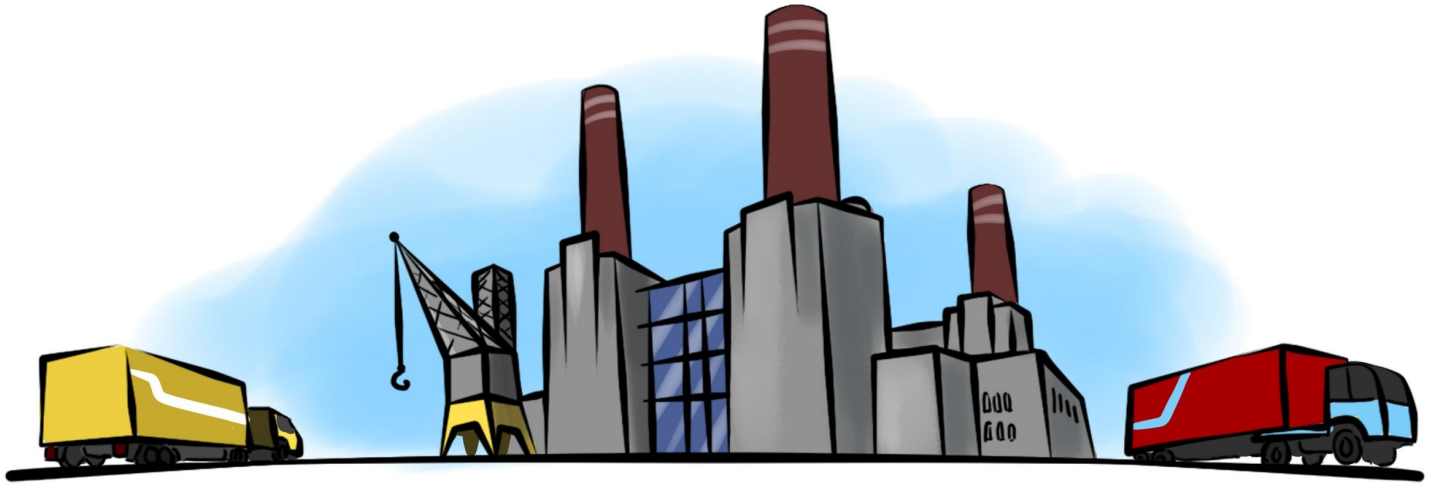
ROBOTIQ

PART PRESENTATION PLAYBOOK

2017

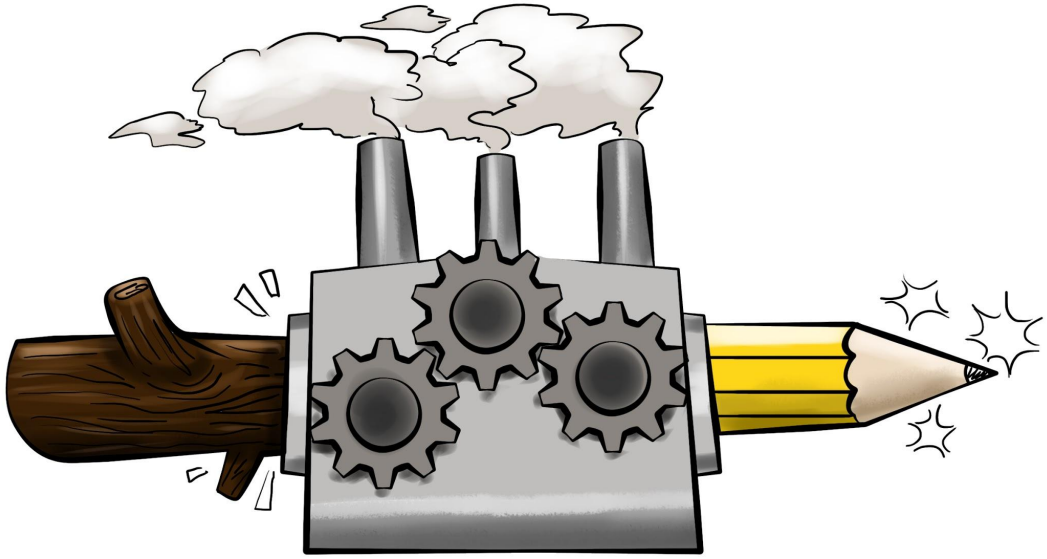
FACTORIES

Factories transform materials and parts into finished products.



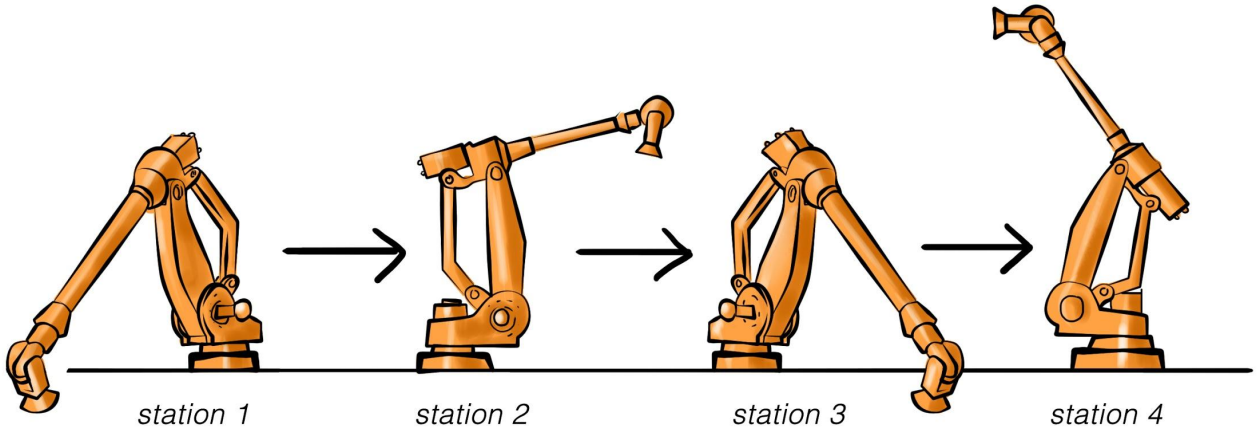
FACTORIES

At their simplest, factories are “black boxes.” They take an input, such as materials and parts, and produce a certain output, which is the finished product.



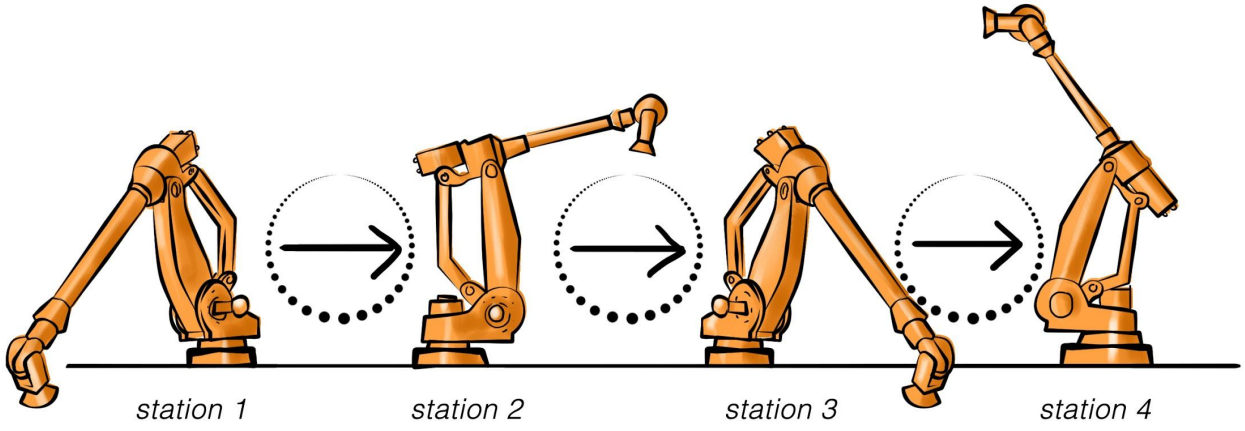
STATIONS IN A FACTORY

Within the plant, the same concept applies to the stations (or “cells”) where the products are made. Each station takes the product-in-progress and transforms it by adding value to it.



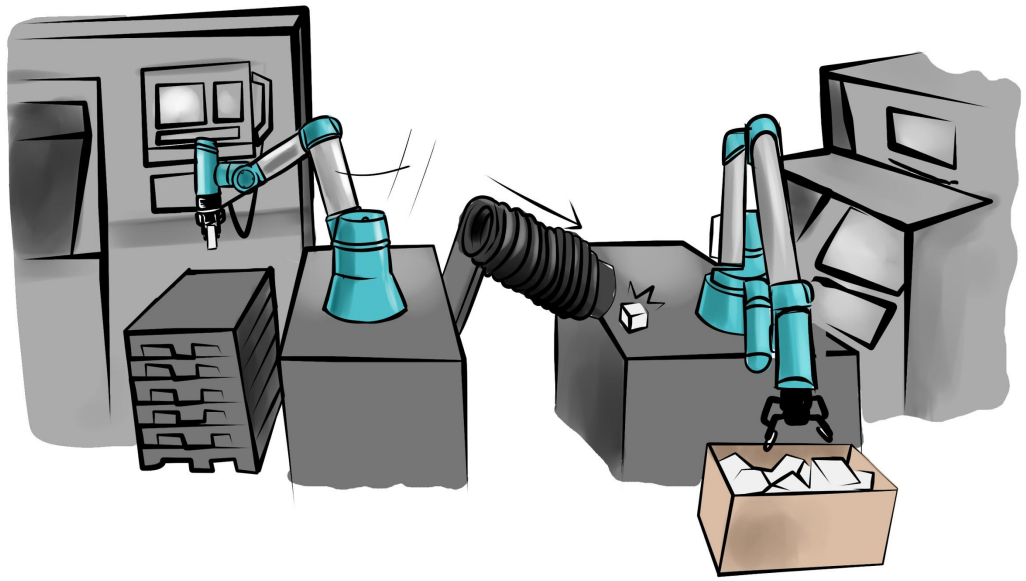
STATIONS IN A FACTORY

The way stations are connected on a factory floor has a huge impact on efficiency.



INTERACTIONS

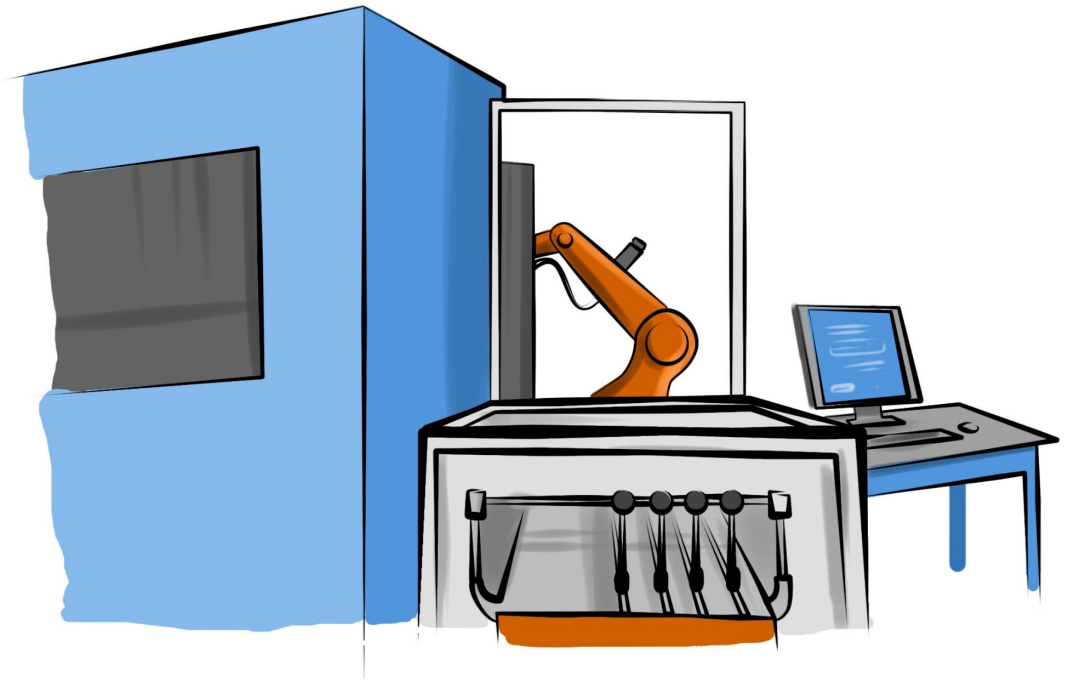
Each station's input and output represents its interactions with the adjoining stations.



When it comes to a robotic cell, the ways in which parts arrive and are presented to the robot are as important as how they leave the station.

A ROBOTIC CELL IN A FACTORY

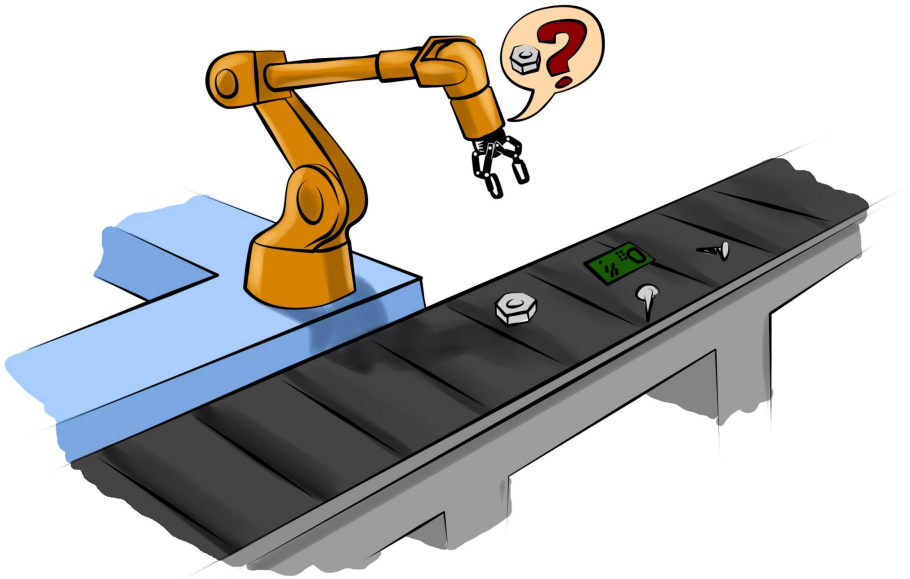
This playbook focuses on how to figure out part presentation when you're transitioning from a manual cell (human operator) to a robotic cell (robot operator).



A ROBOTIC CELL IN A FACTORY

When designing a robotic cell, you have to consider the way parts are presented to it.

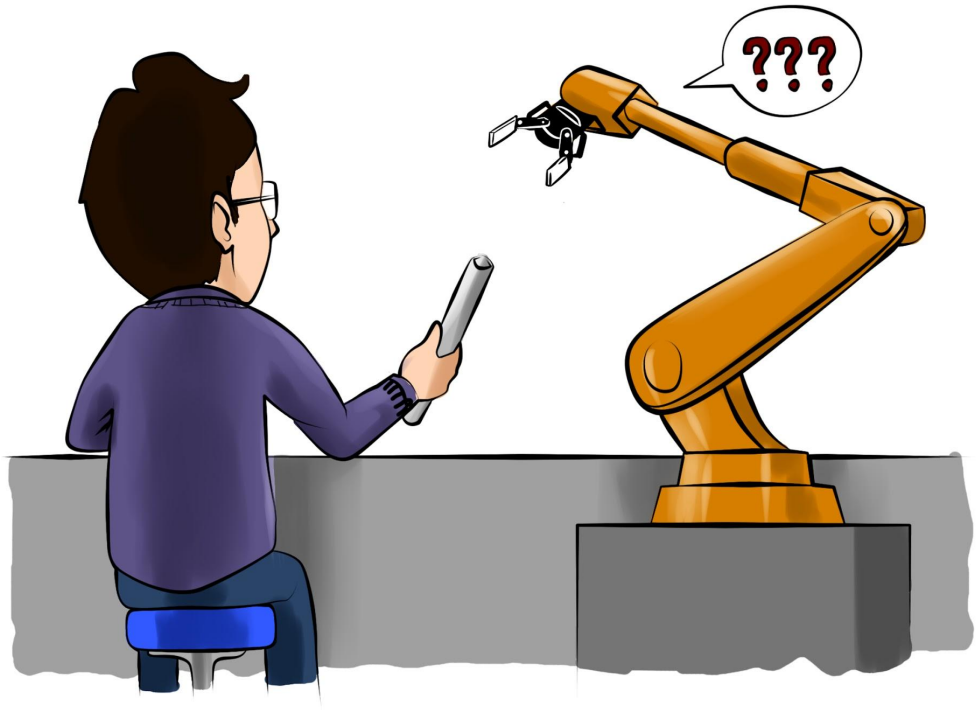
A simple robot arm lacks the senses of sight and touch, so it can't locate a part on a conveyor belt by itself.



PART PRESENTATION

How will parts be presented to the robot?

Getting this step right is crucial to ensuring your cell is effective within the factory.



PART PRESENTATION

- **A common mistake is to start integrating the robotic cell and *then* realize that part presentation is an issue.**

If this happens, it will almost certainly induce extra costs and delays in your robotic cell deployment project.

Consider how to present parts to the robot while you're still in the design phase of your robotic cell deployment.

YES, BUT HOW?

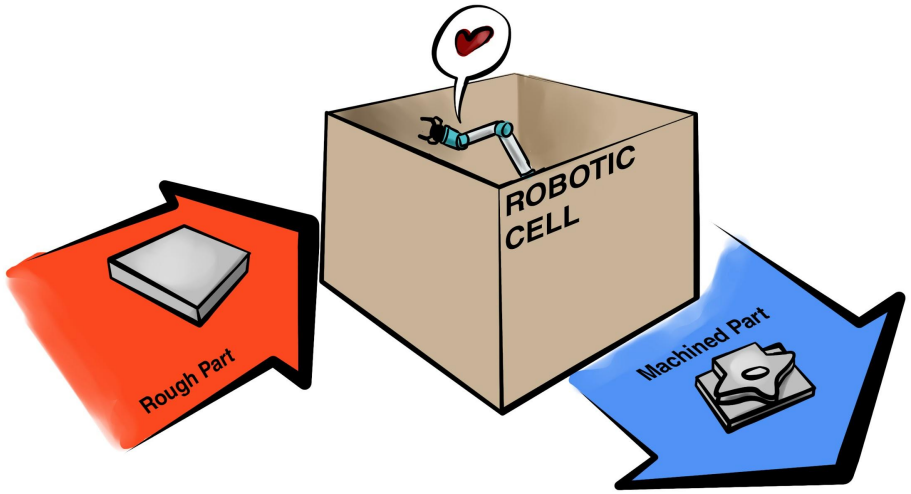
Assess the following in order to address the part presentation challenge:

1. How is the process currently performed in the manual cell?
2. What is the required output from the station?
3. What is the input to the station?

1. MANUAL PROCESS

What process will be automated? Is it:

Testing
Machining
Quality control
Assembling
Packaging
Gluing or painting
Dispensing
Welding
...Or something else?



1. MANUAL PROCESS

Map how the process is performed manually:

- What are the handling steps?
- How do parts arrive?
- How do parts leave the station?
- What are the interactions with the surrounding cells?

2. ROBOTIC CELL OUTPUT

Assess your plans for the robotic cell:

- What is the robotic cell's required output?
- What defines a good part? A bad part?
- How are parts supposed to leave the robotic cell?
- Are there any other paths the parts could take when leaving the cell?
- Are there any other outputs?
- What is the required cycle time?
- What is the typical batch size?

2. ROBOTIC CELL OUTPUT

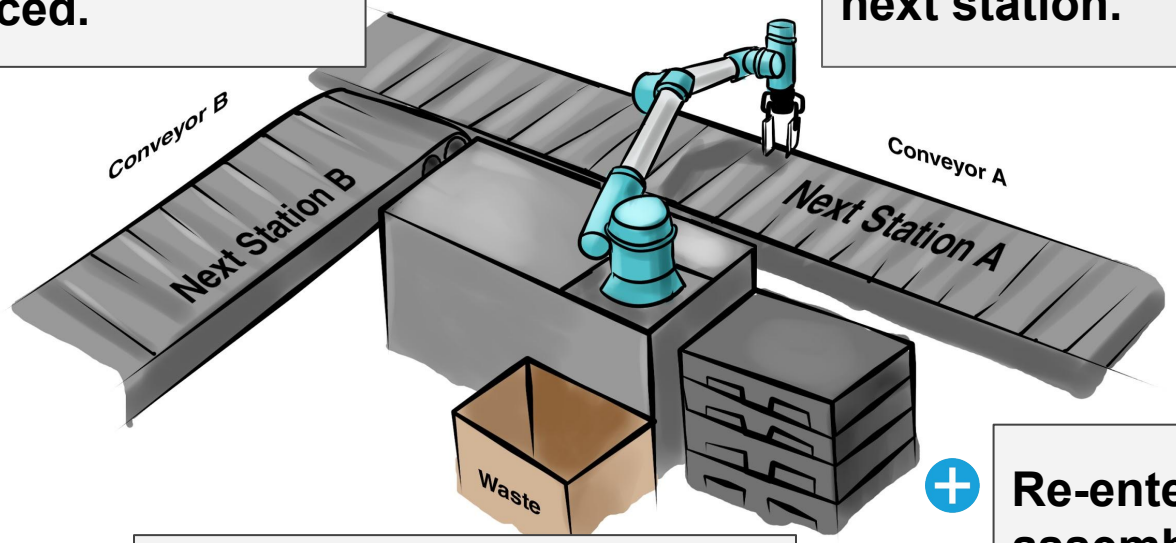
- The cell may have other outputs, such as:
  - Packaging to be disposed of.
  - Parts that do not pass a quality test.

- Concerning the output, ask yourself:
  - What is the task to be performed in the next cell, and how will it be done?
  - How will the output part get to the next station?

2. ROBOTIC CELL OUTPUT

When a part leaves a cell, it can have various destinations. It may:

- **Go to different stations, depending on the part being produced.**
- **Go directly to the next station.**



- **Re-enter the assembly line, if poor quality.**
- **Go to a disposal bin, if waste or poor quality.**

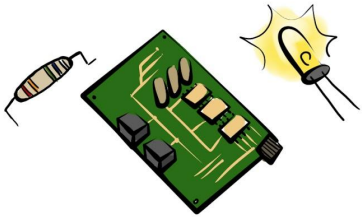
3. ROBOTIC CELL INPUT

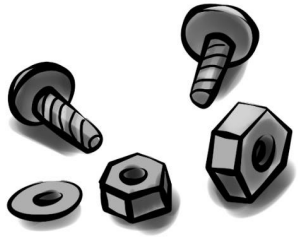
After assessing the output, do the same exercise for the robotic cell's input:

- **What is the main input to the robotic cell?**
- **What other inputs are needed?**
- **How does each input arrive at the cell?**
- **At what speed and frequency do the inputs arrive?**
- **What shapes and geometries might the inputs possibly have?**

3. ROBOTIC CELL INPUT

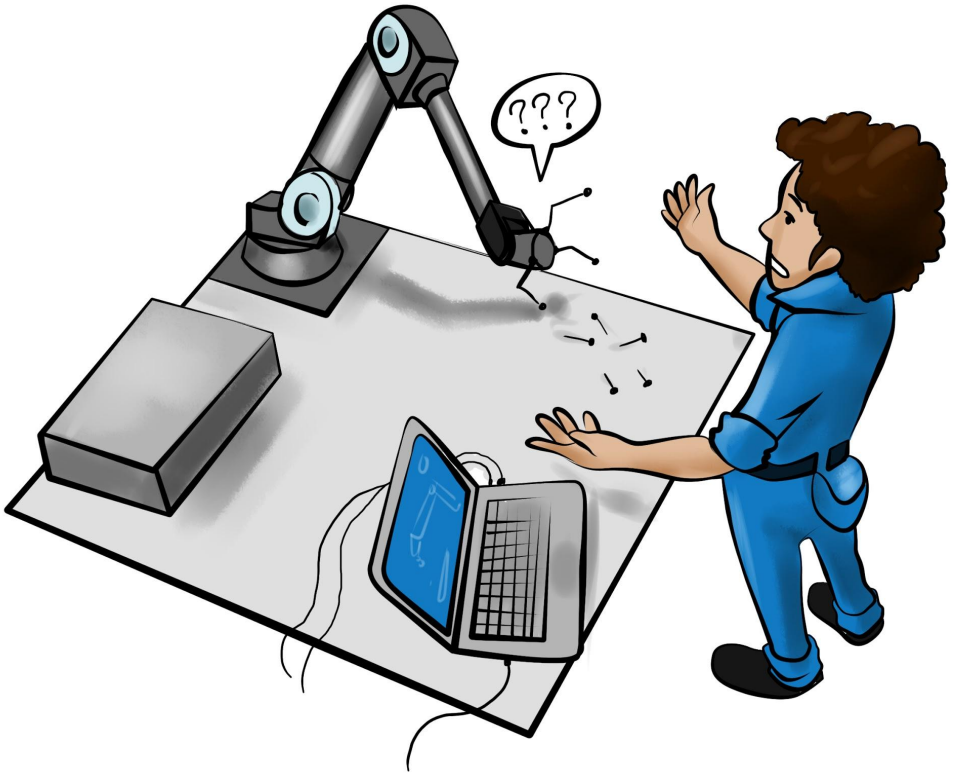
- The cell may need other inputs to complete the task, such as:
  - Screws, nuts, bolts, and other hardware.
  - Paint, glue, grease, etc.
  - Parts to attach to the product.
  - Boxes and foam for packaging.





3. ROBOTIC CELL INPUT

- **Take the time to assess the robotic cell's other inputs as thoroughly as the product itself.**



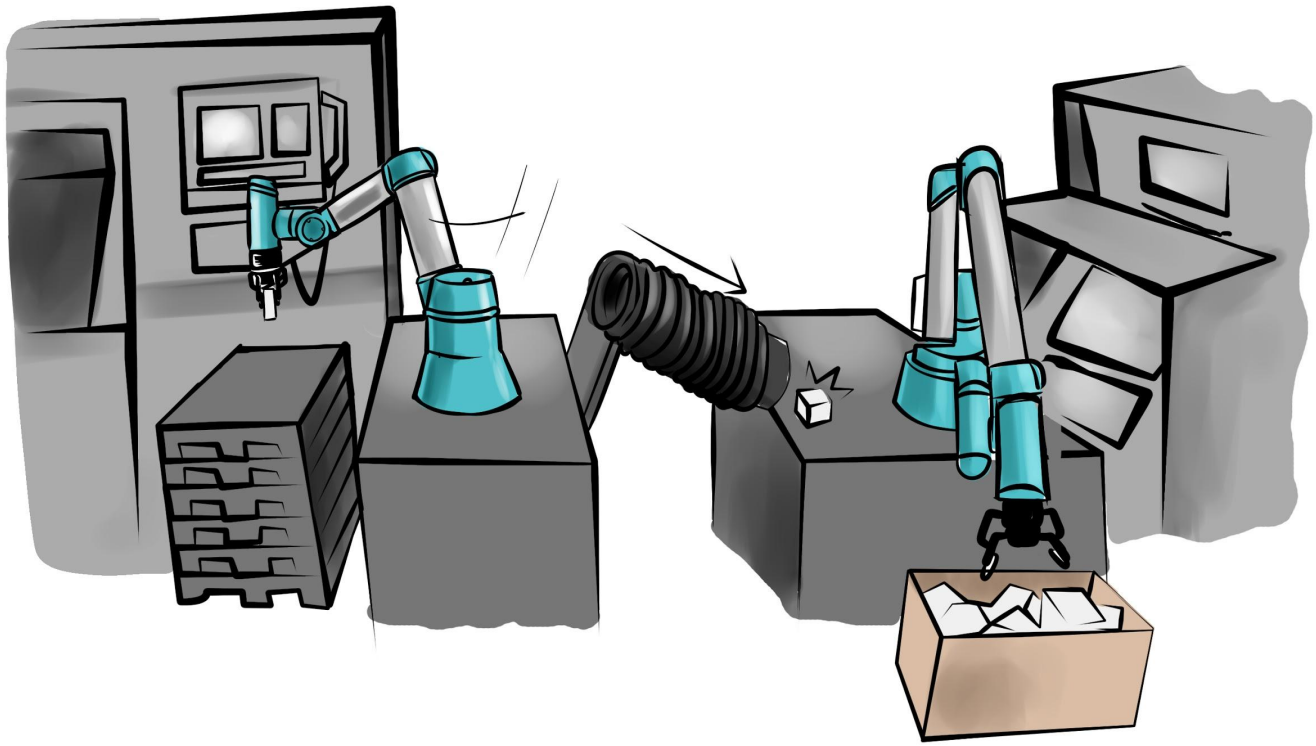
MODIFICATIONS TO THE CELL

Now that you've described the processes of the manual and robotic cells, it's time to compare them:

- **What do you have to change about your existing setup in order to integrate a robot cell?**
- **Which aspects of the manual cell's process will change once it becomes robotic?**
- **Modify what needs to be changed in order for a robot to perform the required task.**
- **Define the best part presentation solution for your robotic cell—as described in this playbook.**

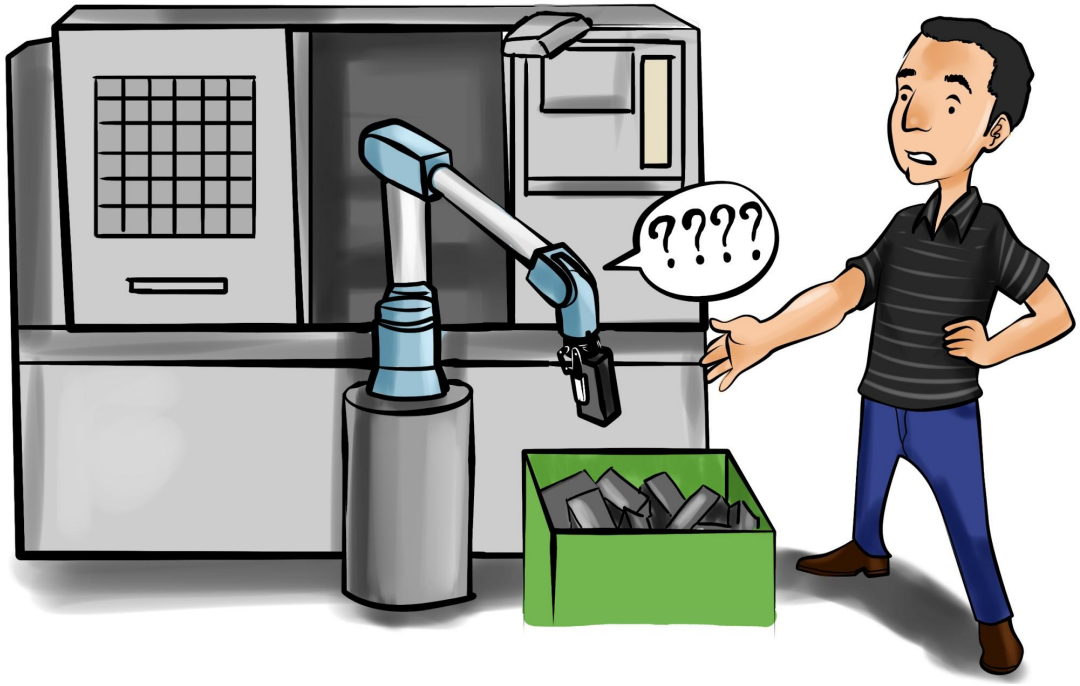
TIP

- **If possible, arrange things so that each station's output is the subsequent station's input. This raises efficiency by reducing non-value-added handling time.**



PART PRESENTATION

- **By itself, a robotic arm cannot detect whether the conveyor in front of it is running, where a part is on a workplane, whether it has grasped an object from a tray, or what part it's handling.**

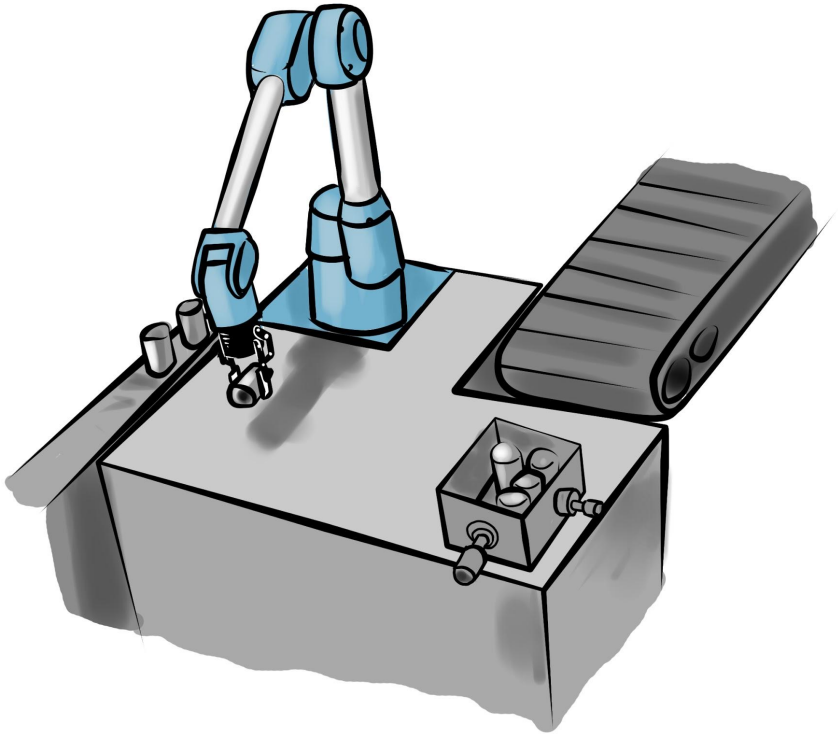


PART PRESENTATION

- When making sure your robot is able to pick parts, you may consider using techniques such as:
  - Precise placement of the part.
  - Force sensors.
  - Vision systems.
  - Presence or proximity sensors (e.g., photoelectric laser sensors).
  - Gripper feedback.

PART PRESENTATION

- **You must find solutions to ensure parts are presented in such a way that the robot can handle them correctly.**



PART PRESENTATION

Here are some solutions you can use to present parts to a robot:

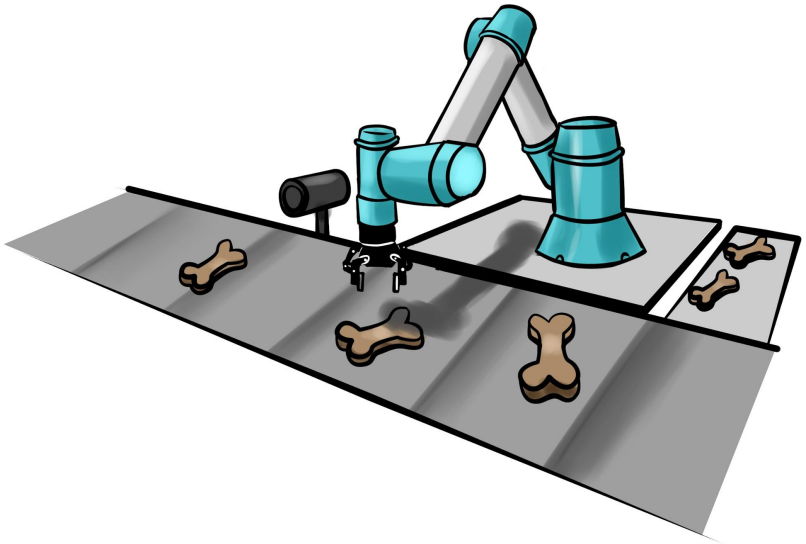
- **Dispensers**
- **Jigs**
- **Trays**
- **Boxes & pallets**
- **Bins**
- **Vision systems**
- **Conveyor belts**

In terms of programming your robot, the solutions here are listed in order of simplest to toughest.

PART PRESENTATION

- **Sometimes a conveyor is all you need for part presentation.**

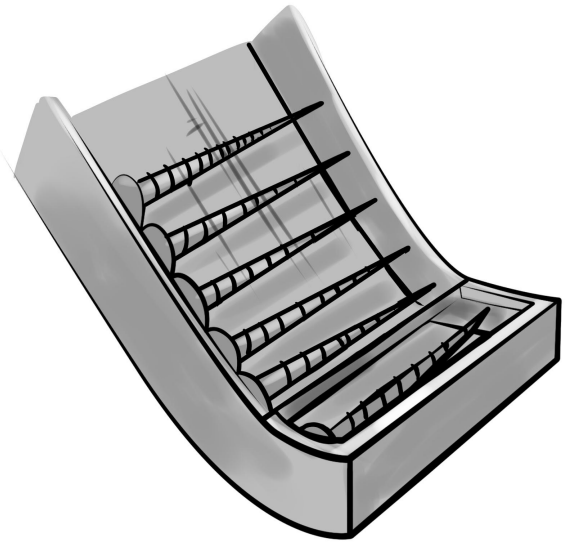
  However, the conveyor is more likely to just be a way to move parts from one station to another—in which case you'll need to combine your conveyor with another solution so the robot will know where the parts are on the belt.



DISPENSERS

- Dispensers let you deliver parts—generally small ones, or hardware like screws and nuts—to the robot in an orderly manner.

They're a good alternative to bin picking because they're easier to deal with when programming your robot.

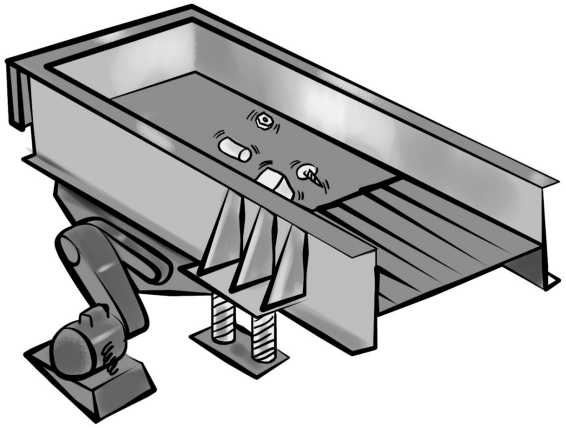


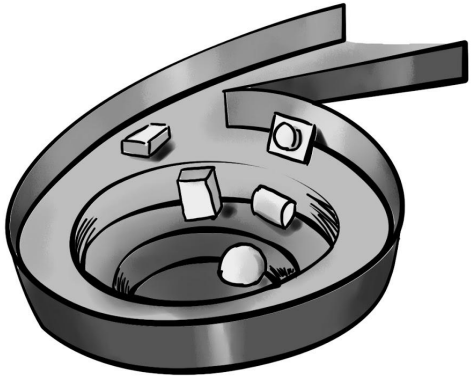
However, using a dispenser does involve adding a device to your robotic cell.

DISPENSERS

There are many types of dispensers:

- **Vibrating bowls.**
- **Mechanical dispensers.**
- **Vibration feeders—which sometimes require a vision system.**





DISPENSERS

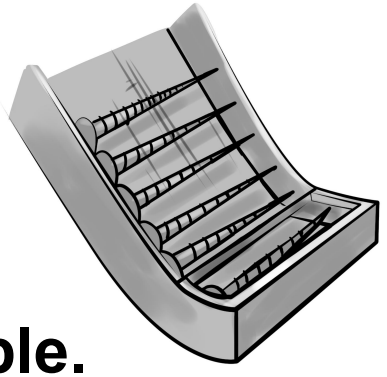
- **No matter what kind of dispenser is used, this solution is simple to integrate with the other elements of the cell.**

You only need to program the robot's pick position, and make sure there's something in place to do the following:

- **Confirm that the gripper has properly picked the part.**
- **Detect whether any part has jammed in the dispenser.**

DISPENSERS - MECHANICAL DISPENSER

Level of difficulty:



Good for:

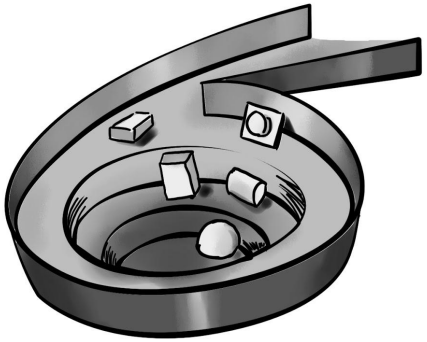
- When the part's geometry is suitable.
- Smaller parts.
- As a simpler alternative to bin picking.
- Parts that would be hard to handle otherwise.

Bad for:

- When the design of the dispenser may be too complicated.
- Small batch sizes, which would require designing and fabricating multiple versions.

DISPENSERS - VIBRATION FEEDER

Level of difficulty:



Good for:

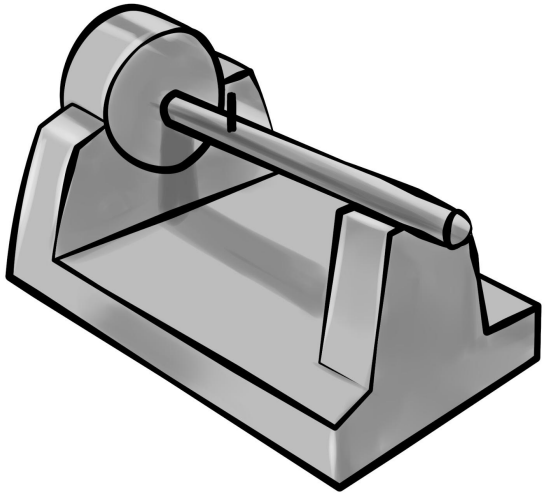
- When the part's geometry is suitable.
- Hardware (like screws, dowel pins, etc.).
- As a simpler alternative to bin picking.

Bad for:

- Parts that are not suited to feeders—typically larger, heavier parts.

JIGS

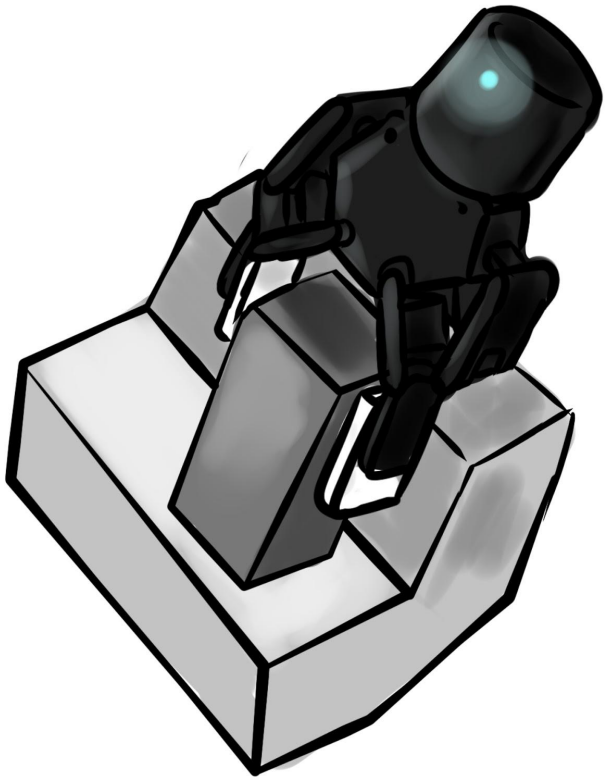
- These devices are commonly used to present a part to a robot at a precise location. Jigs and fixtures can be used by themselves or in combination with other part presentation solutions. For instance, a tray can be placed within a jig to further enhance precision.



JIGS

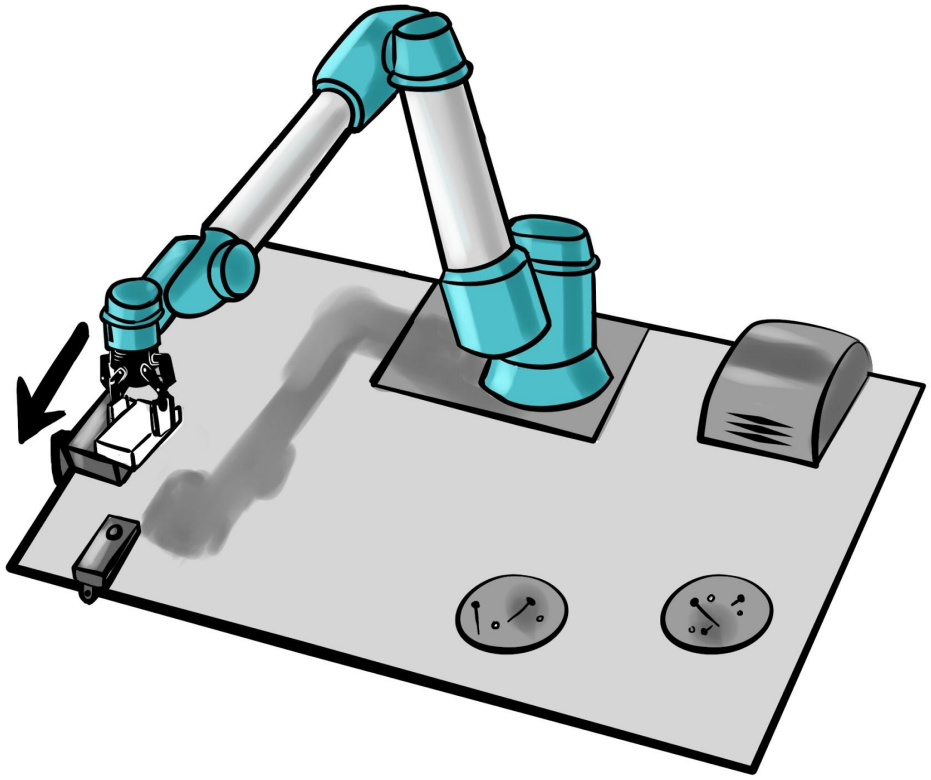
JIGS

- **Fixtures are also used to reposition an object within the robotic gripper.**



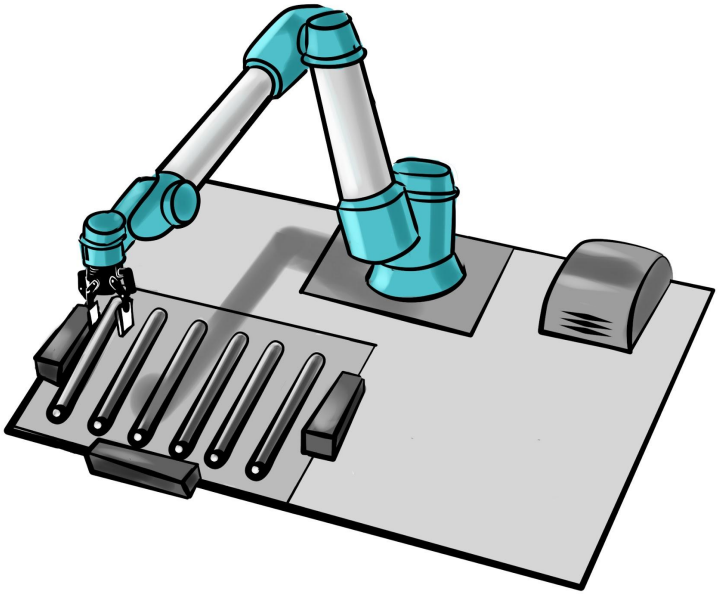
JIGS

- You can add force sensors to the robotic arm to help it place parts against the jig or fixture.

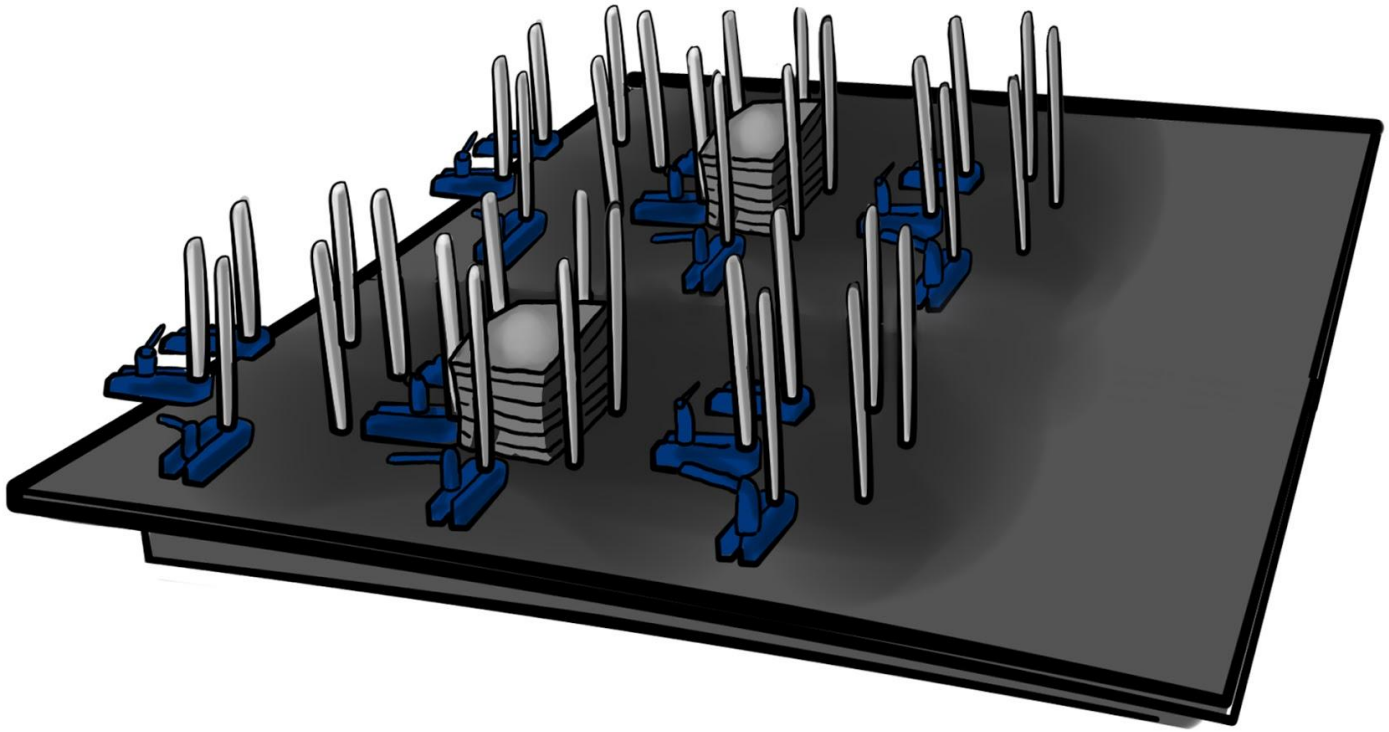


JIGS

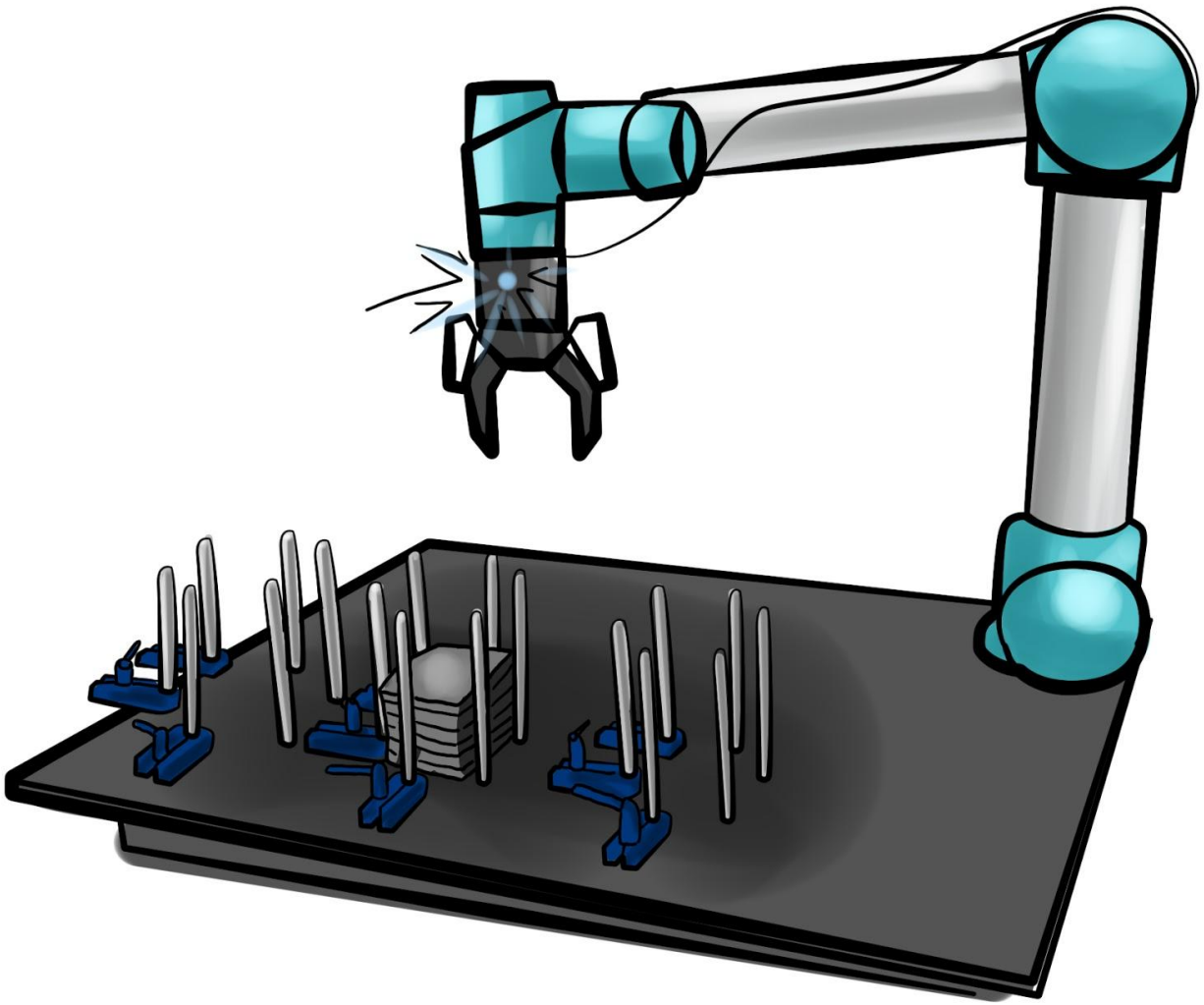
- You have to fabricate and install the jigs, which can cost a significant amount of time and money if the type of part you're using changes frequently. On the other hand, jigs make it much easier to program the robot, since you can assume the parts will always be located in the exact same position.



JIGS



JIGS



JIGS

Level of difficulty: 

Good for:

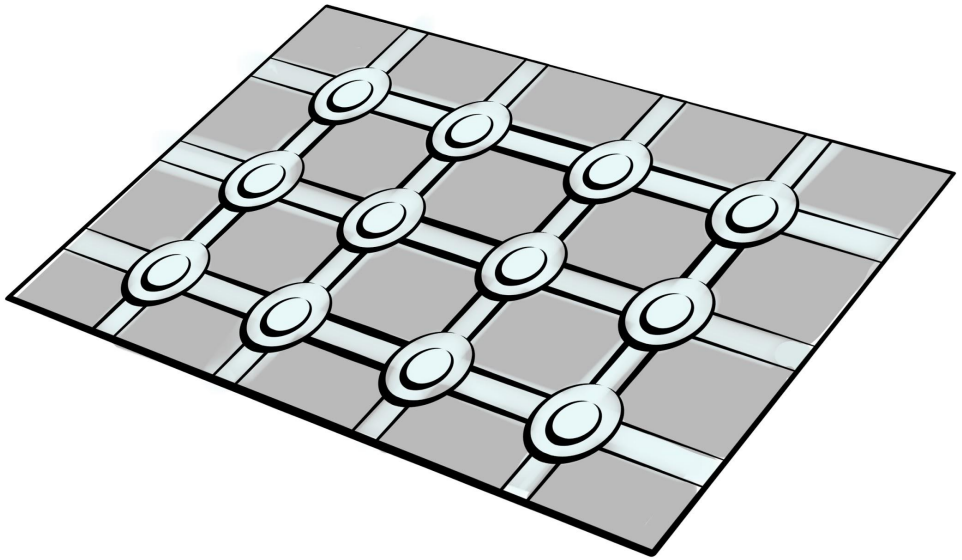
- Applications that require precision.
- Presenting piles, parts or trays precisely.
- Stabilizing an assembly for easier handling.

Bad for:

- Small batch sizes, which would require multiple jig designs.

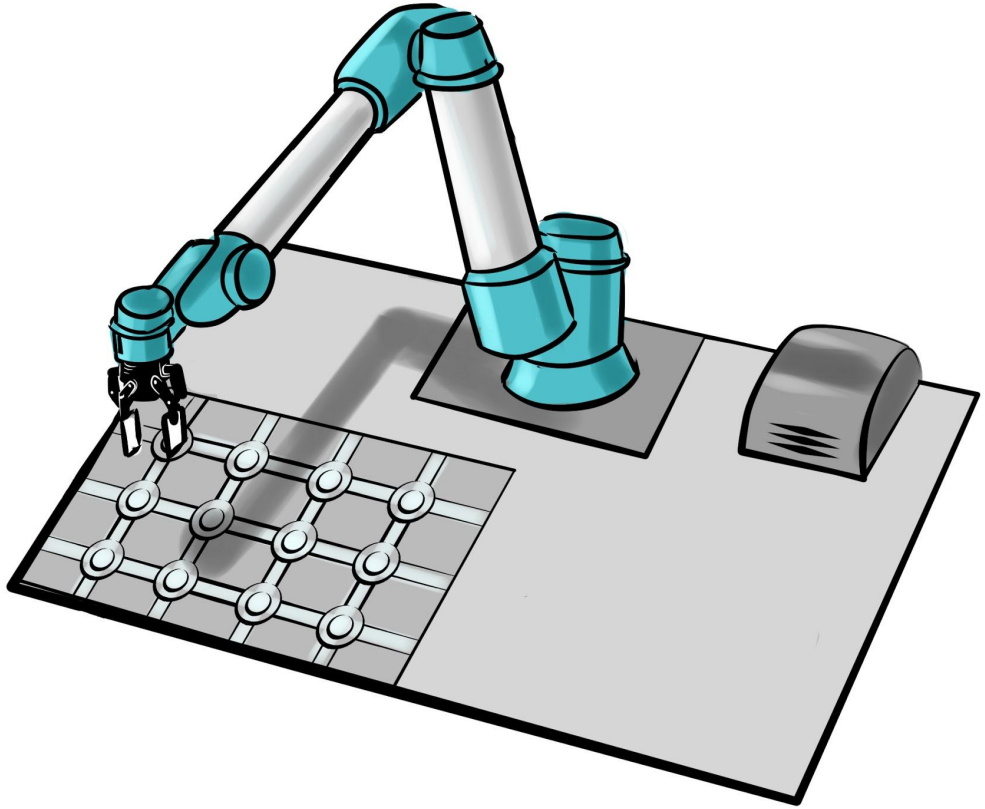
TRAYS

- **Presenting parts on a tray does require some design and fabrication. While this solution is an effective way to precisely present parts to a robot, it involves some additional costs. If the parts the cell will handle are likely to change, then you could face delays from having to redesign the tray.**



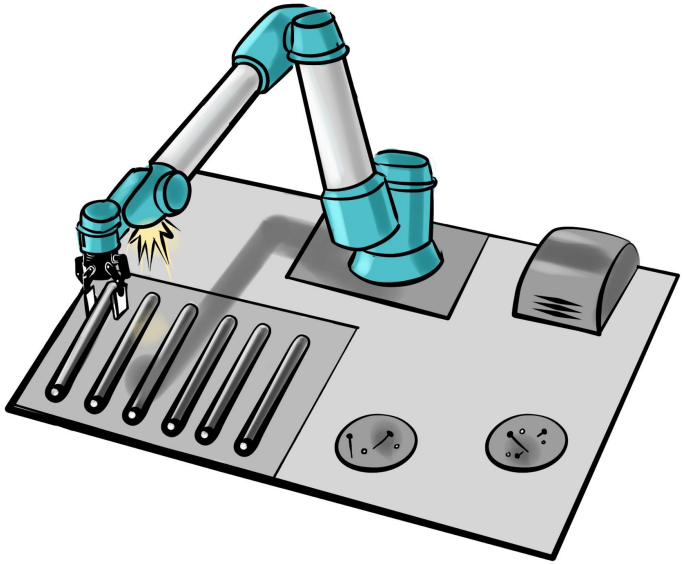
TRAYS

- **Using trays makes it simpler to program your robot. It's easier to program its motion when the parts, and tray, are always in the same spot.**



TRAYS

- When using trays, you might want to add a vision system to your robot. Unless your tray is always completely filled up, using a vision system can help your robot empty the tray efficiently. It will prevent the robot from leaving parts in the tray or trying to pick some up where there aren't any.



TRAYS

Level of difficulty: 

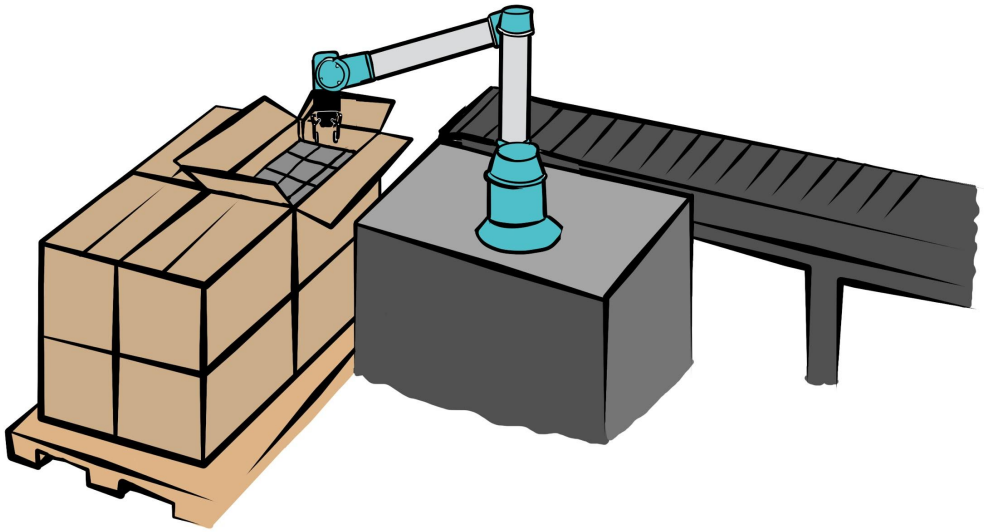
Good for:

- Parts that arrive pre-arranged on trays from the previous station or supplier.
- Parts requiring a precise pick orientation.
- Smaller parts that are being moved around.

Bad for:

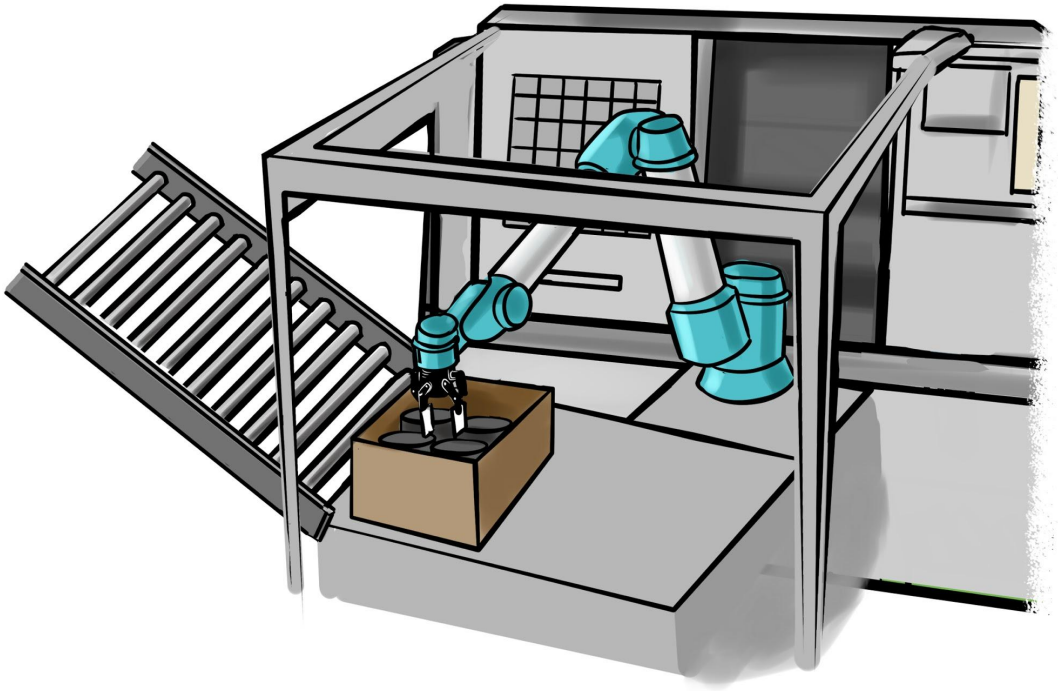
- Small parts that come in big batches (e.g., screws).
- Parts that are large relative to the gripper and robot.
- Small batch sizes.

BOXES



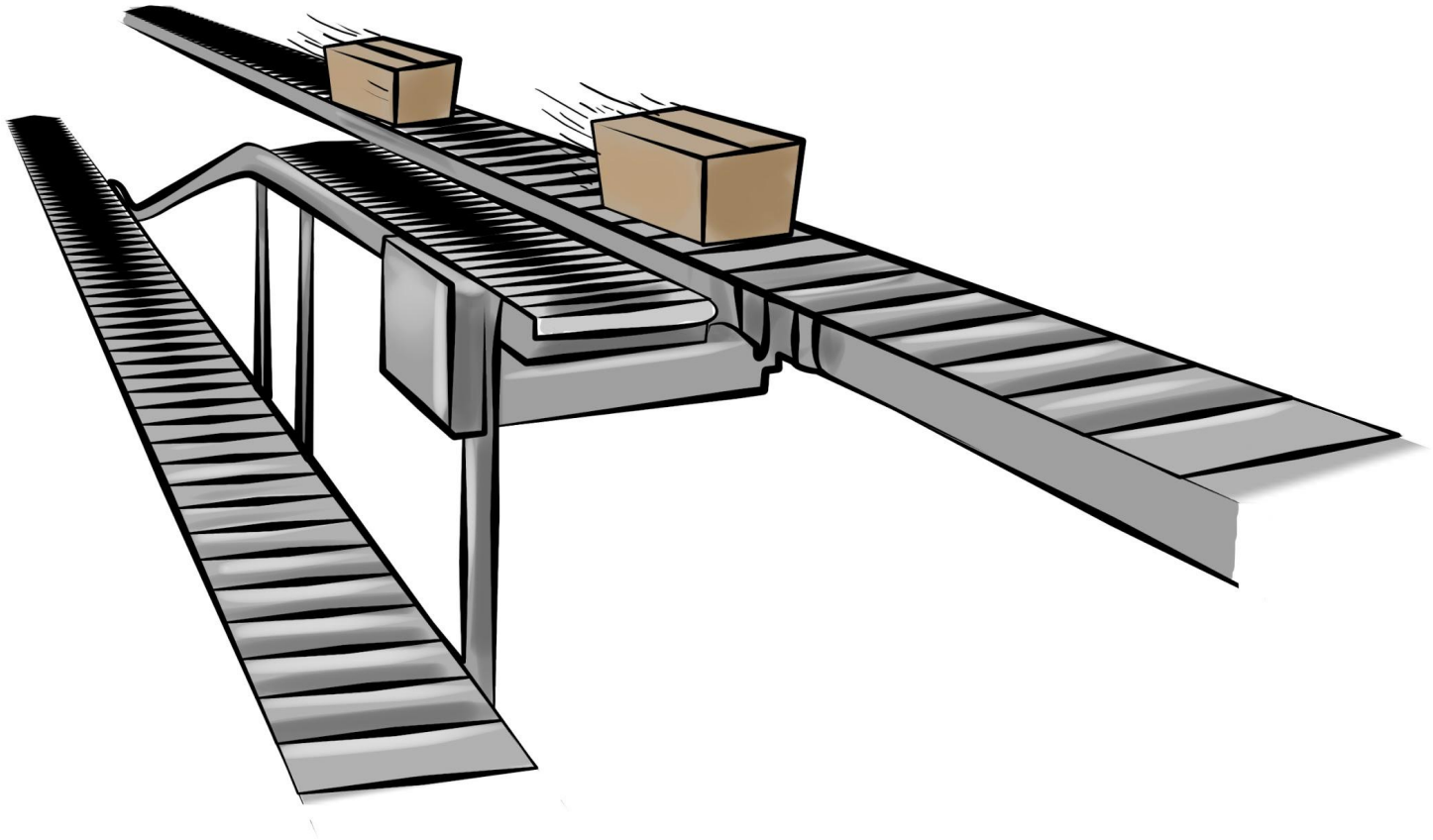
- **Parts that are delivered in boxes may arrive stacked in a precise order. Boxes may also be used within the plant for moving parts from one area to another. These boxes can be used to present parts directly to the robot.**

BOXES



- **Picking directly from the box saves valuable handling time. The robot can unpack the box and then proceed with an operation straight away.**

BOXES



BOXES

- From a robot-programming perspective, a stack of parts in a box is quite easy to handle.
- If your gripper is flexible and adaptive, the positions of the boxes and parts don’t need to be very precise.
- If more precision is required, however, you might have to add a regular vision system as well. You could also place the box within a jig to help with positioning.

BOXES

Level of difficulty

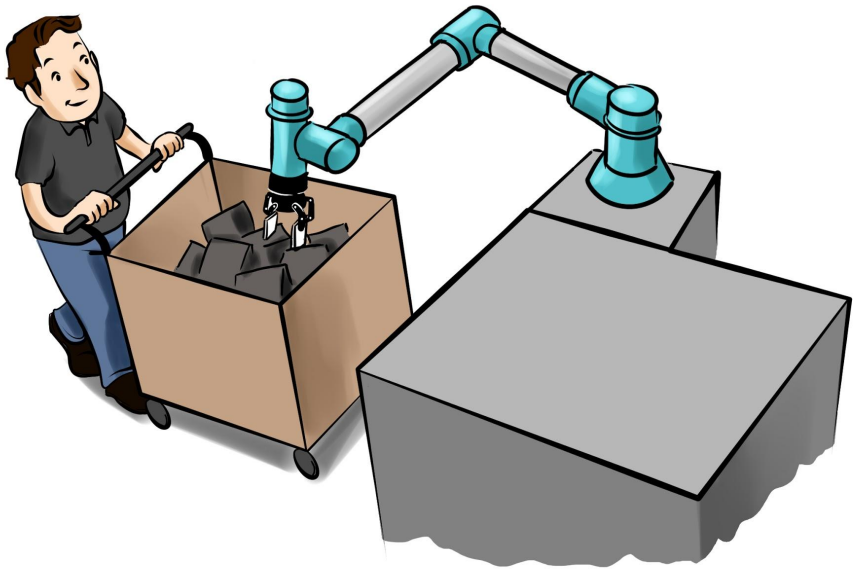
Good for:

- Parts that arrive pre-packaged.
- Parts that are always ordered and arranged in boxes in the same manner.
- When the boxes are suited to the robot's reach and payload.

Bad for:

- When the parts may not be packaged properly in the boxes.

BINS



- **Bins may be the easiest way for *you* to present parts to a robot. All you have to do is drop parts in a bin at random and wheel it over. However...**

BINS

- **...for a robot, this is one of the most challenging part presentation methods! Complex vision systems are often required to have robots pick parts out of bins.**

BINS

- **Adding such a vision system means using advanced programming skills, so make sure you either have them or can hire someone who does.**

  Don’t forget to evaluate the setup costs, including integration and programming, before you choose bin-picking as your part presentation solution.

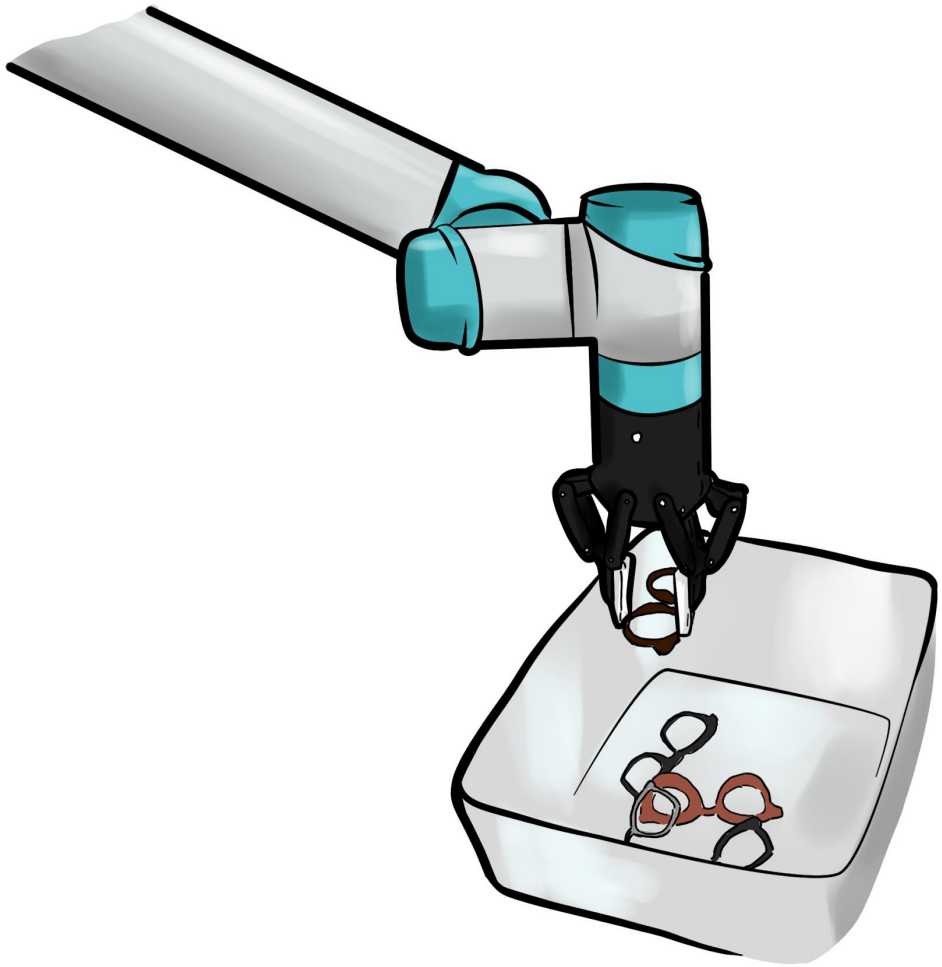
BINS

- **In contrast with part presentation, bins can be a great solution when it comes to parts that are *leaving* the robotic cell.**

  If the parts are going to a station that can handle bin-picking, or they're being disposed of as waste, dropping them randomly in a bin is a simple and effective solution.

  Bins can also work well if the next station is operated by a human worker. Overall, bins can enable a shorter cycle time and will likely require less work from the robot arm.

BINS



BINS

Difficulty level: 

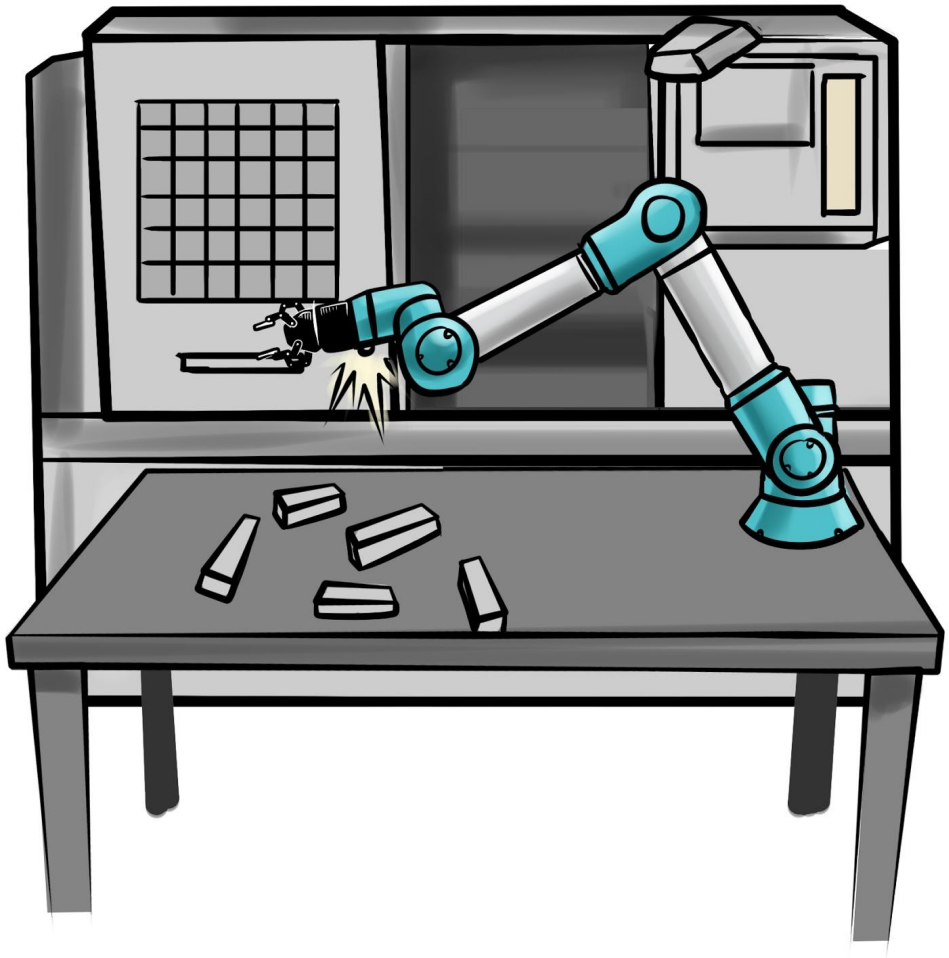
Good for:

- Working in combination with an appropriate vision system (i.e., a bin-picking system).
- Parts that are leaving the station.

Bad for:

- Small pieces of hardware—you may want to go with a dispenser instead.

VISION



VISION

- **Whether parts are brought to the robot by a conveyor, on a tray or pallet, or simply by hand, a vision system can be used to properly pick the parts.**

When you use a vision system, the parts don't need to be positioned as precisely in regards to the robot.

The vision system will detect the part's location and send the information to the robot so it can pick the part accordingly.

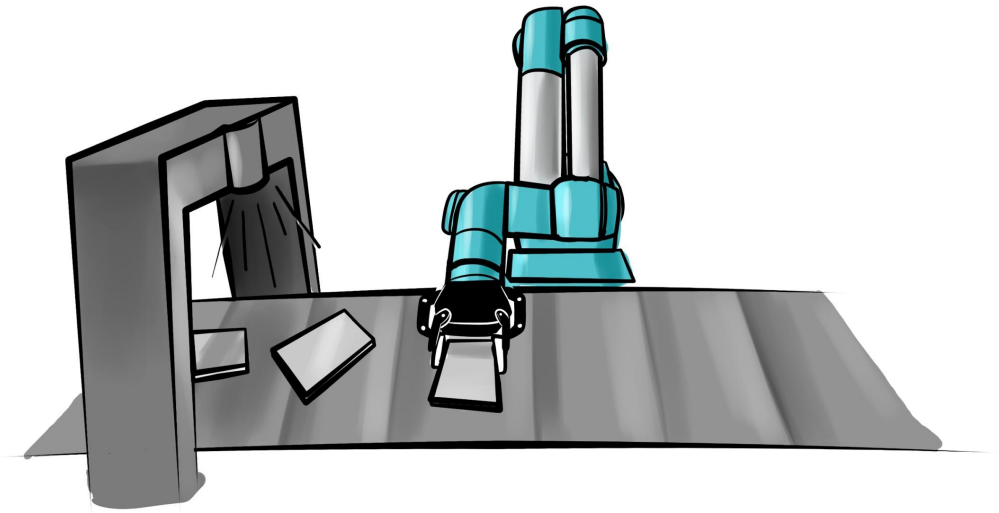
VISION

- **When considering vision systems for a robotic cell, you will find many options on the market.**

Some vision systems are designed for precise part inspection at high speeds; but all you need is a vision system that's able to detect *your* parts on *your* work plane.

Be careful not to get an overly complicated vision system, or you could end up paying more than you needed to.

VISION



- Some vision systems require extensive programming and integration skills, whereas others are more user-friendly. The ease-of-use aspect can have a big impact on installation costs, because it's expensive to have an integrator come in to set up a complex vision system.

  Don't forget, you'll also need to have the integrator come back to do maintenance tasks and to help whenever you need to modify your setup.

VISION

Level of difficulty 

Good for:

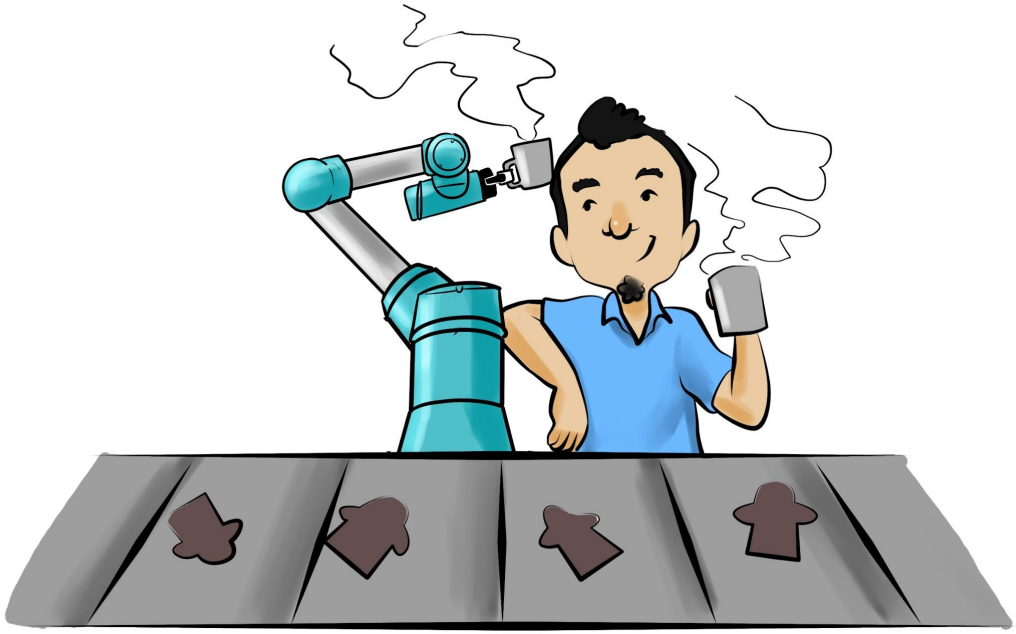
- **If you have in-house skills! Or if it's a user-friendly vision system that suits your application.**
- **Being used in combination with bin-picking or a conveyor.**
- **Quality control (for some vision systems).**

Bad for:

- **When another, less expensive solution is viable.**

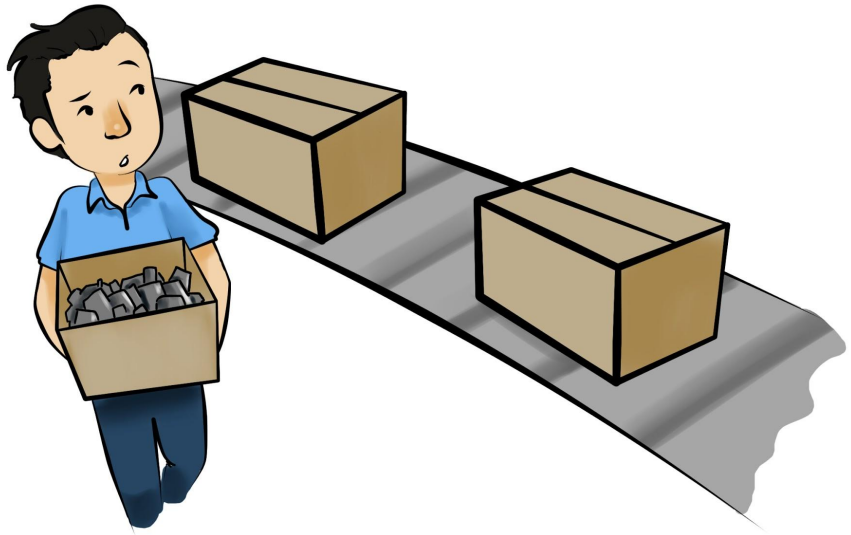
CONVEYOR

- **This sort of setup may already be in place in your plant. If that's the case, a part presentation solution might be right before your eyes.**



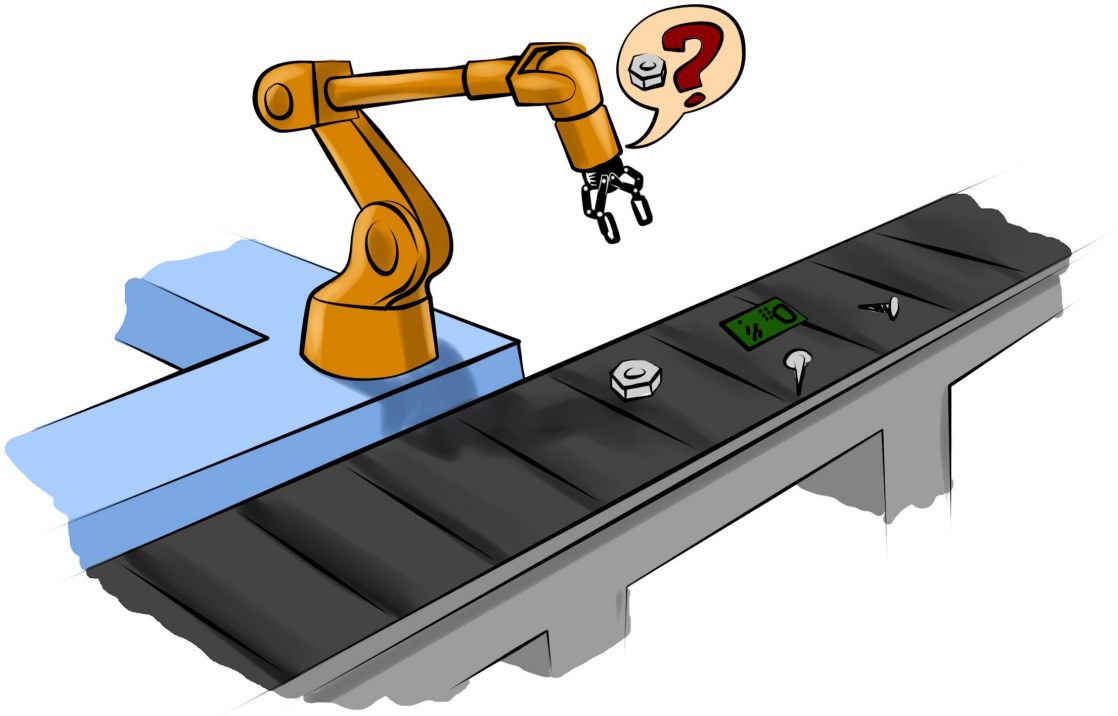
CONVEYOR

- **If you're designing a whole new production line, think about how you want to move the parts around the plant, both from one station to another and between different areas of the factory. A conveyor may be a good fit. If that's the case, you can decide right away to use it for part presentation as well.**



CONVEYOR

- **Make sure you have a solution that will enable your robot to know where the parts are on the conveyor.**



CONVEYOR

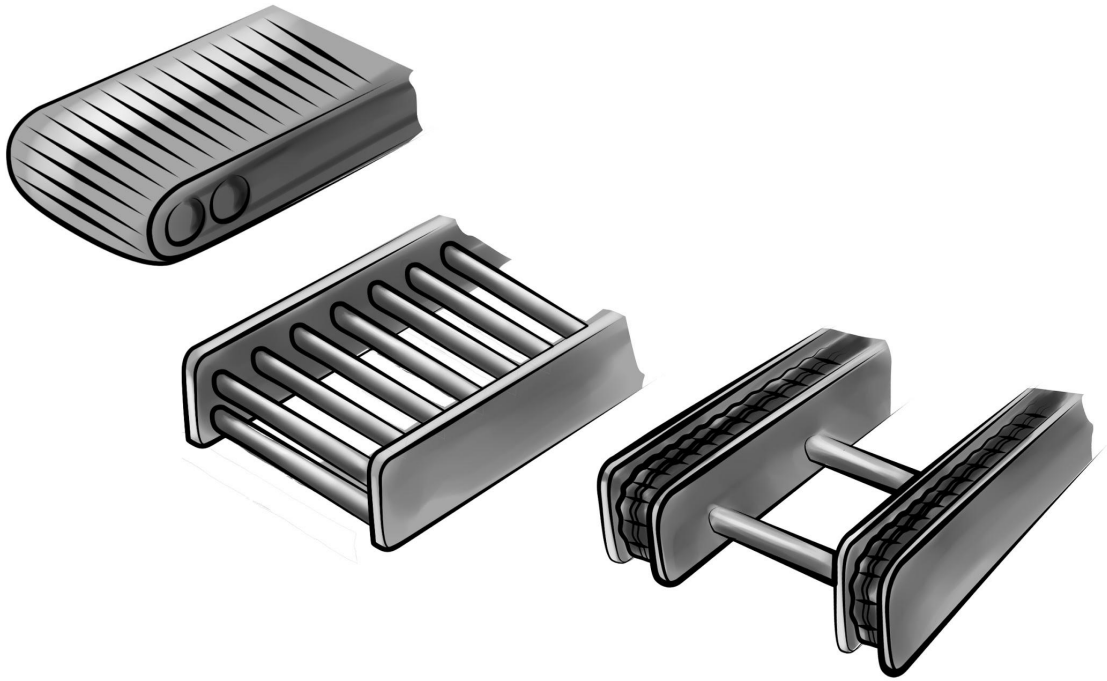
What is your target cycle time for the robotic cell? At what speed must the conveyor operate?

- **When you know the answers, you can start evaluating each potential conveyor:**
  - **Does the conveyor work with your type of part?**
  - **Do you have enough space for it on your factory floor?**
  - **Can it handle the weight of the parts?**

These questions can be major deal-breakers, so don't make a final decision without considering them.

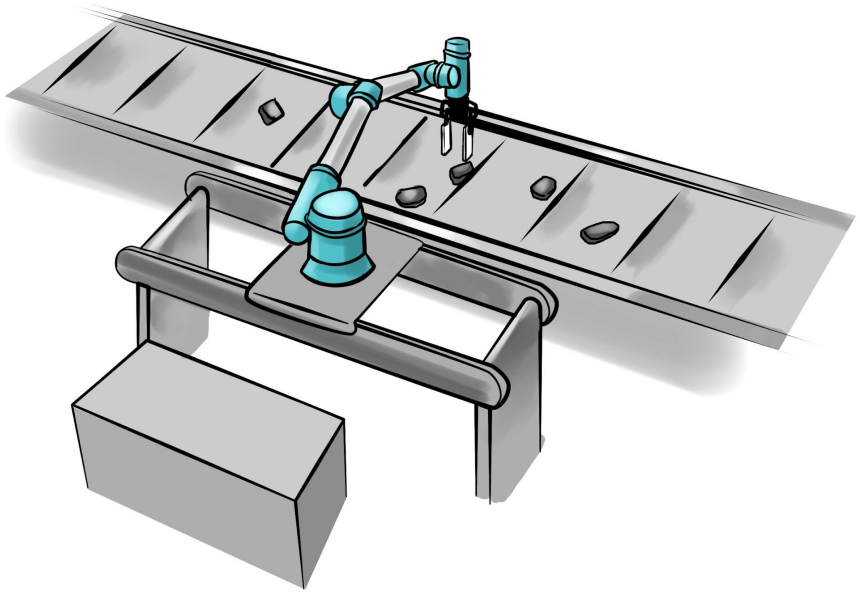
CONVEYOR

- **There are a few types of conveyor available, including roller, belt, and chain.**



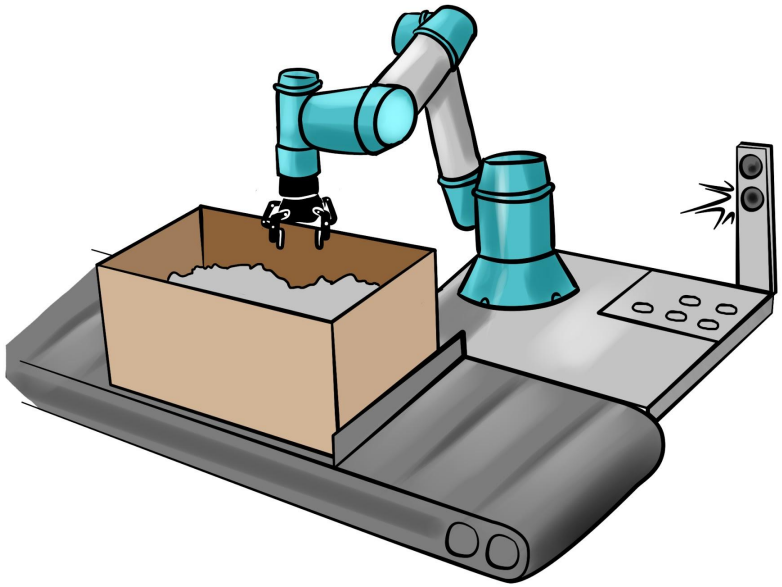
CONVEYOR

- When using a conveyor with a robot, you'll have to figure out how you want to deal with it. There are several options:
  - **You could dock the robot to the conveyor and make it move with the part.**



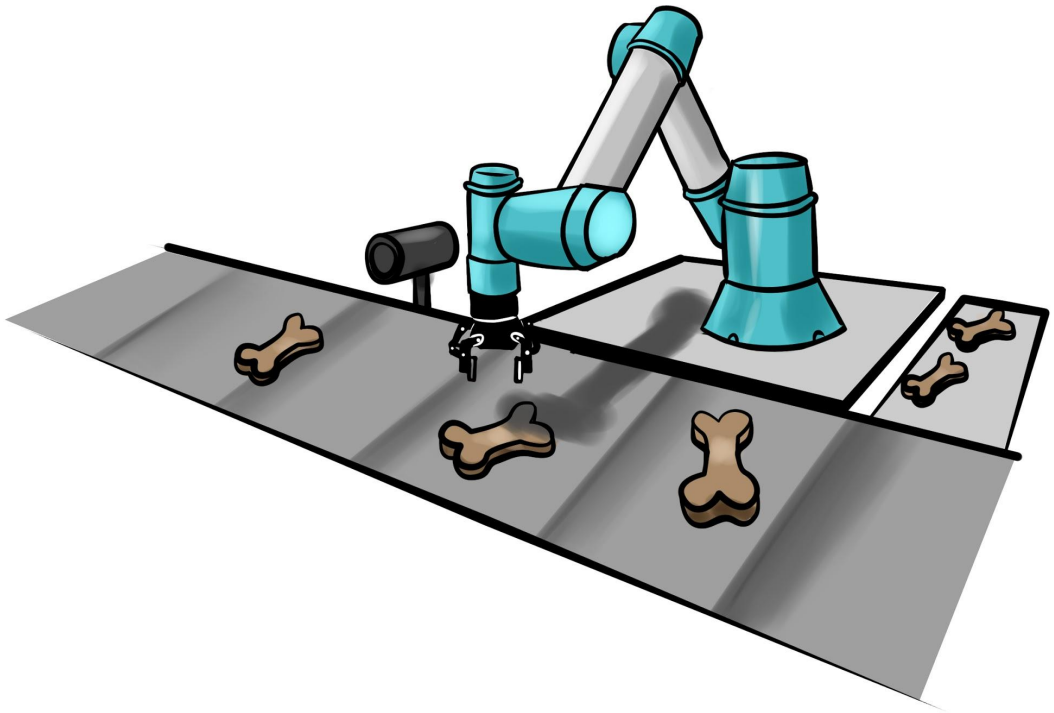
CONVEYOR

- **You could add stops to halt the part when it gets to the robotic cell. The stop(s) can be released when the part should continue.**



CONVEYOR

- You could use a vision system or sensors to detect parts on the conveyor.

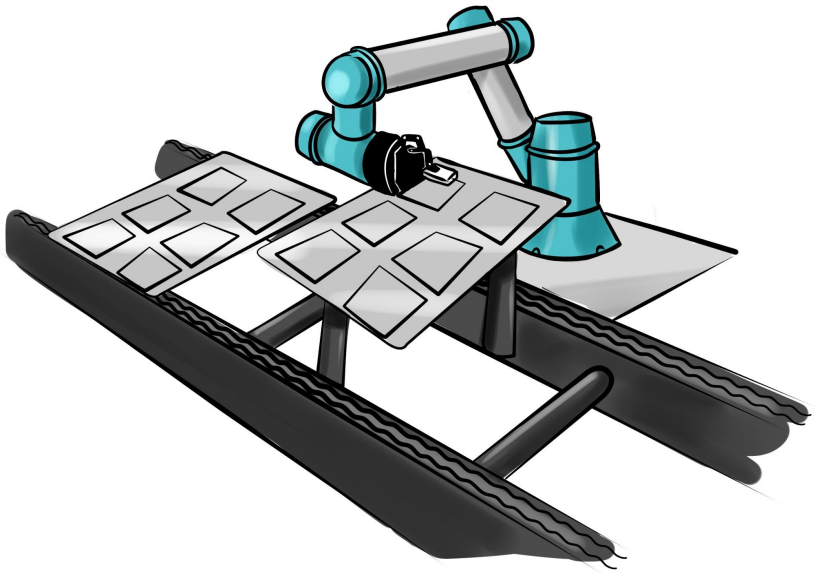


CONVEYOR

- **You could track the conveyor. This means using its motor's encoder counts to track the path of the conveyor belt.**

CONVEYOR

- You could add a mechanism that removes the part from the conveyor while the robot is working on it.
- Lastly, you could program the robot's motion, ensuring it's appropriate for the conveyor's speed.
- Be creative!



CONVEYOR

- No matter what type of conveyor you decide on, you'll need a way for your robot to know where the parts are located.

- The right solution for you depends on your unique context, including the speed and cycle time required, the type of object, the process to be performed, and the existing setup.

CONVEYOR

- **Choosing a conveyor will affect the time and cost of integrating the robotic cell with the production line. It will also make the integration process more difficult if there is currently no conveyor in place.**

Make sure you have the in-house resources to conduct your project, because otherwise you'll need to bring in an integration expert, which will add to the cost.

CONVEYOR

Level of difficulty: 

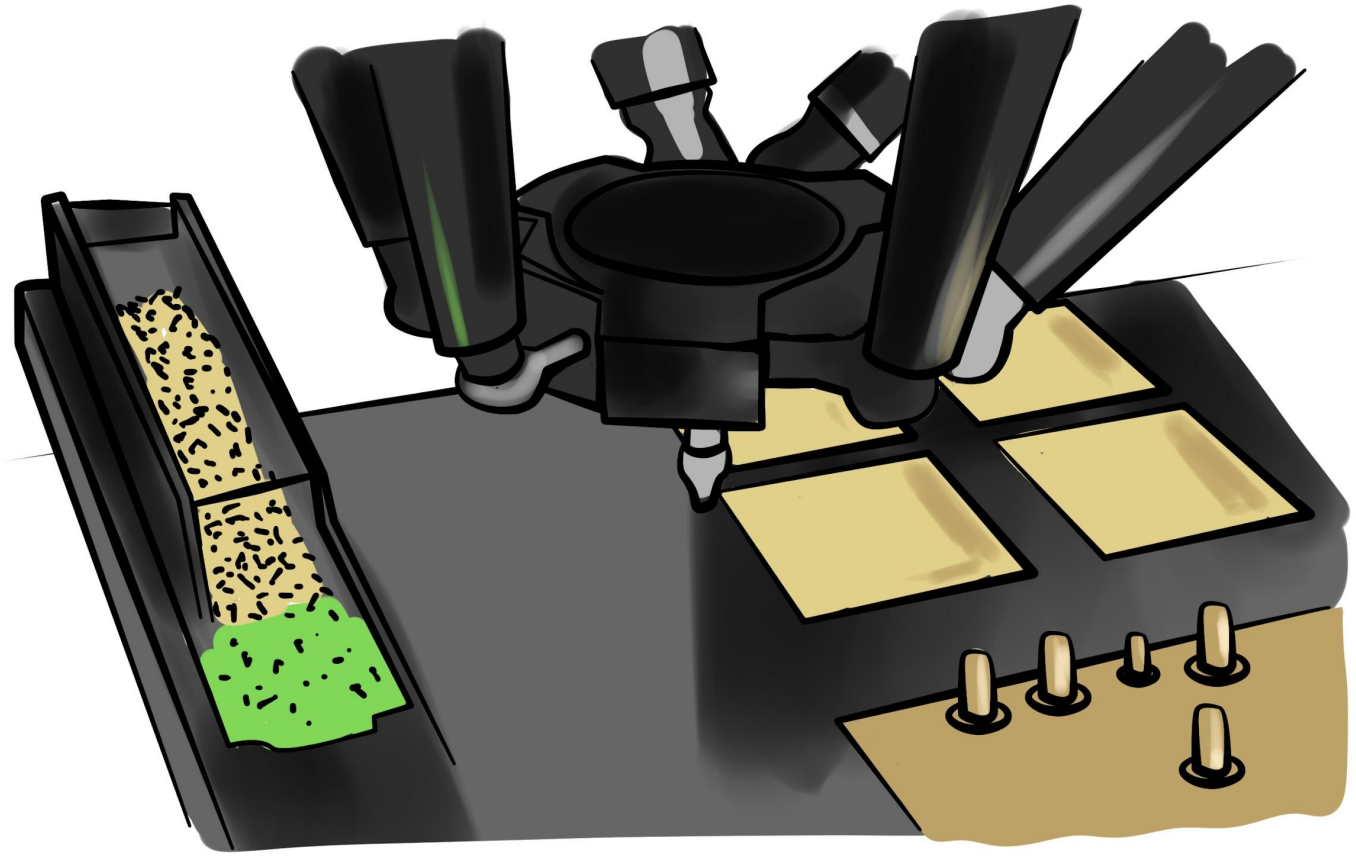
Good for:

- Both presenting parts and moving parts around the plant.
- Setting the pace for cycle time.

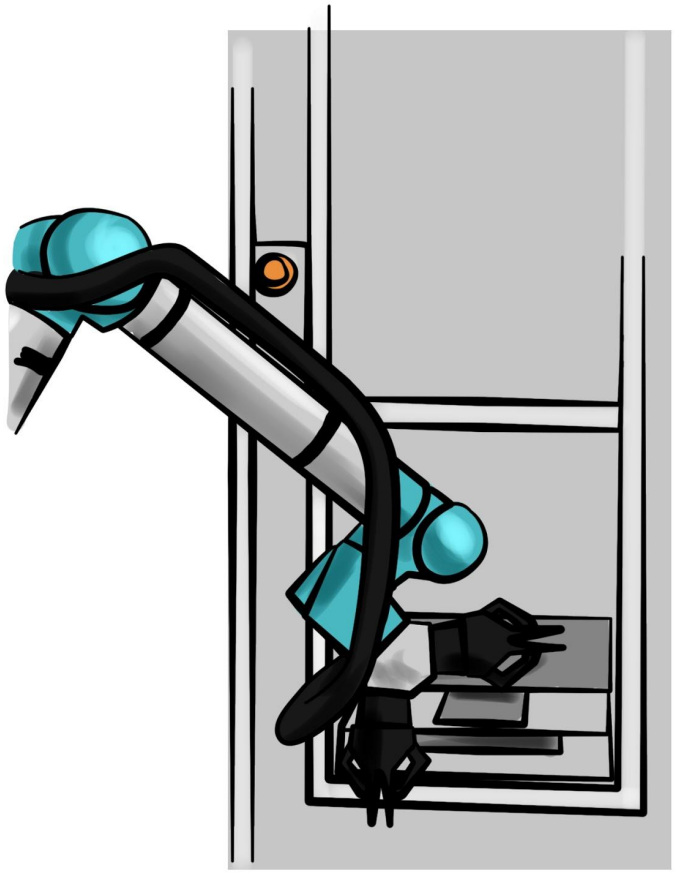
Bad for:

- Confined spaces.
- When other solutions for moving parts are already in place.

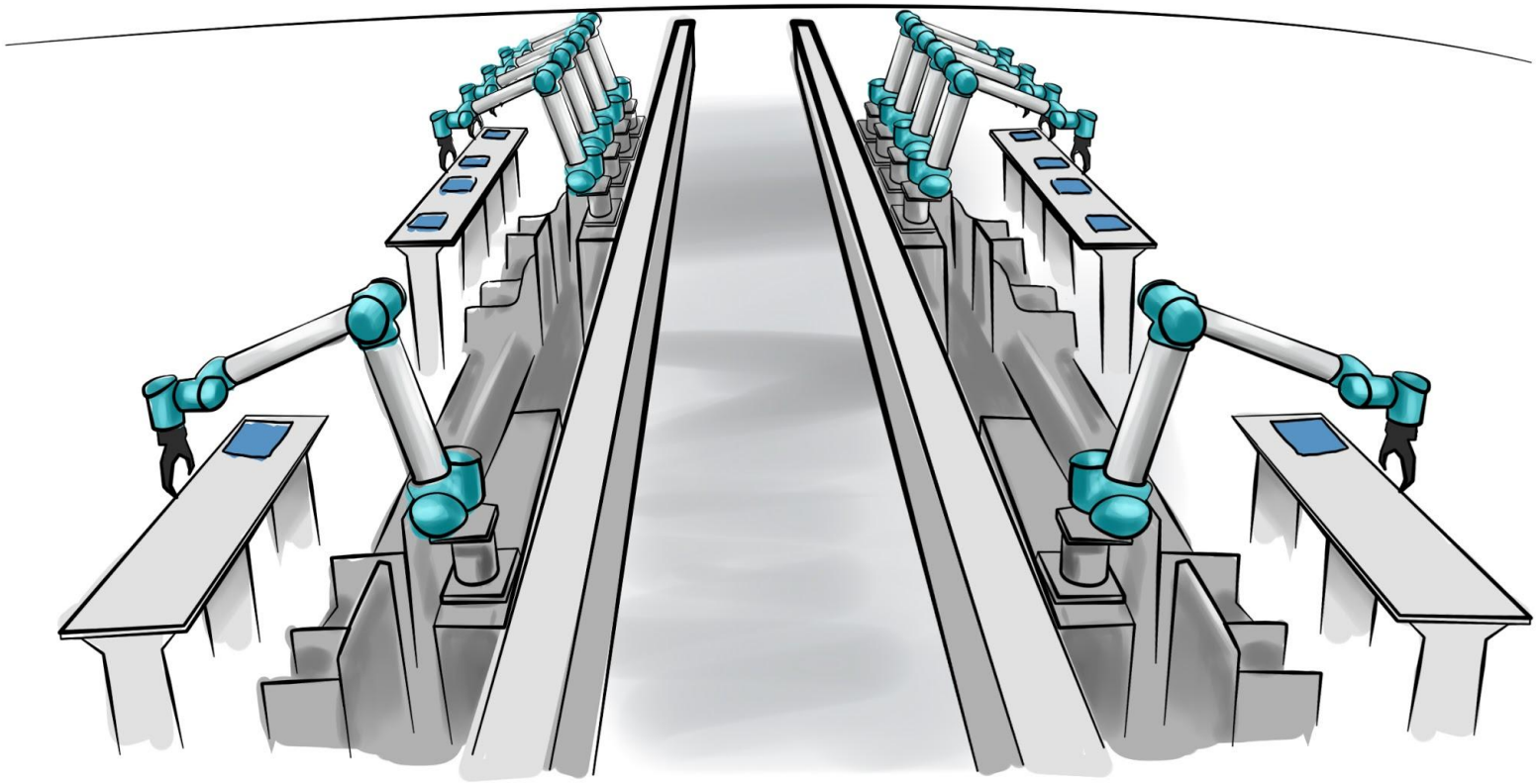
INTEGRATION EXAMPLES



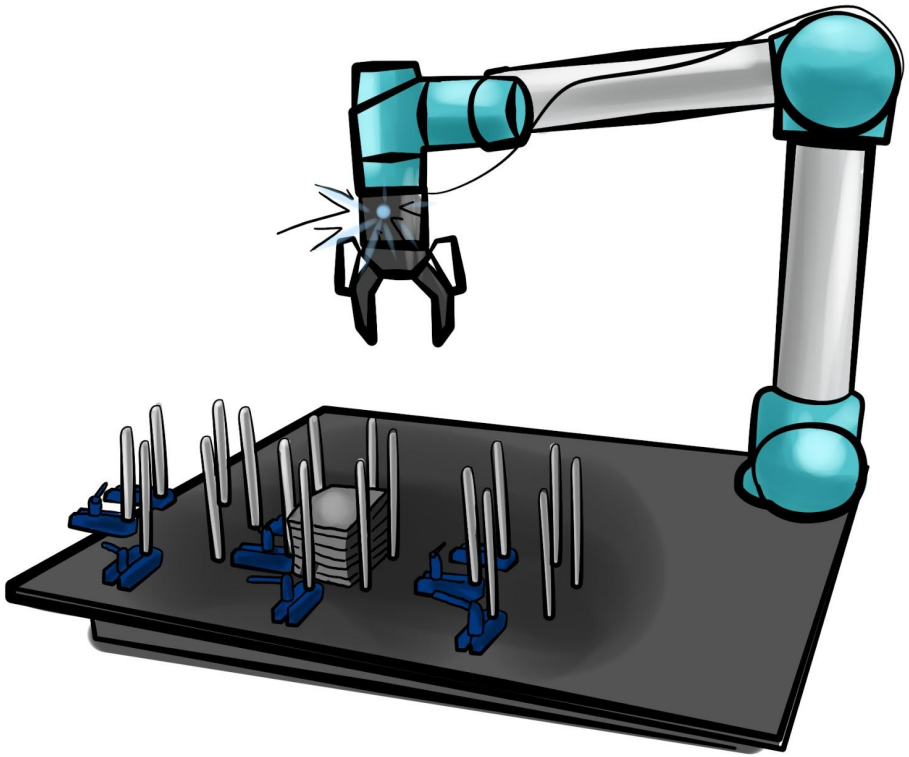
INTEGRATION EXAMPLES



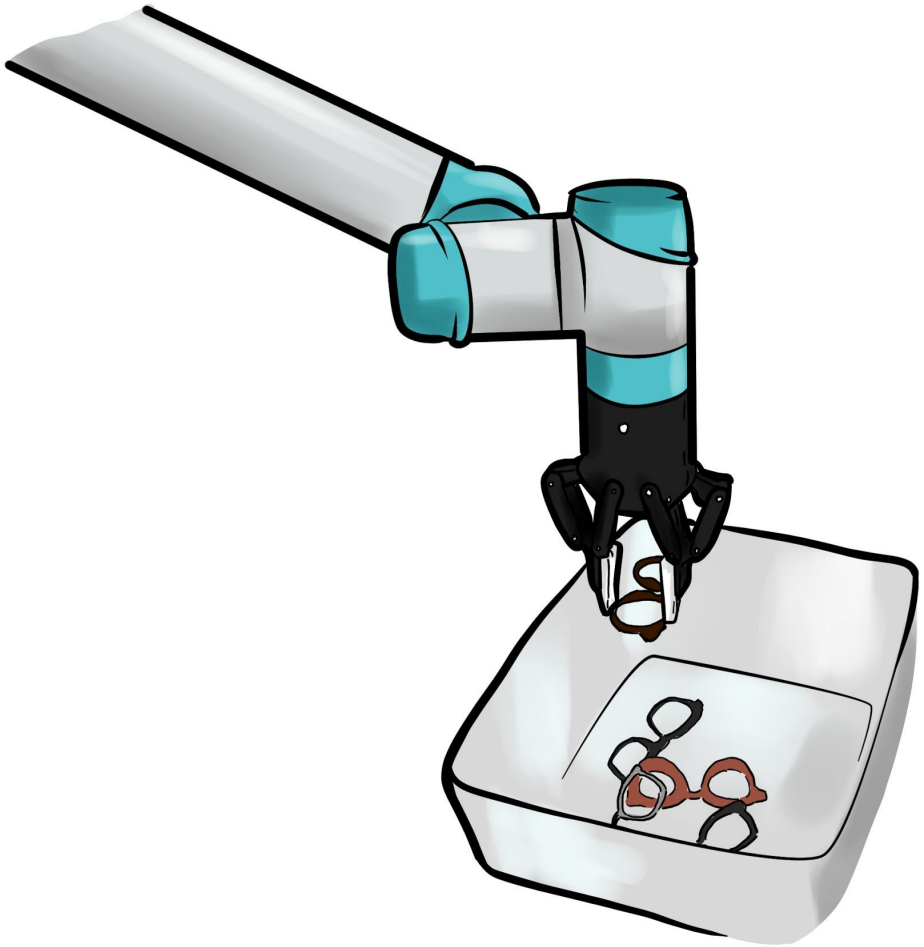
INTEGRATION EXAMPLES



INTEGRATION EXAMPLES



INTEGRATION EXAMPLES

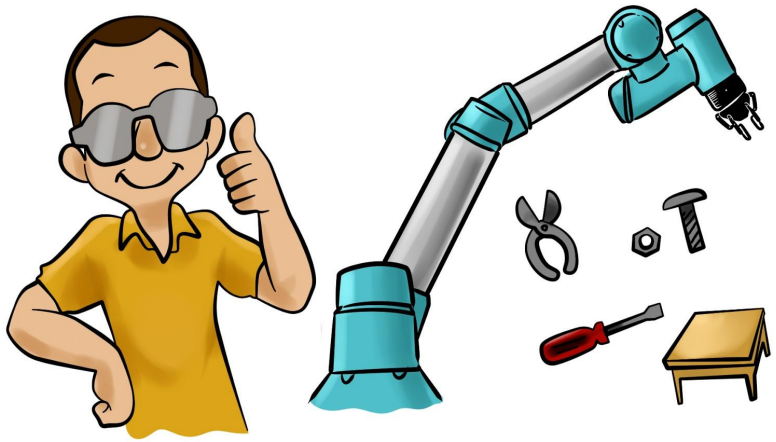


HOW TO CHOOSE

There's more than one right answer.

- **There are most likely several viable solutions for your automation project.**

- **Aim to keep it simple. This means you should avoid over-complicating your design and integration plan.**

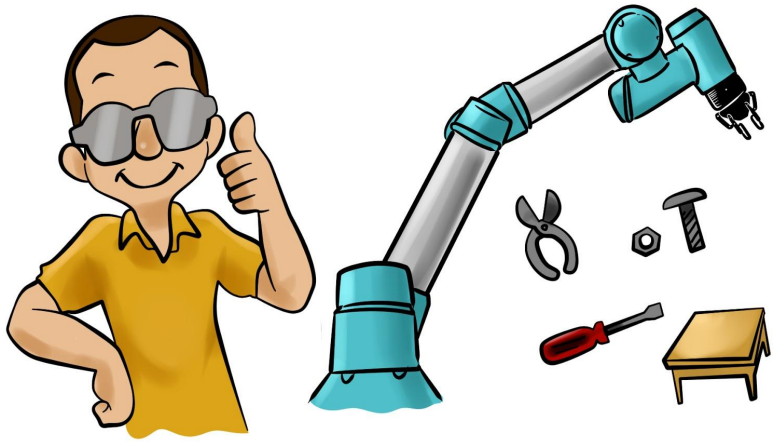


HOW TO CHOOSE

There's more than one right answer.

The "right" solution depends on many factors:

- Your existing setup
- Your in-house skills
- The part's geometry, size, and weight
- Cycle time
- Batch size
- ...etc.



HOW TO CHOOSE—A FEW TIPS

- **Try to minimize the number of handling steps in your process.**
- **Remember that adding a robotic cell shouldn't mean having to add an extra station just so your robot will work properly.**
- **Try to integrate your robotic cell with the production line as smoothly and logically as possible.**

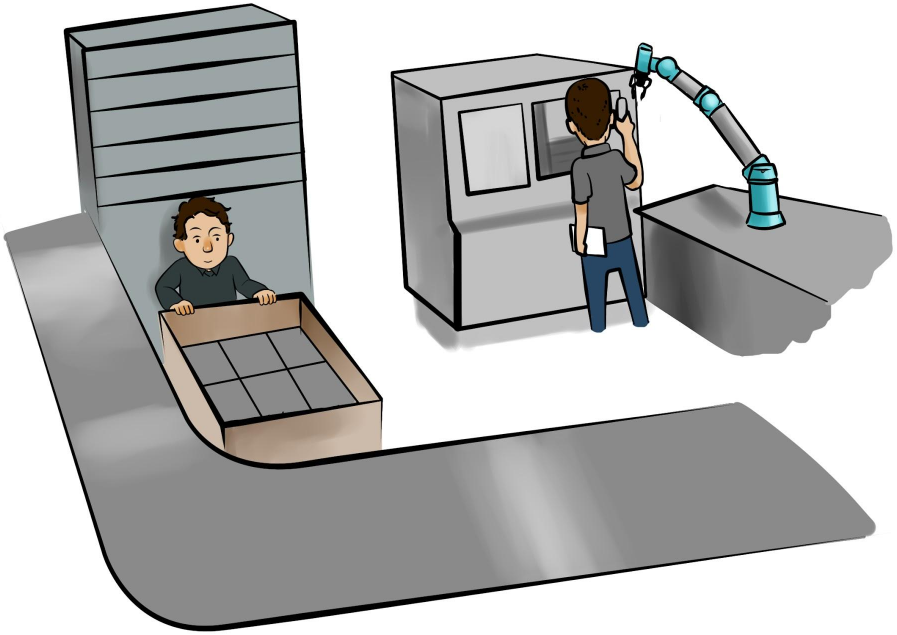
DESIGN & INTEGRATE

- **The part presentation solution is part of the entire robotic cell integration. It may require modifying your existing setup.**

- **Design and modify your existing part presentation setup at the same time as you design and integrate the robotic cell.**

ROBOTIC CELL INTEGRATION

- **The way parts are supplied and presented to the robot is what defines how the robot interacts with the other parts of the station.**



ROBOTIC CELL INTEGRATION

- **When designing the robotic cell, you should also consider how parts and supplies are moved around your factory—whether it's by:**
  - **Conveyor**
  - **Cart driven by an employee**
  - **Mobile robot**
  - **Being carried by an employee**
  - **Something else**

ROBOTIC CELL INTEGRATION

- **Remember, a robot should be a tool that unlocks possibilities, not something that limits your production chain.**

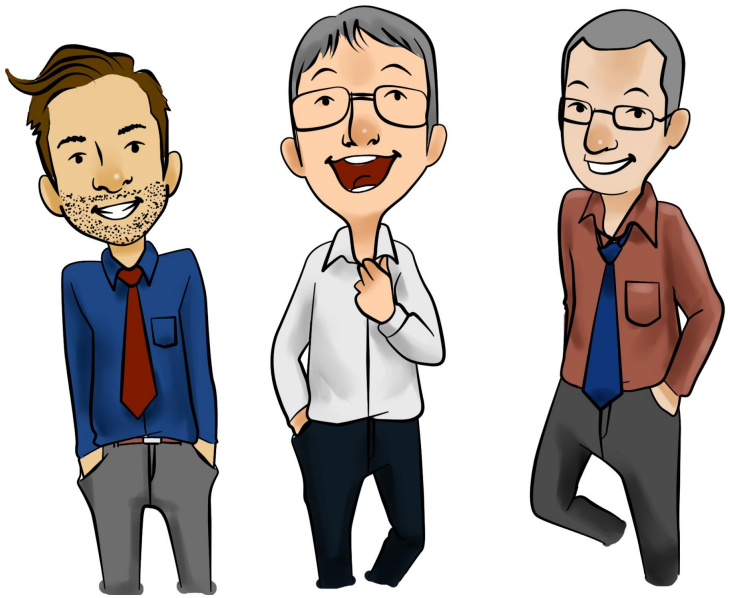
Your goal should be to integrate the robot into your plant's operations as seamlessly as possible.

DESIGN YOUR ROBOTIC CELL

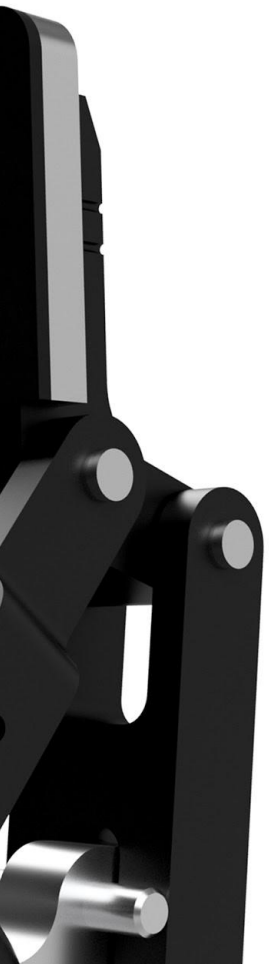
- **Start designing your robotic cell with Blueprints. It's a free service to help manufacturers in the design phase. The first step is to map the process!**

COACHES TEAM

- **Remember to assess your robotic cell's application and check what's already in place at your plant before you start designing the cell.**



Robotiq coaches will then help you design your robotic cell.



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