

Making Connections

Engineering Design Principles
Spring 2018

Rationale

We have all seen and probably used toys that are meant to create or build some kind of object. While we have likely spent hours of our lives creating these models, there was always one large problem with the various types of toys - they are only compatible with blocks of the same brand. Legos can only combine with other Legos. Construx and K'nex work in the same fashion. While this is an obvious marketing ploy to buy a consistent brand, imagine the possibilities if you could connect them together.

Project Goal

The goal of this project is to do just that. You are to design a piece that can connect blocks of different brands using Fusion 360. I have a few sample blocks for you to work with, but you are also allowed to bring in your own if you have another type. Grading for this project will be based on the difficulty, functionality and compatibility of your design. For example, a simple design that just strictly connects two pieces will not receive as good a grade as a piece that connects two pieces and allows the angle to be adjusted afterwards.

Lesson Standards

Standards based on the Ohio Academic Content Standards in Technology

- Standard 1: Nature of Technology
 - **Benchmark A:** Synthesize information, evaluate and make decisions about technologies.
 - 12.3 Invent a product using goal-directed research.
- Standard 6: Design
 - **Benchmark A:** Identify and produce a product or system using a design process, evaluate the final solution and communicate the findings.
 - 9.1 Explain and apply the methods and tools of inventive problem-solving to develop and produce a product or system.
 - 9.4 Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).
 - 9.5 Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations)
 - 9.7 Demonstrate knowledge of pictorial and multi-view CAD drawings (e.g., orthographic projection, isometric, oblique, perspective using proper techniques).
 - 11.2 Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product (e.g., proposed or existing designs in the real world).

- 12.5 Evaluate final solutions and communicate observations, processes and results of the entire design process using verbal, graphic, quantitative, virtual and written means, in addition to three-dimensional models
 - **Benchmark B:** Recognize the role of teamwork in engineering design and of prototyping in the design process.
 - 11.4 Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.
 - **Benchmark C:** Understand and apply research, development and experimentation to problem-solving.
 - 11.3 Describe and demonstrate the reverse engineering process in problem-solving.

Project Timeline:

Day 1: Introduction/Initial Research/Brainstorming

- Teacher Explanation of Project, including Rationale, Timeline, and Grading Criteria (10-15 minutes)
- Student Exploration
 - Analyze different types of building tools
 - Brainstorm connector ideas
 - Preliminary Drawing

Day 2: Initial Designs

- Students continue where progress stopped from day before and finalize an idea to connect blocks.
- Students begin to take precise measurements of two blocks using given tools, i.e. rulers and calipers
 - Students replicate selected blocks and assign dimensions accordingly. Blocks should be hand drawn sketches or digital drawings. Drawn objects should look 3D but at this point they shouldn't be 3D objects. Students could also choose to do perspective drawings from top, front, and side rather than 3D.

Day 3-end of project: Model Design and Testing

- Students continue drawings until finished
- Students then mock up a drawing again (with necessary dimensions) of their connector pieces that join the two block together. Drawing should be shown to teacher for review and critique.
- Students begin to use Fusion 360 (or other 3D modeling program) to create a rough draft of 3D model
- Students conference with teacher to get feedback on design prior to initial print.
- Students print connector model and test with actual pieces.
- Students make adjustments as necessary to model
- Students are encouraged to reprint to test again (depending on available materials)
- Students and teachers are encouraged to analyze print settings as well as model properties to get desired results.

Project Expectations

As instructed, you are to use Fusion 360 (or another modeling program) to create your own connecting pieces for building blocks designed by different manufacturers. For testing purposes, these will need to be 3D printed. Grading on this project will be based on a report worksheet and on the following 4 aspects:

1. **Overall Design** - What did you design? (50% of total points)

This is the base grade. Were you able to create a connector that is intended to fit the design of two different building blocks? The grade for this includes proof of brainstorming, drawings with measurements of two existing blocks and 1 student-created connector, and 1 original 3D model.

2. **Compatibility** - Do the blocks connect and disconnect easily for the consumer? (30% of total points)

The blocks should easily stick together, stay together securely, and come apart easily.

3. **Complexity** - What is your design capable of doing? (10% of total points)

While still an important feature in some cases, your design should do more than just “connect” two pieces together. Is there a some type of joint between them, like a hinging capability or rotational capability between the connected pieces?

4. **Aesthetics** - What does it look look like? (10% of total points)

While this seems trivial to this matter, consumers will not buy products that are not aesthetically pleasing. Ensure the connections have a design that allows the pieces to connect in seamless way.