ADM Unit 3 | Mission Brief 3.1

Digital Twin Validation Study

Compare simulated and physical robot motion and quantify the model error.

Customer	Department	Difficulty	Time
AeroSim Manufacturing	Virtual Commissioning	Intermediate	2 class periods

Production Goal: Verify that the digital twin predicts physical performance.

Background

A new robotic process was developed in a digital twin before the physical cell was available. Before production begins, engineers must verify that simulated positions, paths, and cycle times accurately represent the real workcell.

Learning Objectives

- Plan a simulation-to-physical validation test
- Collect comparable position and timing data
- Calculate error and explain discrepancies
- Recommend model updates

Equipment

- Digital twin or simulation environment
- Physical VEX CTE Workcell
- 6-Axis Arm
- Measurement tools
- Stopwatch
- Engineering notebook

Student Instructions

1. Select five robot target positions distributed through the work envelope.
2. Record each simulated coordinate and predicted travel time.
3. Run the simulated path three times and record cycle time.
4. Transfer the same program to the physical cell after safety review.
5. Measure actual endpoint position or reference alignment at each target.
6. Run three physical trials and record cycle time.
7. Calculate position error and percent timing difference.
8. Identify at least three causes of mismatch and update one model setting.
9. Repeat one test to evaluate the improvement.

Engineering Requirements

- Validate at least five positions
- Use three simulation and three physical timing trials
- Calculate error using a consistent method
- Document one model correction

Constraints & Safety

- Use approved speeds during initial physical testing
- Verify clearance before automatic operation
- Do not adjust physical hardware during comparison
- Use the same command sequence in both systems

Deliverables

- Validation test plan
- Simulation and physical data table
- Error calculations and graph
- Updated model screenshot
- Validation conclusion

Reflection Questions

1. Which variable produced the largest mismatch?
2. Why might physical acceleration differ from simulation?
3. What tolerance is acceptable for this process?
4. What additional sensor would improve validation?

Engineering Support

Engineering Tip
Validate the highest-risk positions first: low clearance, long reach, or near workcell boundaries.

Common Mistake
A simulation that looks correct is not validated until physical measurements are compared.

Stretch Goal
Create an acceptance limit and automatically flag positions that exceed it.

Career Connection
Digital manufacturing engineers validate digital twins before deploying high-cost robotic processes.

Before You Submit

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