

Collision-Free Path Redesign

Modify an unsafe robot path so it clears all obstacles while adding the least possible cycle time.

Customer Precision Cell Engineering	Department Robot Safety	Difficulty Intermediate	Time 1-2 class periods
---	-----------------------------------	-----------------------------------	----------------------------------

Production Goal: Restore safe operation after a fixture change.

Background

A fixture was added to an existing workcell, creating a collision risk along the original direct path. Engineers need a new path that preserves production speed and maintains a documented safety margin.

Learning Objectives

- Identify collision zones in a digital model
- Create safe intermediate waypoints
- Compare path length and cycle time
- Verify clearance in simulation and physical operation

Equipment

- Digital twin
- Physical workcell if approved
- Virtual obstacle/fixture
- Python program
- Measurement tool
- Engineering notebook

Student Instructions

- 1 Run the original path in simulation and capture the collision location.
- 2 Define a required clearance margin around the obstacle.
- 3 Create three alternative waypoint paths.
- 4 Measure or estimate path length for each.
- 5 Simulate each path and record cycle time and minimum clearance.
- 6 Select the shortest path that meets the clearance requirement.
- 7 Verify the selected path at reduced speed on the physical cell.
- 8 Document final coordinates and the reason each waypoint exists.

Engineering Requirements

- Zero collisions in ten simulated cycles
- Maintain the required clearance margin
- Add no more than 20% to original cycle time
- Verify one reduced-speed physical cycle

Constraints & Safety

- Do not remove the obstacle
- Do not exceed the approved work envelope
- All waypoint coordinates must be documented
- Physical verification requires instructor approval

Deliverables

- Collision screenshot
- Three path concepts
- Clearance/cycle-time comparison
- Final code
- Physical verification notes
- Reflection

Reflection Questions

- 1 Why was the shortest geometric path not necessarily the safest?
- 2 Which waypoint added the most time?
- 3 How could tool orientation create a collision?
- 4 What sensor could monitor unexpected obstacles?

Engineering Support

Engineering Tip

Check the entire robot and end effector, not only the tool-center point, when evaluating clearance.

Common Mistake

A waypoint that clears the tool may still cause an elbow or wrist collision.

Stretch Goal

Create a reusable safe-travel function for several pickup locations.

Career Connection

Robot simulation specialists perform collision studies before expensive equipment is installed.

Before You Submit

- Notebook evidence included
- Requirements checked
- Testing documented
- Reflection completed