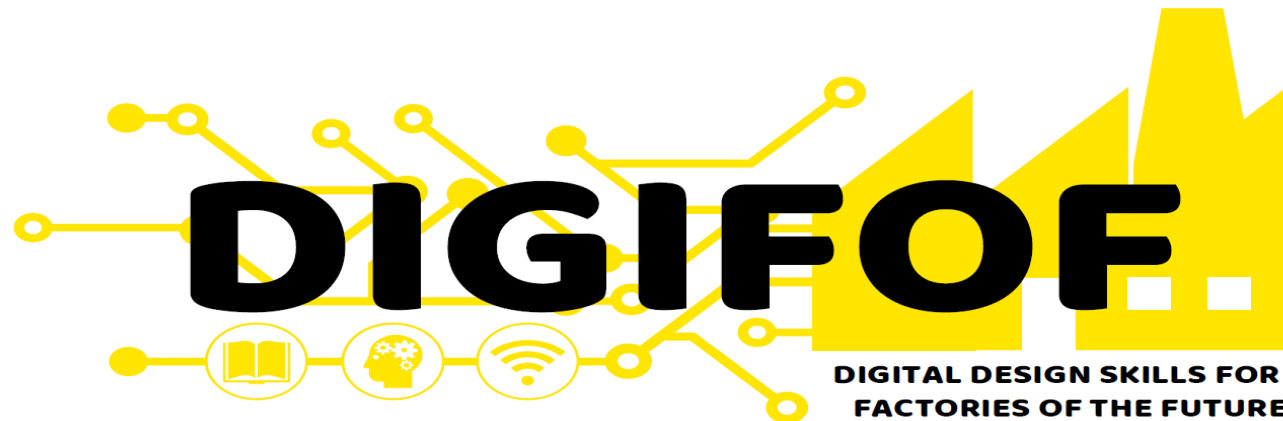


Process Simulation in manufacturing

Introduction to simulation and Flexsim

Prof. Fabiana Pirola



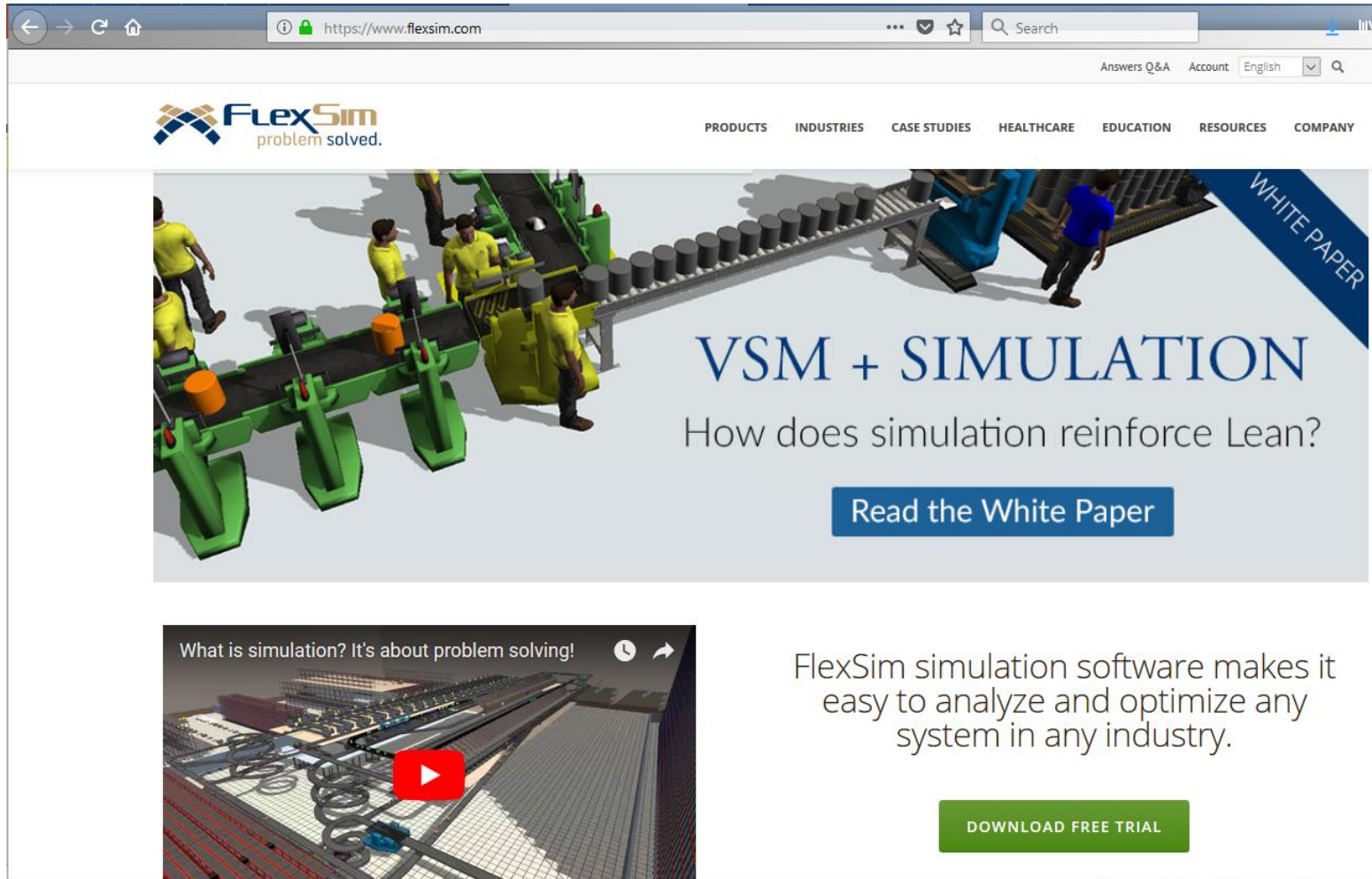
Agenda



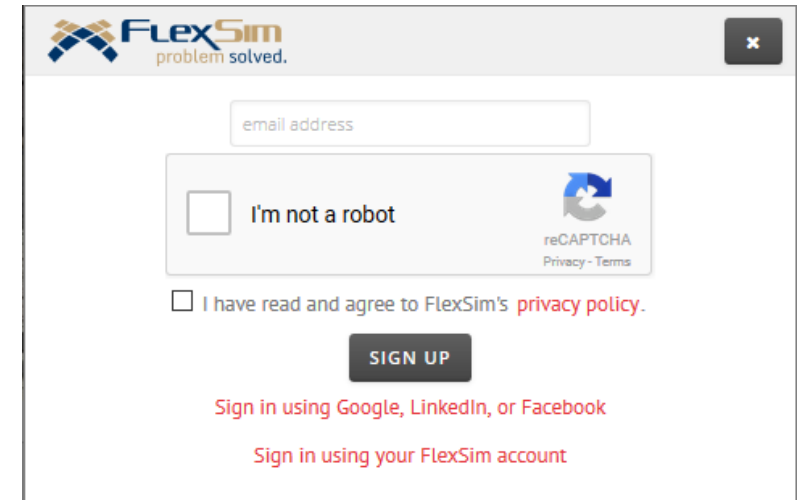
- What is Simulation?
- Why to Simulate?
- Which are the main phases of a simulation project?
- What is FlexSim?
- The FlexSim Simulation Logic
- Demo Case: Simple manufacturing process
- FlexSim Tutorials
- Advanced Topics



Downloading FlexSim

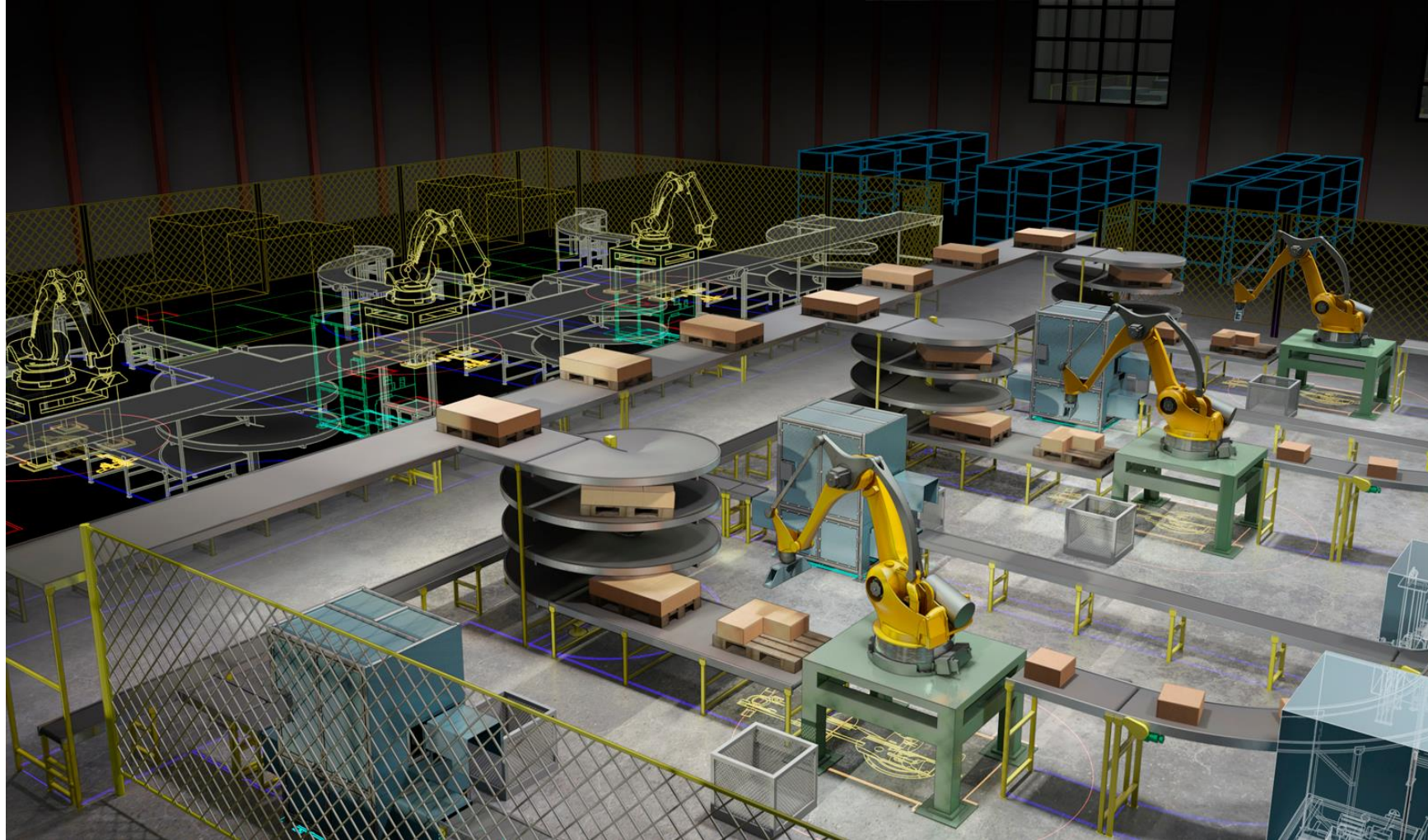


The screenshot shows the FlexSim website homepage. At the top left is the FlexSim logo with the tagline "problem solved.". A navigation menu includes links for PRODUCTS, INDUSTRIES, CASE STUDIES, HEALTHCARE, EDUCATION, RESOURCES, and COMPANY. The main banner features a 3D simulation of a factory floor with workers and machinery. The text on the banner reads "VSM + SIMULATION" and "How does simulation reinforce Lean?". A blue button labeled "Read the White Paper" is positioned below the text. A diagonal banner in the top right corner of the main image says "WHITE PAPER". Below the main banner is a video player with the title "What is simulation? It's about problem solving!" and a red play button. To the right of the video player, the text states "FlexSim simulation software makes it easy to analyze and optimize any system in any industry." Below this text is a green button labeled "DOWNLOAD FREE TRIAL".

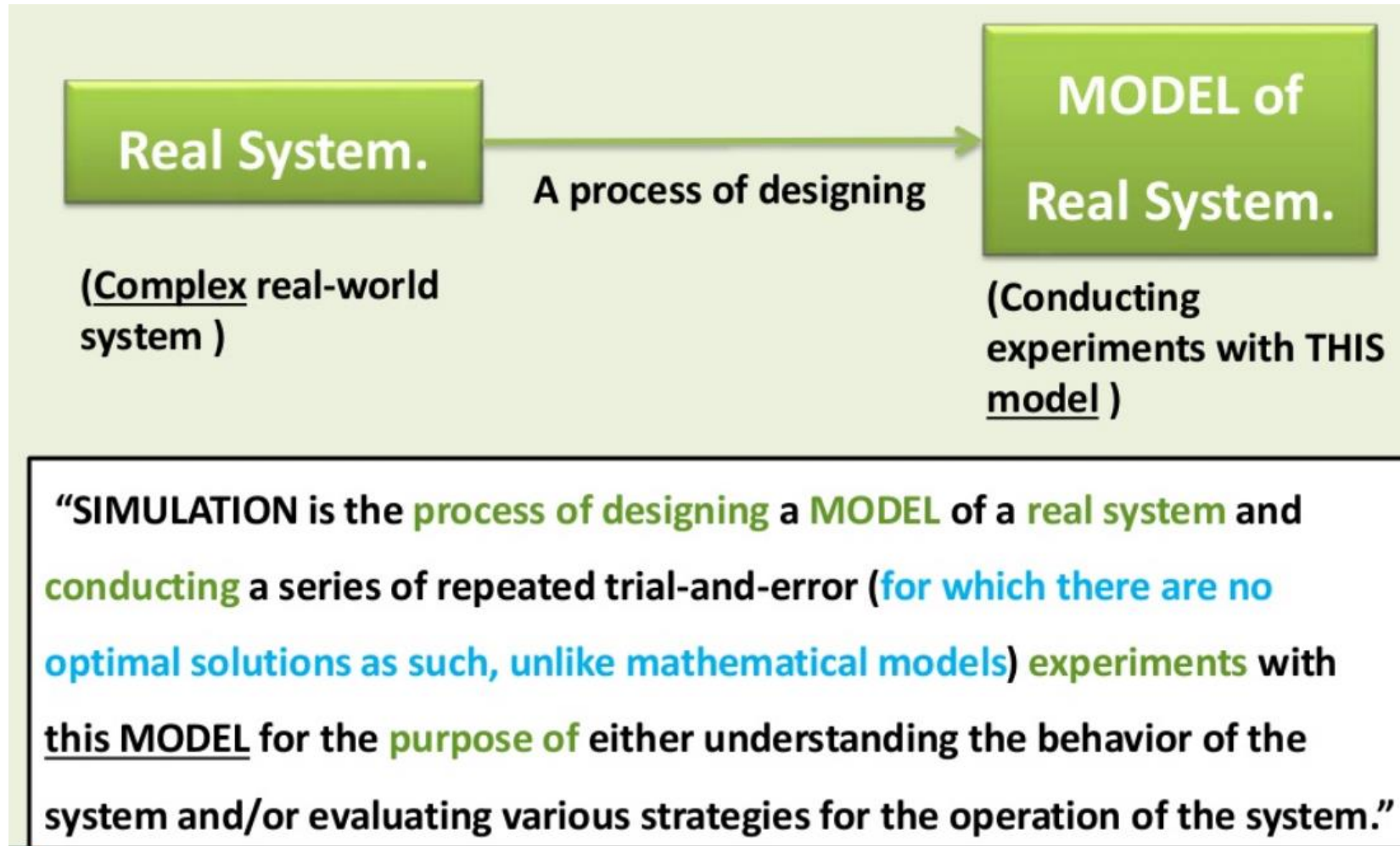


The screenshot shows a sign-up form for FlexSim. It includes an "email address" input field, a reCAPTCHA "I'm not a robot" checkbox, and a checkbox for "I have read and agree to FlexSim's privacy policy.". A "SIGN UP" button is located below the form. Below the button, there are two links: "Sign in using Google, LinkedIn, or Facebook" and "Sign in using your FlexSim account".

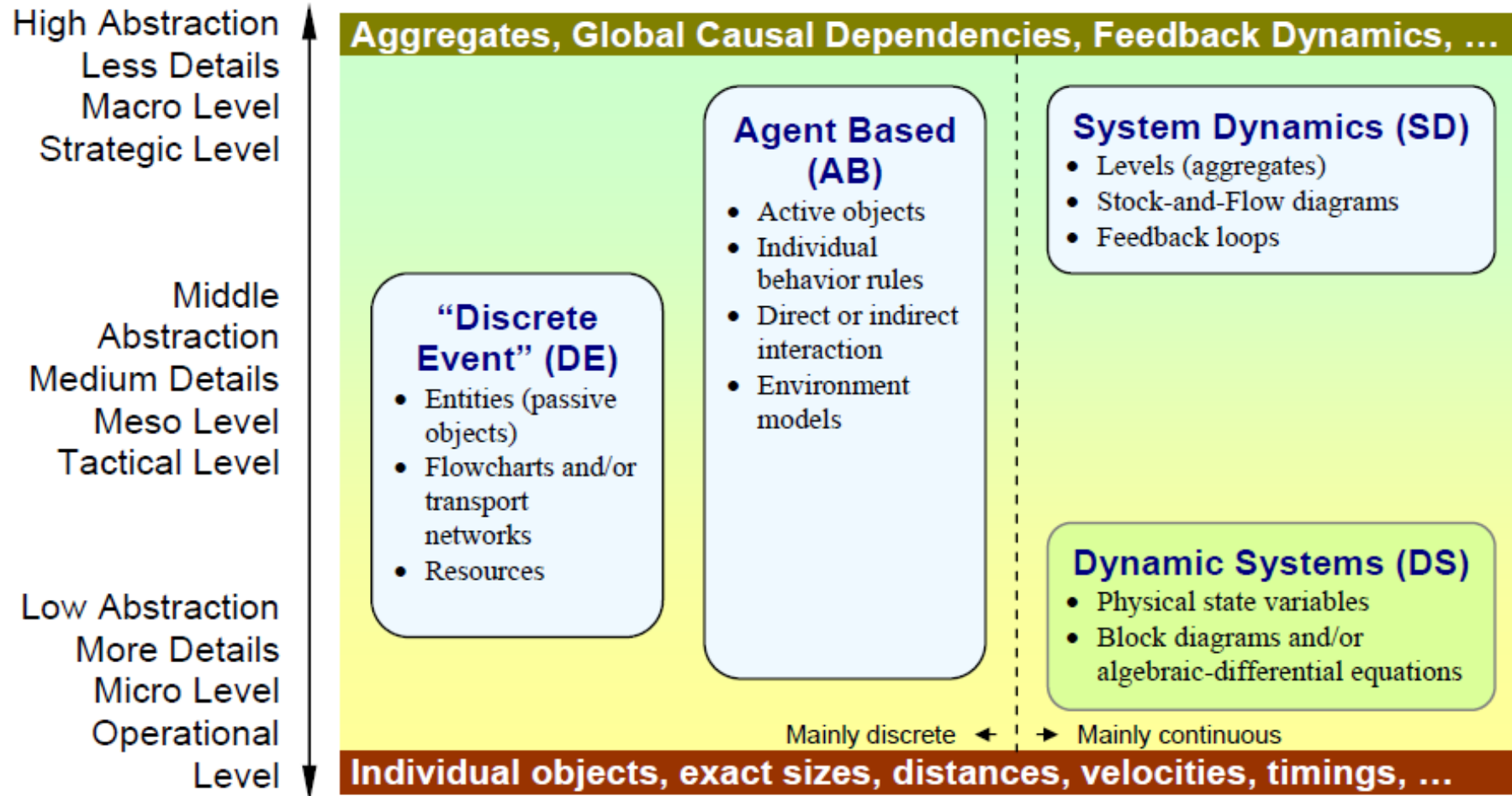
What is Simulation?



What is Simulation?



Simulation paradigms

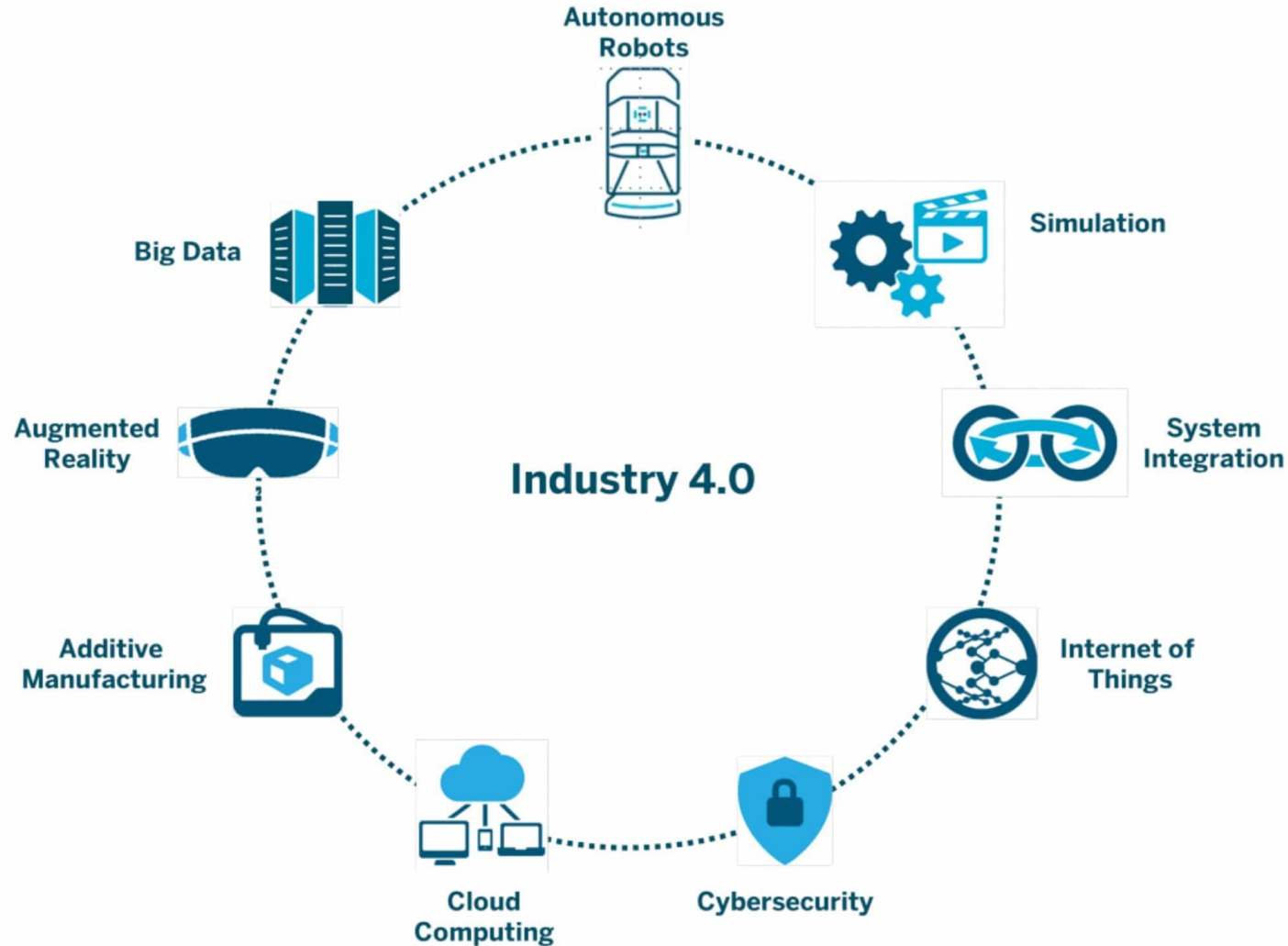


Types of simulation



Discrete Event Simulation	Agent Based Simulation	System Dynamics
Process-oriented: focus is on modeling the system in detail	Individual-oriented: the focus is on modeling the entities and interaction between them	System-oriented: the focus is on modeling the system observable
Based on entity flows through blocks	Based on the single agents interacting with each others	Based on stocks and flows between stocks
Entities are passive	Agents are active	Continuous systems, no entities
Global system behavior	Global behavior results as the interaction of many agents	Global system behavior as a number of interacting feedback loops
Adopted in business process, manufacturing, logistics and service delivery processes	Mainly applied in social sciences including marketing, social processes, and healthcare/epidemic models	Adopted in urban, social, ecological types of systems.

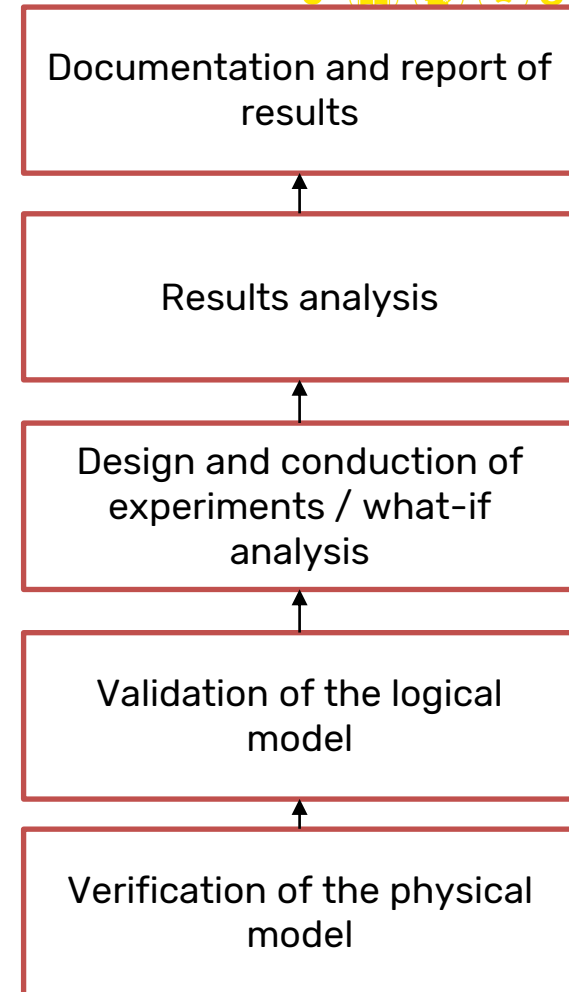
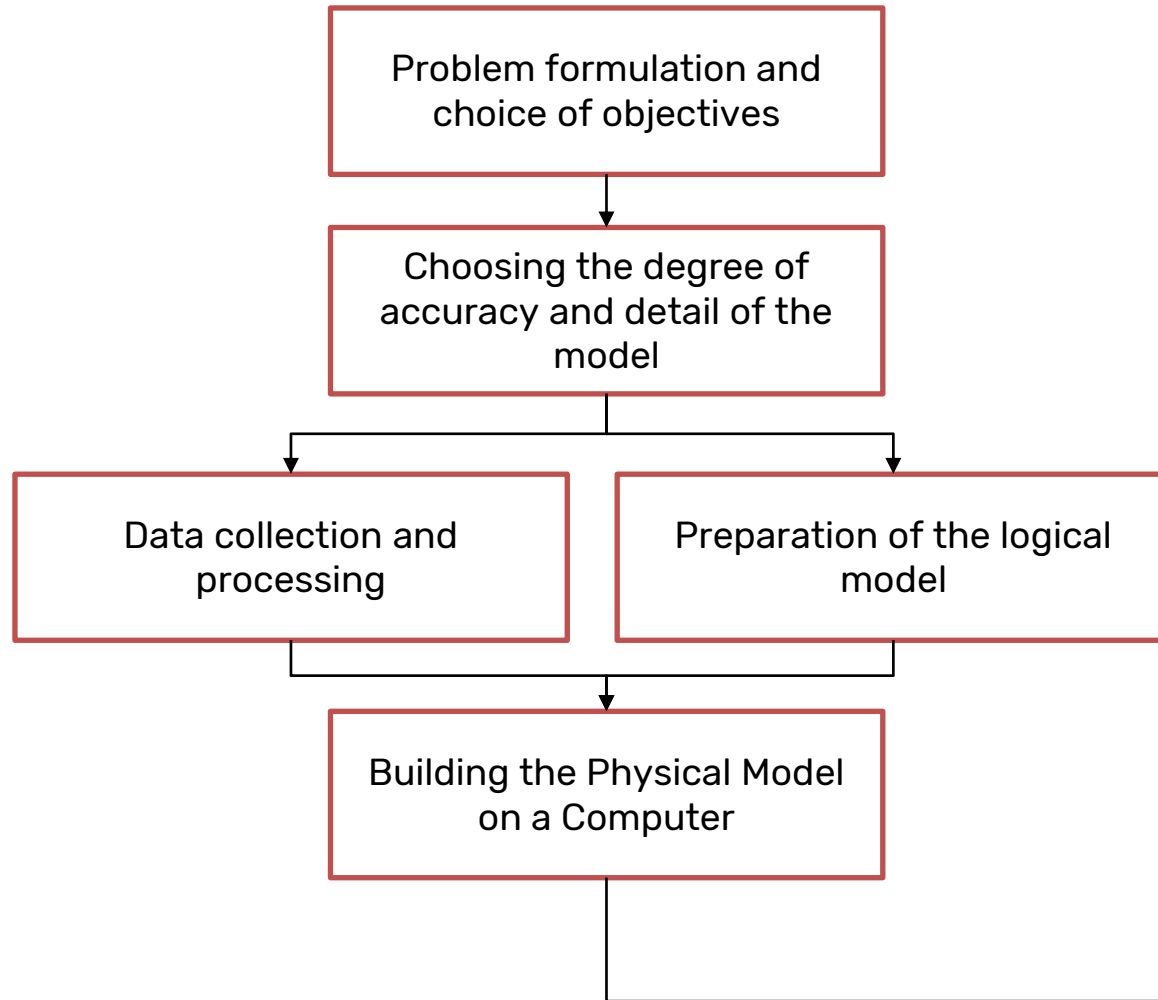
Why to Simulate?



We have far more data, evidence, and computer models to make decisions today, but that also means we have far more information overload and excessive choice proliferation. The number and complexity of choices seem to be growing beyond our abilities to analyze, synthesize, and make decisions. The acceleration of change reduces the time from recognition of the need to make a decision to completion of all the steps to make the right decision. ... **Many of the world's decision making processes are inefficient, slow, and ill informed.**¹

¹The Millennium Project, "15 Global Challenges. Facing Humanity," last modified 2009, <http://www.millennium-project.org/millennium/challeng.html>.

Which are the main phases of a simulation project?

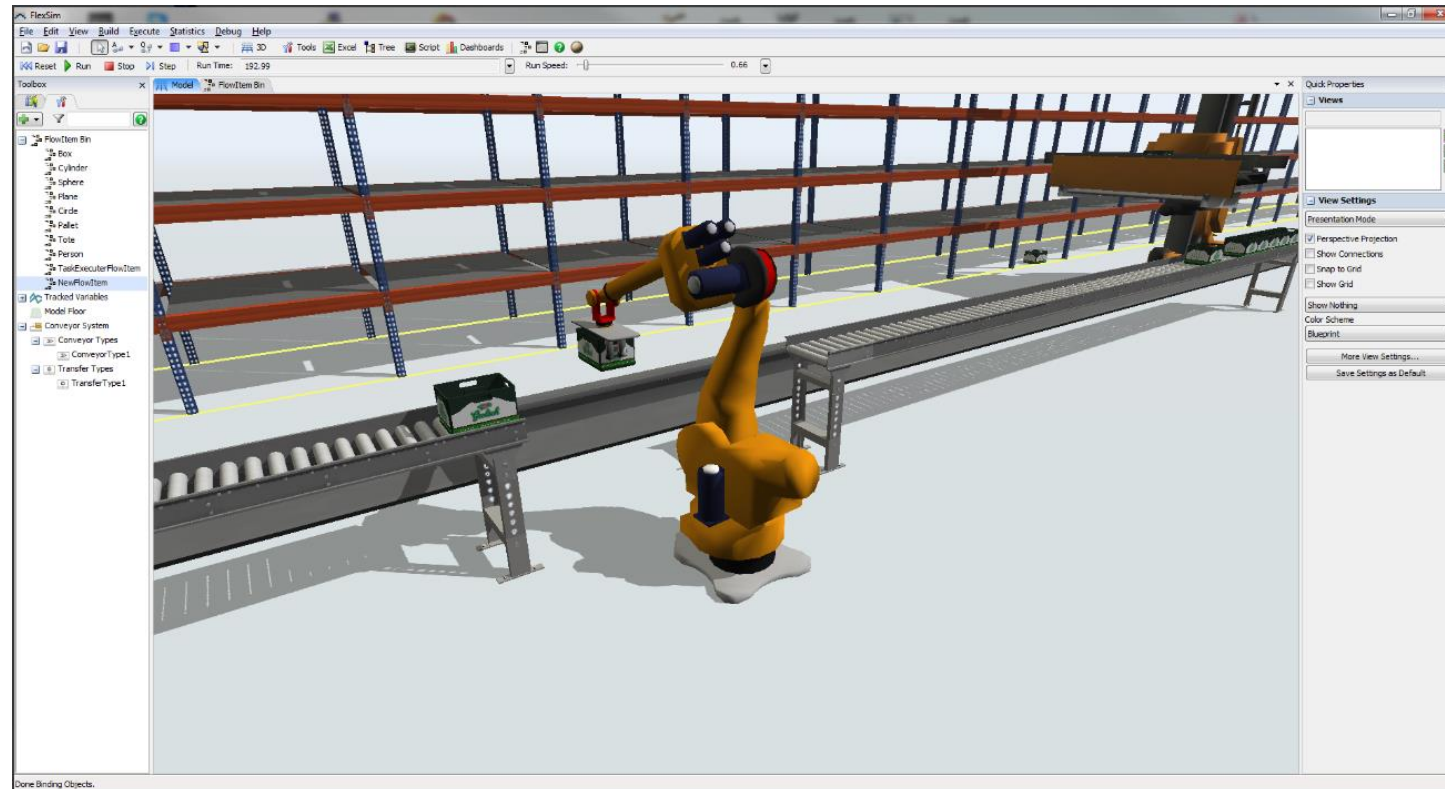


What is FlexSim?

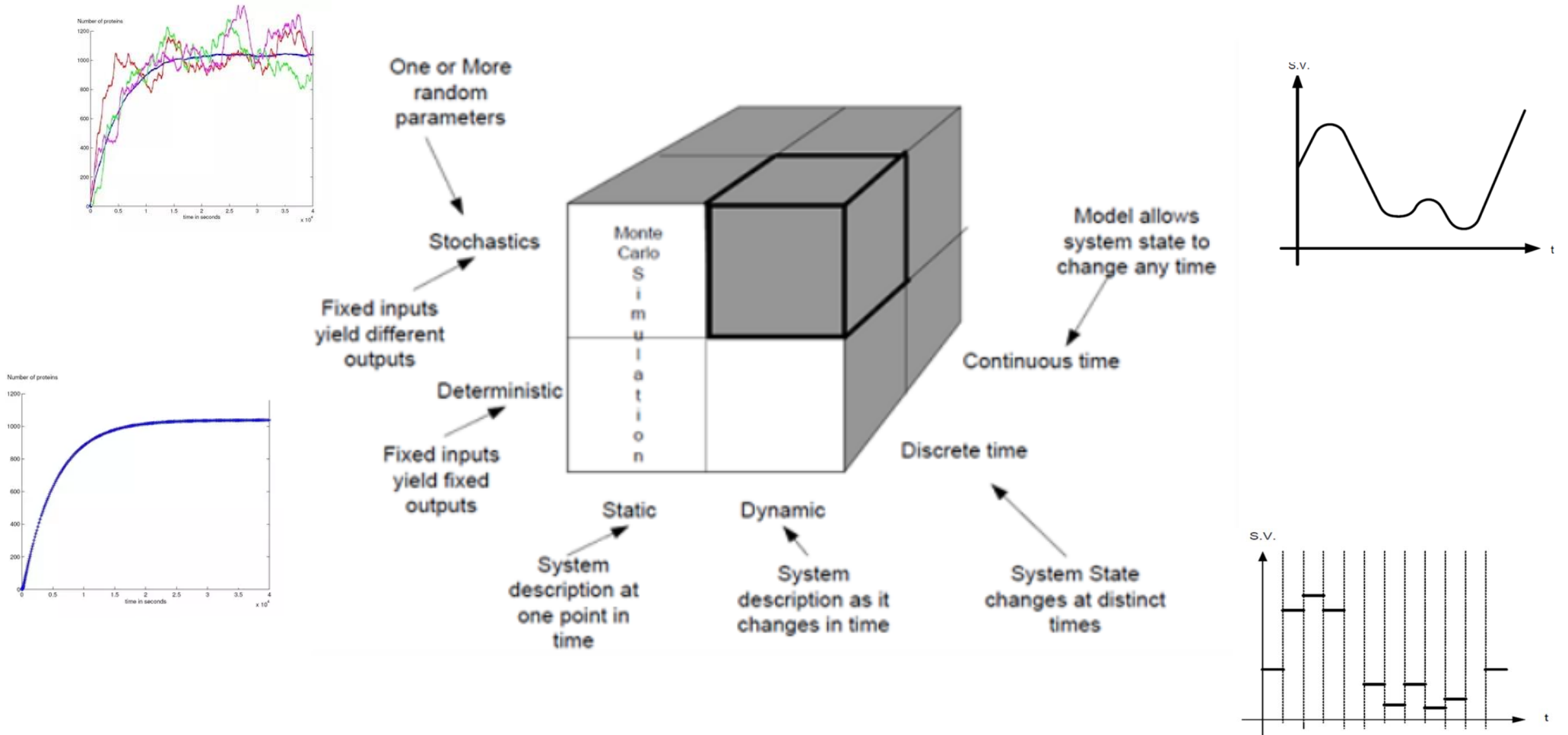


What is FlexSim?

- FlexSim is a 3D object-oriented simulation software.
- FlexSim is a Stochastic, Dynamic, and Discrete Time simulation software.
- It models, simulates, predicts, and visualizes systems.



What is FlexSim?



Applications



Manufacturing



Material Handling



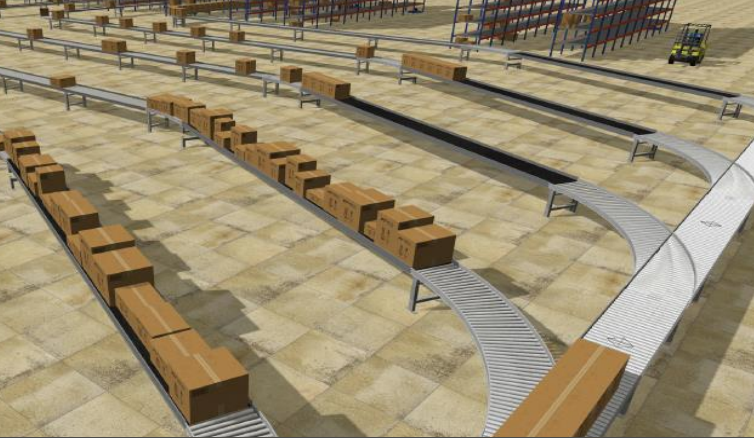
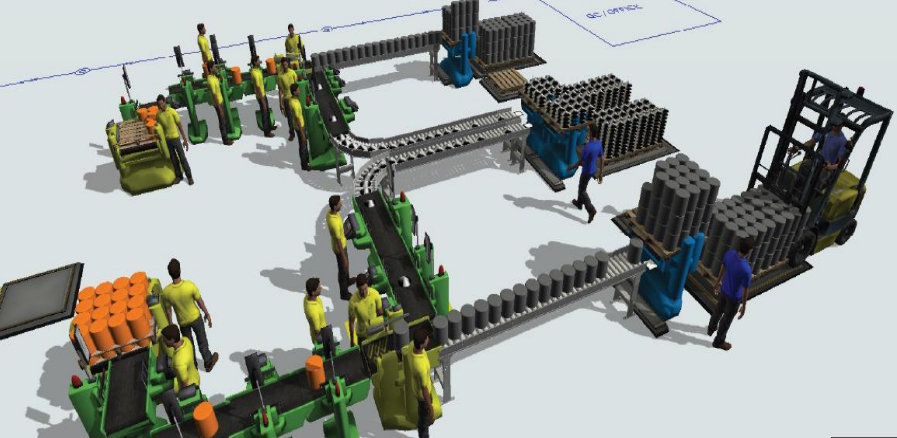
Healthcare

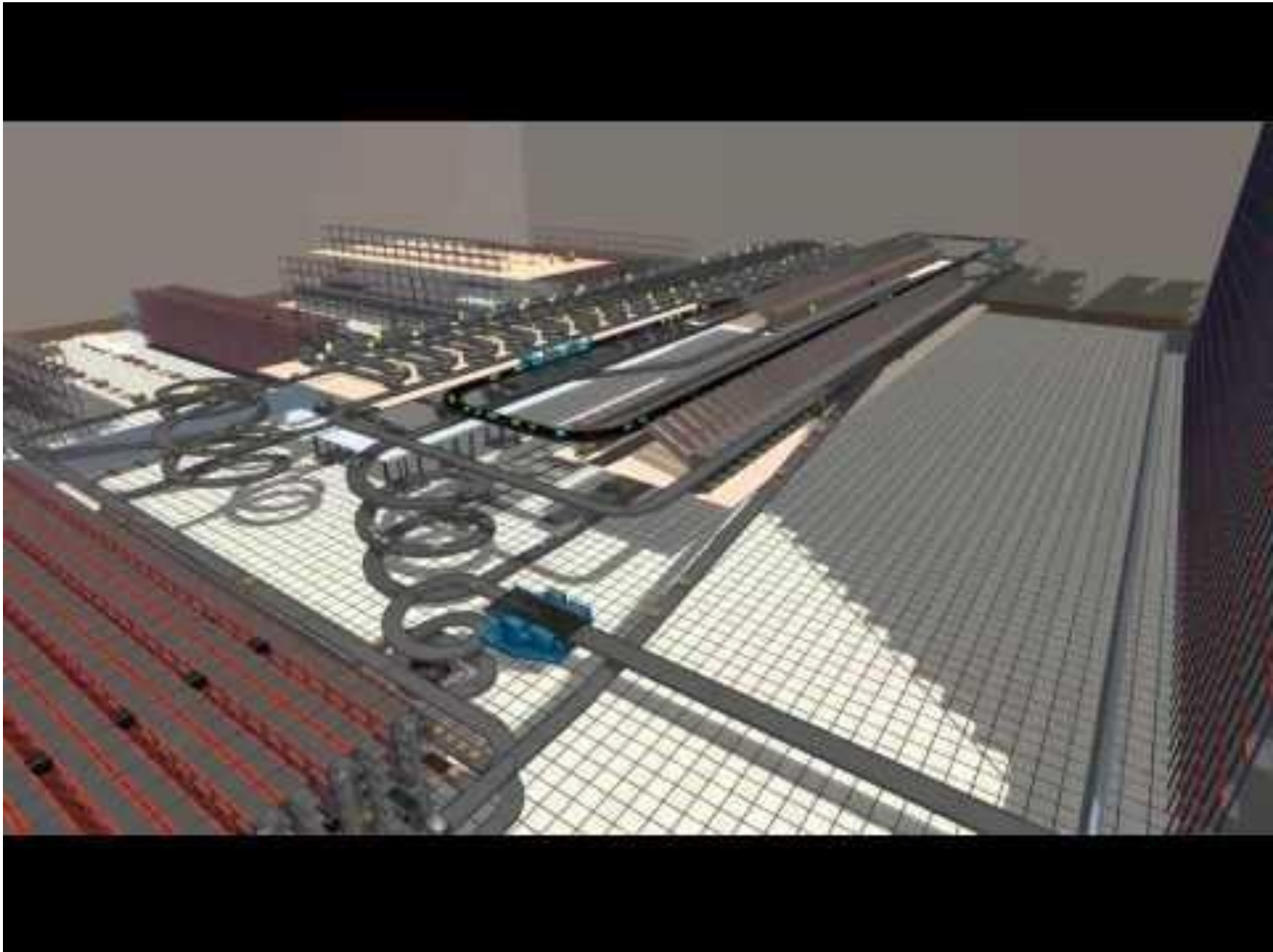


Packaging

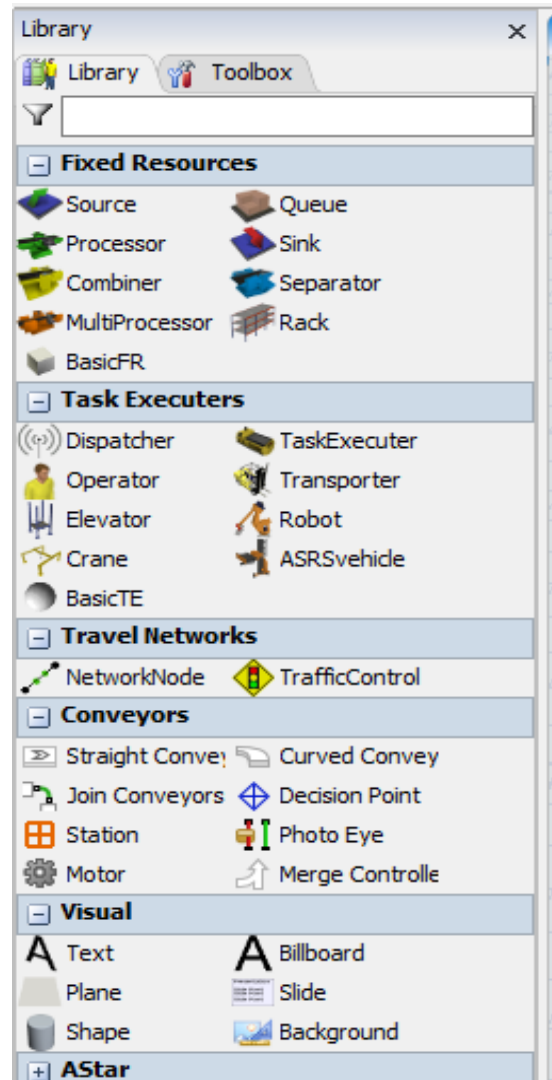


Logistics



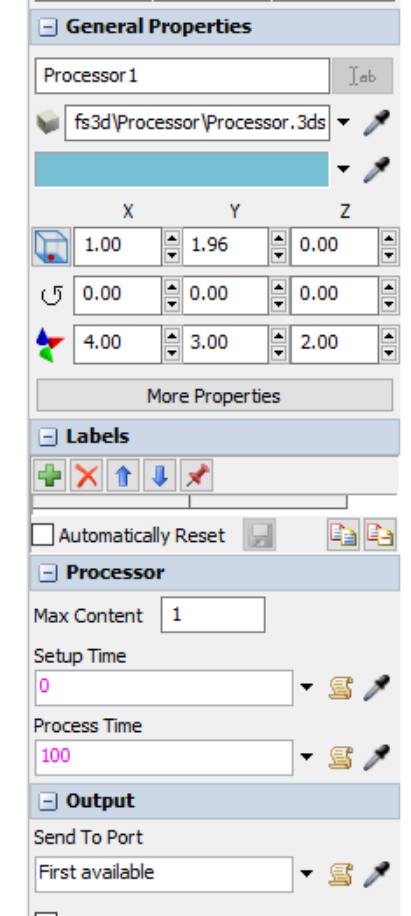


FlexSim Simulation Logic

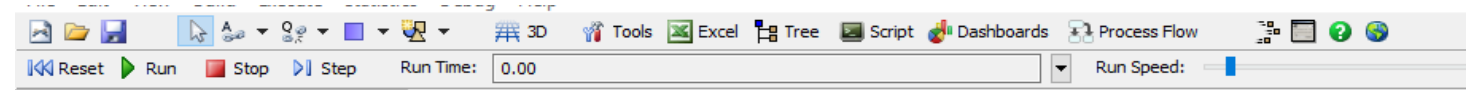


- Objects Library

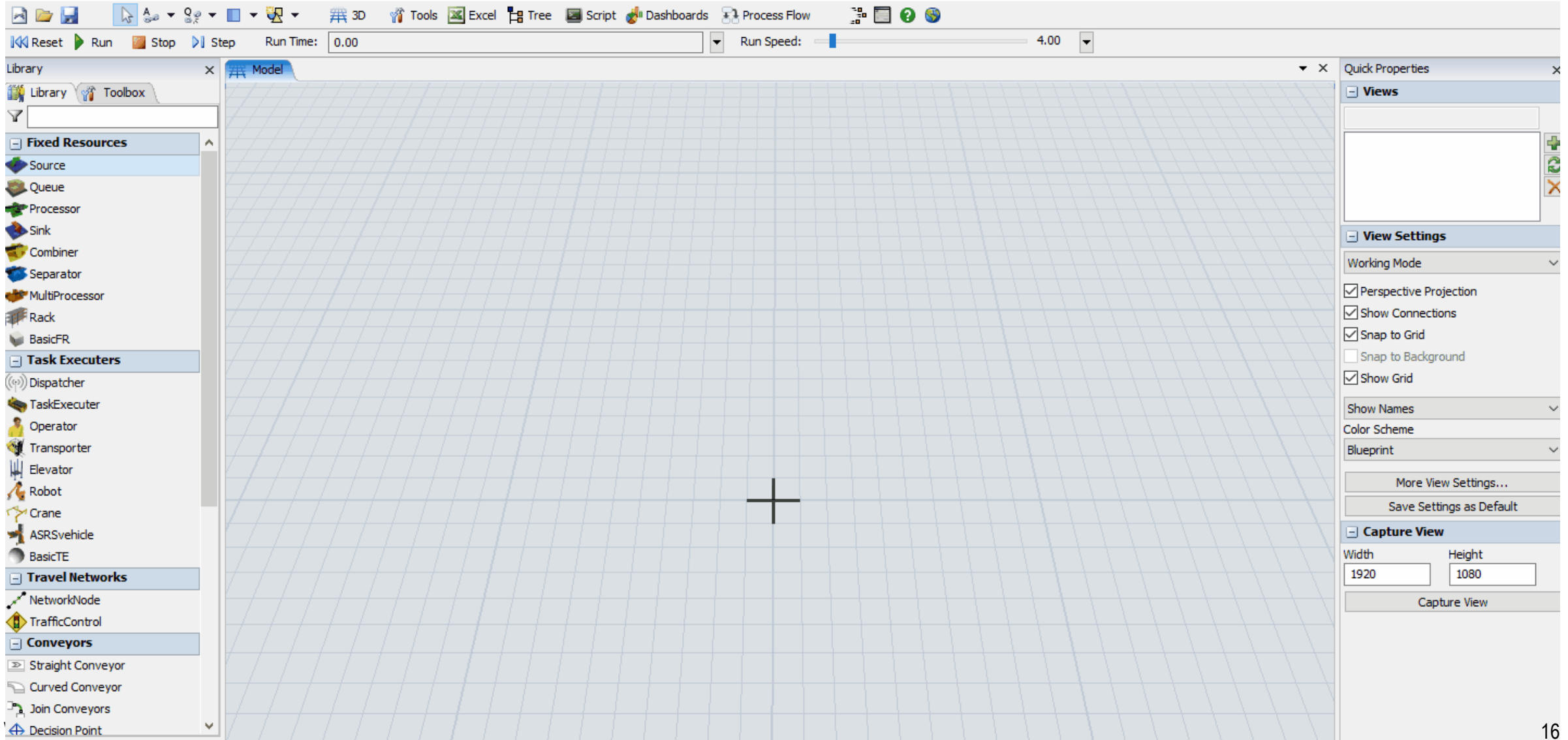
- Object properties and statistics



- Run settings

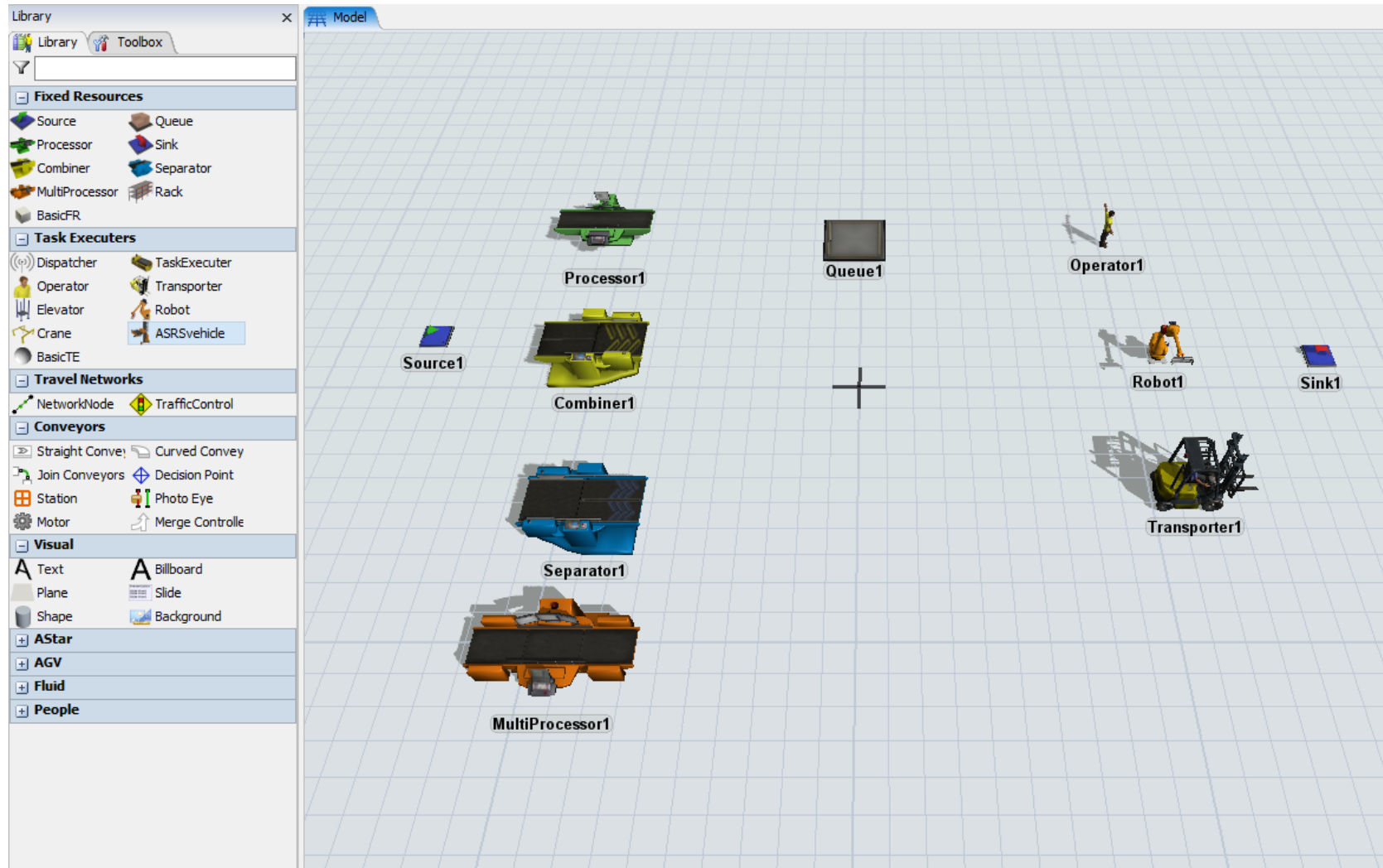


FlexSim Simulation Logic

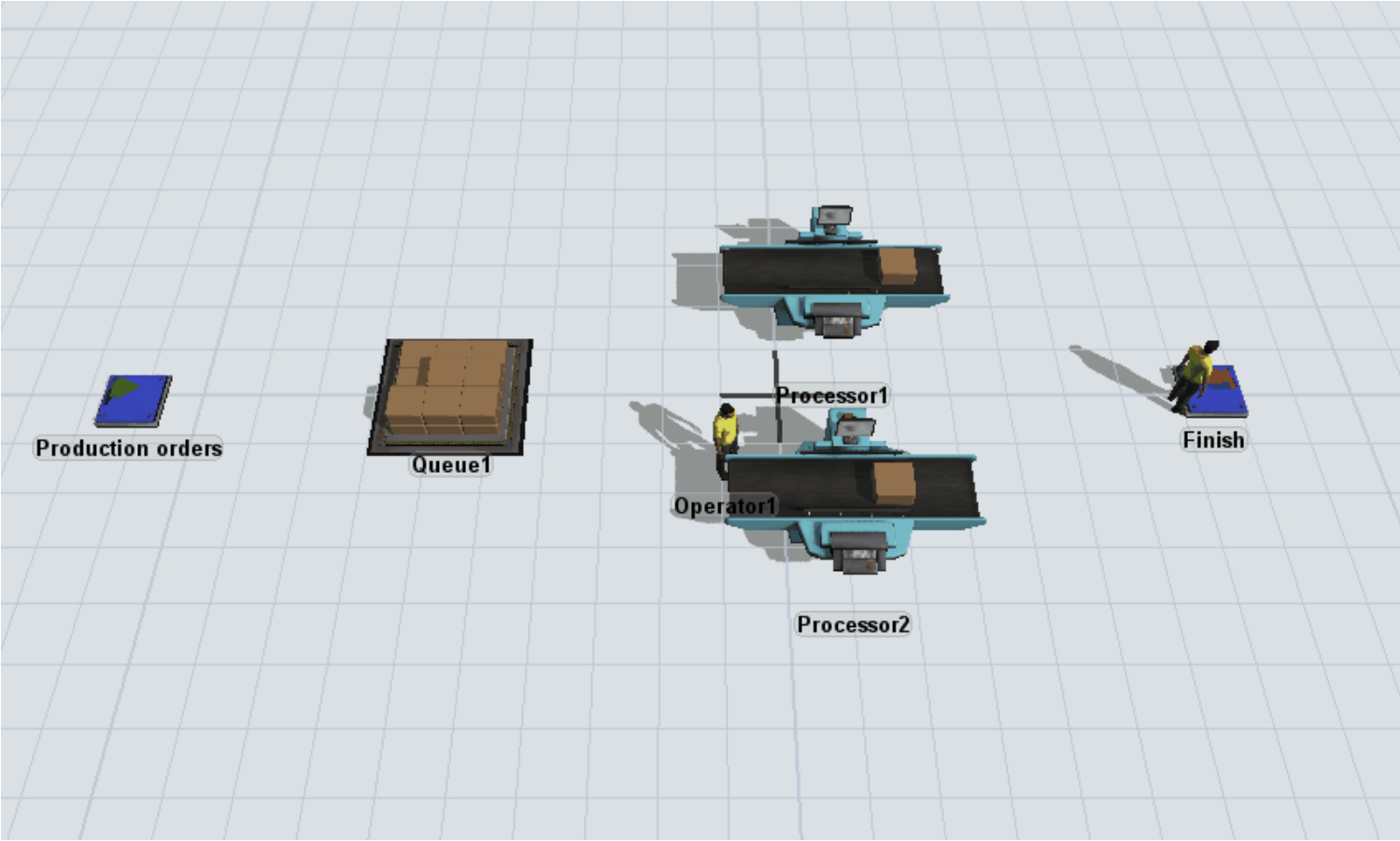


The screenshot displays the FlexSim software interface. The top menu bar includes options like Reset, Run, Stop, Step, Run Time (0.00), and Run Speed (4.00). The left sidebar contains a Library with categories: Fixed Resources (Source, Queue, Processor, Sink, Combiner, Separator, MultiProcessor, Rack, BasicFR), Task Executors (Dispatcher, TaskExecutor, Operator, Transporter, Elevator, Robot, Crane, ASRSvehicle, BasicTE), Travel Networks (NetworkNode, TrafficControl), and Conveyors (Straight Conveyor, Curved Conveyor, Join Conveyors, Decision Point). The central workspace is a grid with a crosshair. The right sidebar shows Quick Properties, View Settings (Perspective Projection, Show Connections, Snap to Grid, Show Grid), and Capture View (Width: 1920, Height: 1080).

FlexSim objects



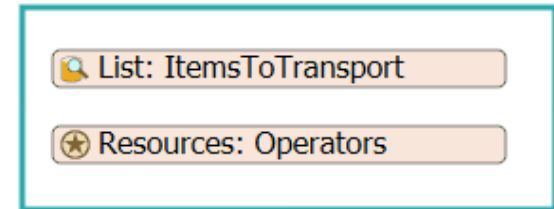
Simple Manufacturing Process: 3D Model



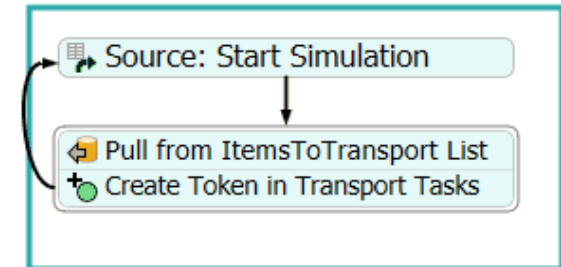
Simple Manufacturing Process: Process Flow



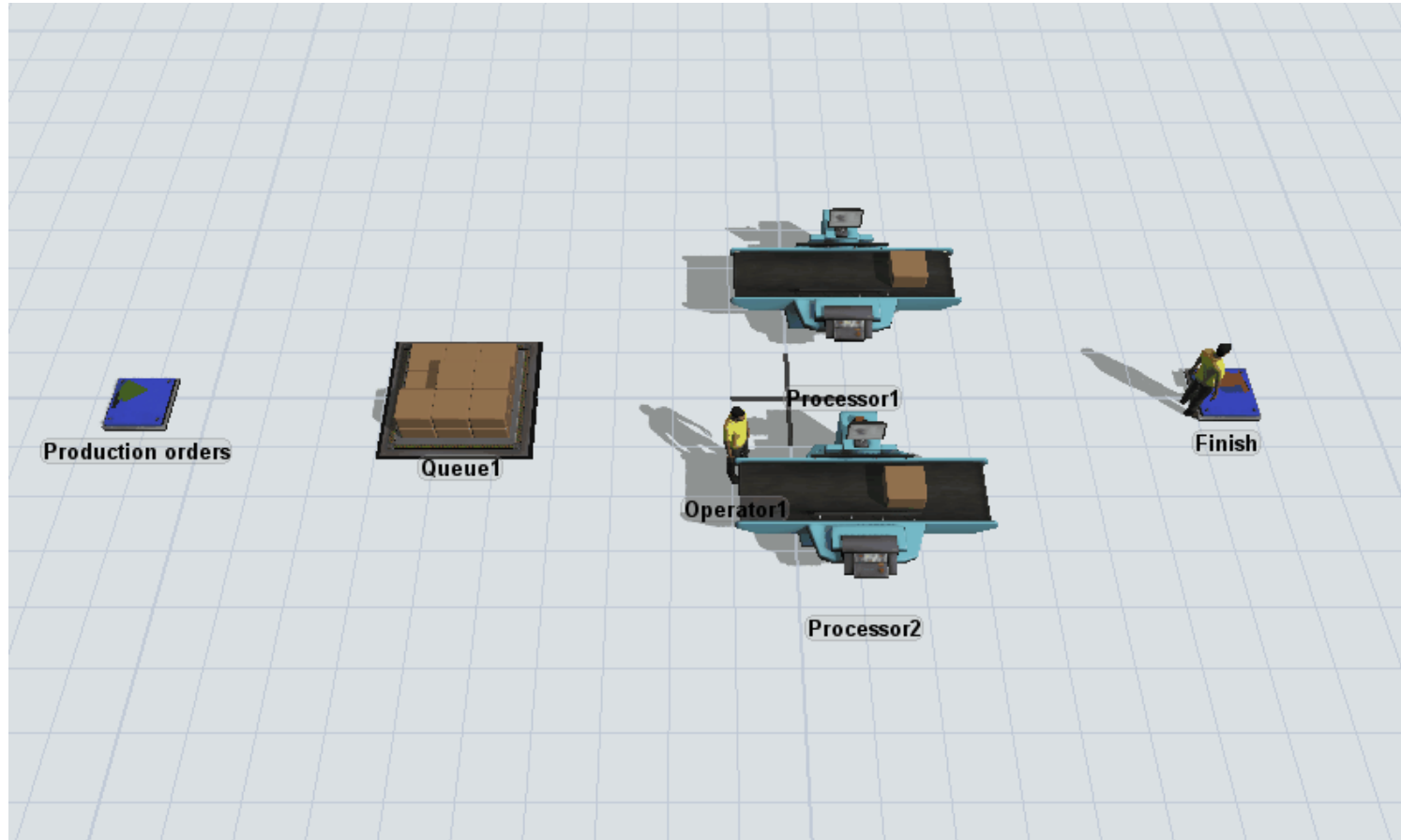
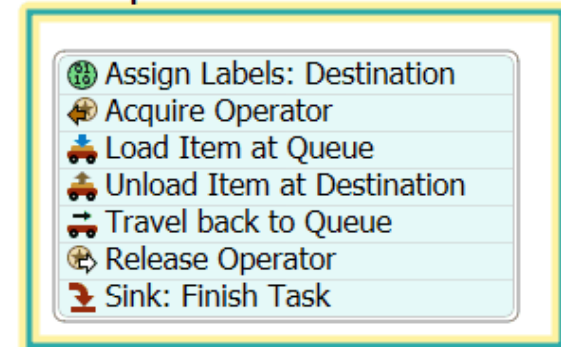
Shared Assets



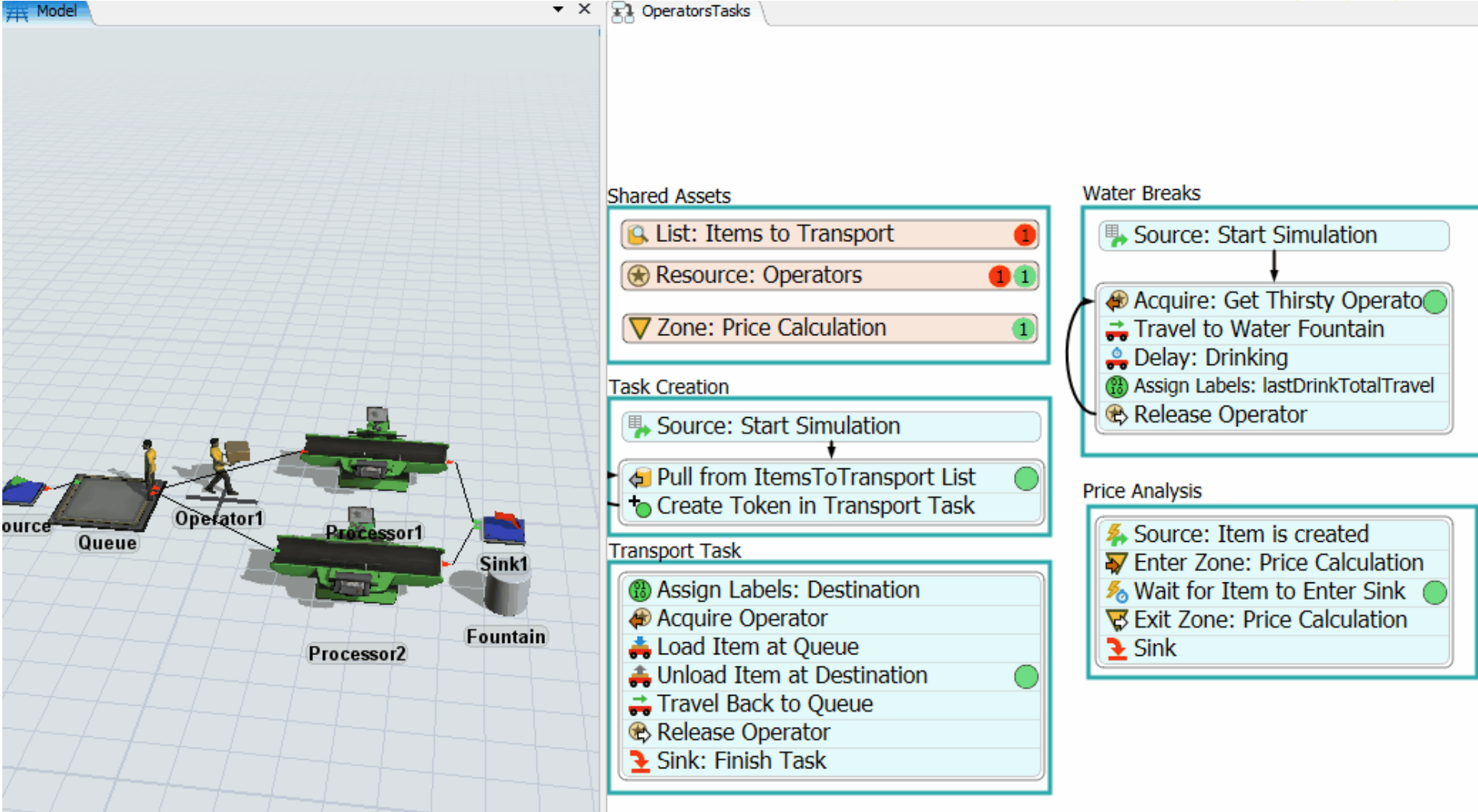
Task Creation



Transport Tasks



Simple Manufacturing Process: Adding detail



The screenshot displays a simulation environment with a 3D model on the left and a task configuration panel on the right. The 3D model includes a source, a queue, two operators (Operator1 and Operator2), two processors (Processor1 and Processor2), a sink (Sink1), and a fountain. The task configuration panel is organized into several sections:

- Shared Assets:**
 - List: Items to Transport (1)
 - Resource: Operators (1, 1)
 - Zone: Price Calculation (1)
- Task Creation:**
 - Source: Start Simulation
 - Pull from ItemsToTransport List
 - Create Token in Transport Task
- Transport Task:**
 - Assign Labels: Destination
 - Acquire Operator
 - Load Item at Queue
 - Unload Item at Destination
 - Travel Back to Queue
 - Release Operator
 - Sink: Finish Task
- Water Breaks:**
 - Source: Start Simulation
 - Acquire: Get Thirsty Operator
 - Travel to Water Fountain
 - Delay: Drinking
 - Assign Labels: lastDrinkTotalTravel
 - Release Operator
- Price Analysis:**
 - Source: Item is created
 - Enter Zone: Price Calculation
 - Wait for Item to Enter Sink
 - Exit Zone: Price Calculation
 - Sink



Tutorials FlexSim

Learning FlexSim



FlexSim Student Portal

textbook downloads | student license | video series | student forum | online learning | faq

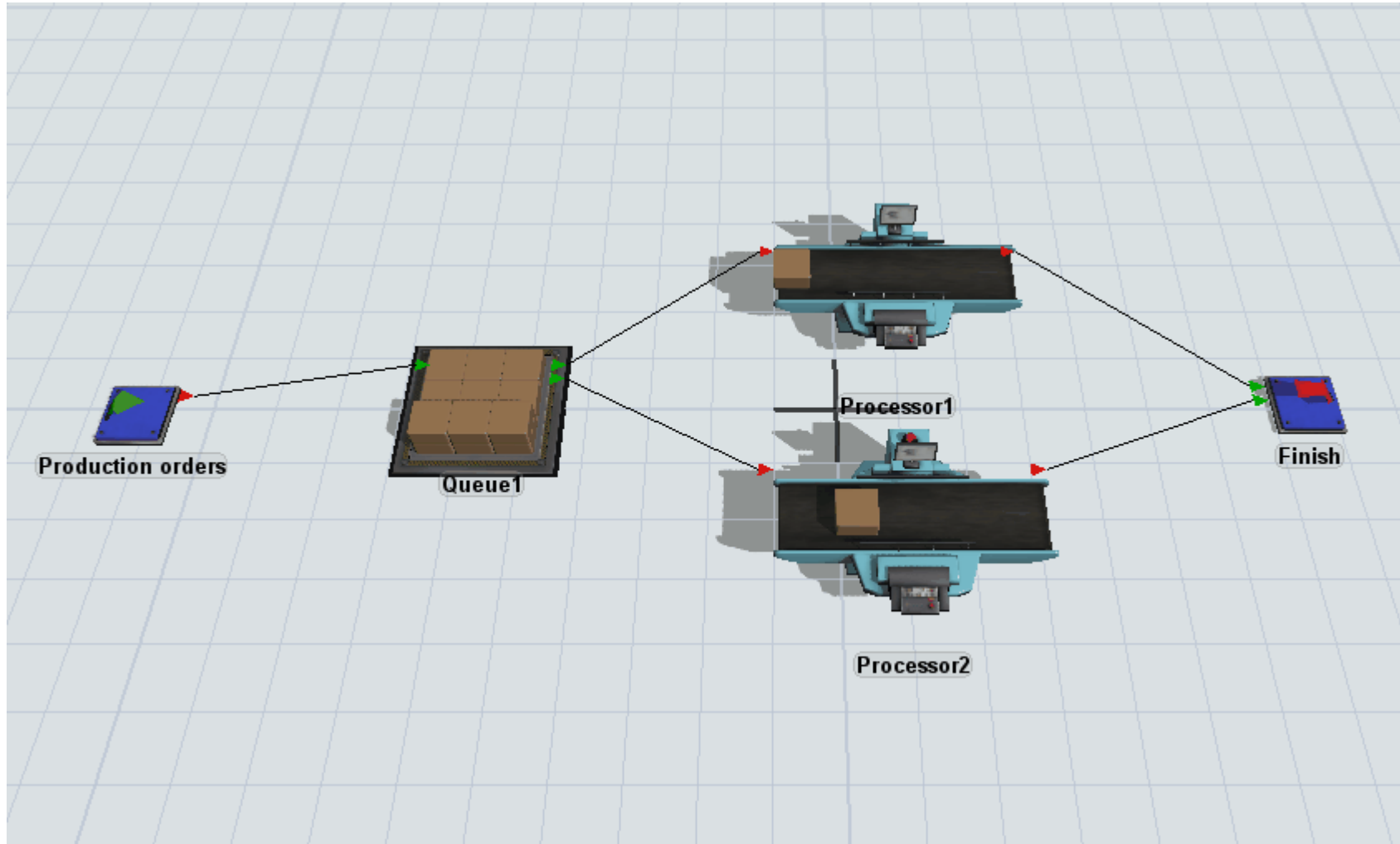
[Visit the Educator Portal](#)



Applied Simulation: Modeling and Analysis using FlexSim



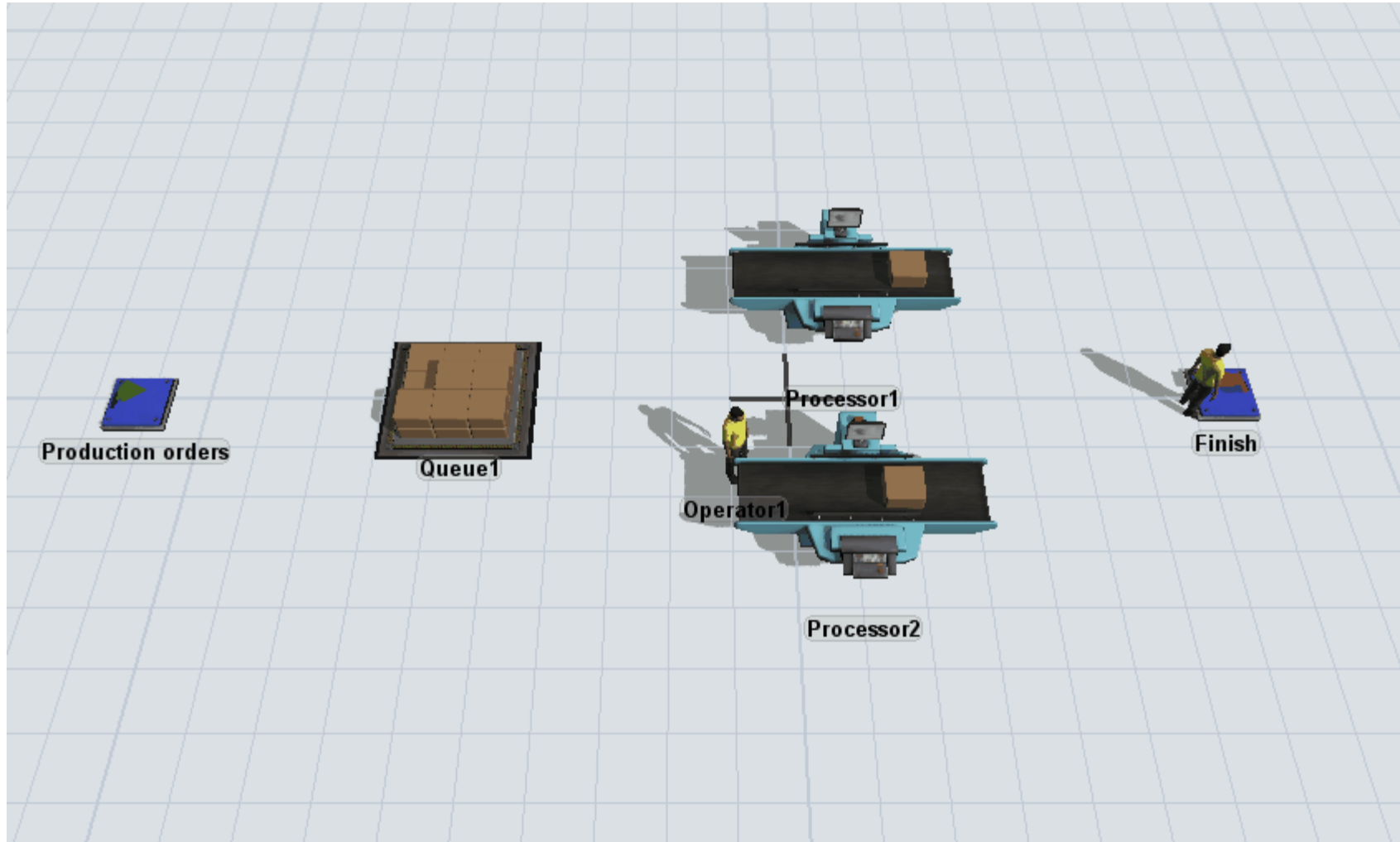
Tutorial 1



Important Concepts:

- Objects' properties
- Objects' Statistics
- Objects' interconnections
- Arrival Style (i.e. Interarrival time)
- Processing time

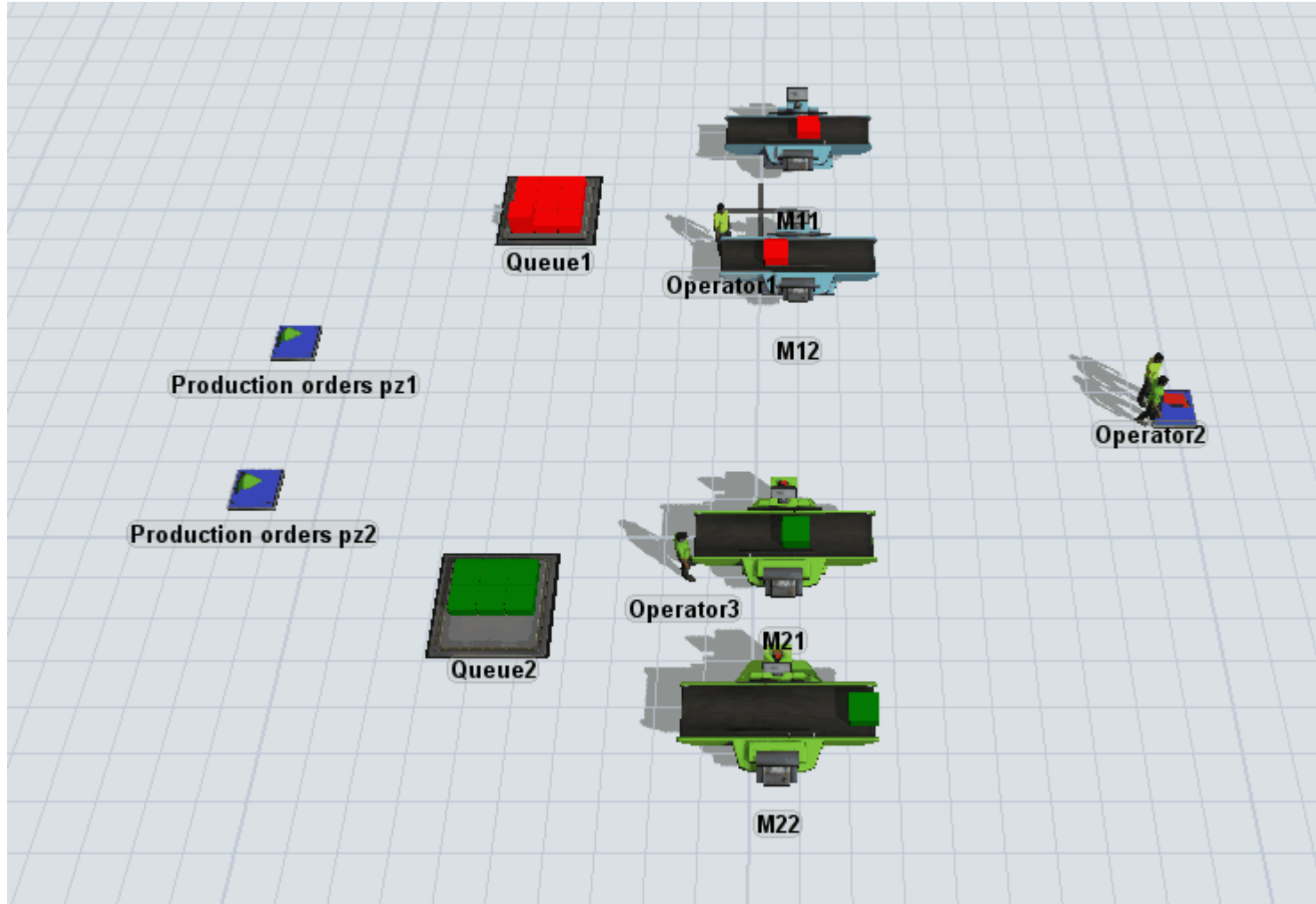
Tutorial 2



Important Concepts:

- Task executers (transportation)

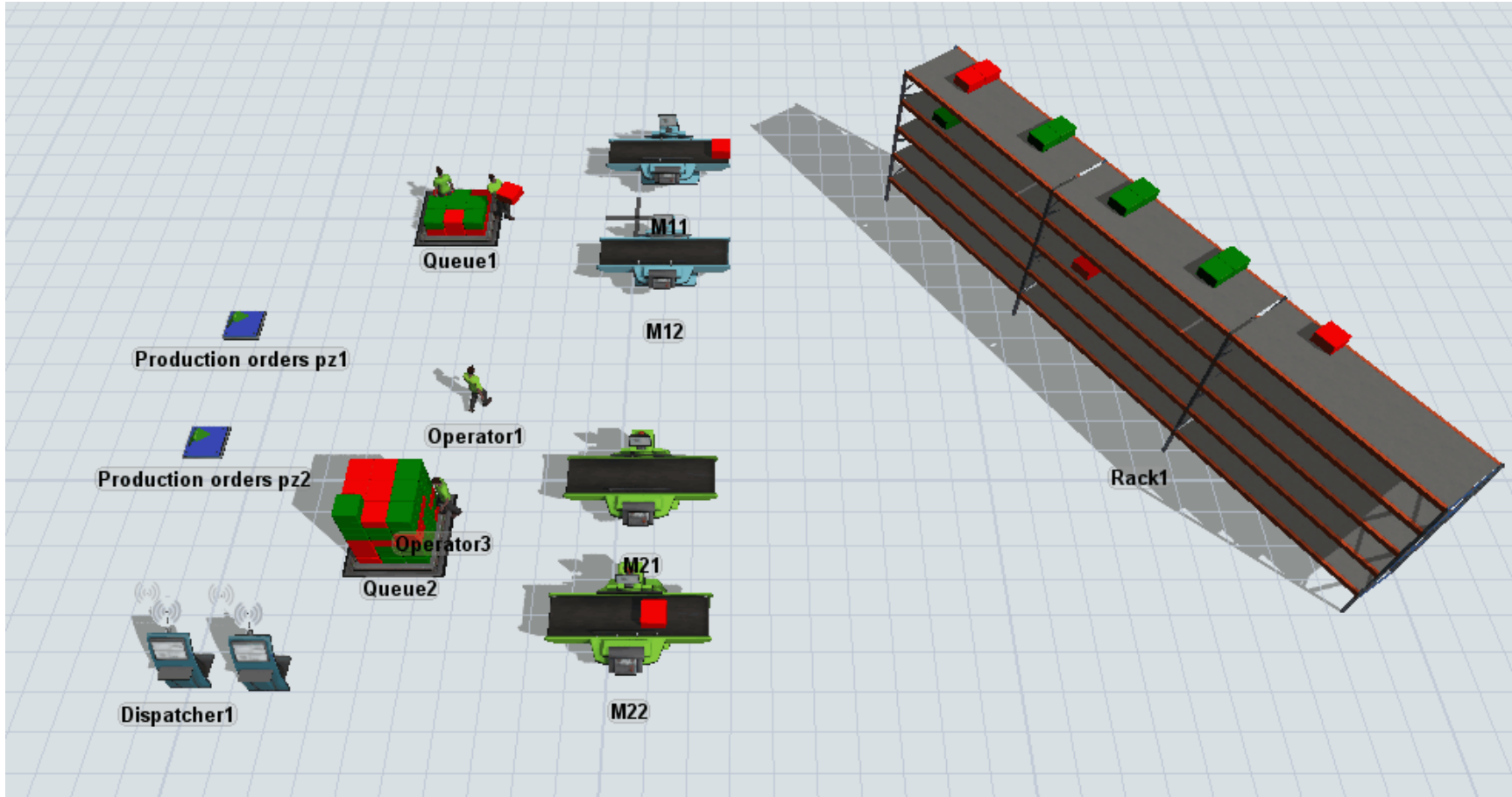
Tutorial 3



Important Concepts:

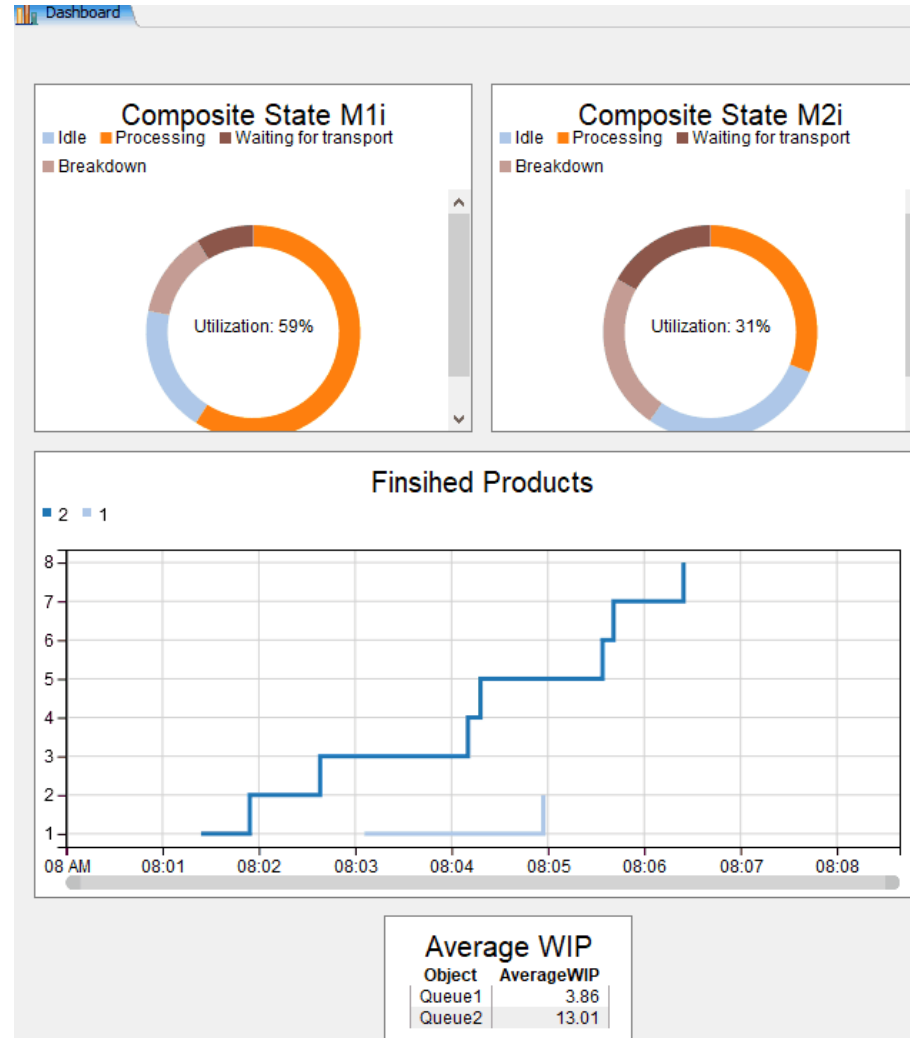
- Product properties (i.e., type, color)
- Scalation of production (i.e. Multiple processors' types)

Tutorial 4



Important Concepts:

- Task executers coordination (i.e. Dispatcher)
- Item List
- Global Tables (i.e., Process time, Process steps)
- Job-shop production sequencing
- Warehousing (i.e. Rack)



Important Concepts:

- Performance Measurement (i.e., Dashboard).
- Machine Failures (i.e., MTBF, MTTR).
- Group of Resources

Tutorial 6



Simulation Experiment Control

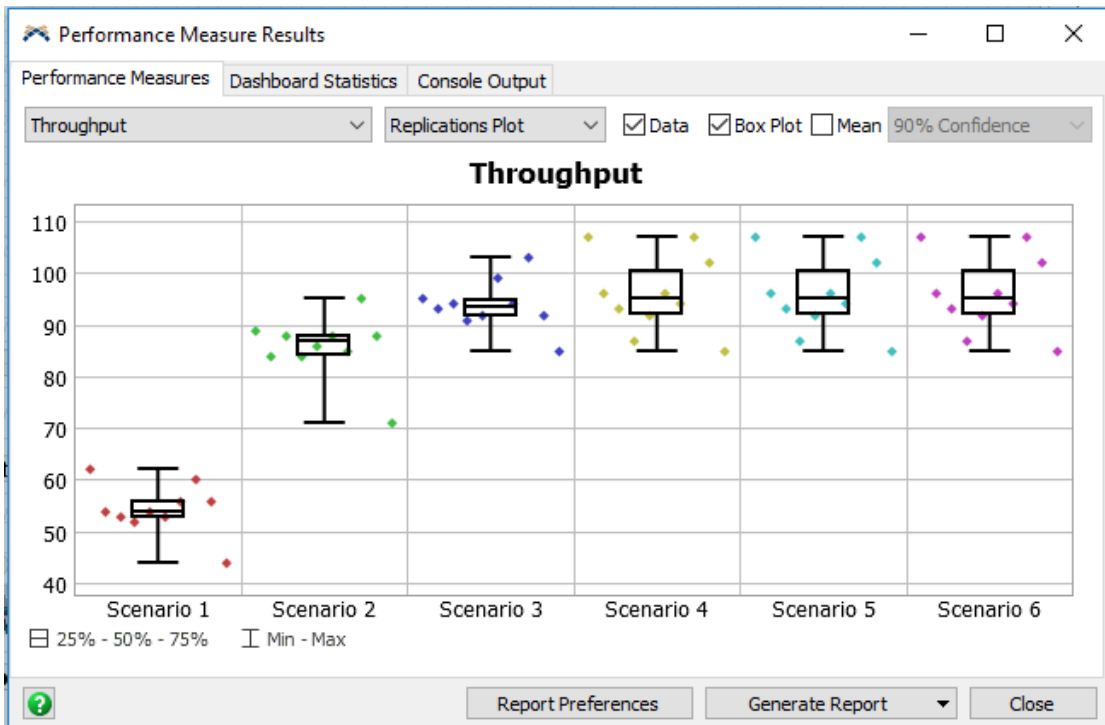
Scenarios Performance Measures Experiment Run Optimizer Design Optimizer Run Optimizer Results Advanced

Variables Scenarios Choose default reset scenario:

Variable	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Num. Operators 1 /Nr TEs in Team /Dispatcher 1	1	2	3	4	5	6
Num. Operators 2 /Nr TEs in Team /Dispatcher 2	1	2	3	4	5	6

Important Concepts:

- Statistics Collector
- Design of Experiments



Performance Measure Results

Performance Measures Dashboard Statistics Console Output

Throughput Data Summary Mean Based on 90% Confidence

Throughput

	Mean (90% Confidence)	Sample Std Dev	Min	Max
Scenario 1	51.6 < 54.4 < 57.2	4.9	44.0	62.0
Scenario 2	82.3 < 85.8 < 89.3	6.1	71.0	95.0
Scenario 3	91.0 < 93.8 < 96.6	4.8	85.0	103.0
Scenario 4	91.5 < 95.9 < 100.3	7.5	85.0	107.0
Scenario 5	91.5 < 95.9 < 100.3	7.5	85.0	107.0
Scenario 6	91.5 < 95.9 < 100.3	7.5	85.0	107.0