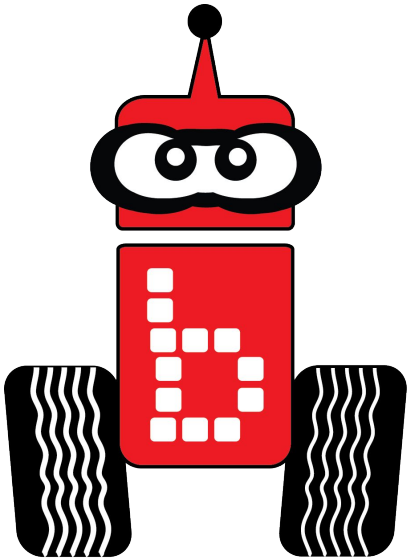

Engineering and Bulldozing

- **Key Concepts:**
  - **Learn to apply the engineering design process.**

- **Pacing:**
  - **45 minutes per activity**

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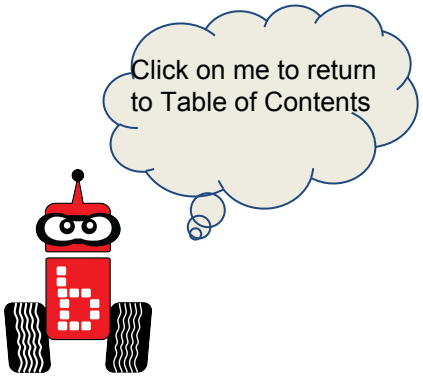

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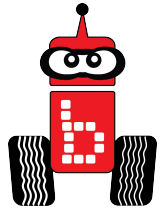
Engineering Design



Goals

- To help students understand how to apply the engineering design process
- Give students practice building with LEGO
- To compare and contrast different types of effectors
- To analyze a task first and then think about the design of an effector

Standards:

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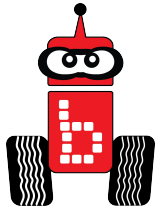
Building the Tallest Tower



Activity 1:

Materials: LEGO, student notebook, soup cans, research tools, and Engineering Design Process for students

Activity 1

Build the tallest tower using LEGO. You can not stack bricks to make a tower.

Students will:

- Identify the problem: The tallest tower that will support a soup can
- Research, brainstorm, and plan possible solutions to address your problem
- Determine which solution will best address the problem
- Build a tower from your determined solution
- Test your prototype/tower
- Re-design and repeat the Engineering Design process as needed

Guiding questions:

Identify and explain tower structures you know? Discuss with advantages and disadvantages.

Extra Optimization: Challenge students to hold objects with more mass.

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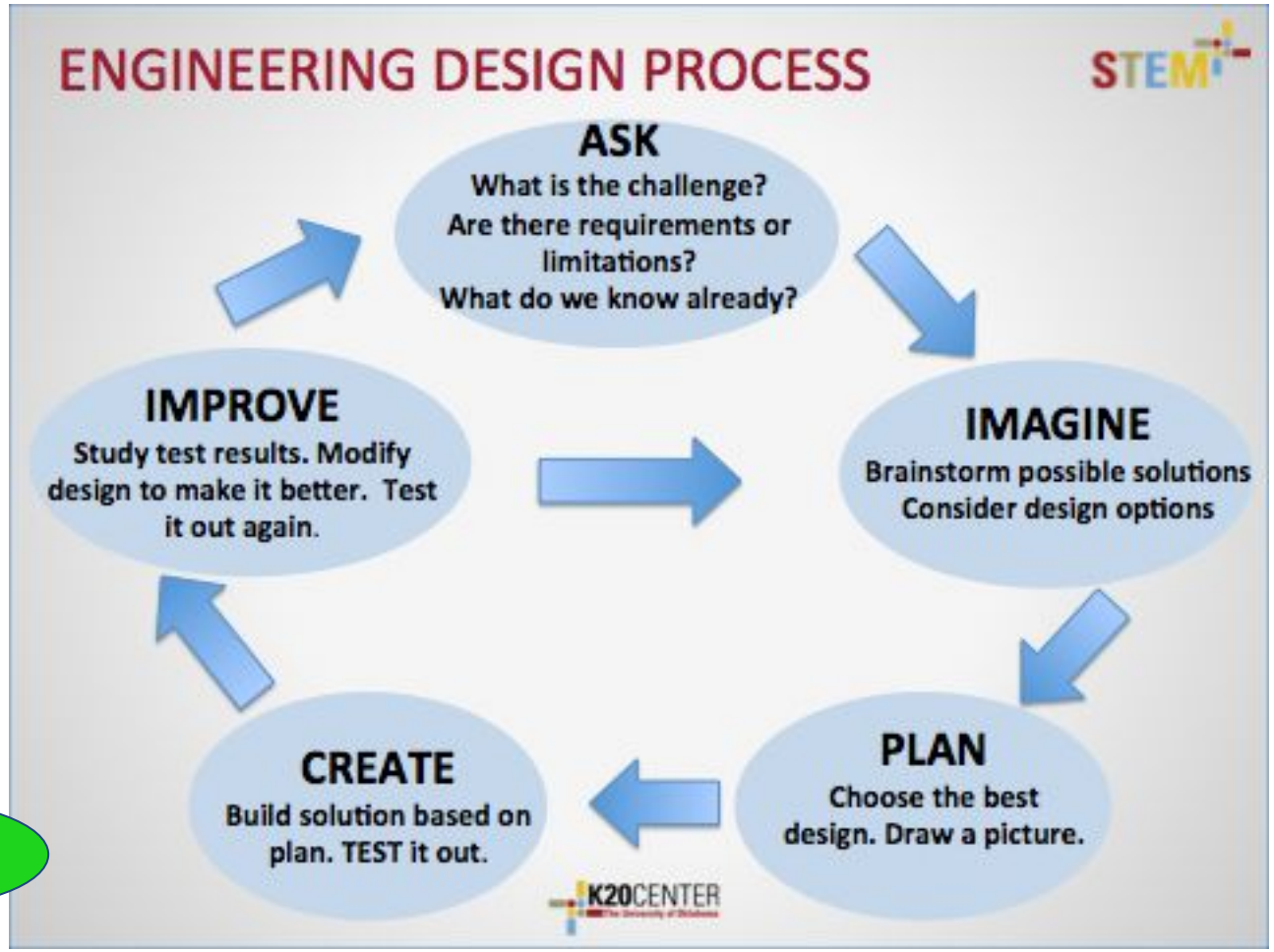
Engineering Design Process

Engineers use this process to design, test, and produce products. Process of creating solutions of human problems through creativity and applications of math and science knowledge.



Printable Diagram

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Engineering Design Process

Structure and Function

What is the function of a spoon?

What structural features does it have to help the spoon serve its function?

1) Decide what it needs to do (function)
2) Design a structure to match the function

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Types of Bulldozer Blades

Blades

- The bulldozer blade is a piece of heavy metal plate, installed on the front of the tractor, with the aim of pushing things, handle rough obstacles and shoving sand, dirt and debris. The dozer blade on front of the tractor usually comes in 3 varieties:

1. A Straight Blade ("S-Blade") which is short and has no side wings, and can be used for fine grading.

2. A Universal Blade ("U-Blade") which is tall and very curved, and has large side wings to carry more material.

3. A "S-U" combination blade which is shorter, has less curvature, and smaller side wings. This blade is typically used for pushing piles of large rocks, such as at a quarry.

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Types of Bulldozer Blades

Bulldozers have been further modified over time to evolve into new machines which are capable of working in ways that the original bulldozer can not. One example is that loader tractors were created by removing the blade and substituting a large volume bucket and hydraulic arms which can raise and lower the bucket, thus making it useful for scooping up earth and loading it into trucks. Other modifications to the original bulldozer include making it smaller to let it operate in small work areas where movement is limited, such as in mining. A very small bulldozer is sometimes called a calfdozer.

Nevertheless, the original earthmoving bulldozers are still irreplaceable as their tasks are concentrated in deforestation, earthmoving, ground leveling, and road carving. The heavy bulldozers are mainly employed to level the terrain to make it fit to construct on. The construction, however, is mainly done by small bulldozers and loader tractors.

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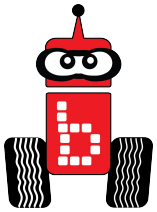
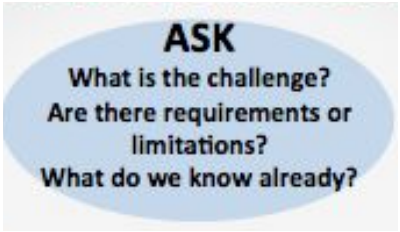
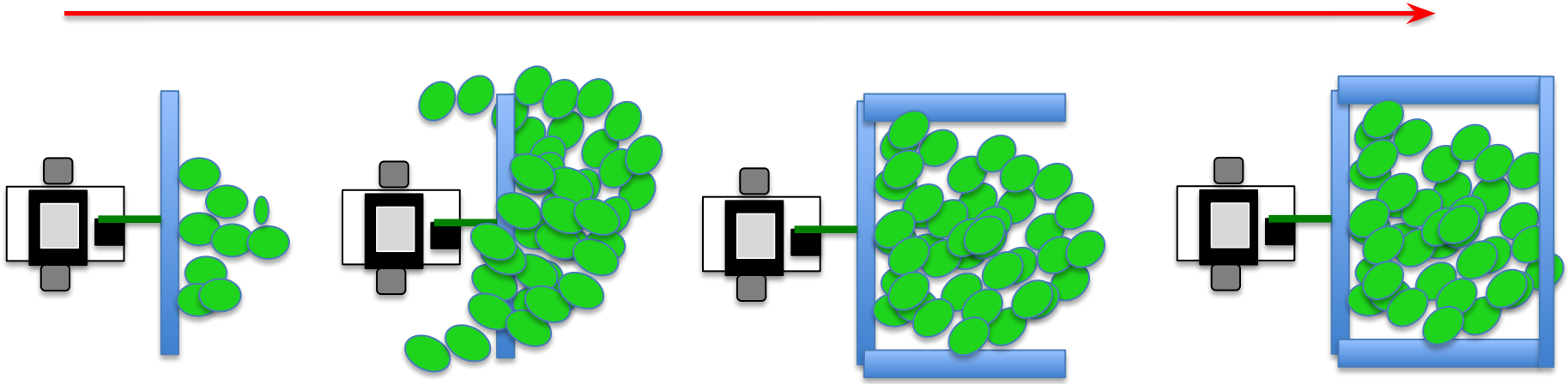
If your task is pushing something:



A flat front blade will work



- Unless there is too much stuff
  - Sides will help
- If you have to turn or back up, sides and a front will help
  - Now the front has to be lowered over the objects



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Some bulldozer blade designs on robots:

What task are these designed for?

What are the advantages of these designs?

What tasks wouldn't these designs work well for?

What are the disadvantages of these designs?

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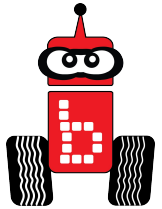
Designing a Bulldozer Blade



Activity 2:

Materials: LEGO, student notebook, soda cans, Engineering Design Process, research tools

Students will:

Build a bulldozer blade out of LEGO that can push cans.

- Identify the problem: building a bulldozer blade that will push cans
- Research, brainstorm, and plan possible solutions to address your problem
- Determine which solution will best address the problem.
- Build a blade from your determined solution
- Test your prototype/bulldozer blade
- Re-design and repeat the Engineering Design Process as needed

Guiding questions:

Identify and explain bulldozer blades you know. Discuss the advantages and disadvantages.

What job does a bulldozer do? What is it good for? (pushing) Can you lift or grab with a bulldozer? What happens if you push rapidly? What if you push an object from the top?

What happens if you push an object from the bottom? The blade is an incline blade.

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Bulldozer Practice

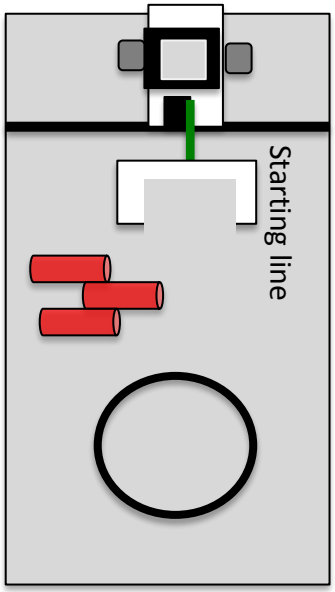
Activity 3:

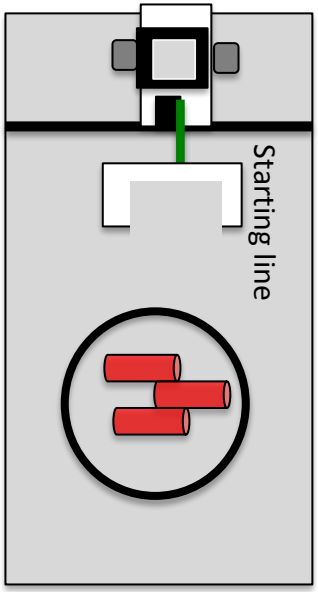
Materials: Robot, Engineering Design Process, Mat, Notebooks, and JBC code planning sheet

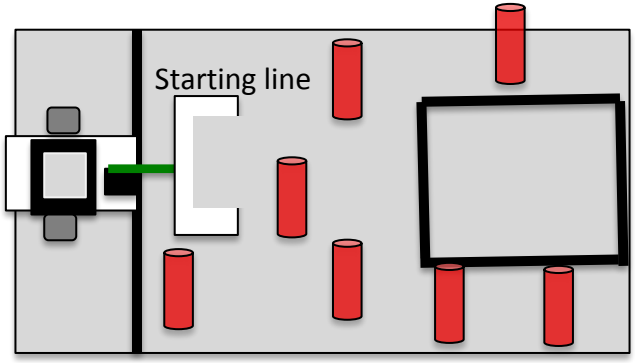
Bulldozer Practice: Turn the JBC mat over and use a dry erase marker to make a circle. Robot must start behind a starting mark. Students must write code to push objects (cans) into the circle. Students will use the Engineering Design Process to optimize their efforts. The can may not be tipped over.

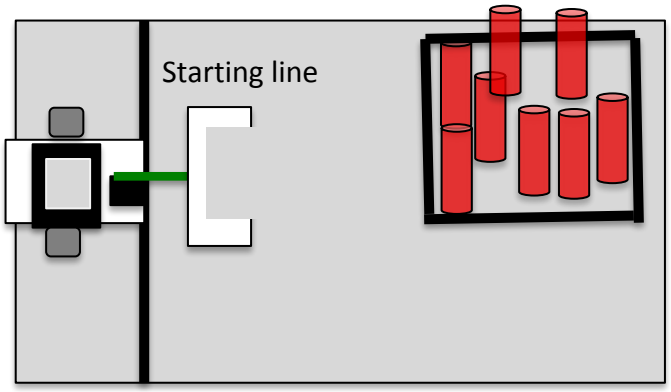
Variations:

- Use more cans
- Use a different object
- Create a smaller/larger circle
- Spread cans out to make it harder









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Assessment

Assessment 6: Load Em Up

Setup: Use Surface-A. Place 3 empty 12oz soda cans in circles 2, 9, and 10.

Goal: The robot will manipulate the can in front of each garage into the garage. Put the can from circle 2 into the green garage, can 9 into the blue garage, and can 10 into the yellow garage. You will attempt all cans in a single run.

Limitations:

1. All robots must be autonomous (no remote controls, wireless communication, or touching the robot after starting a run).
2. The robot must start completely behind the vertical projection of the inside of the start line.
3. The team must declare which garages they intend to put cans in before starting a run.
4. The cans must not tip over and some part of each can must remain in the inside edge of the solid and dotted lines denoting the garage touching the surface, or that can does not count towards completion.
5. The robot may be touching cans at the end of the round.

Completion: When the robot successfully manipulates two of the cans into two of the garages in one run.

Extra Optimization – Challenge students to attempt to push all three cans into their garages in one run.

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Assessment

Assessment 7: Bulldozer Mania

Setup: Use Surface-A. Place 1 empty 12oz soda can in each numbered circle (12 cans total).

Goal: The robot will manipulate at least 3 cans behind the starting line on the surface.

Limitations:

1. All robots must be autonomous (no remote controls, wireless communication, or touching the robot after starting a run).
2. The robot must start completely behind the vertical projection of the inside of the start line.
3. The robot's drive wheels must completely leave the starting box (crossing over and no longer touching the black line marking the starting box).
4. The cans must not tip over and some part of each can must touch the surface and be behind the start line (actual or virtual within the 8' enclosure), or that can does not count towards completion.
5. The robot may be touching cans at the end of the round.

Completion: When the robot manipulates at least three upright cans behind the starting line in one run.

Extra Optimization – Challenge students to design a "bulldozer" that can push all 12 cans behind the starting line.

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Assessments and Rubrics

Suggestions: *Understanding* or *Group Collaboration* rubrics

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