Robot House Builder

Vocabulary

Construction - the industry related to designing and building various structures
Additive Manufacturing - the process of creating an object by building it one layer at a time
Blueprint - a design plan or other technical drawing for creating an object
Job Outlook - the likelihood that the selected occupation will be available and hiring in the future

Direct Instruction

Engage with Building and Design!

Start the Engage section by presenting the students with the lesson challenge. They will assume the role of Robotic Construction Engineers at ORA Mechatronics. Build-2-Suit, a local construction firm, has hired the team to plan and create small structures with the Ozobot Robotic Arm. If your proof of concept is successful, they will acquire a full-sized robotic arm to construct similar structures in your community!

Either,

a. Create an object out of blocks and unveil it (likely just put a large, cardboard box or tote over the structure. Invite students to come and investigate the structure carefully).
b. Distribute blocks, or materials to create the blocks, to the students and have them spend a few minutes creating their own blocks.

Have the students spend a few minutes observing the structures and answering the questions in the Engage section of the Student Activity Sheet.

Before solving this challenge, we need to learn more about robotic arms in construction and the careers related to them!

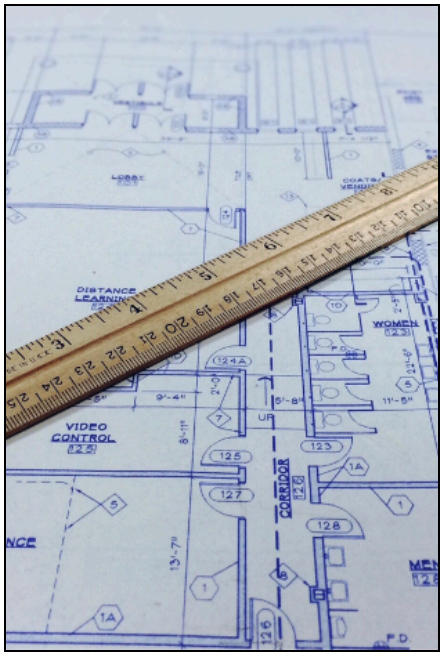
Next, show the Lesson 3 video.

Explore Construction Engineer Career Connections

Students will do a brief guided virtual scavenger hunt related to Construction Engineer Jobs. Individually or in small groups, have them complete the Explore section on the Student Activity Sheet. If students are struggling with the job outlook section, have them go to the US Department of Labor and Statistics Occupational Outlook Handbook. In this tool, you can find information about thousands of jobs. On the Index page, search for your career (Use Ctrl+F on a Windows machine or Chromebook). When you click on the career of your choice, there is a short video about the career as well as several key pieces of information. The Construction Engineer is linked to the Civil Engineer career.

Explain the uses of robotic arms in construction and how to create cross-sections.

Start the Explain section by asking the students "How are robotic arms used in construction?" Students should be able to recall from the video different aspects of construction using robotic arms such as laying bricks, 3D printing homes, or painting.



As shown in the video, the use of cobots decreases tiredness on the job and has the added benefit of decreasing accidents due to fatigue!

When creating a house with a robotic arm, we have to start with the base. Ask the students "If we start by building one wall of the house and then start on the following walls, what might happen?" From experience with the ORA Essentials course, they may answer that ORA may knock over the first wall while constructing the adjacent walls. So, for this reason, we need to build the house layer by layer.

Ask the students if they know what a cross-section view looks like. After getting responses, tell the students that it is a view, layer by layer of the building. Students can think of it like an MRI scan of the home. Students will use their engineering paper and ORA Coordinate Tool to draw the base layer of the home. Decide beforehand how many layers students need to draw for the project. Tell them to include openings for things like doors and windows.

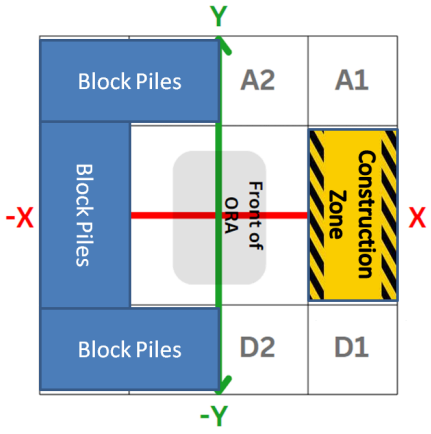
After students create their cross-section blueprints, they will program ORA to create their model homes!

Elaborate: Use ORA Robot House Builder!

Students will program ORA to create a small house based on their cross-section blueprints.

Setup:

Students may place blocks in A3, A4, B4, C4, D3, and D4 as needed. These will be the 'supply' blocks. B1 and C1 are designated as the 'construction zone'

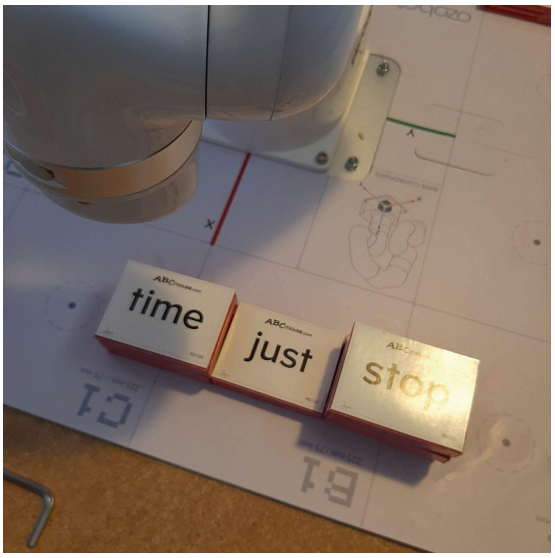


Task Requirements:

1. Students must build a simple house that:
    a. Fits in the construction zone
    b. Has at least one door
    c. Has at least one window

d. Has a roof
e. Is at least three 'layers' tall
f. It is planned on engineering paper

2. ORA must start in the initial position.
3. ORA must use the vacuum grippers to pick up building blocks to recreate the house as laid out in the blueprints.
4. ORA must finish in the Initial Position.



Teacher Tip: For a quicker activity, students design and build only one layer of the structure. Additionally, have students use the provided graph paper to lay out their designs. Tape the graph paper on the ORA mat.

Direct students to create their blueprints using the provided engineering paper and Printable ORA Coordinate Tool and plan this code in the Elaborate section of their Student Activity Sheet. After designing/sketching the blueprints, writing the pseudocode, direct students to create the code on their devices in the Ozobot Editor. Ensure students are connected to your shared workspace.

As students complete their code, they will test it. Click on a student's or student group's tab on the Ozobot Editor. Click "Run" to execute their code. Reset the materials between each code run. Remember to follow the Safety Protocol established in ORA Essentials. Example solution code or use Share Code khoaxz8.

If students are waiting for the ORA, they could:

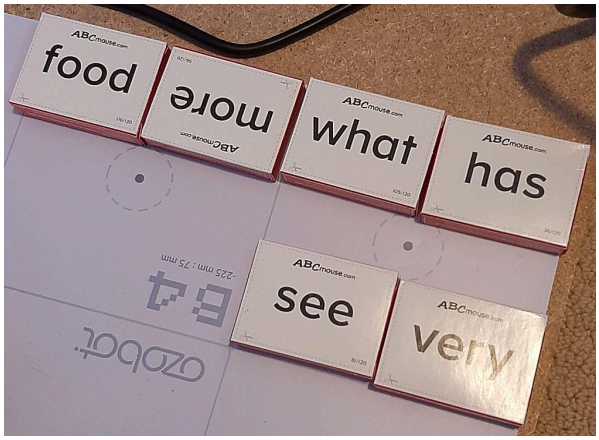
- Complete the Evaluate section of the Activity Sheets.

Elaborate: Example solution

1. Setup

a. Right is an image of the raisin box arrangement to set up the lesson example solution code.

b. Right is an image of the end result of the example solution code being run.



2. Designed Materials

a. There are no student-created objects.

3. Sample Code

a. Example Solution Code or use Share Code khoaxz8

4. **Code Description**
    a. The example solution code uses **lists** to plot the x, y, and z coordinates of the initial and final positions of the boxes. When the first box is picked up and placed, the list moves to the next set of coordinates and so on until all of the boxes have been placed. This is a great example of "efficient" coding that you can show students.

Evaluate: Exit Ticket

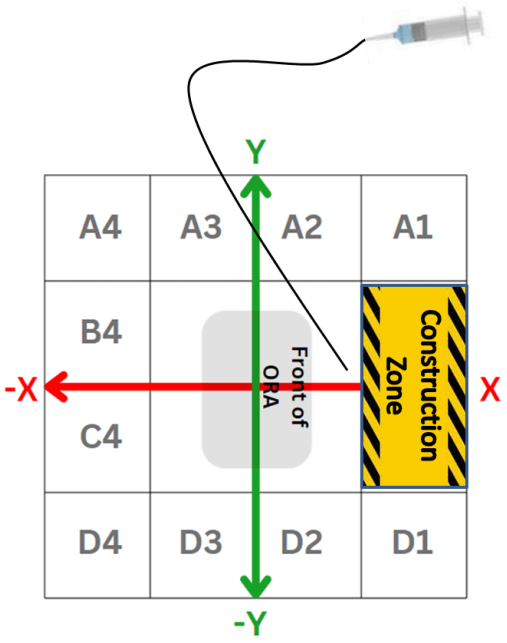
Students will fill out and submit the Evaluate section of the Activity Sheets.

Optional Extension: 3D Printing a House

In this activity, students will develop a media for 3D printing a structure. Hint: a good place to start would be homemade play-doh. Students will need a large syringe and tubing. Students will first develop a recipe that can be extruded from the tubing. Second, students will need to devise a way to attach the extruder to ORA to be used as a printer!

Source: https://all3dp.com/1/3d-concrete-printing-guide/

Setup: Students will attach the non-syringe end of the tubing to ORA's end tool. The syringe will be filled with student-created 3D printing media.



Task Requirements:

1. Ensure safety using care and caution.
2. Students must create a media that is thin enough to move through the tubing, but thick enough to create layers.
3. Students must test 'drying' time for media.
4. ORA must start in the initial position.
5. ORA must move the end tool in a path that traces the layers from the Elaborate Section.
6. Students must manually extrude the media from the syringe.
7. ORA must finish in the Initial Position.