Hands-On Engineering Design Activity for First Year Engineering Students Using Lego Pieces

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Overview

- Background and Rationale
- The Idea
- Method of Conduct
- Student Feedback
- Discussion

Background and Rationale

Image Source: the Royal Academy of Engineers
(https://www.raeng.org.uk/education/2018-the-year-of-engineering)

Background and Rationale

- First-Year Engineering Curriculum

Pre-Calculus	Calculus	More Calculus
Physics	More Physics	
Chemistry	More Chemistry	
Humanities	More Humanities	

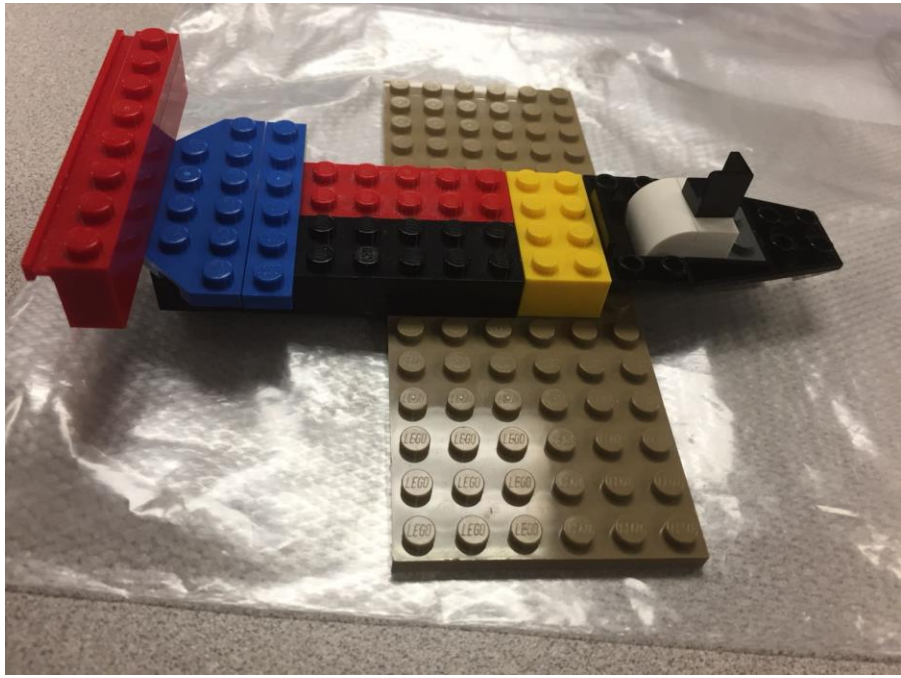
General Education Requirements

Introduction to Engineering course
(Fundamentals of Engg Design)

The Idea

The Idea

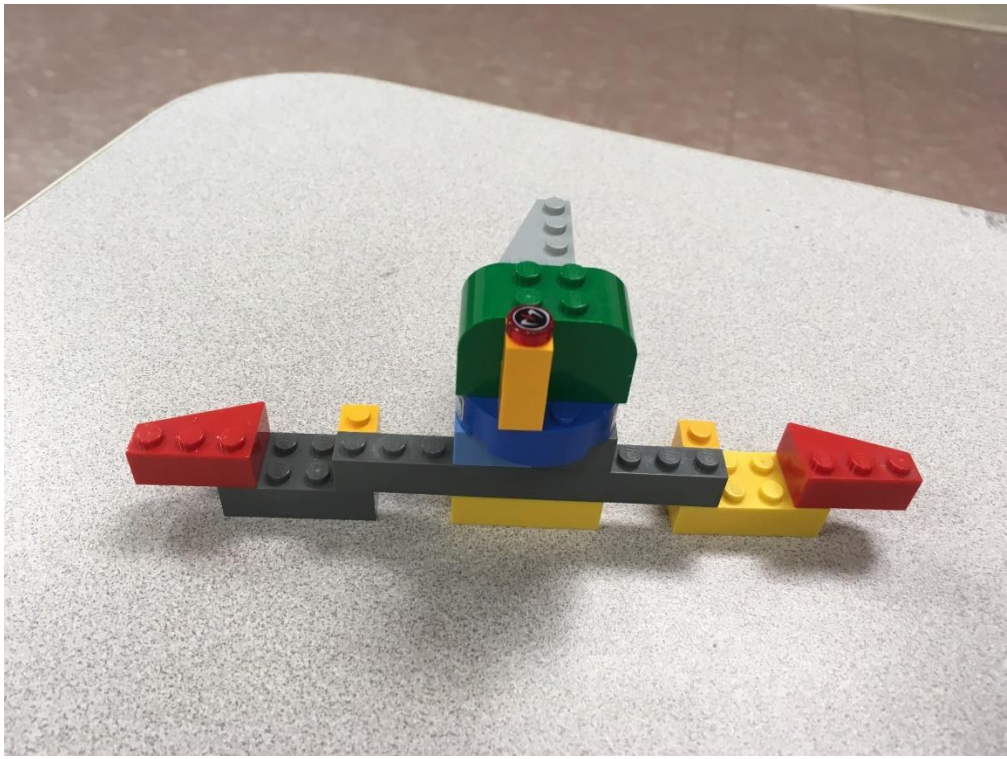
- Widget: A placeholder name for an abstract unit of production, such as manufactured device or other product
- 10 or 11 random Lego pieces
- Students working in groups (4 per group)
- Lots of creativity and imagination



Method of Conduct

Preparation

- Divide students in groups
- Provide sample widgets, reports, other useful instructions and material
- Report about the product (Widget) should include definition, purpose, uses, construction and operation, parts list, assembly instructions, design sketch, and references
- Three-part activity



Examples of products/Widgets

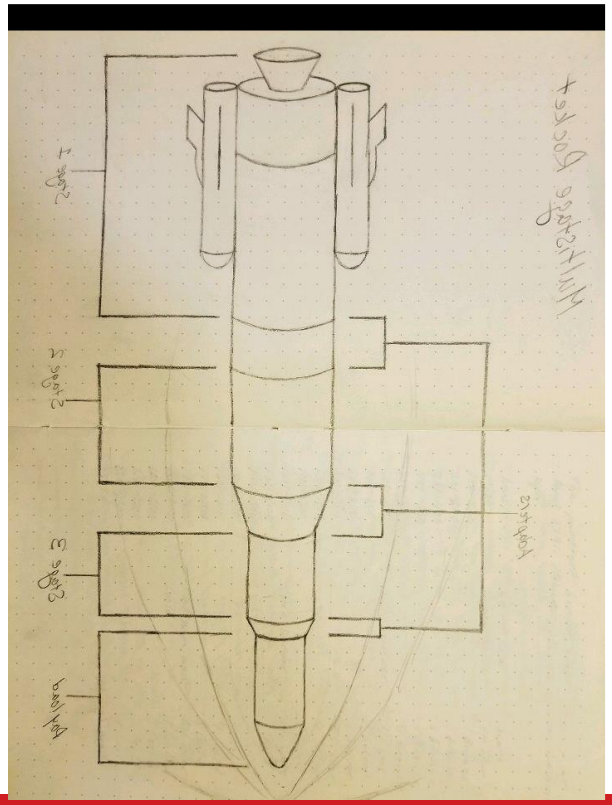
- Carburetor
- Lunar Excursion Module (LEM)
- Hologram Apparatus
- Atmospheric Water Generator (AWG), aka Cloud Seeding Device
- Enigma Machine
- Portable Particle Accelerator

The Widget Activity Part 1 - Design

- Identify a suitable product
- Consult reputable references
- Gather information for the report
- Complete the design sketch

The Widget Activity Part 2 - Build

- Must use all 10 parts to build the product
- Match design sketch as closely as possible
- Prepare a parts-list
  - Part number
  - Part color
  - Description of the part
  - Number of pieces
  - Array notes
- Prepare Assembly Instructions



Sample Parts-List

PARTS LIST				
Part #	**Part Color**	**Description**	**# of pieces**	**Array Note**
1	Dark blue	Ion source	1	2 x 2
2	Orange	RF source	1	2 x 2
3	Light blue	Combiner ring	1	2 x 2
4	Yellow	Drift tubes	4	2 – 2 x 3, 1 – 2 x 4, 1 – 2 x 6
5	Grey	Beam Delivery System	1	2 x 3
6	Green	Interaction point	1	2 x 2
7	Red	Beam	1	2 x 4

Sample Assembly Instructions

ASSEMBLY INSTRUCTIONS		
Step	**Instructions**	**Note**
1	Place Part 1 and Part 6 next to each other.	Parts are not connected.
2	Place Part 3 over Parts 1 and 6. Connect over right array of Part 1 and left array of Part 6.	
3	Place Part 2 directly over Part 3 and connect.	
4	Place Part 4 (2x4) over right array of Part 6 and connect.	
5	Place Part 4 (2x3) under Part 4 (2x4) and connect at last right array of Part 4 (2x4).	
6	Place Part 4 (2x3) over Part 4 (2x3) from Step 5 and connect below at last right array.	
7	Place Part 4 (2x6) under Part 4 connected in Step 6 and connect at the last right array above.	
8	Place Part 7 at the end of Part 4 (2x6) in Step 7.	Parts are not connected.
9	Place Part 5 over Part 4 and Part 7 from Step 8 and connect Part 5 at the last right array of Part 4 and the last left array of Part 7.	
ASSEMBLY IS COMPLETE. THE WIDGET IS READY TO USE		

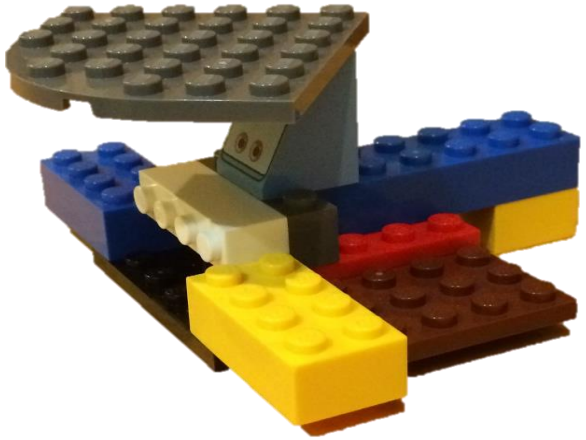
The Widget Activity Part 3 – Reverse Engineer

- Groups randomly exchange their Lego pieces and assembly instructions
- All groups attempt to build the Widget of some other group using only the assembly instructions
- Assembly instructions do not include names of the final product or any sketches
- This activity is timed

Sample Student Project 1

Title: Snow Terminator

Definition: Reinvented model of a snowplow vehicle

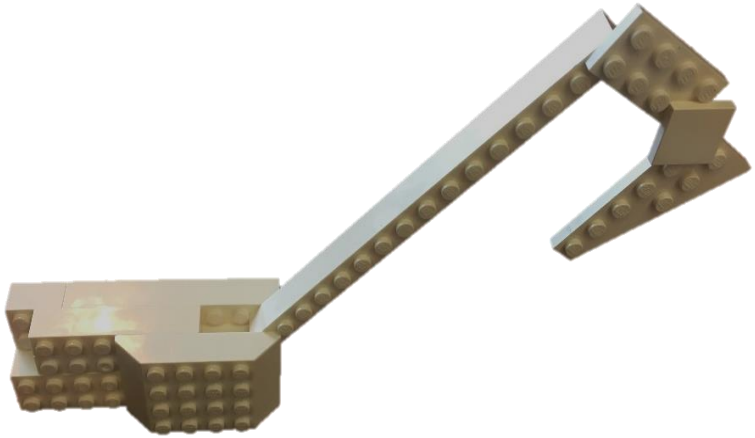


Purpose: **:** It will be capable of more efficiently removing snow off the road. It will be equipped with a wider adjustable shovel to fit the size of any street and a powerful engine to propel it to remove more snow. It is also capable of melting snow. It makes the road safer in the winter.

Sample Student Project 2

Title: Excavator

Definition: Power-driven machine for digging, moving, or transporting loose gravel, sand, or soil



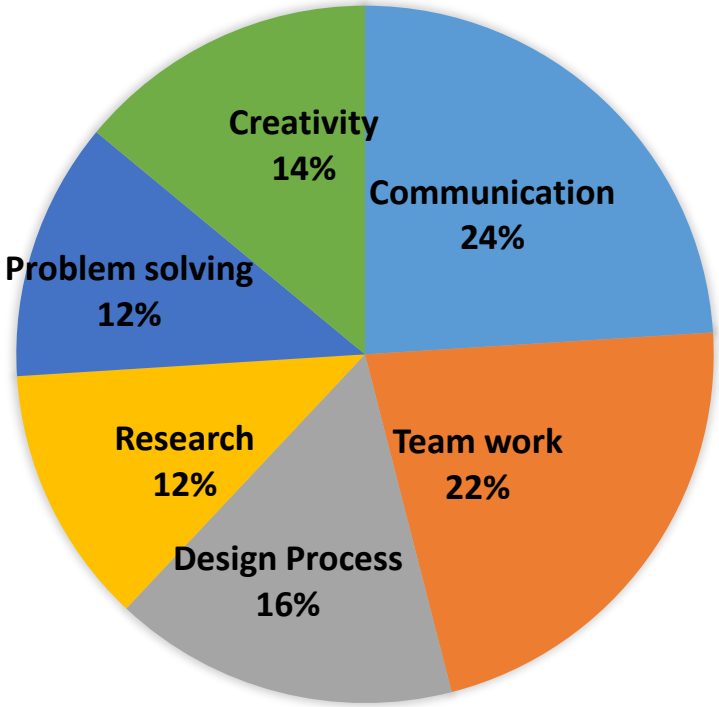
Purpose: This machine has many uses rather than just lifting dirt. The purpose of this machine is to innovate the process of construction. The machine is able to carry large supplements of materials to different areas. It can carry materials from rocks to water. This machine helps with leveling areas as well.

Student Feedback

Student Feedback Summary

Q #	QUESTION	AVERAGE RATING (1 – 5)
1.	The widget activity has increased my interest in engineering.	**3.4**
2.	I found the widget activity to be interesting and fun	**3.85**
3.	The widget activity is a good way to introduce engineering design to first year students	**3.8**
4.	The widget activity helped increase my understanding of engineering design process	**3.55**
5.	The widget activity helped me work better in groups	**3.6**
6.	I think it's important that students be introduced to the design process early in their first semester in college	**4.15**
7.	I recommend this activity for first year engineering students	**3.9**

Student Feedback



SUMMARY OF STUDENT RESPONSE (ACTIVITY HELPED ME IMPROVE…)

Student Feedback Comments

- Great idea, one of my favorite activities in the class.
- It was a good early introduction on how to be clear and precise in instruction, while keeping the overall design simple.
- The idea and intentions behind the activity were great. I believe it encouraged all students to use real-life problem solving and critical thinking to tackle a project that relates to something that is not theoretical.
- The assignment was very fun from the design process to the presentation and even helps as a way to get people into communicating with each other and getting them more accustomed to the environment. If introduced earlier, it could be a fun ice breaker.

Discussion

Post activity discussion…

1. Which team completed the assembly the quickest?

2. What helped assembling the widget the fastest, i.e., was it the written instructions or accurate parts list or both?

3. What did you learn about an engineering design process?

4. If a team finished first, who should get credit for it – the team that followed instructions or the one that wrote the instructions?

Any Questions or Comments?