a motivation assignment that allows for design creativity and student choice within the technology education classroom. The parameters of the challenge allow students to explore and experiment in a nonrestrictive environment, breaking away from the prescriptive methods employed in many CAD lessons. To introduce this lesson, it is recommended that the instructor bring in a variety of cardboard packaging and display items. These displays can be found at your local market or grocery store. Often these displays can be found at the end of an aisle holding batteries, magazines, and other highly visible items. These displays fold together and stand on their own. When students have the opportunity to manipulate different types of displays, they are better able to visualize how this type of package design works. This will aid in the surface development and pattern design of individual locker organizers.

This design-based activity provides students with a practical, real-world activity in the CAD classroom. This is design with a purpose.

Resources:

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