Automotive Body Shop

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Manufacturing Process Improvement: Optimizing Your Automotive Facility Design

Simulations can provide a risk free, rapid testing-bed for designing and implementing your manufacturing facility. This how-to guide, with our downloadable simulation, demonstrates how this can be achieved using SIMUL8.

When designing a flexible and efficient automotive body shop the typical objectives include:

- Line Speed Strategy (Over-speed and Push or Pull)
- Buffer and Protective Capacity Strategy
- Optimizing Conveyance Loops
- Determining Broadcast Point Locations for Subcomponent Builds
- Analyze Build Schedule and Effects on Sequence
- Batch Build vs Build-to-Schedule
- Material Handling & Shared Resources (Forklifts & Labor)
- Proving out Capability and Throughput (Vehicles per Hour)

All of these objectives contain interrelated factors that make it difficult to test decisions independently and predict the overall impact on the line. Add in real-world variability of random events like machine breakdowns and simulation provides you with a powerful, robust analytical tool that proves insight into the future performance of your facility, prior to implementation. This is why the automotive industry has for decades relied on simulation to drive successful vehicle program launches.

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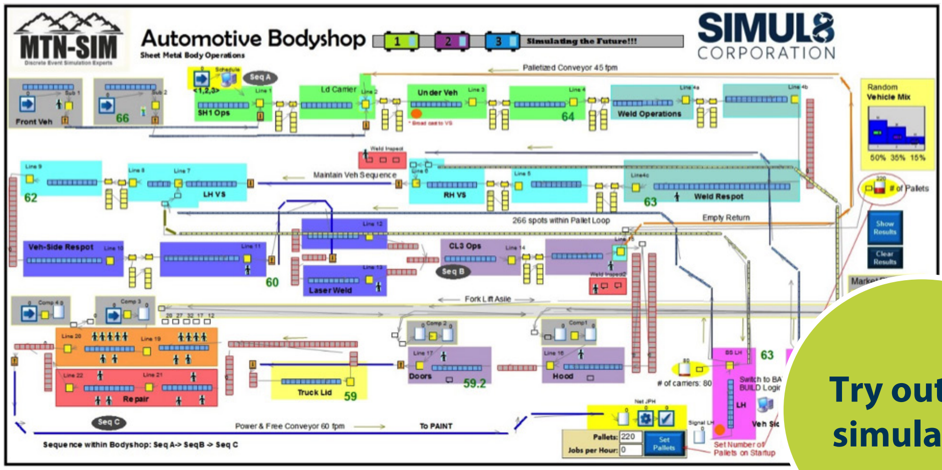
Our Automotive Body Shop Simulation

This guide is designed to give you an understanding of how simulation can help your manufacturing facility drive success. From optimizing pallets to scheduling broadcast signals, we talk you through the most important steps involved in designing and implementing your automotive facility using simulation.



Try out our simulation

Understanding the Process

There are usually 3 facilities associated with the manufacturing of an automobile: Body Shop, Paint, and Final Operations. The body shop is where the sheet metal comes together to form the basic shape and style of the vehicle. Once the upper body is assembled it is then sent to the paint shop. Then the painted vehicle makes its way to the last facility.

Final operations is where all of the drive components get added to the vehicle; such as the engine, drivetrain, and dashboard. The body shop is usually an asset intensive facility containing a vast assortment of advanced manufacturing equipment; including welding robots, delicate dimensional control equipment, and several advanced material handling systems. These multi-million dollar facilities, even with all of their flexible equipment, need to get revamped upon every new vehicle launch.

This is why the automotive industry has a long history of using simulation within their plants and vehicle operations departments. Let's take a look at a typical generic body shop and explore how simulation is applied to lead future vehicle programs.

Using Simulation for Improving an Automotive Body Shop

Simulation is powerful and can model a wide range of processes within a manufacturing plant. As you can see from the simulation model a typical body shop contains several sequential lines and many key rendezvous points where subcomponents must get welded together.

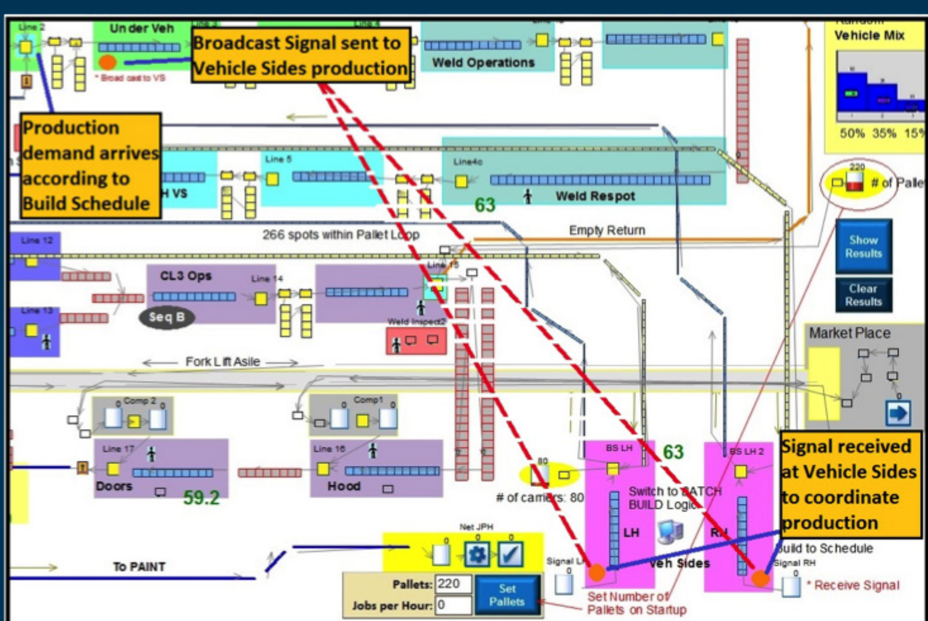
What-If Analysis

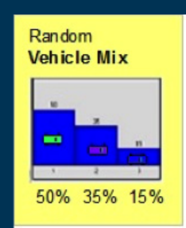
An important benefit of using simulation is the ability to carry out **"What-If"** Scenario Analysis, such as testing various broadcast points within the system for the signal.

In this simulation there are 3 different vehicle types, where orders arrive with a probability profile of 50%, 35% and 15% (see Figure 1). Often different vehicle types may require a unique pallet type, this can often complicate the build schedule. Assuring that there will be an available empty pallet upon a build call from the build schedule can be difficult to engineer.

The build schedule is not just important to customer orders, but also to guaranteeing key rendezvous points will have the correct subcomponent on time. In this example there are 3 main areas where the sequence can get out of the original order (depicted as Seq. A, Seq. B and Seq. C). This is usually caused by parallel lines, buffers, quality tests, or rework loops.

Maintaining sequence may be critical at various points within the system, especially where **"Broadcast Signals"** schedule subcomponent builds. This is the case for a vehicle side assembly, as is shown in this simulation, because there might be 3 unique styles per vehicle type. Simulation studies can lead with the development of the best algorithm as to implementing "Build to Schedule" or "Batch Build" schemes. This simulation sends a build signal to the Vehicle Sides Assembly Area at Line 3 to coordinate production (see Figure 2).





^ Figure 1
Vehicle Probability Profile

< Figure 2
Example of Modeling Signal Broadcast

Usually the earlier the signal the more likely for "Out of Sequence" to occur. Whereas, signaling closer to the rendezvous point ("Just In Time" manufacturing) increases the chance for potential performance loss through waits. Conducting a thorough what-if analysis is key to developing a robust and flexible system; which can handle multiple vehicle types.

Pallet Optimization

In our simulation we have 220 pallets within the **"Palletized-Loop"**, and 266 spots for a pallet to reside within the system as it travels through the loop. Usually we start the operation with an empty pallet; the pallet is the platform which holds the vehicle in place as it travels through the facility. To make things more complicated we might be producing multiple types of vehicle all traveling down the flexible lines.

"Conveyance Loops" need room to expand and contract to assure optimal throughput; delays due to downtime or changeovers can degrade performance. We need to ensure that an empty carrier is available and ready for the next build, yet not blocking a transfer machine. Simulation is the best solution for visualizing your conveyance loops and all of their interconnections.

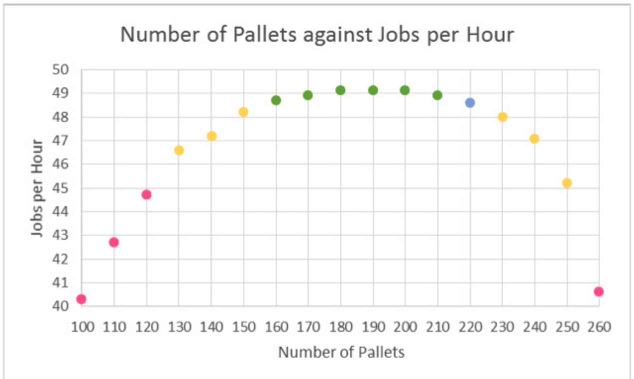
Making the Right Decisions

So now you have your simulation ready for the test phase, it's now time to use your results to provide you with a data-backed design for your manufacturing plant. This is particularly critical when it comes to capital investment: the cost of pallets and carriers add-up fast and calculating the correct levels is vital to an organization's profit margins.

Let's look at an example from within our simulation we are able to alter the number of pallets available to the main palletized-loop. This allows us to determine a robust operating range for the number of carriers within the system; too few may cause lengthy delays and too many may cause unwanted blockages.

Using the built-in "Set Pallets" button we can customize the simulation inputs and start testing varying values. Having carried this out for values in increments of 10 from 100 to 260 the following table and graph have been constructed (see Figures 3 and 4).

These results show how, from the starting number of pallets of 220, it is possible to reduce the number of pallets in use by 60 to 160 without experiencing a decrease in jobs completed per hour (JPH). In actual fact, at first there is an observed increase in productivity.



^ Figure 3
Results Analysis Graph

> Figure 4
Results Analysis Table

Number of Pallets	JPH
100	40.3
110	42.7
120	44.7
130	46.6
140	47.2
150	48.2
160	48.7
170	48.9
180	49.1
190	49.1
200	49.1
210	48.9
220	**48.6**
230	48
240	47.1
250	45.2
260	40.6

Now that we have our results we can now aid management to make effective business decisions. A single pallet with all of its dimensional control equipment can cost upwards of $25,000, and a plant might have 250 pallets within its system. If the decision was made that the current JPH was satisfactory, at $25000 per pallet this change in design would save the organization $1,500,000 – capital that would be freed up to invest elsewhere in the business.

This is just one example of how we can use simulation to design an automotive facility and provide data-backed results that can aid in management decision making.

Keep reading to find out what you can add to the simulation to further optimize your facility.

Potential Further Analysis

All of the above analysis can be carried out within our simulation. However, there is more opportunity within the simulation to conduct further calculations, helping you to optimize your automotive facility.

Mathematical calculations fall short in relation to including most of these realistic events; whereas they are common and easily built within a simulation. Hence, **"Over-speed Strategies"** and **"Push-or-Pull Strategies"** can all be tested and compared to one another. This body shop uses a slight push as bodies travel through the system; starting out with a rate of 66 vehicles per hour (VPH) and pushing toward 59 VPH at the end of the process.

All material handling systems such as **"Power & Free"** or **"Electric Monorail"** conveyors are included in the simulation. They are captured using the same simulation technique as the palletized-loop. We can then test for the optimal number of pallets, or carriers, within each respective delivery system. The simulation will allow for testing different speeds and accumulation center "pitch" of the carriers as they travel loaded and unloaded through the system.

Another key objective of any manufacturing facility is to have effective cycle times, line speeds, and buffering within the process. These all become more difficult to calculate when we add the stochastic behavior of real-life events. This includes: fluctuating demand schedules, breakdowns, change-overs, shared resources and labor; all events that affect availability & performance.

Lastly, this simulation allows us to analyze a **"Market Place"** of components that get delivered line-side by forklifts. These may be some of the smaller components that are attached to the trunk lids and doors such as hinges or brackets. The simulation can provide answers to how much stock to have within the market place and when to replenish it, as well as the number of forklifts required to keep line-side totes full.