Engineering Design

Electric Vehicle Design Challenge

Student Edition

Brad Christensen
Matt Aldeman
William Hunter

Energy Learning Exchange
Illinois State University

Center for Mathematics, Science, and Technology
Illinois State University

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What is Engineering Design?

Science is the study of the natural world. This study often identifies patterns. The study and use of patterns is basically the definition of "mathematics." What is discovered can be applied "to solve problems and extend human capabilities". That is the definition of "technology." The process of developing technology is called "engineering."

Engineering Design is the process of applying knowledge of the natural world and its patterns to solve a problem. It is not just "math" or just "science" or limited to a particular age group or gender. It is a skill that all students should have, regardless of academic ability or career goals. Engineering Design can be as simple as making a schedule to get ready for school in the morning and arriving on time. It can be as complex as operating a rover on Mars.

For the past several decades, most people think that a better understanding of mathematics and science will improve our ability to solve problems leading to new inventions and innovations. The intended outcome is a stronger economy, increased national security, and an elevated standard of living. That explains the current interest in STEM (science, technology, engineering, mathematics) classes at your school.

Why is Engineering Design Important?

Over the past several years, the need for engineers has grown faster than the supply. Simply stated, our technological society requires lots of engineers. The Bureau of Labor Statistics estimates that the United States will see an 11% increase in jobs for engineers by 2018. Contributing to this situation is fact that over 60% of the engineering students currently enrolled in post-graduate degrees in the United States are from other countries and most of them will return to their own county after graduation.

By the way, engineers make some serious money. Most start out around $40,000 per year and their salaries quickly increase.

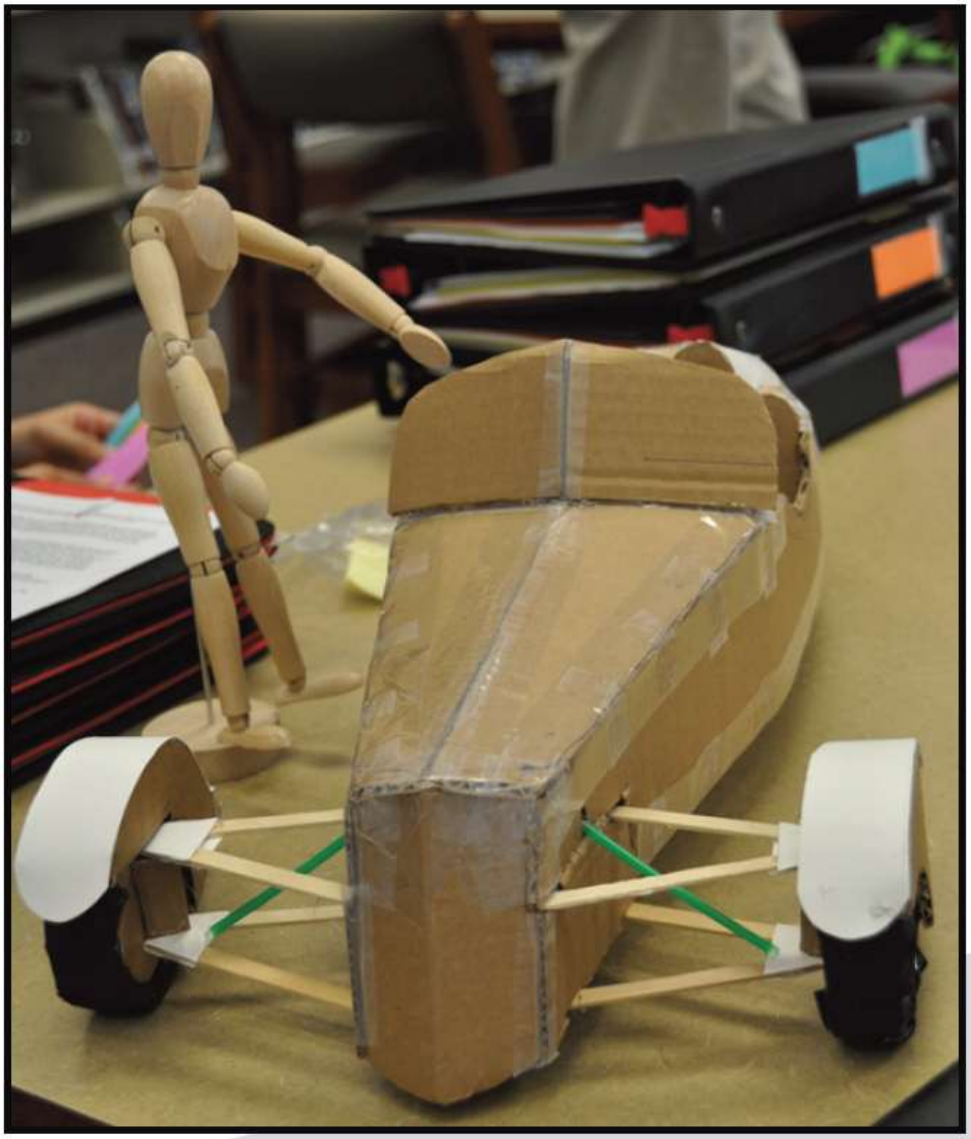
But what if you never plan to be an engineer? Should you still learn how to do the engineering process? Yes. The *Common Core State Standards for Mathematic* and the *Next Generation Science Standards* (NGSS) list what ALL students should know and be able to do to be ready for careers or college. In math, all students should be able to do the following:

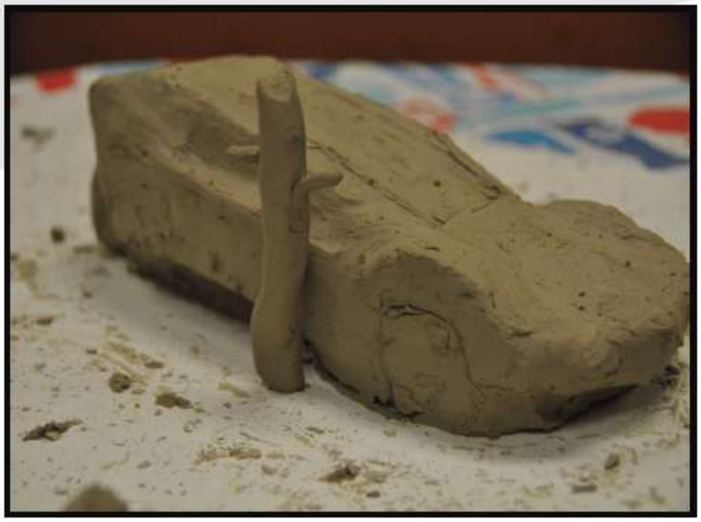
1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

All science students are supposed to be able to the do the things on this list:

1. Asking questions and defining problems
2. Planning and carrying out investigations
3. Analyzing and interpreting data
4. Constructing explanations and designing solutions
5. Obtaining, evaluating, and communicating information
6. Developing and using models
7. Engaging in argument from evidence
8. Using mathematical and computational thinking

Education experts think these skills are so important that they are repeated at every grade level, K-12.





2. Determine the scale of the clay model

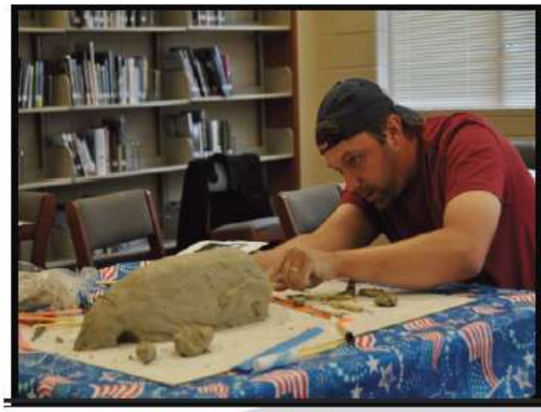
a. Compare a standard component of the model to an actual vehicle. Most cars are about 52 inches tall. Most automotive tires are between 24 and 32 inches in diameter. For example: if your model is 5 inches tall and you want it to be about standard height, you have a scale of about 1 inch = 10 inches.

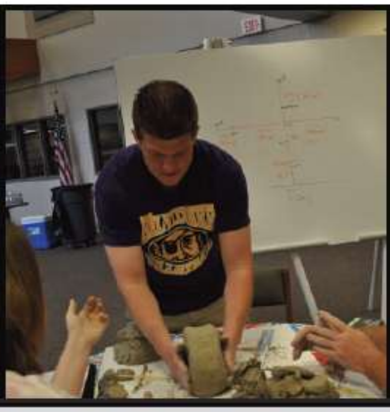
b. You may wish to go to the parking lot to gather specifications from various cars or research dimensions of similar vehicles.

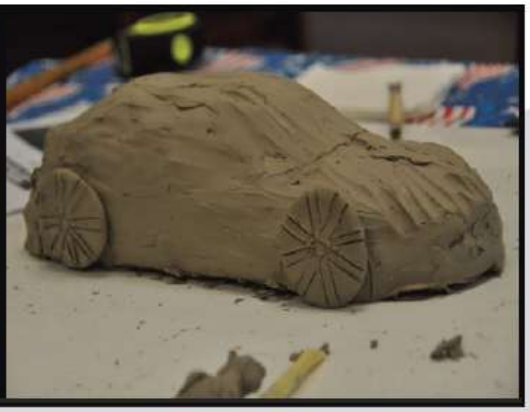
c. Build a "model person" to the same scale as your vehicle. Compare your clay vehicle to the model person, making sure your vehicle would be able to accommodate a person/people inside. Revise your clay model as necessary. Remember, the occupants can recline to a comfortable angle.

Think About It

A scale model is simply a ratio. Understanding ratios is critical to the ability to use mathematics as a tool. Fractions and percents are often used to describe ratios. Although you have been instructed on ratios, fractions, and percents for several years, you may still not understand the concept to the point of being able to do it.





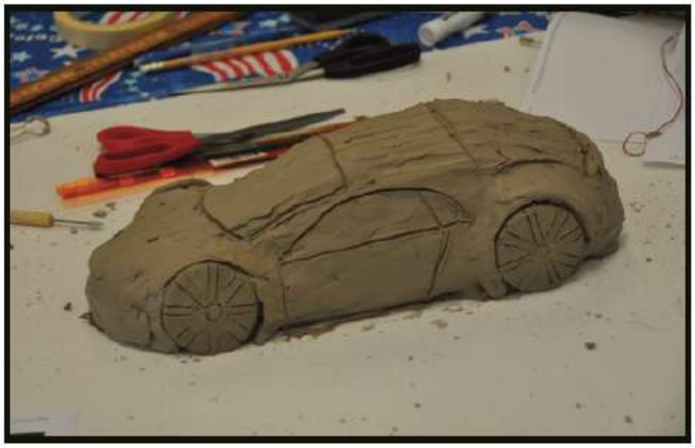


3. Refer to your design goals and original sketches. Perhaps the goals and original designs are no longer feasible or you have abandoned some ideas in favor of others. These modifications are a natural part of the process, but one that some find frustrating. The engineering process involves making the best decisions possible based on the available data. As more data becomes available, designs evolve.

Record changes to your design goals in Section 1 and add sketches to Section 2 of your Engineering Journal. Be sure to indicate the reason for each decision.

Think About It

You are probably accustomed to "one right answer" especially in mathematics. That is not how the engineering process works, however. When more information is discovered, designs change. This constant updating and revising can be frustrating.



Power Requirements

Now that the general size, shape, weight, and performance goals have been established, it is time to determine power requirements.

Be sure to record all calculations in Section 3 of your Engineering Journal. Showing all of your work will make it much easier to make changes and identify errors.

The motor must be sized such that it can provide enough force to overcome a variety of loads, including:

1) Accelerate the vehicle
2) Climb hills
3) Overcome rolling resistance
4) Overcome aerodynamic drag