# Robot Arms in Space

**Direct Instruction**

**Engage with Robot Arms in Space!**

Start the Engage section by presenting the students with the lesson challenge. Tell students:

“For this challenge, you will assume the role of Robotic Arm Controller at ORA Mechatronics. Tyler Knee, eccentric entrepreneur and founder of Ty Knee Aerospace, a company specializing in CubeSats, has approached your team to solve a problem. One of the CubeSats from his recent launch failed to deploy its solar panel. Without power, the CubeSat will not function! Luckily, the launch vehicle captured the CubeSat. Your team will use ORA and a model CubeSat to prototype a solution to deploy the stuck solar panel in orbit!

Have the students spend a few minutes thinking about what they may know about robot arms in space and answering the questions in the Engage section of the Student Activity Sheet. Then tell the students:

“Before we can solve this challenge, we need to learn more about robotic arms in space and the careers related to them!”

Next, show the Lesson 10 video.

**Explore Robotic Arm Controller Career Connections**

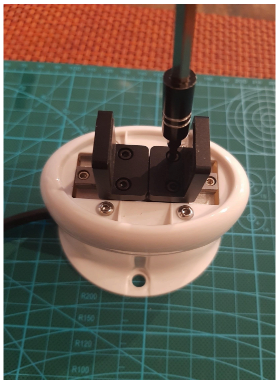
Students will do a brief guided virtual scavenger hunt related to the Robotic Arm Controller career connection. Individually or in small groups, have them complete the Explore section on the Student Activity Sheet. If students are struggling with the job outlook section, have them go to the US Department 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. Since Robotic Arm Controller is not in the DoL Handbook, a related career students could explore is Robotics Testing Technician.

**Explain Finger Grippers, CubeSats, and Robotic Arms in Space**

Start the Explain section by asking the students, “What sort of items have we picked up with the finger grippers?” Students should be able to recall ORA picking up items like Evo and the wooden cylinders. Tell the students that the finger grippers can be turned around so they close on much smaller objects!

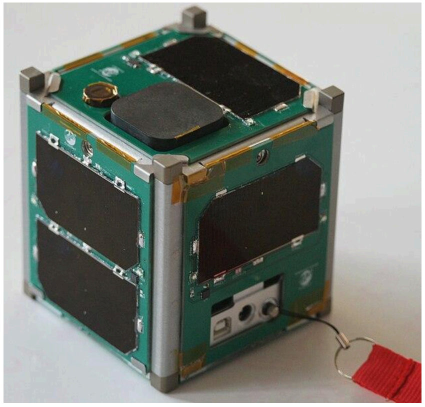
**Teacher note**: If you have a small group, demonstrate how to change the finger grippers. If you have a larger group, feel free to show pictures and give a brief explanation of changing the finger grippers around.

To change the finger grippers around, start by removing the finger grippers from ORA. Instructions for this are found in the Quick Start Guide. Place the finger grippers on a flat surface with the finger grippers facing upwards. You will see two, black 2mm hex bolts on each finger gripper. Gently remove the bolts and the finger gripper pieces come off. Then, turn the finger grippers around and line the bolt holes back up. Be careful not to cross-thread the bolts as you insert them. Once you have your finger grippers turned around, you will be able to grab much thinner pieces of material!




As discussed in the video, CubeSats are small satellites that can host a wide variety of experiments. Due to the relatively low cost, CubeSats are a way that many people can perform experiments in space.

Colleges and even K-12 institutions can design and put a CubeSat on a launch vehicle. To power the CubeSat, they often rely on small solar panels. If a CubeSat needs more power, the design team will include solar panels that can pop out, like the model that will be used in the lesson challenge.



Vermont CubeSat
Wikicommons

Ask the students, “What advantage do robotic arms have in space?” Students should be able to recall from the video that they can move items easily with precision, and while their human components need space suits, a robotic arm can work in the vacuum of space. The space shuttle had a robotic arm called the Canadarm, which could move payloads or deploy satellites.

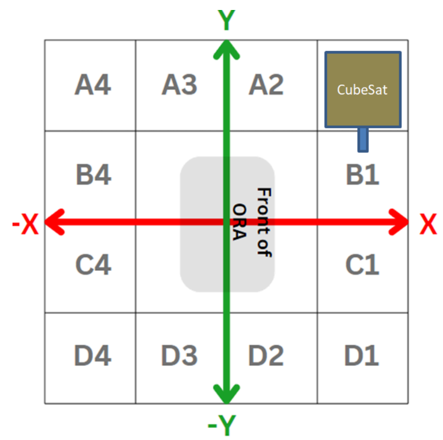
The International Space Station has the ERA, or the European Robotic Arm, which can help with spacewalks, moving materials, or visually inspecting the hull of the station.

Show the students the CubeSat Construction slide deck. If you have a premade CubeSat model to show the students, that would also be helpful. This information will help students design and build their own CubeSat model with a deployable solar panel!

**Elaborate: CubeSat Deployable Solar Panel Panic!**

In this challenge, students will program ORA to deploy a stuck solar panel on a CubeSat model.

**Setup**:
Have students place the CubeSat model in A1 with the opening tape-tab facing in the -Y direction. Optional: students may tape the CubeSat to the mat if the solar panels get stuck inside the box when deploying.




**Task Requirements**:
1. ORA must start in the initial position.
2. ORA must use the zero-clearance finger grippers to open the hinged lid of the CubeSat Cover.
3. ORA will grab the tape-tab from the small solar panel and lift the solar panel from the box.
4. ORA will hold the solar panel upright to charge the batteries of the CubeSat.
5. ORA will NOT return to the initial position.

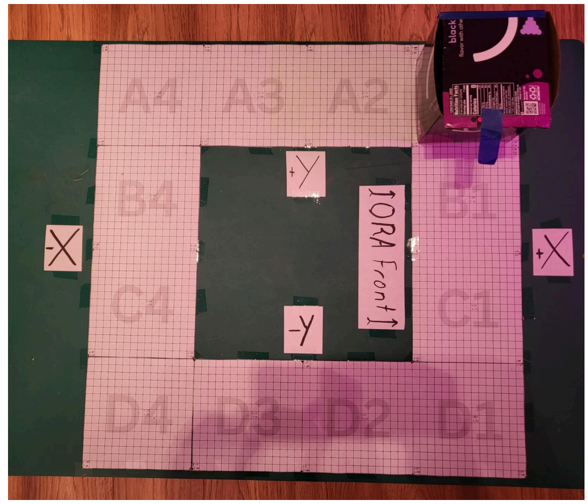
Direct students to plan this code in the Elaborate section of their Student Activity Sheet. After writing the pseudocode, direct students to create the code on their devices in the Ozobot Editor. Ensure students are connected to your shared workspace.

As students complete their code, they will test their code. Click on a given 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.

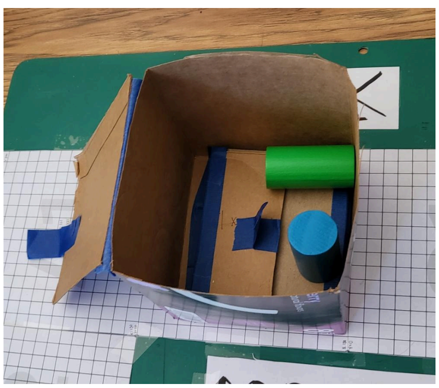
If students are waiting for the ORA, they could: Complete the Evaluate section of the Activity Sheets as an exit ticket.

## Elaborate: Example solution

1. **Setup**
   a. Right is an image of the setup for the lesson challenge.




2. **Designed Materials**
   a. For this challenge, the students will create a CubeSat model. The CubeSat Construction slide deck walks through the process of creating the CubeSat, and an image of the final product with optional cylinders to hold the cardboard flat is included below.



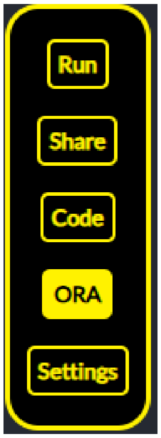
3. **Sample Code**
   a. [Example Solution Code]

4. **Code Description**
   a. The code begins when ORA moves to C1. The end tool rolls 90 degrees and then moves to the proper Z height. Then, the finger grippers move in the positive Y direction to grab the tab on the CubeSat lid. The finger grippers close, and ORA lifts the lid of the box. Then, ORA releases the lid to fall behind the CubeSat. ORA then moves to grab the tape-tab on the solar panel stack. ORA closes the finger grippers and lifts the solar panels to a height of 300mm. This should expose all the solar panels to begin collecting light.

## Evaluate: Exit Ticket

Students will fill out and submit the Evaluate section of the Activity Sheets as an Exit Ticket.

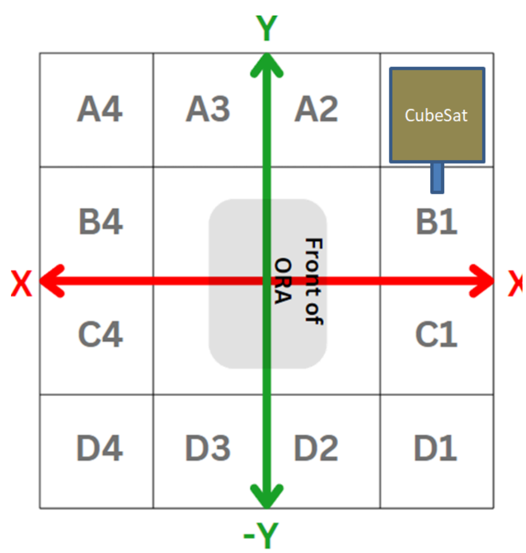
### Optional Extension: Precision Movement with Custom User Points




In this activity, students revisit the program in the Elaborate section to use custom user points in Ozobot Editor to increase precision.
When opening the lid of the CubeSat, ORA likely moved directly from where it grabbed the tape-tab to where it let go. The box lid is a hinge, so the box lid moves in an arc as it opens.
To replicate a smoother action, we will use custom user points from the ORA menu

Source: Canva

**Setup**: Use the same setup as the Elaborate section.




**Task Requirements**:

1. The task has the same requirements as the Elaborate section.
2. Students must make user points and have ORA move along these user points to smoothly open the lid of the CubeSat.
3. Students must also use the user points to deploy the CubeSat solar panel.