Material Movers

Direct Instruction

Engage with Material Moving

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

"For this challenge, you will assume the role of Automated Distribution Manager at ORA Mechatronics. Generic Shriveled Grapes, a raisin company, is looking to bypass existing ports and unload small amounts of raisin boxes from shipping containers using robotic arms. GSG is looking for proposals and will award the contract to the best robotic arm shipping container unloader!"

Have the students spend a few minutes thinking about shipping and distribution 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 shipping and distribution and the careers related to them!"

Next, show the Lesson 12 video.

Explore Distribution Manager Career Connections

Students will do a brief guided virtual scavenger hunt related to the Distribution Manager 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.

Explain the uses of robotic arms in the shipping and distribution industry.

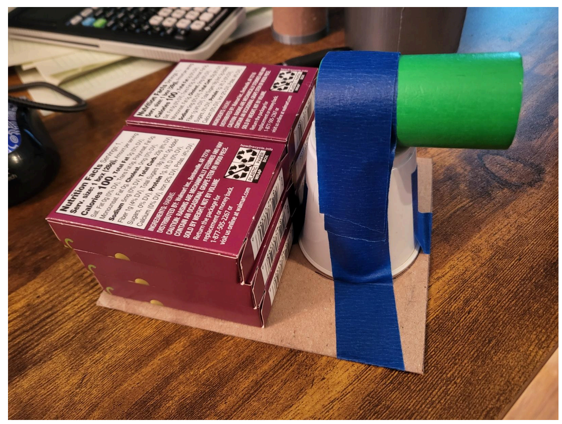
Start the Explain section by asking the students, "How are robotic arms used in the shipping and distribution industry?" Students should be able to recall from the video different aspects of the shipping and distribution process using robotic arms, such as lifting heavy objects, precisely picking and packing goods, and loading/unloading pallets.

As discussed in the video, robotic arms are used in many ways in the shipping and distribution industry, including:

- Palletizing: Robotic arms can automate the process of placing products onto pallets, which can improve accuracy, cost-effectiveness, and predictability.

- Material handling: Robotic arms can help ensure goods are stored properly, easy to find, and transported correctly.
- Picking and packing: Robotic arms can replace humans at workstations for picking, packing, and preparing orders.
- Loading and unloading: Robotic arms can load and unload heavy items from conveyor belts.
- Transporting fragile products: Robotic arms can transport fragile products without causing damage.
- Reducing manual labor: Robotic arms can reduce the amount of manual labor required.
- Minimizing risk of workplace injuries: Robotic arms can reduce the risk of workplace injuries from lifting heavy objects and repetitive stress injuries.

Preparing Materials for the Lesson Challenge (skip this step if providing pre-made pallets and a shipping container)

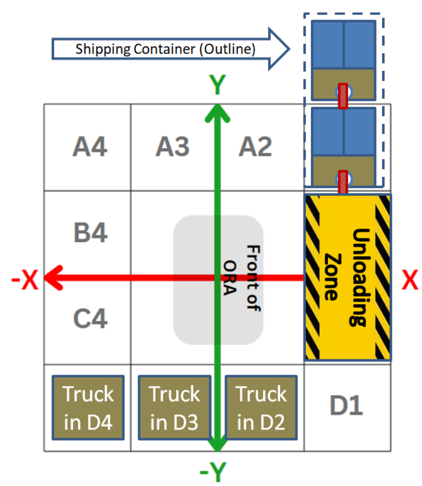


Open the Pallet Construction slide deck and hand out the cardboard, cups, cylinders, and tape to students.

Following the instructions, have students cut the pallet bases to 12cm x 14cm and then attach the cup and the cylinder. If the shipping container needs to be built, also create a 13cm x 13cm x 30cm box.

Elaborate: Unloading the Shipping Container

In this challenge, students will program ORA to unload a model shipping container with two pallets inside. Students will remove the pallets from the container and then move the products on the pallets to three waiting trucks to transport those goods to a store.



Setup:
Place the 'shipping container box' with the opening in the -Y direction. Place the two pallets with stacked raisin boxes in the pallet so that the pallet 'handle' is pointed in the -Y direction. Note: no materials are needed for the 'trucks' in D2, D3, and D4.

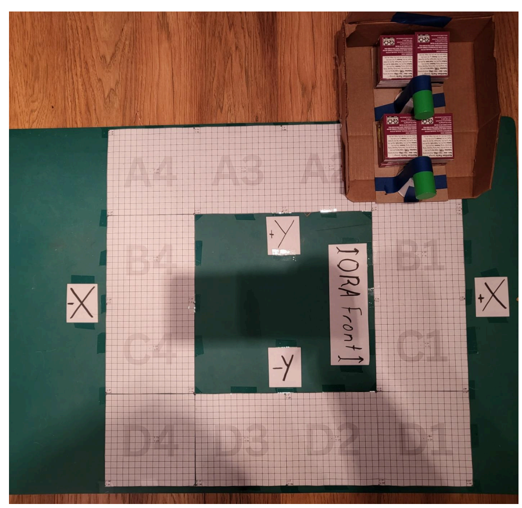
Task Requirements:
1. ORA must start in the initial position.
2. ORA must use the vacuum grippers to grip the first pallet by the handle and pull it to the Unloading Zone.
3. ORA will move two boxes from the pallet and place them in a single pile in D2. Then repeat this by placing two boxes from the pallet into D3 and D4.
4. ORA will remove the empty pallet from the Unloading Zone.
5. ORA will reach into the shipping container to grip and remove the second pallet into the Unloading Zone.
6. ORA will again unload two boxes from the pallet, into D2, D3, and D4, so that there are 4 boxes in each 'truck.'
7. ORA must finish in 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 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.]

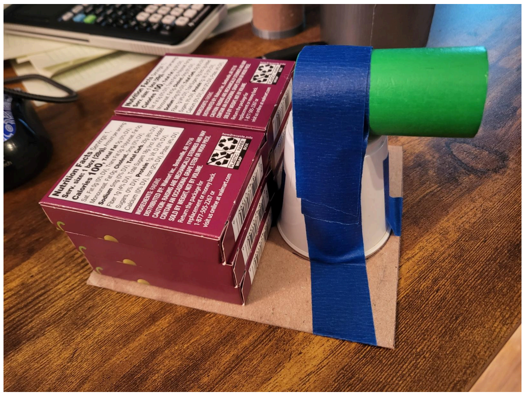
If students are waiting for the ORA, they could:
- Complete the Evaluate section of the Activity Sheets as an exit ticket.

Elaborate: Example solution
1. **Setup**
   a. Right is an image of the setup for the lesson challenge.



2. **Designed Materials**
   a. For this challenge, either the students or the teacher will create a model shipping container and pallets. The shipping container is a cardboard box approximately 28cm x 23cm x 8 cm (a shoebox with the lid and one of the short sides removed works). The pallets are constructed with two cups, two wooden dowels, and two pieces of non-corrugated cardboard as shown here.

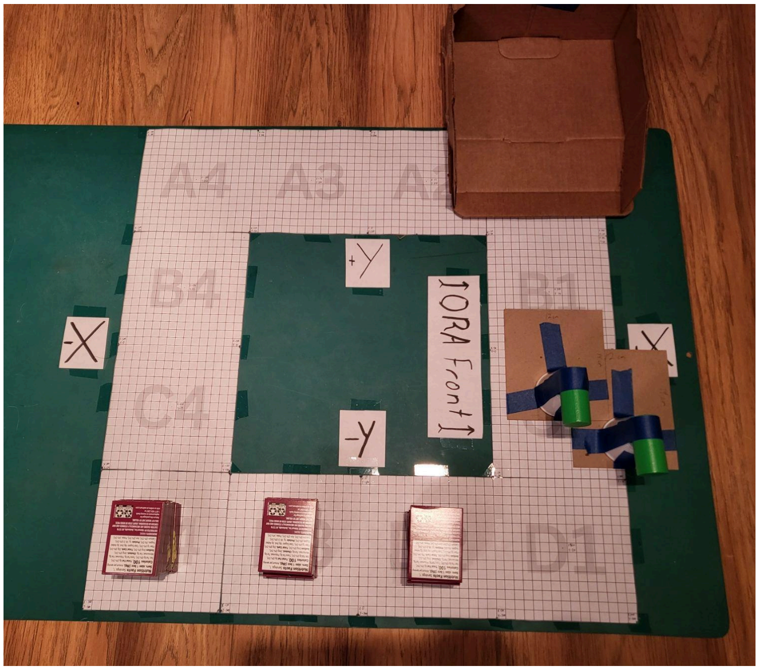
3. **Sample Code**
    a. [Example Solution Code]



4. **Code Description**
    a. The code begins when ORA removes the first pallet from the shipping container. This motion drags the pallet so that the raisin box midline is along the Y=0 line between B1 and C1. ORA then uses the vacuum gripper to take the top two raisin boxes and place them in a single stack in D2. This process is repeated for D3 and D4. ORA drags the pallet by the wooden cylinder and places it at the outside edge where C1 and D1 meet. ORA then moves into the shipping container to remove the second pallet. ORA will unload the pallet in a similar method to the first pallet. At the end, there should be 4 raisin boxes stacked in D2, D3, and D4. ORA finishes by moving to the Initial Position.
    b. Below is an image of the quadrant map after the program has been executed.

Evaluate: Exit Ticket

Students will fill out and submit the Evaluate section of the Activity Sheets as an exit ticket.



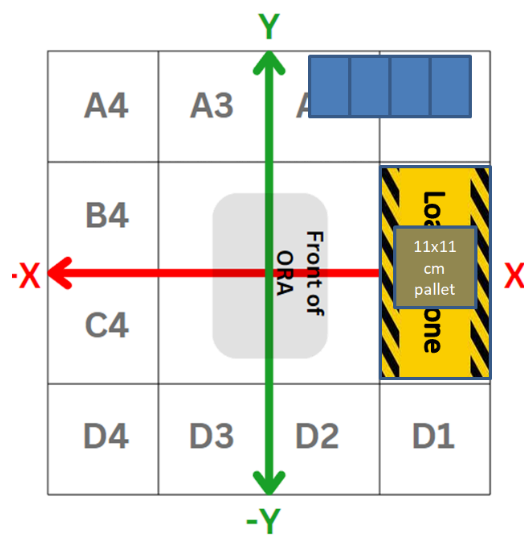
Optional Extension: Pallet Optimization

In this activity, students will work on optimizing the arrangement of products on a pallet to maximize pallet density.

GSG is changing its pallet size from 12cm x 14cm to an 11cm x 11cm square. How can you fit all 12 raisin boxes on the new pallet to minimize gaps and spaces?

Source: Canva

Setup: Cut out a new piece of cardboard 11cm x 11cm in size (don't use a cup-cylinder handle in the extension) and place it in the Loading Zone. Students may place/arrange 12 raisin boxes in A1 and A2 as they see fit.



Task Requirements:

1. Students will decide on the best arrangement to fit the 12 raisin boxes on the pallet.
2. After students decide on an arrangement, they may arrange the boxes in A1 and A2 as they see fit.
3. Students will then program ORA to move the raisin boxes onto the pallet in the decided best arrangement.
4. Students will then measure the final height and determine the pallet density. Remember, a lower volume per product is a higher density!

Example calculations

The stack to the right is highly optimized. It is 11cm x 11cm x 7.5 cm. All stacks will have a base of 11cm x 11cm since the pallet is that size. This is a volume of 907.5 cm^3. Dividing this number by the number of raisin boxes (12) is 75.625. This means that each box takes up about 75.625 cm^3, which is roughly the volume of a single box. This is good!

If the boxes are full, you could use the mass divided by the volume (which is actually the density). The boxes used in the example are 28 grams each. 12 boxes would equal 336 grams. If you divide 336 grams by the volume of 907.5cm^3, the density is 0.37 g/cm^3

The stack to the right is poorly optimized for an 11cm x 11cm pallet. When placed on the pallet, the volume is 11cm x 11cm x 10.2cm. This makes it have a total volume of 1234.2 cm^3. Comparing this to the first stack's calculation, this means there is about 326 cm^3 of wasted, empty space on the pallet! Dividing the volume by the number of raisin boxes gives 102.85 cm^3 of shipping space per box! This is not an efficient use of shipping space.

As described above, if you divide 336 grams by the volume of 1234.2 cm^3, the density is 0.27 g/cm^3