25TH ANNUAL

25TH LCI CONGRESS
OCTOBER 24-27, 2023

Industrialized Construction: A New Horizon for Lean

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25 YEARS OF LEARNING: SUPERCHARGE YOUR LEAN JOURNEY IN THE MOTOR CITY

Tuesday, October 24, 2023

Bridging the Manufacturing/Construction Prefabrication Gap

- There is a gap between lean philosophy and methodology in the Construction Industry.
- This exercise demonstrates principles from the manufacturing lean revolution and begins to translate them into construction application.

Construction Manufacturing System Fundamentals

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Basic Lean Principles

Topics Covered

Customer Value

Value Add Vs. Non-Value Add

Value-Add

Meaningful to customer or changes product/ service in meaningful way

Nonvalue-Add (Waste)

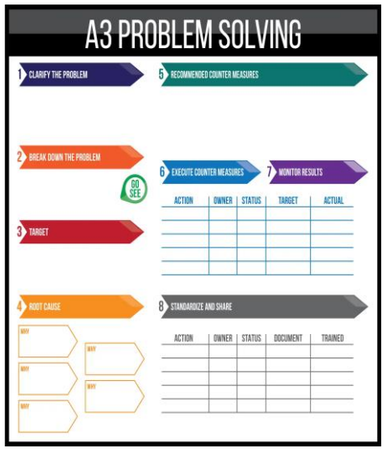
Consumes resources, but does not add value

8 Process Wastes

DEFECTS
OVERPRODUCTION
WAITING
NON-UTILIZED TALENT
TRANSPORTATION
INVENTORY
MOTION
EXTRA PROCESSING

PDCA

Problem Solving Tools



Foundations of a Construction Manufacturing System

Identify **Value** from the Client's POV

Define the **Value Stream**

Achieve **Flow** of Work Processes

Establish "**Pull**" System

Continuous **Improvement**

Principles

+

Align Behavior with Performance

Think & Manage **Systematically**

See & Solve Problems

"Failure is an **opportunity** to grow"

Respect & Engage **People**

Mindset

Eight Wastes in Construction

Defects

Overproduction

Waiting

Non-Utilized Talent/Resources

Transportation

Inventory

Motion

Extra-Processing

DOWNTIME

Defects
Efforts caused by rework, scrap and incorrect information

Overproduction
Production that is more than needed or before it is needed

Waiting
Wasted time waiting for the next step In a process

Non-Utilized Talent/Resources
Underutilizing people's talents, skills, knowledge and resources

Transportation
Unnecessary movements of products and materials

Inventory
Efforts caused by rework, scrap and incorrect information

Motion
Unnecessary movements by people (e.g., walking)

Extra-Processing
More work or higher quality than is required by the customer

Applying Lean Manufacturing Principles & Mindset

Lego Airplane Production Simulation

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Airplane Production *surviving in a competitive market*

Your market: Airplane Manufacturing

- Airplane production is a tough business!
- Customers are getting more demanding
- Offshore manufacturing is increasing
- You have no money to hire staff or buy more capacity
- Margins are shrinking
- Operate your department efficiently or you'll face trouble!

Roles and Objectives

Workers	Inspector	Tear Down
4 people	1 person	1 person
Build the components/ assemblies	Perform quality control	Perform raw materials supply & tabulate production results

DEMAND: 12 Planes Per Shift

Shift: Six Minutes

PHASE 1: MASS PRODUCTION

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Phase 1 Instructions

- Aircrafts are assembled **in batches of 5**
- Build 5 planes based on your work instruction before delivering to the next station
- If you receive an incomplete plane, place aside
- No pre-building allowed
- Each worker must get their own raw materials from the warehouse
- Raw materials must be in supply containers (no stock piling)
- Build as many as you can in your shift
- Workstation 6 will track:
  - Time to 1st plane
  - Number of planes
  - Scrap
  - WIP – Work In Process
  - Total time worked

8 Process Wastes

DEFECTS
OVERPRODUCTION
WAITING
NON-UTILIZED
TALENT
TRANSPORTATION
INVENTORY
MOTION
EXTRA PROCESSING

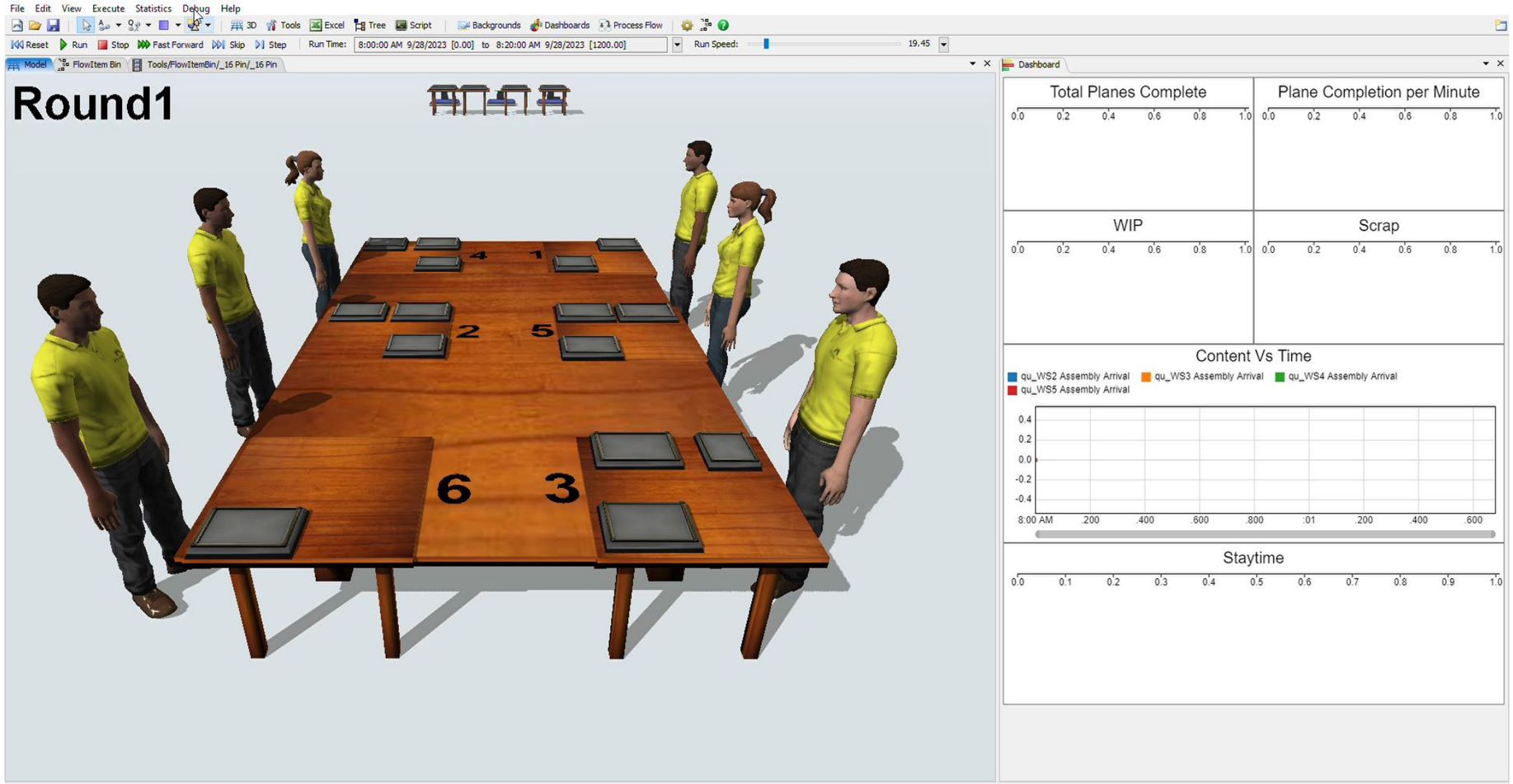
Phase 1 Data Report Out

Total Time	Time to 1st Plane	WIP	Scrap	# of Planes Completed

Did we meet our targets?

Scrap = defective assemblies
WIP = number of assemblies in process (anything out of the cups)

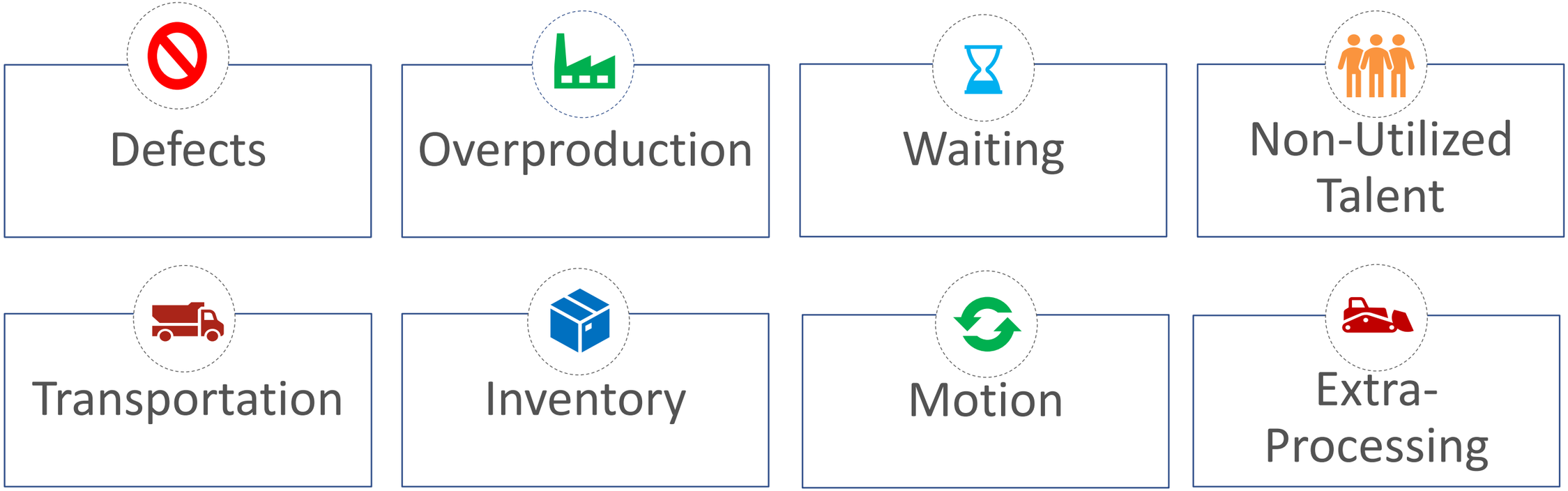
FlexSim Model Summary – Round 1



Round 1 Reflections

Which of the 8 waste did you see in this exercise?

- Do any of these exist in your work today? If so, which ones?



PHASE 2: Cellular Manufacturing

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Phase 2: Cellular Manufacturing

- Workstations have been organized for a **cellular layout** (in order)
- Your supply stock is “just in time” – the stock is now at your table
- Quality has communicated tolerance checks
- The rest is the same
- Workers must perform only their assigned jobs
- NO TALKING (about work)!
- Work hard! You are rewarded for your individual performance!

Phase 2 Instructions

- Still build in batches of 5
- Build as many as you can in your shift (6 minutes)
- If an operator finds a defect, turn it over on the table and wait for more to complete the batch. Do not fix any defects. We are trying to be efficient!
- No pre-building allowed. Operators must build on the plane itself.
- Workstation 6 will track:
  - Time to 1st plane
  - # of planes
  - Scrap
  - WIP
  - Total time worked

Phase 2 Data Report Out

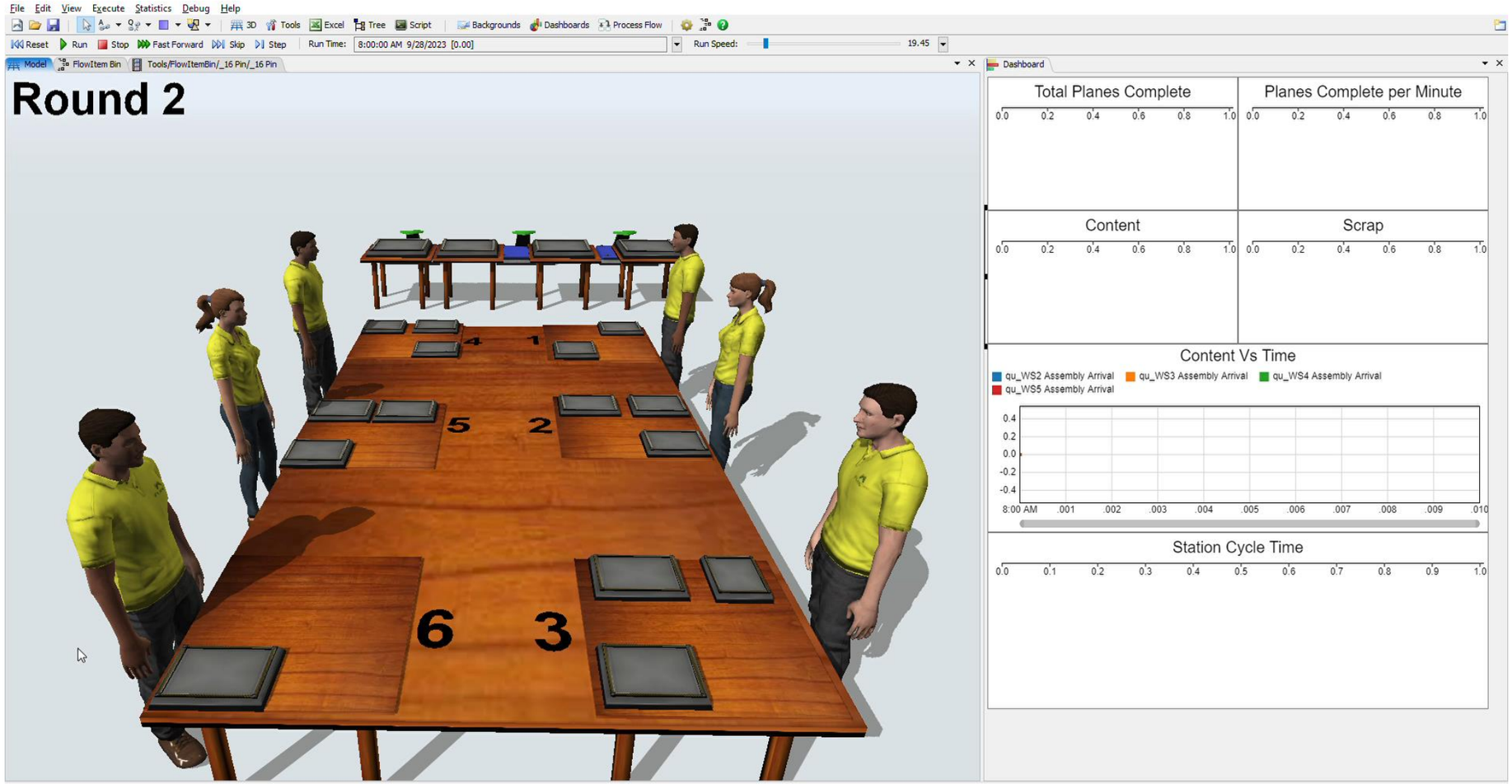
Total Time	Time to 1st Plane	WIP	Scrap	# of Planes Completed

Did we meet our targets?

How do these results compare to the previous phase?

Scrap = defective assemblies
WIP = number of assemblies in process (anything out of the cups)

FlexSim Model Summary – Round 2



Phase 2 Reflections

- How did resequencing the work moving the material closer to point-of-use improve your throughput?
- What are some changes you could make to your plant layout in real life?
- Are there any other changes you see that could be improved?

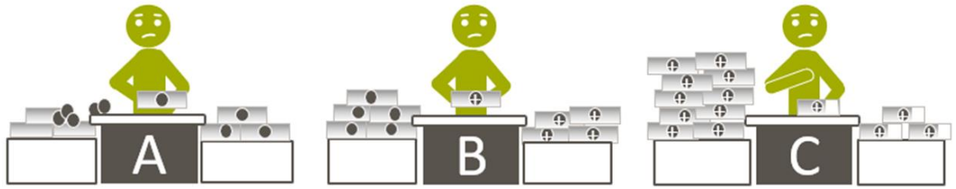
Push vs. Pull

Push system:

Also known as a material replenishment system (MRP)

Production is based on forecasts or projects of demand.

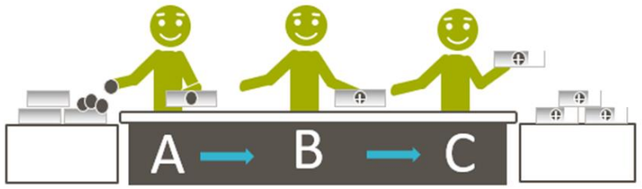
Once produced, subassemblies are pushed to the next station whether needed or not



Pull system:

Also known as lean, single-piece flow, or just-in-time (JIT)

Production at one station only occurs when initiated by a customer downstream.



Phase 3: Pull Manufacturing

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Phase 3: Pull Manufacturing

- Batch size of 1
- Only allowed 1 in process and 1 in queue for next station
- You can fix your own defects
- Operators can now talk to each other
- The rest is the same
- Workstations have been organized for a cellular layout (in order)
- You CAN pass to the next workstation or across table
- Your supply stock is “just in time” –the stock is at your table
- Only build in your area

Phase 3 Instructions

- Fix your own defects. If you find someone else's defects turn the assembly over on the table.
- Build as many as you can in your shift (6 minutes)
- No pre-building allowed. Operators must build on the plane itself.
- Workstation 6 will still track:
  - Time to 1st plane
  - # of planes
  - Scrap
  - WIP
  - Total time worked

Phase 3 Data Review

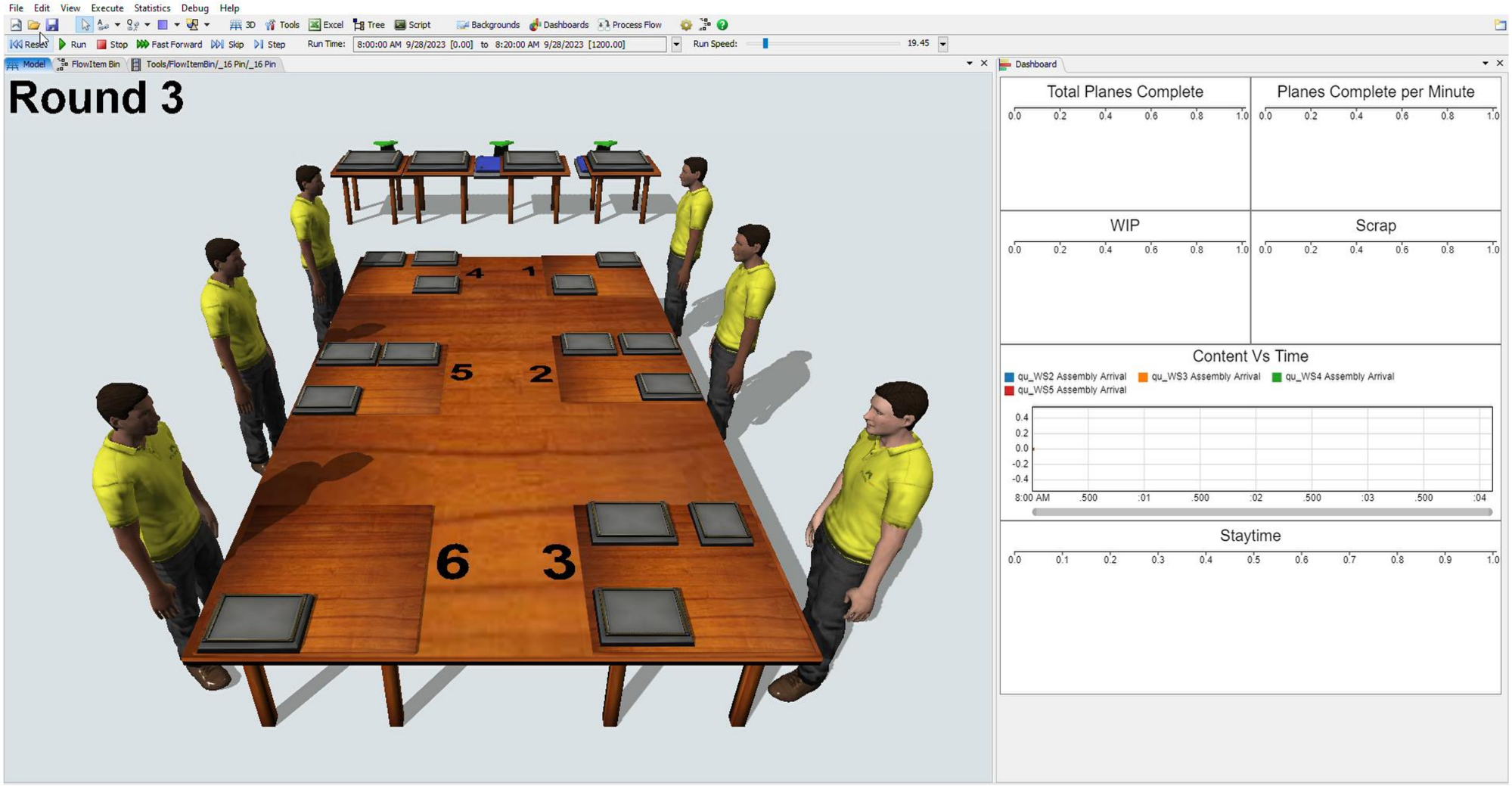
Total Time	Time to 1st Plane	WIP	Scrap	# of Planes Completed

Did we meet our targets?

How do these results compare to the previous phase?

Scrap = defective assemblies
WIP = number of assemblies in process (anything out of the cups)

FlexSim Model Summary – Round 3



Round 3 Reflections

- What is your current demand?
- How do you know if you are ahead or behind?

Takt Exercise

- What is Takt?
  - A manufacturing term used to describe production rate required to meet customer demand
- Takt vs. cycle time

$$Takt\ Time = \frac{Available\ Production\ Time}{Customer\ Demand}$$

- Do you know your current Takt and/or cycle time in your actual system?

Why is takt important?

- Reduces waste (overproduction)
- Understanding capability of meeting customer demand
- Supports optimization of labor force when analyzed against cycle time
- Help establish and maintain single-piece flow

Phase 4: Workload Balancing

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Phase 4: Workload Balancing

- Pay attention to your cycle time (<30 sec)
- Each worker will check for and fix any defects
- Workload rebalanced per operator
- The rest is the same
- Workstations have been organized for a cellular layout (in order)
- You CAN pass to the next workstation or across table
- Your supply stock is “just in time” –the stock is at your table
- Batch size of 1
- Only build in your area
- Only allowed 1 in process and 1 in queue for next station
- Operators can talk to each other

Phase 4 Instructions

- Rebalance your line
  - Using the supplied sticky notes balance your line
  - Remember – 30 seconds per station!
- Fix any defects
- Build as many as you can in your shift (6 minutes)
- No pre-building allowed. Operators must build on the plane itself
- Workstation 6 will still track:
  - Time to 1st plane
  - # of planes
  - Scrap
  - WIP
  - Total time worked

Phase 4 Data Review

Total Time	Time to 1st Plane	WIP	Scrap	# of Planes Completed

Did we meet our targets?

How do these results compare to the previous phase?

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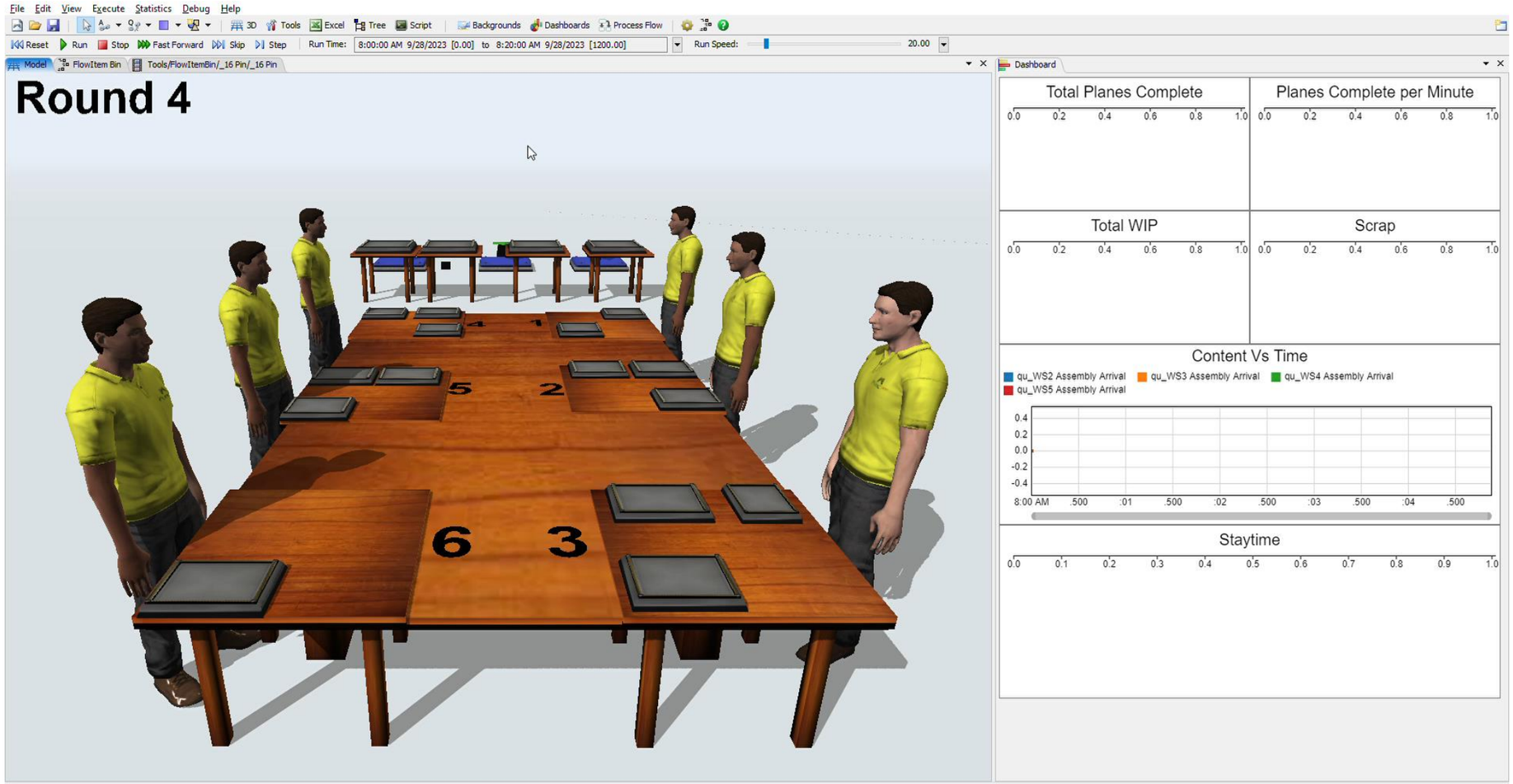
FlexSim Model Summary – Round 4



Phase 4 Reflections

- What are some value add and non-value add steps you identified?
- If you were asked to improve what you your target be? What steps would you take?
- What difference could this make in the real world? Is this at all realistic? Why? Why not? What would you expect to achieve?
- Consider which improved: Quality, Cost, Delivery, Safety

Final Reflections

- What additional changes would you make to the system to continue driving improvement?
- What did you learn in each phase? How did you feel?
  - Phase 1: Traditional
  - Phase 2: Cellular
  - Phase 3: Pull
  - Phase 4: Balanced
- How did we change:
  - Value vs. Waste
  - Respect
  - Flow/Pull
  - Quality