

Plating Capacity Optimization: A Digital Twin for Capacity Planning



Optimization + Simulation for Capacity Planning



AnyLogic Conference 2026

Plating Manufacturing Line Automated Conveyor System



STAGE I · CASE STUDY CONTEXT

STAGE II · DEVELOPMENT

STAGE III · CONCLUSIONS

Agenda

Objectives

Company & personal profile

Client & challenge context

Model & optimizer construction

Why AnyLogic?

Results & impact

1. Exertus Consulting services
2. About myself

1. Explanation of the plating process
2. Business requirements that management had
3. Operational complexity that needed to be included and solved

1. Combined solution: LP optimizer + Simulation
2. AnyLogic model construction

1. Why AnyLogic was the selected tool

1. Tangible & intangible benefits from the project
2. Q&A

Company profile

Who are we?



Personal profile

About myself



Plating process Context



Business requirements



Operational complexity



Solution process

LP + Simulation



Database integration



Process & Material Handling library



Agent-based modeling



AnyLogic selection



Results

Benefits achieved



Q&A



■ ONE-PAGE REPORT · ABOUT EXERTUS

We redesign our clients' **operating model** with **robust processes** that are profitable and high-value.

+20

Years

+280

Projects

11

Countries

17

Industries

+70

Consultants



Process Transformation

Operating model with end-to-end best practices: S&OP / IBP, supply chain and manufacturing.



Digital Transformation & Advanced Analytics

Software Factory, AI and analytics for problems with high economic and strategic impact.



Organization & Change Management

Structure, talent and adoption to sustain the transformation.

DIFFERENTIATOR Consulting and software development in a single team, with no license fees.

RESULTS 1x to 4x ROI per project · 100% repeat business · up to +34% productivity

■ KEY CLIENTS



+60 leading brands across 17 industries

 **exertus.mx**

 **contacto@exertus.com.mx**

01. Company & Personal Profile

About Myself

EDUCATION

Industrial & Systems Engineer

TEC de Monterrey // Purdue University

CURRENT ROLE

Process Optimization Consultant

Exertus Consulting

SIMULATION BACKGROUND

- **Companies:** Toyota Automated Logistics (formerly Bastian Solutions) & Ternium
- **Tools:** AnyLogic, Arena, FlexSim
- **AnyLogic experience:** ~2 years building AnyLogic models for our clients
- **Conference:** 2025 Winter Simulation Conference (attendee)
- **Training:**
 - Prof. Eduardo García Dunna — TEC de Monterrey
 - Benjamin Schumann Consulting — The Art of AnyLogic Modeling & Tailored Training



02. The Challenge

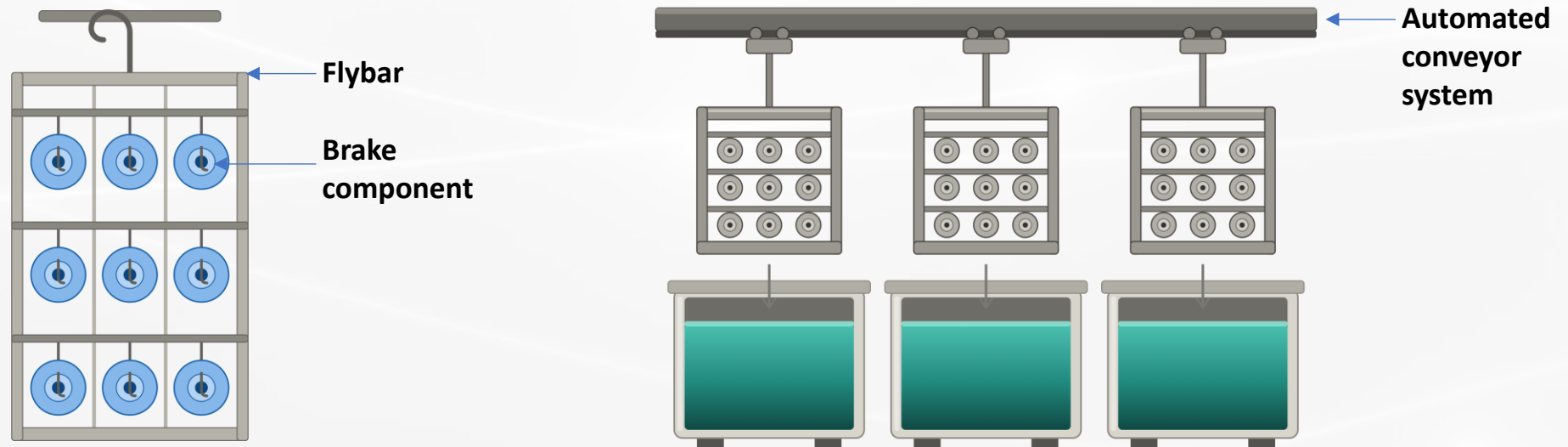
Case Study Context

Client and product profile

- **Who is the client?** Automotive components manufacturer.
- **End product.** A brake component with a durable protective coating, ready for assembly.

What is the plating process?

- **What it does.** Automated conveyor system that dips automotive brake components, held by a flybar, into chemical tanks.
- **Benefits.** Protects the brake components from corrosion and wear so they survive road salt and heat.

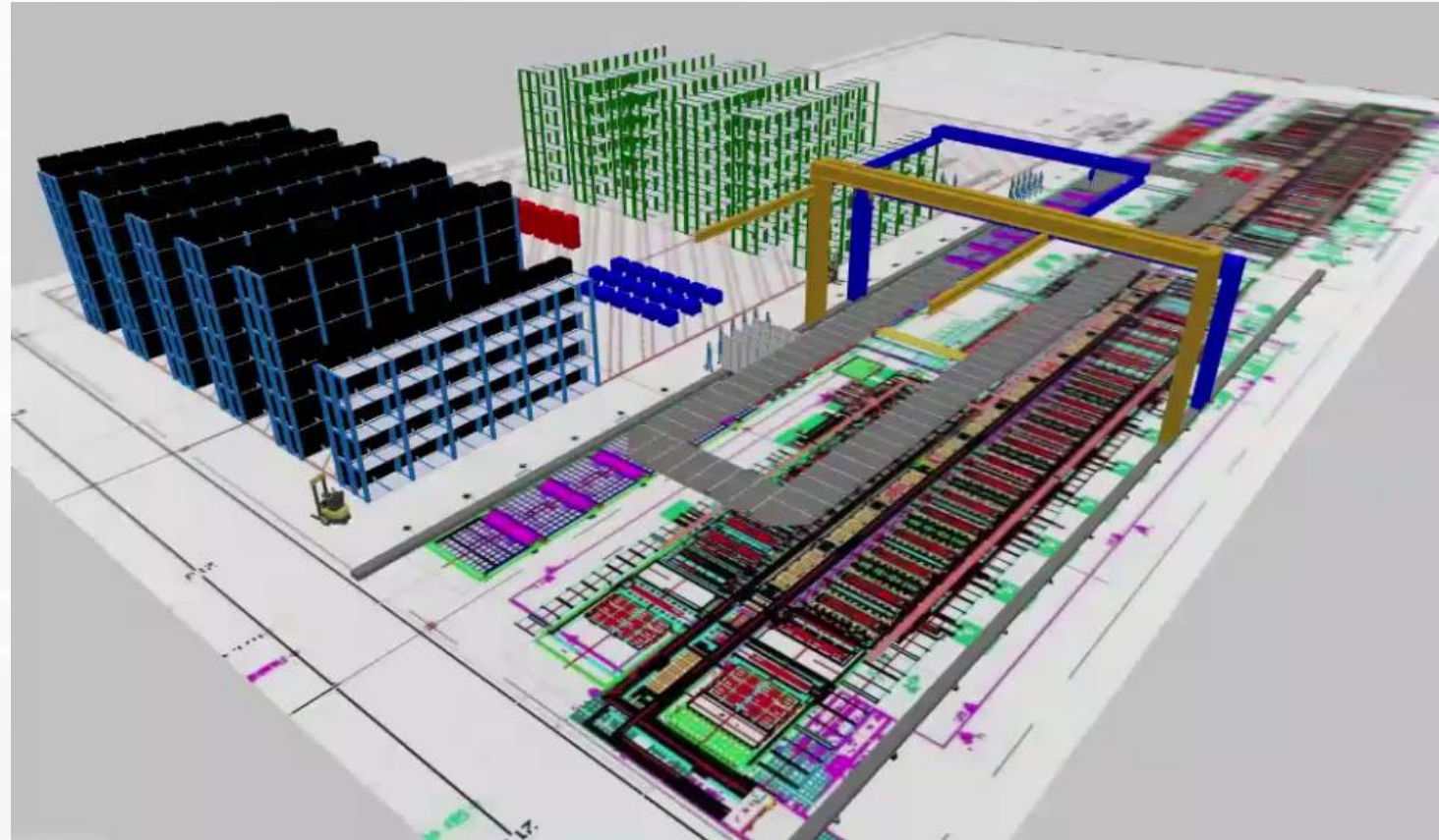


02. The Challenge

3D Model Built in AnyLogic

How the automated conveyor line runs

- **Step 1.** Forklifts supply brake components to loading stations.
- **Step 2.** Workers load components into the flybar, which is then taken by a crane onto the conveyor system.
- **Step 3.** All flybars are lowered into the plating tanks simultaneously and processed.
- **Step 4.** If one flybar needs rework, it stays longer and the whole line waits for it.
- **Step 5.** The conveyor advances; about 50 flybars can be in process at any moment.
- **Step 6.** A crane takes the flybar to an unloading station, where workers unload it.



02. The Challenge Business Requirements

Rapid demand growth

- **Line 1:** grew from ~100,000 to 1.3 million pieces per year.
- **Line 2:** an identical line is being expanded toward 2 million pieces.
- **One twin, two lines:** because both lines share the same design, a single detailed twin represents both.

Could the process actually support this demand — and in what configuration?

Questions management needed answered

- Is the 2-million-piece target achievable?
- Where are the operational bottlenecks?
- What is the optimal mix of SKUs?
- How costly are SKU changeovers?
- What resource levels avoid creating new bottlenecks?
 - Flybars
 - Forklifts
 - Operators
 - Loading/Unloading stations
 - Cranes

02. The Challenge Operational Complexity

Different capacity per SKU

- Larger brake-component SKUs fit fewer pieces per flybar

SKU changeover is highly costly

- Each changeover requires significant time, labor, and a full loading station.

OEE factors

- Rework, availability, performance losses, and scrap

Same SKUs all shift

- Better completion for those SKUs
- More overproduction
- Lower SKU coverage
- Less flexibility

Too few flybars

- Conveyor underutilized

Too many flybars

- Fewer production cycles per flybar

So the project had to find:

the optimal total number of flybars and resources • the optimal mix of SKUs • the impact of changeovers • the link between SKU size and throughput

03. Model & Optimizer Construction

Linear Optimization + Simulation Workflow



Linear-programming



Simulation

1

Demand entered via Excel — Planners load demand and product mix through a simple spreadsheet interface.

2

Optimizer builds the sequence — A linear-programming tool orders ~100 SKUs to minimize the impact of flybar changeovers.

3

AnyLogic simulates the plan — The sequence is executed under realistic operating conditions in the digital twin.

4

Sensitivity analysis — Optimize resource requirements.

5

Scenarios tested first — Alternatives are compared before anything is committed on the floor.

Note: the optimizer sets the sequence; the optimal number of resources was found by testing configurations in simulation.

03. Model & Optimizer Construction

Agents, Java Classes & Database

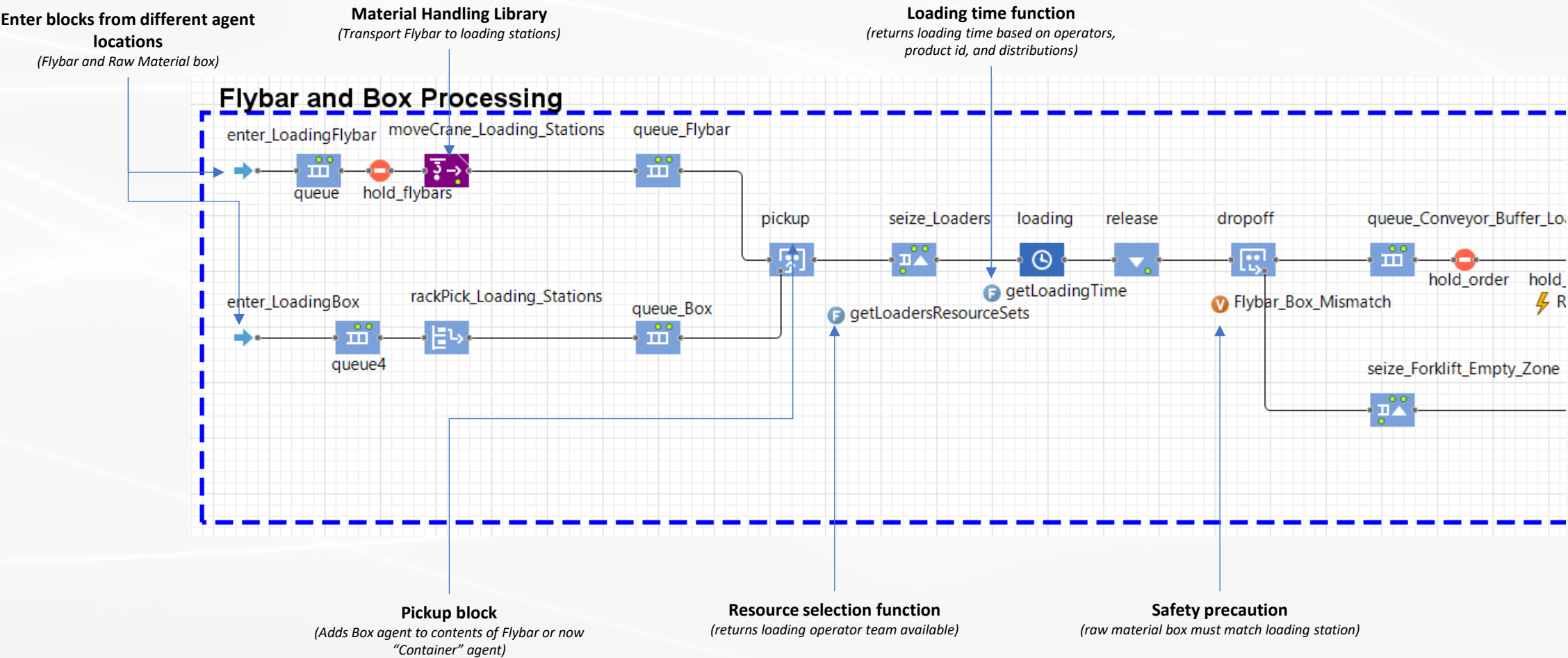
- Plating*
 - Box
 - Conveyor
 - Flybar
 - Forklift
 - LoadingStation
 - LoadingTeam
 - Main
 - Op_Stations
 - Op_Unload
 - Operator
 - Order
 - Transfer
 - Unloading_Station
 - Products_MP
 - Simulation: Main
 - Run Configuration: Main
- Database
 - demanda_total
 - distribuciones
 - estaciones_finales
 - inventario_inicial_flybars
 - inventario_inicial_mp
 - inventario_inicial_racks
 - inventario_inicial_retrabajo_ev
 - ordenes_demanda
 - recursos_carga
 - recursos_descarga
- Resources

LP model determined order sequence

	orden_id	producto_id	rack_mp	flybar_capacidad_piezas	retrabajo	flybars_activos	cantidad_de_flybars	tiempo_carga_por_pieza_seg	tiempo_descarga_por_pieza_seg	flyb
1	1	14	2	117	☐	3	3	16.25	6	
2	2	14	2	117	☐	3	3	16.25	6	
3	3	14	2	117	☐	3	3	16.25	6	
4	4	30	7	117	☐	3	3	16.25	6	
5	5	30	7	117	☐	3	3	16.25	6	
6	6	30	7	117	☐	3	3	16.25	6	
7	7	18	4	135	☐	3	3	10.29	11.86	
8	8	18	4	135	☐	3	3	10.29	11.86	
9	9	31	7	117	☐	3	3	16.25	6	
10	10	31	7	117	☐	3	3	16.25	6	
11	11	26	6	72	☐	3	3	16.25	6	
12	12	26	6	72	☐	3	3	16.25	6	
13	13	26	6	72	☐	3	3	16.25	6	
14	14	27	4	72	☐	3	3	16.25	6	
15	15	27	4	72	☐	3	3	16.25	6	
16	16	27	4	72	☐	3	3	16.25	6	
17	17	13	2	108	☐	3	3	16.25	6	
18	18	13	2	108	☐	3	3	16.25	6	
19	19	34	7	168	☐	3	3	10.29	11.86	
20	20	3	1	63	☐	3	3	13.5	9	
21	21	3	1	63	☐	3	3	13.5	9	
22	22	3	1	63	☐	3	3	13.5	9	
23	23	4	2	63	☐	3	3	13.5	9	
24	24	4	2	63	☐	3	3	13.5	9	
25	25	4	2	63	☐	3	3	13.5	9	
26	26	20	4	63	☐	3	3	13.5	9	
27	27	20	4	63	☐	3	3	13.5	9	
28	28	20	4	63	☐	3	3	13.5	9	
29	29	21	5	63	☐	3	3	13.5	9	
30	30	21	5	63	☐	3	3	13.5	9	
31	31	21	5	63	☐	3	3	13.5	9	
32	32	37	8	168	☐	3	3	10.29	11.86	

03. Model & Optimizer Construction

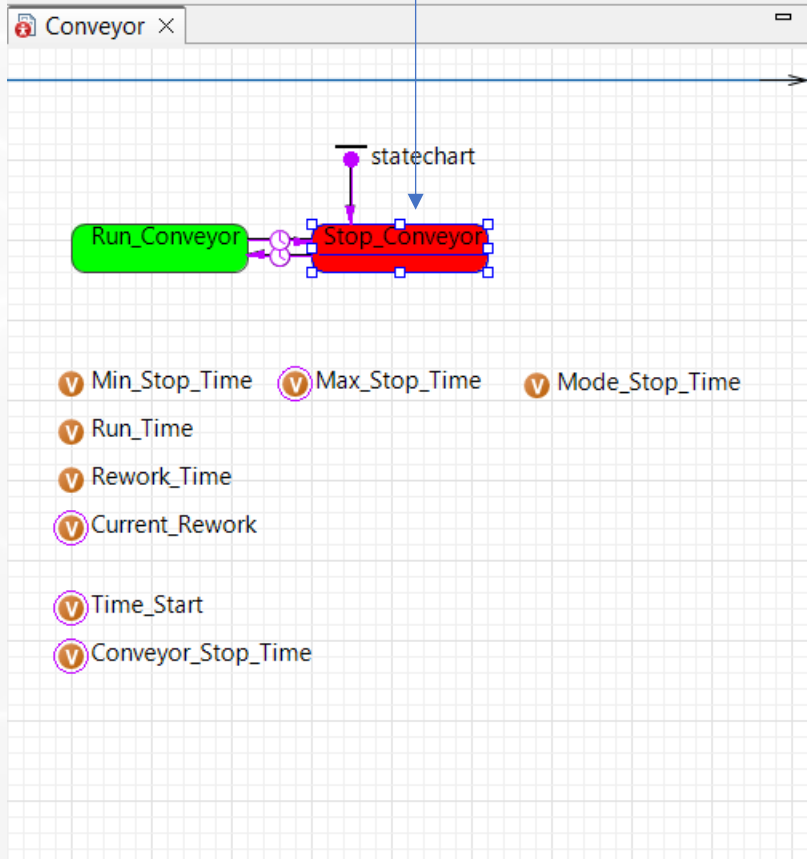
Process Modeling & Material Handling Libraries



03. Model & Optimizer Construction

Agent-Based Modeling

Statechart
(changes behavior of the conveyor)



Properties ×

Stop_Conveyor - State

Name: Stop_Conveyor ☒ Show name ☐ Ignore

Fill color: red

Entry action:

```
//pauseSimulation();
traceln("Conveyor will stop running");
main.conveyor.stop();
main.Conveyor_Start.unblock();
main.Conveyor_text.setVisible(true);
Time_Start = time();
```

Exit action:

```
if (Current_Rework > 0) {
    Current_Rework = Current_Rework - 1;
    main.Rework_Task = main.Rework_Task - 1;
}
Conveyor_Stop_Time = time() - Time_Start;
main.Conveyor_Total_Cycles = main.Conveyor_Total_Cycles + 1;
traceln("Time stopped (sec): " + Conveyor_Stop_Time);

// Validate rework stoppages
if (Conveyor_Stop_Time > Max_Stop_Time) {
    main.Rework_stoppage = main.Rework_stoppage + 1;
}
```

Debugging tools
(pause simulation)

Conveyor logic
(stop)

Rework logic
(increases conveyor processing time)

Statistics
(obtains processing time data)

04. The AnyLogic Solution

Why AnyLogic

No single modeling strategy could capture the plating line. AnyLogic let us combine all three in one model.

Process Modeling Library

- Loading & unloading operations
- Production flow
- Buffers
- Resource utilization

Material Handling Library

- Conveyor movement
- Four independent cranes
- Material transport with real travel & handling times

Agent-Based Logic

- Custom conveyor dynamics
- One rework flybar can delay every other flybar
- System-wide effects captured

Why it mattered: a single environment plus a 3D view that made the model credible to operators and management.

04. The AnyLogic Solution

Real-World Variability with Distributions

OEE factors

- Availability — operating hours
- Performance — processing time
- Scrap — pieces lost after processing

Rework

- Stops the conveyor longer at a tank, impacting throughput

Partial loading flybars

- Broken hooks reduce effective capacity of flybars (e.g. 20 → 15)

Loading and unloading times

- Operators, SKU, and capacity per flybar impacted this

05. Results & Impact

Three Production Strategies Evaluated

Scenario 1

Fixed flybars all day · 80 flybars

Volume over responsiveness

- + Highest throughput & volume
- + Best completion for produced SKUs
- Highest overproduction
- Lowest SKU coverage
- Least flexible

Scenario 2 ★

Controlled changeovers · 88 flybars (80 + 8)

RECOMMENDED — best balance

- + High throughput maintained
- + Overproduction down sharply
- + More SKU coverage
- + Better flexibility
- One changeover at a time, using a loading station

Scenario 3

Immediate changeovers · future SMED

Maximum flexibility

- + High throughput maintained
- + Minimal overproduction
- + Maximum SKU coverage
- + Greatest flexibility
- The operation is currently not capable of this

05. Results & Impact Benefits

2M

piece target shown achievable with the optimized
number of resources

+7–10%

throughput improvement

Max

conveyor utilization sustained

Measured against the historical baseline

- **Bottlenecks eliminated** by balancing resources.
- **Overproduction reduced** by moving from a fixed-flybar shift to controlled changeovers.
- **SKU coverage increased** more products served within the same day.
- **SKU mix critical for throughput** given the capacity of each flybar.

The result: A complete operational study that optimizes performance and aligns strategic decision-making.

Thank you

Questions & Discussion



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