Use AutoCAD | Inventor with ProModel Simulation to Optimize Factory Layouts

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Learning Objectives

- Explain the value of using ProModel simulation for process optimization
- Describe when to use manufacturing simulation
- Create a simulation model with Factory Design Utilities that opens directly in AutoCAD/Inventor to start a factory layout
- Identify how to create a simulation model from an existing AutoCAD layout

Description

It is common for factory layouts to be designed using AutoCAD and Inventor to ensure spatial accuracy and safety compliance. However, it is not the norm to be as diligent with process design. Often plant designers will rely on equipment vendor rates and assume equipment and resources will integrate and run according to the design on paper. But what happens when the reality of process variation and equipment & labor inter-dependencies come into play?

It’s very difficult to take all these factors into account using only CAD drawings and layouts. The solution is to use simulation to optimize the factory workflow then create a direct link from the simulation to the factory layout, providing a Digital Twin of the Factory. We will demonstrate the value and basics of how using ProModel & Process Simulator Autodesk Editions, synced with AutoCAD and Inventor, can help optimize your digital twin first so that you are not playing trial and error with your real equipment, inventory, and labor.

Speaker(s)

Aaron Nelson has been the product manager of ProModel Corporation’s two flagship product families, the ProModel / MedModel Optimization Suites and Process Simulator, since 2018. As part of this role, he and his team work closely with Autodesk’s AutoCAD, Inventor, and Factory Design Utilities technology teams developing the integrations between the ProModel and Autodesk toolsets.

Aaron is also one of our instructors teaching our ProModel and Process Simulator training classes both in-person and online. Previously, he was the customer technical support manager and started with ProModel in 2007 as a customer technical support engineer.

Before joining ProModel, Aaron graduated with a BS in management from the University of Phoenix in 2007.
Andy Schild is a sales director with ProModel and has been with the company for 12+ years, working with manufacturing and logistics clients to help leverage ProModel’s simulation engine to help improve efficiency in manufacturing and supply chains. Currently, Andy is the ProModel point of contact for the sales and marketing relationship with Autodesk.

Prior to ProModel, Andy worked in Sales roles in the industrial automation space and graduated with a BS in Industrial and Systems Engineering from Rochester Institute of Technology (RIT).

**ProModel Resources**

Class Live Q&A Fri Nov 20 at 12:30-1:30 PM EST (17:30 UTC)

**AU Silver Sponsor Virtual Booth**

https://www.autodesk.com/autodesk-university/conference/expo/ProModel-Corporation

4 Live 30 min ProModel Demo’s During AU – Register on Nov 17 at our Virtual Booth

- Nov 17 Americas 4 pm EST, 21:00 UTC
- Nov 18 EMEA 1:30 pm EMEA, 13:30 UTC
- Nov 18 Americas 12:00 pm EST, 17:00 UTC
- Nov 19 APAC 10 am APAC, 02:00 UTC

Model Dataset files available as additional file download from this AU Class page.

- **Process Simulator Autodesk Edition Website**
- **Process Simulator 30 Day Evaluation from the Autodesk App Store**
- **Process Simulator Quick Start Video**
- **Process Simulator Tutorial**
- **ProModel Optimization Suite Autodesk Edition Website**
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**Purchase Your Process Simulator Autodesk Edition Subscription Here**
The Value of Using ProModel Simulation for Process Optimization

Where Does Simulation Help?

New Factory Design
- Validate Layout and Operational Assumptions
- Validate Quantities of Equipment
- Determine Correct Labor Allocations
- Determine In-plant Logistics and Material Handling Needs

Existing Factory Improvement
- Identify Process Waste
- Line Balancing
- Target and Testing Improvements
- Validate and Quantify Impact of Process Changes

ProModel Methodology

**Visualize** the Process
- Business Rules
- Facility Constraints
- Resource Constraints
- Demand
- Process Flows

**Analyze** the Results
- Throughput
- Resource Utilization
- Equipment Utilizations
- Inventory Levels
- Lead Times
- Costs

**Optimize** Scenarios & KPI Comparisons
- Demand & Mix
- Schedule Changes
- Labor Quantities
- Labor Allocation
- Qty. Equipment
- Batch Sizes
- Buffer Sizes
- Downtime Changes
When to Use Manufacturing Simulation

Simulation Helps Understand the Impact Of:

- Variability
- Complexity
- Constraint
- Uncertainty

When to Simulate?

When Complexity is High Due to Many Interdependencies and Increased Variability

**Modeling and Simulation Usage**

- **Interdependencies**
  - MRP, LP/IP, Math Models
  - Spreadsheets

- **Variability (Randomness)**
  - Cycle Times, Process Times, Scrap Rates, Equipment Downtime

- **Increasing Complexity**
  - Discrete Event Simulation
  - ProModel Simulation
  - Monte Carlo
Overview of Finished Models and Basic Model Building Process:

Start With the End in Mind

The result of the model building process in Process Simulator looks like this. It starts with material or part arrivals, called entities in Process Simulator, on the left side, and they flow through the processes from left to right, and then the finished product exits the system at the right side once they complete the process.

Completed Model Being Simulated in Process Simulator by ProModel Corporation.

Define Scenarios in Scenario Manager and See Results in Output Viewer

Define the experimental scenarios you want to test using the scenario manager. As the model is simulating, process performance metrics are being collected behind the scenes for each scenario. After the simulation finishes, these metrics are available to be analyzed in the reports and the dashboard module called Output Viewer.
Open in AutoCAD or Inventor

After the model is built and optimized, it can be opened in AutoCAD or Inventor, where it may be used to create an accurate model of your production line using real-world coordinates, helping you coordinate your design physically in 3D space.

Later in the handout, you will see details on how to build a simple model in Process Simulator.

Use Existing AutoCAD drawings to Build Simulation Models Directly in AutoCAD

If you already have an existing factory layout or even part of one, you can use the ProModel Optimization Suite, instead of Process Simulator, to build your model directly in AutoCAD.

After building the starting model in AutoCAD, open it up in ProModel Optimization Suite to add any additional logic and properties you may need.
After completing the model, create the scenarios you want to test and run the simulation model for those scenarios.

Then analyze the results in Output Viewer and determine if you need to make any changes in order to meet your production goals. If so, make the changes in AutoCAD and re-simulate in ProModel. Repeat this iterative process until you have optimized your factory.

Later in the handout, you will see details on how to build a ProModel Optimization Suite Model from inside AutoCAD.
Model Building Process

But before we jump into that, let’s introduce a modeling building process called LEAP. This is the strategy used to build a simulation model in Process Simulator or ProModel / AutoCAD.

1. **Locations**
2. **Entities**
3. **Arrivals**
4. **Processing**
Create a simulation model with Factory Design Utilities that opens directly in AutoCAD/Inventor to start a factory layout

To build models and take advantage of the Autodesk integration, you must have Microsoft Visio installed in order to use Process Simulator, and you must have Autodesk’s AutoCAD, Inventor, and Factory Design Utilities installed.

Now let’s see how to build a simple model from scratch in Process Simulator

**Process Simulator Workflow & Integration**

- New process design and layout or change the current process and/or layout
- In Process Simulator:
  - Start with a blank page
  - Lay Factory Assets into model (Locations)
  - Define additional Resources and constraints (operators, MHE)
  - Define product mix (Entities)
  - Define process Flow (Routings)
  - Define parameters for experimentation
  - Define key performance metrics & reports
  - Set-up and run simulation Scenarios of process/layout options
  - Analyze reports to identify the best process/layout Options
  - Open in or Export to AutoCAD / Inventor
Open Process Simulator, start with a blank Microsoft Visio ® worksheet, the Process Simulator Ribbon Menu at the top, and the Autodesk Factory Design Utilities Asset Browser on the left.

First, drag an entity (part) onto the canvas from the Asset Browser menu on the left and assign any applicable properties in the Properties window on the right.
Next, drill down or search the Asset Browser to find the right assets (Model Locations/Activities) to place on the layout, in this case, two CNC lathes.

Continue to add equipment as needed, for this example, one milling machine and an inspection station.
The activities also have properties, primarily process time, which is defined by a probabilistic distribution that is determined based on plugging in historical processing times for each machine into the Stat-Fit program, which comes with Process Simulator.
After adding all the locations/activities (Assets), then define the work units (entities) routing for the material workflow by using the Visio connector tool to drag lines from the work unit to appropriate locations. The arrows from the entity to the first pieces of equipment are called arrivals. Arrivals have properties, namely arrival patterns, which are defined in the Properties window to the right of the drawing. Right-click on the connector to access properties.

Finish defining the part routing and then define any Route properties that may be needed (Processing Requirements). In this case, a rework loop is added for 10% of the work coming off the end of the line, so in the route properties window, 10% is added to indicate the 10% of the parts follow this rework route from the visual inspection machine back to the milling machine.
Next, resources will be added. Resources are not a mandatory element of a Process Simulator model, but in this case, since a worker and a forklift are a part of the example, they were added as resources.

In order for the man resource to be utilized to inspect, he is assigned as the resource for the visual inspection station with a triangular distribution $T(3,5,10)$ minutes to ensure his inspection time has some realistic process time variation.
Similarly, the forklift resource is assigned as the resource for the route, which delivers parts from the vertical milling machine to the inspection station.

Finally, another optional element, a path network, will be added for the forklift. It is named ForkliftPath. A path network defines all the travel or movement options for a resource. The inspector doesn't require a path network because there is no need to model his movement, only his utilization while inspecting.
After creating the ForkliftPath path network, it is assigned to the forklift resource.

Next, hit “Simulate” from the ribbon and watch your model come to life.

Notice the running clock time in the upper right and which scenario is being run in the upper left. Each scenario ran for 40 hours. Also, notice that the inspector turns green when he is being utilized.
Add two more scenarios to compare to baseline, a second scenario with a 5% fail rate and a third with a 15% failure/rework rate. Simulate scenarios again.

Then view the results of the two additional scenarios compared to the baseline scenario with a 10% rework rate. It’s overly simplistic, but not surprisingly, the scenario with the lowest rework rate had the highest throughput, and the one with the highest fail rate had the lowest throughput.
Once the model has been optimized in Process Simulator, it can now be opened in AutoCAD or Inventor, and physical factory design can begin.
Use an Existing AutoCAD Drawing to Quickly Build a Simulation Model Directly in AutoCAD—Integrated with ProModel Optimization Suite

Now let's see how to build a model from an existing drawing inside AutoCAD.

ProModel AutoCAD - Workflow and Integration

Step 1 - Start in AutoCAD

› Open AutoCAD Layout with Factory Assets
› Mark the locations in the AutoCAD drawing that will be used as locations in the ProModel model
› Define process flows in AutoCAD that will be used as product/part routes in the ProModel model
› Set the AutoCAD drawing view (turn on/off layers) that you would like to be visible in the ProModel model
› Press the “Open in ProModel” button from the AutoCAD ribbon
› The base ProModel model will be created and opened:
   • The layout will automatically be imported and scaled.
   • Locations in ProModel are automatically defined form Factory Assets
   • Entities are automatically defined based on the process flows
   • Basic routes are automatically defined based on the process flows

Step 2 - In ProModel

› Define additional locations, resources, and constraints (buffers, operators, material transporters, and conveyors)
› Define additional products/parts/materials
› Refine the routes
› Define the arrival schedules
› Define parameters for experimentation
› Set-up and run simulation scenarios of process/layout options
› Analyze reports to identify best process/layout options
› Go back to AutoCAD to make any changes to layout (add/subtract Factory Assets, update drawing, and re-sync back to the ProModel Model as needed)
Start with an AutoCAD drawing without simulation properties. The Factory Assets in the upper right portion of the screen will be used as locations/activities for the simulation model.

The ProModel ribbon on top, the simulation browser, and properties windows on the right side of the screen, and the command line at the bottom of the screen will be used to transform the drawing into a dynamic simulation model.

First select assets that need to be locations for the model by highlighting the locations tab in the simulation browser, then click on the assets to be used as locations and hit enter.

They will be displayed in the command line and in the simulation browser.
Do the same for the conveyor assets, which need to be locations.

Next, define the Entity (part) for the model, in this case a spade via the simulation browser.
The next step, defining arrivals and processing, is done in the ProModel AutoCAD Edition by using flows.

To create a flow, start by selecting the flows tab in the simulation browser, then add, then name it in the simulation browser (flow1) and then select the entity (spade) which will go through flow1 from the simulation properties window.

Next, begin selecting locations (assets) on the AutoCAD drawing in the sequence with which the entity will flow through the process. If you select an asset that was not originally turned into a location, this flow process will do it for you.

As this is being done, notice the arrows (routes) being generated between locations and the flow logic being displayed in the simulation browser. At the same time, default properties for each of the routes are also being added in the simulation properties window.
After finishing the initial model, open the model in ProModel using the button in the AutoCAD ribbon. All the assets, including those which are locations, are brought into the model along with the location properties. You can tell which assets are locations because they have a small red spot with a white x.

In addition to Locations, the Entity, Arrivals, Routing and Processing Logic is also brought over.
Then simulate the model to visualize the process flow in motion. The blue dots symbolize the spades going through flow1.

After the model is run, analyze the results using Output Viewer’s dashboards and reports.

By doing so, it was determined that one of the press brakes should be moved. Make the layout changes in AutoCAD.
Then open the model in ProModel again to see the changes brought over. Run an additional simulation to validate that the layout changes produce the desired results.

Lastly, from the ProModel Tools tab, select 3D animator and hit Play to see the final model animation in 3D.
Summary

- ProModel provides a powerful suite of simulation tools to model any type of manufacturing environment

- Simulation provides a platform for maximizing the performance of your factory

- In conjunction with Autodesk, the integration provides a seamless integration to create or leverage existing layouts with optimized process flow!

Learning Objectives

- Explain the value of using ProModel simulation for process optimization:
  - Design more efficient and effective factories the first time; Saves Time and $$

- Describe when to use manufacturing simulation:
  - When complexity is high due to many interdependencies and lots of variability

- Create a simulation model from scratch with Factory Design Utilities that opens directly in AutoCAD/Inventor to start a factory layout:
  - Use Process Simulator Autodesk Edition

- Identify how to create a simulation model from an existing layout:
  - Use ProModel Optimization Suite Autodesk Edition

ProModel Resources

- Andy Schild: aschild@promodel.com; Aaron Nelson: aneslon@promodel.com
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