



Value Stream Mapping + Simulation

Taking Your Map to the Next Level

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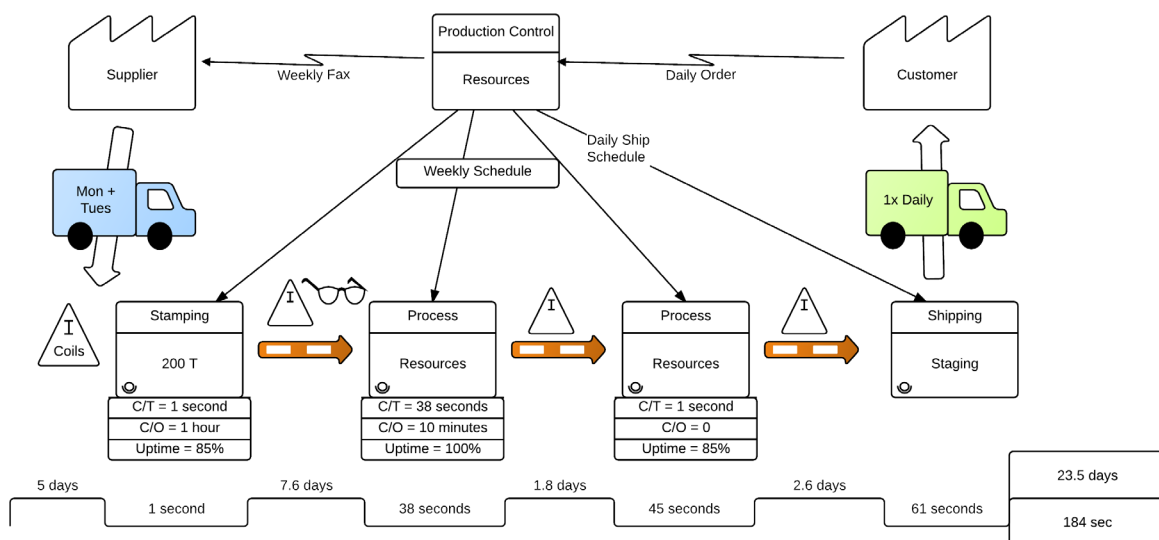
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What Is Value Stream Mapping?

Value stream mapping is a visual flowcharting tool used frequently in Lean manufacturing to diagram the information and material flow in a system. This tool makes it possible to identify constraints, value-added time, and non-value added time—all with the intention of recognizing possible system improvements. It's often done before an improvement project to determine the current state, followed by a future-state proposal using an altered version of the map to determine the benefits of the proposed changes.



Value stream mapping uses standard symbols that represent different aspects of a system and help to visually describe the system to others. Standard calculations are available to assess the performance of various parts of the system. These standard symbols and calculations make it easy to determine which parts of the system should be the focus of improvement efforts.

Does it Have Limitations?

Value stream mapping is an effective tool when it comes to visually representing simple material flow systems. However, as the system exhibits more complex behavior, the map becomes less capable of representing the reality that is occurring.

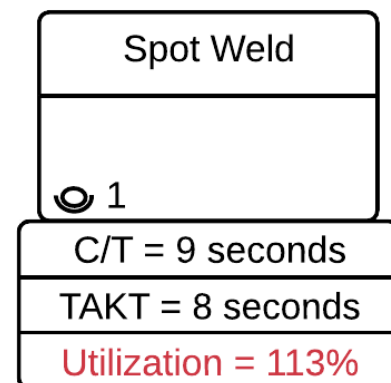
THE BOTTLENECK PROBLEM

Let's imagine a system is mapped out where the customer demand results in a **takt time** less than the **cycle time** of one or more of the processes. In this case, the utilization of that process step (cycle time divided by takt time) would be calculated as above 100 percent. In reality, that process can't have a utilization above 100 percent, so the system is unable to meet the customer demand. The result is a queue that continuously builds before the **bottlenecked** step. In a value stream map, the size of the inventory before the process is just a snapshot of an ever-increasing queue; the total non-value added time is only accurate for that specific time frame. This becomes a problem when a future state map is drafted and changes are made based on irrelevant data – and the predicted results of the project are not met.

takt time: the average unit production time needed to meet customer demand

cycle time: the total time from the beginning to the end of a process

bottleneck: a congested process that causes the entire system to slow down or stop

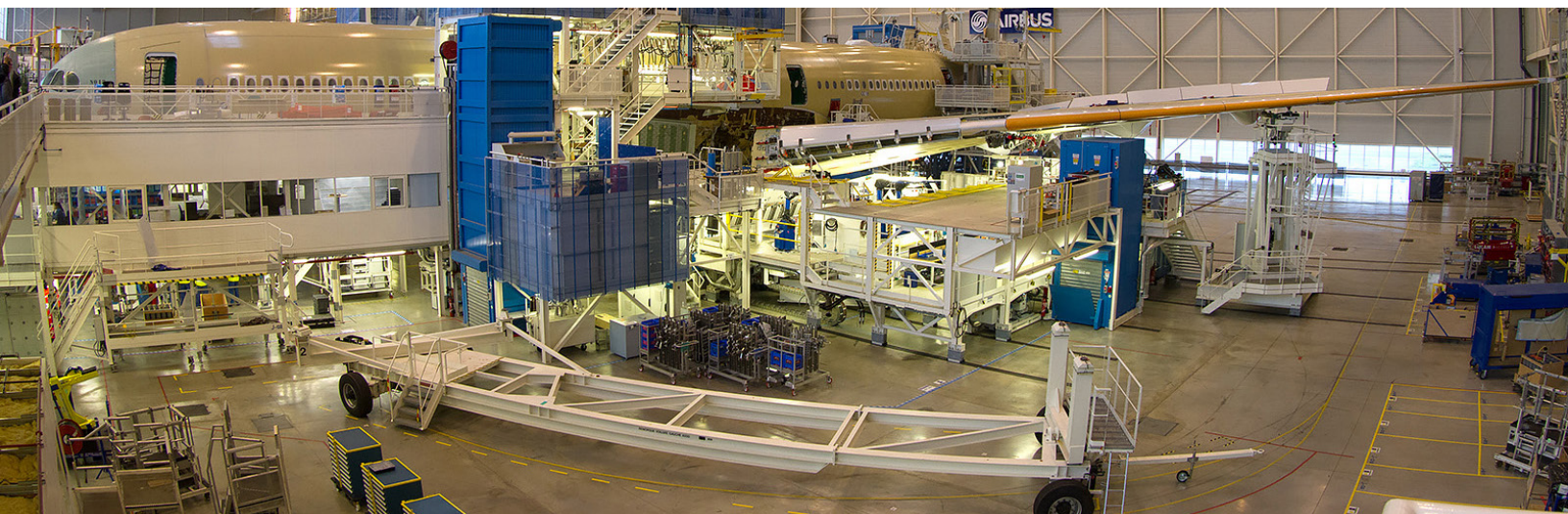


THE DEPENDENCY PROBLEM

Value stream mapping has a tendency to treat each individual process as an independent step in the system, but systems have complex interdependencies that are often glossed over while creating a map. An example involves the previously mentioned utilization calculation of cycle time divided by takt time. If an upstream process is highly utilized, it would affect the availability of work that can be done on downstream products – decreasing the utilization of all downstream processes.

THE VARIABILITY PROBLEM

One of the most dangerous assumptions of value stream mapping is the use of a static cycle time. In most systems these processing times are not exact, and mapping them using exact numbers ignores the difficulties created by variability. Lean manufacturing is focused on reducing the waste in a system; much of that waste is from queueing steps before process steps. These queueing steps are usually added to the system to separate the variability that is exposed between processes. By failing to model the variance in processing times, value stream mapping ignores this important intricacy of the system.



Overcoming the Limitations

The limitations of value stream mapping are rooted in the fact that a value stream map is just a snapshot of the current system. Evaluating processes as they are currently observed fails to predict how things will change in the immediate future. This is a problem, since all changes will be executed in a future state of the system.

Thankfully, all is not lost. If value stream mapping is combined with **simulation**, then one can predict not only how changes will affect the current system, but also how those changes will affect the system as it exists in the future. Simulation is also effective at modeling the interdependencies that are present in almost every system, because it reproduces how objects would actually have to flow through the system. And simulation is useful for solving the variability problem, because it can model the variance in process times as it imitates product movement through the system.



WHAT IS SIMULATION?

Simulation modeling is the process of creating and evaluating a virtual prototype of a real-world system. The virtual environment provides a safe place where data is easy to come by and where mistakes result in improvement instead of ending careers. When it's presented in an intuitive and easy-to-use software package, simulation is a powerful problem-solving tool that allows decision makers to answer important "what if" questions about their business.

1. SOLVING THE BOTTLENECK PROBLEM

By modeling the movement of products through a system, it's possible to identify the bottlenecks quickly. Bottlenecks are obvious during simulation because of the ability to actually watch inventories build up queues before the congested processes. This continual growth, shown only in a simulation, is evidence that the proceeding step is not capable of meeting customer demand. The utilization of this step is also correctly calculated at somewhat less than 100 percent, which would be much closer to the actual utilization of the observed process.

2. SOLVING THE DEPENDENCY PROBLEM

As the simulation moves products through the system, the actions of one part of the system are dependent on the other parts. Simulation does not allow a product to be processed unless there are actually products available to be processed. This makes it possible to accurately depict the value added vs. non-value added time of the system, and also more adequately represents the utilization rate of each of the processes.



3. SOLVING THE VARIABILITY PROBLEM

Simulation is probably most suited to solving the variability problems associated with static value stream mapping analysis. The use of randomly determined representations of process times makes it possible to accurately reflect the variance that is represented in the system. Any proposed changes to reduce waste can be made with more confidence. And since many inventory buffers are in the system to separate the variability between process steps, modeling that variance can show how implementing supermarkets or pull strategies will actually affect the dynamic system – and not just the static system represented in a traditional value stream map.



Case Study

How Advanced Process Optimization, Inc. used simulation modeling in concert with traditional Lean techniques to deliver an advanced process improvement solution

The Client: A rail bearing manufacturer, and an industry leader in friction reduction and drive systems.

The Task: Evaluate the process performance of a rail system bearing reconditioning and assembly facility—with the goal of identifying opportunities to improve throughput.

INTRODUCTION

What would be a typical Lean manufacturing approach to this sort of process analysis? The solution might involve time studies and value stream mapping (VSM). These techniques provide valuable insights and a direction to launch Kaizen initiatives focused on improving performance. A well-made VSM will take a high-level look at the average cycle times, changeover times, and inventory levels for a process—all powered by information gathered on a Gemba Walk audit by your friendly process improvement specialist. Identify the waste, overburden, and fluctuations—Muda, Muri, and Mura—so you can start to eliminate and control them.

These are all good things. But what these techniques *don't* provide is the depth of analysis found in simulation modeling. You'll gain the ability to model variation over long time horizons, truly exposing the inefficiencies in a system. And by having a stochastic (random) representation of the data, the variance found in the real world is better represented. Multiple (and longer) simulation runs will show a time-varying range of effects on constraints, inventory, and key metrics.

In this improvement project, Advanced Process Optimization, Inc. (APO) married traditional Lean Six Sigma (LSS) techniques with simulation modeling using FlexSim. Their experience showed how simulation modeling can reinforce LSS by adding



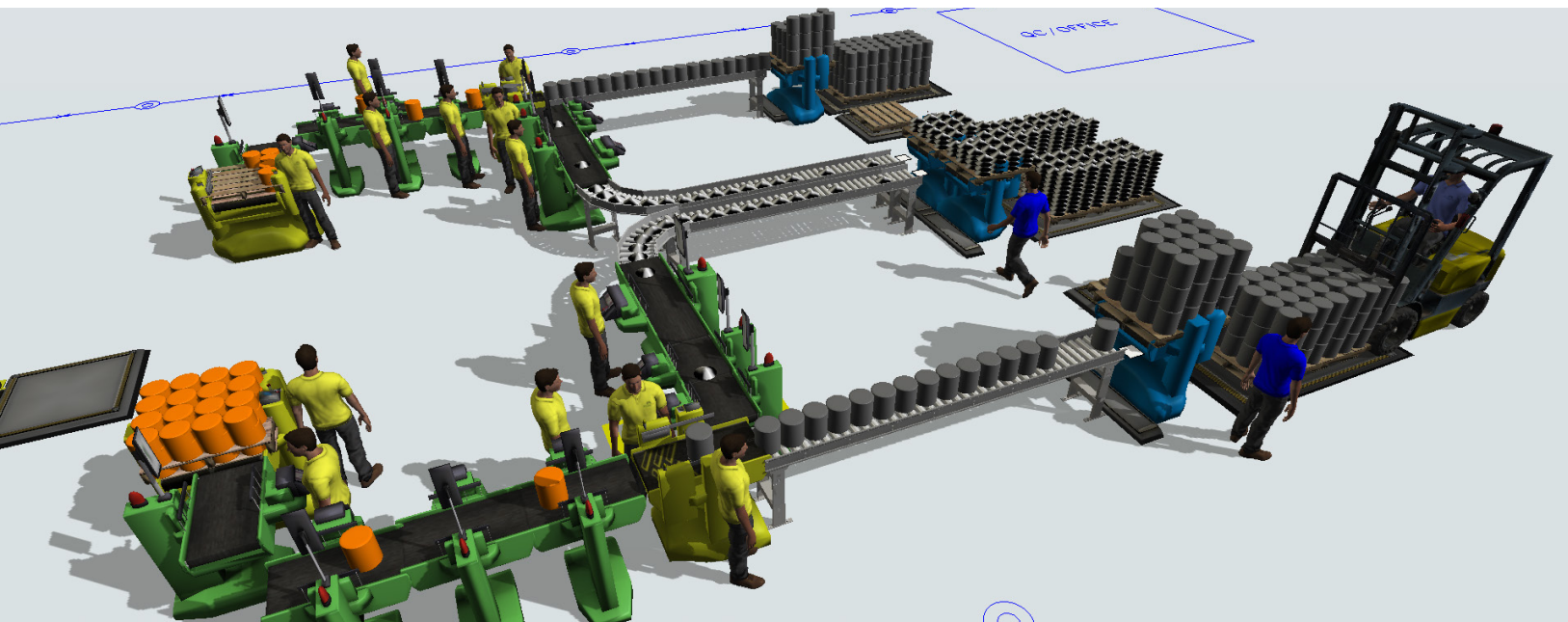
powerful analytical capabilities, eye-opening visualization, and new ideas plus ownership while vetting.

1.

CURRENT-STATE MODEL – TRUST AND ANALYSIS

APO used FlexSim to create a current-state model of the facility centered on the project scope: four original equipment lines and three reconditioning inspection/assembly lines. The model was populated with data taken from an onsite time study, and driven by a year's worth of production data. From this starting point, APO leveraged the Lean principles of single piece flow, supermarkets, Kanban, water spider replenishment and more to conceptualize a future state of the system.

This current-state simulation model served two purposes. It provided built-in reporting and analysis tools that APO used to better understand what is happening during simulation runs of the current-state model. But even more importantly, it established trust. The model was proven to accurately emulate the system, a crucial requirement that sets the stage for all future experimentation with the facility in a virtual space.



2. FUTURE-STATE MODEL – VISUALIZATION

The future-state model took full advantage of FlexSim's realistic and native 3D capabilities. APO used an AutoCAD drawing as the plant's footprint and populated it with 3D FlexSim objects to represent the human and machine resources used in the facility. This allowed the model to be both a realistic and properly scaled portrayal of the future state concept.

This mock-up—or “paper doll” exercise, as it is sometimes referred to in Lean—allowed APO to visualize the new workspace and flow of materials through the system. They could then check the projected performance against the current-state model they had developed earlier.

3. DESIGN VETTING – IDEAS AND OWNERSHIP

Once the future-state model was ready, the client team assembled to vet the design. APO actually *wanted* the team to tear their design apart—looking for weaknesses, flaws, errors, and missed opportunities to uncover better designs.

The beauty of a simulation model is that we have an immersive environment to virtually experience the workspace while conducting what-if scenarios on the system.

Jason Merschat
President and CEO
Advanced Process Optimization, Inc.

The vetting process is an invaluable opportunity for a future-state design to be improved. The design capabilities of the system are pushed by the addition of variation to test robustness, conflicts, hidden dependencies, constraints, and bottleneck influences. The same goes for staffing levels, replenishment, flow



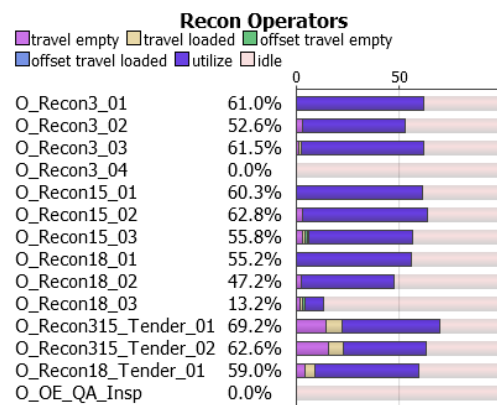
rate, and anything else seen as important to the process. Each time, the model is modified and improved.

With FlexSim, this entire process is easy. It requires no physical resources or manpower to test the system, only ideas and a few button clicks. And when the client team gets to actively participate in changing values and variables—building a better future-state piece-by-piece—they begin to take ownership of the model and its results.

RESULTS AND CONCLUSION

The future-state model predicted a **one-year cost savings of \$607K** due to eliminating non-value added processes, waste, and labor—while also seeing **a throughput increase of 52% and a labor productivity increase of 108%**! The client is in the process of implementing this new design at their first location, and APO will go to two additional locations to model those systems as well. APO will now switch gears from analysis and design to focus on implementation, helping the client get ramped up and integrate some of the more challenging lean tools.

APO found that this hybrid traditional Lean and simulation technique took full advantage of the unique benefits of simulation: minimizing risk, evaluating scenarios, and optimizing based on constraints. It also opened new ideas and opportunities throughout the vetting process. Lean techniques and tools remain the foundation for their process improvement approach, but simulation modeling is the next evolution in visualizing, analyzing, and designing a process.



PROJECTED IMPROVEMENTS

52% Throughput increase
 108% Labor productivity increase
\$607K one-year cost savings!





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