White Paper:

SIMULATION AND THE LEAN ENTERPRISE

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Simulation and the Lean Enterprise

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INTRODUCTION

Lean is now widely recognized as one the most effective means for increasing competitiveness and improving operational efficiency. What many practitioners of Lean don't realize, however, is that Lean results can be obtained quicker and to a greater extent through the use of simulation technology (see Figure 1). ProModel has developed tools especially adapted to Lean methodologies to help realize the full potential of Lean throughout the enterprise. This applies to Lean training, Lean project prioritization, value-stream mapping, waste elimination and ongoing process improvement. Here we provide a Lean overview followed by a description of how simulation is being used to enhance Lean performance. We like to think of simulation as the Lean way to implement Lean.
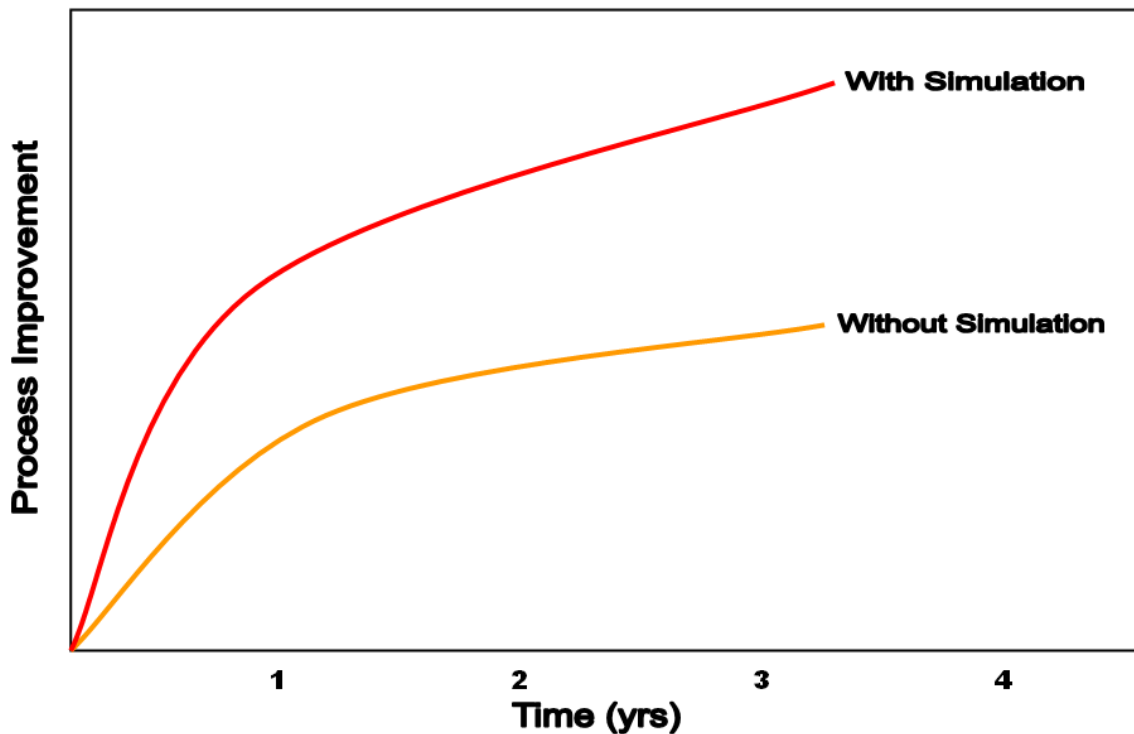
Figure 1. Simulation Achieves Lean Better and Quicker

Through predictive simulation modeling, the time to implement Lean is greatly reduced and hidden forms of waste (poor operational planning, suboptimal use of resources, etc.) become much more apparent. Progressive companies have been using simulation for years to find innovative solutions to creating value and eliminate waste, all in a risk-free environment.

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LEAN OVERVIEW

In order to understand how simulation can be beneficially applied to Lean initiatives, it is essential to understand the fundamentals of Lean thinking. What is Lean and what tools does it provide to achieve its objectives? How are processes transformed into Lean processes and what does it mean to be a Lean enterprise? These are questions that should be answered in order to get an adequate picture of what Lean is all about. Following this Lean overview, we will show how simulation is being used to help realize the full potential of Lean.

What is Lean?

The Lean Enterprise Institute defines Lean as a set of "principles, practices, and tools [used] to create precise customer value—goods and services with higher quality and fewer defects—with less human effort, less space, less capital, and less time than the traditional system of mass production."[1] In essence then, Lean emphasizes (1) performing only those activities that contribute something that the customer is willing to pay for or expects in the product or service, and (2) doing so as efficiently as possible.

While Lean starts with a clear definition of customer value, it acknowledges that all value is created by some process. The primary goal of Lean, therefore, is to develop capable processes that are waste free. Waste, or *muda*, is defined by Shoichiro Toyoda, founder of Toyota, as "anything other than the minimum amount of equipment, materials, parts, space, and worker's time which are absolutely essential to add value to the product."[2] In a service industry, it would be any action that doesn't add value to the service. Taiichi Ohno, pioneer of the Toyota Production System (TPS) has identified seven forms of waste in manufacturing, which he calls "The Seven Deadly Wastes."[3] While these forms of waste are typically associated with manufacturing enterprises, it should be apparent that they also apply to service industries.

1. **Over-production**: producing items, information, etc., earlier, faster or more than the next process step can handle.

2. **Waiting**: idle time waiting for materials, equipment, personnel or information.

3. **Transportation**: unnecessary movement or transport of items or people.

4. **Non-value added (NVA) Activity**: activities that are not essential for adding value to the product or service.

5. **Excess inventory**: any inventory beyond what is needed to supply only what is needed, only when it is needed (created by over-production).

6. **Wasted motion**: inefficient or unnecessary operator or equipment actions that don't add value to the product or service.

7. **Defects**: mistakes made that require inspection, repair or scrapping.

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Benefits of Lean

Lean provides numerous benefits including:

- Reduced lead/cycle time

- Decreased work-in-process (WIP)

- Reduced cost

- Increased resource (equipment, operator) utilization

- Easier scheduling

- More streamlined flow

- Reduced floor space

- Improved quality

- Improved worker morale

These benefits lead to increased profitability and an improved workforce. Some of the benefits are dramatic and almost immediate such as reduced WIP and cycle times. Most benefits, however, accrue gradually over time as the Lean journey progresses.

Principles of Lean

Lean is more than just a set of tools and techniques. It is a fundamental way of thinking about a process, which focuses on value creation and waste elimination. Instead of focusing on isolated problems, one is more systems oriented and looks at individual problems systemically in terms of how they relate to overall process objectives. In their book *Lean Thinking,* James P. Womack and Daniel T. Jones present the following five principles for implementing Lean[4]:

1. **Specify value**: determine what the customer values in a product or service in terms of features, functionality, quality, delivery, service, etc.

2. **Define the value stream**: for each product family or type of service, identify the process, or sequence of actions that needs to occur to deliver the product, service or solution to the customer in the most efficient and effective way.

3. **Get the product or service to flow**: streamline the process so that every step occurs in a tight and integrated sequence. Replace "batch and queue" with single-piece flow wherever possible.

4. **Pull from the customer**: Make or provide only what the customer wants, when they want it. This involves establishing a *takt* time (target process interval) and regulating inventories and activities to achieve a consistent flow to the customer.

5. **Pursue perfection**: Continually strive to reduce the effort, time, space, cost, and mistakes while offering a product which is in every way, what the customer wants.

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This principle-oriented approach to Lean provides an effective roadmap for achieving the goals of Lean. Having a well-architected value stream, for example, allows value to flow without interruption. Ideally, this means single-piece continuous flow of products and services at a *takt* rate that equals customer demand. Continuous flow can only be achieved when disruptions in the system are eliminated. Common disruptions included late deliveries, equipment failures, operator delays, defective work, machine setups and operator error.

In practice, these disruptions are not entirely preventable, so one is left with trying to manage the impact of disruptions on the overall process. Remember, that in a process that supports continuous, single-piece flow, operations are tightly coupled so that any disruption ripples through the system affecting both upstream and downstream operations. It therefore becomes crucial, wherever disruptions occur, to minimize the impact of these disruptions.

The most common way to buffer a process from disruptions is to set up inventories in the process. This is usually done by establishing a storage or supermarket whose level is regulated by some sort of signal (*kanban*) to ensure that the right amount of inventory is maintained to buffer the process from disruptions.

Of course the last step of Lean highlights the importance of approaching Lean as an ongoing journey of continuous improvement rather than a one-time exercise. The companies that benefit the most from Lean are those that are committed with relentless persistence for the long haul.

Tools and Techniques of Lean

There are many tools and techniques of Lean that help create Lean processes, including those shown below. Note that these are not necessarily confined to manufacturing processes, but can be used beneficially in service processes as well.

- **Value-stream mapping (VSM)**: Used to statically visualize, analyze and improve process and information flows. Eliminates NVA activities.

- **A3 Reporting**: Used to define problems, identify solutions and develop and document action plans for implementing process improvements.

- **Kanban (pull) production**: Used to regulate production and movement between process steps where continuous flow isn't possible. Eliminates overproduction.

- **Workflow diagram**: a.k.a. spaghetti diagram, this is a layout of the facility with arrowed lines depicting the physical flow of work (material, people, etc.) within the facility. Eliminates unnecessary handling and movement.

- **Work cells**: A streamlined arrangement (usually in a U-shape) of sequential operations where single-piece flow can occur and workers can be effectively shared. Eliminates NVA activities and unnecessary handling.

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- **5S**: A systematic method for organizing and standardizing of the workplace (sort, straighten, shine, standardize, sustain). Eliminates defects and wasted motion.

- **Quick Changeover**: A method of reducing the time to setup operations to minimize process disruption and permit smaller batch sizes to be run. Eliminates waiting time, NVA activities and overproduction.

- **Total productive maintenance (TPM)**: Systematically maintaining equipment to keep it operational, thus minimizing disruptions. Emphasizes employee involvement and preventive maintenance. Eliminates waiting.

- **Visual Controls**: Utilization of visual signals and images to quickly and clearly direct attention and provide feedback. Eliminates overproduction and waiting.

- **Poka Yoke (mistake proofing)**: Makes the operation such that it can only be performed the right way. places accountability for quality on the operation where it is controlled and makes the operation as error proof as possible. Focuses on prevention of defects rather than detection and correction. Eliminates defects.

- **Point of use storage (POUS)**: Delivers items directly to the place where they are going to be used. Eliminates waiting and unnecessary handling.

- **Cross-training**: Employees can perform a variety of functions and thereby provide greater flexibility. Eliminates operator waiting.

These tools should be used systematically rather than haphazardly. The idea is to identify the most detrimental waste in the system and then select and implement the solutions that best eliminate the waste.

The Lean Enterprise

While Lean can be beneficially applied to any process within an organization, its greatest benefit comes when it is applied across the enterprise. Lean expert Jim Womack recently emphasized, "In *The Machine That Changed the World* in 1990, Dan Jones, Dan Roos and I made an effective case that Lean thinking can be applied by any company anywhere in the world but that the full power of the system is only realized when it is applied to all elements of the enterprise."[5] A Lean culture should start at the top and permeate all the way to the bottom.

An enterprise becomes Lean by first developing an awareness and intolerance of waste. When a waste consciousness pervades the entire organization, people begin proactively seeking improvements and challenging even the least structured activities to ensure they align with customer value and business goals. They also start looking for waste in staff and management functions that have traditionally considered themselves exempt from Lean initiatives. It only when Lean is this entrenched in the minds of employees that an enterprise can hope to become completely rid of waste.

A Lean enterprise, by definition, delivers maximum value to its stakeholders, with little or no superfluous consumption of resources (materials, human, capital, time, equipment, information, energy, etc.). Indeed, the same basic Lean principles that benefit a production system or supply-chain can

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be redirected for use in any business function. Remember, Lean is essentially about achieving a desired outcome with minimal waste. Every process, project or function conducted by a business has some desired outcome as its objective and requires the most effective and efficient use of time and resources to be successful.

As a generic process for implementing Lean at any level in the organization, consider the universal applicability of Mike Rother's steps for implementing Lean (brackets indicate added comments):

1. Select a value stream [or any business function] where business objectives require measurable improvement,

2. Develop an understanding of the current state [i.e., the current process or procedures used].

3. Design and agree upon an improved future state that can be introduced within six or 12 months [or even sooner].

4. Put together an action plan to implement that vision (who is responsible for achieving what elements of the vision with what measurable results by when?).

5. After implementation, create the next future state map for that value stream and again charter a team to achieve that future state.

SIMULATION AND LEAN

With an understanding of the basic tenets of Lean at both the process and enterprise levels, we are ready to explore the application of simulation in the implementation of Lean. As we shall see, simulation provides an effective means of achieving the goals of Lean on many different levels. Whatever stage of Lean you are in, simulation can help you reach the full potential of Lean by helping you make better decisions, faster.

To get a basic idea of how simulation helps improve Lean initiatives, consider the two following real-life scenarios:

Scenario 1

After reading the book *Lean Thinking*, the production manager of an electronics manufacturer decided to implement single-piece flow in an assembly line and eliminate in-process buffers. The benefits were immediate and impressive: WIP dropped by nearly 90% and cycle time was reduced by a similar amount. To his dismay, however, throughput dropped by nearly 30%. Through a quick simulation analysis, the manager discovered where limited buffers were needed and what the optimal size of these buffers should be. Throughput was restored while still achieving dramatic reductions in WIP and cycle time.

Scenario 2

A manufacturer makes three different models of hot tubs, each with different de-

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mands. All models have some initial operations that are the same, but then have different plumbing and assembly requirements using a different mix of skills. The industrial engineer for the company learned in a Lean workshop that reducing the production batch size can achieve a more level loading of resources and result in greater productivity. Participants of the workshop were cautioned, however, that increased setups may mitigate the benefits of running smaller lot sizes. After making an educated guess at what the best batch size should be, the engineer built a simulation model and found that by doubling the batch size they could achieve a 12% higher throughput than the initial estimate would have provided. They further discovered that increasing the batch size actually decreased WIP by achieving a better loading of resources. This analysis resulted in a cost avoidance of $100,000 that the company would have otherwise needed to spend to achieve this added capacity.

These are but two examples of how simulation helps achieve the goals of Lean, and they represent only the tip of the iceberg. Simulation has been shown to be effective in all enterprise processes and can be applied to strategic planning as well as more tactical and operational planning. Wherever you are in your Lean journey, ProModel's predictive technologies can help you accelerate your travel and avoid wrong turns and unforeseen obstacles. Table 1 highlights the different ways simulation helps achieve the goals of Lean from training to ongoing improvement.

Table 1. How Simulation Helps Achieve the Goals of Lean

Lean Step	Goal	Simulation Benefits
Training & Enculturation	Help the organization see the value of Lean and create a Lean mindset.	A quick visual model of a process using **Process Simulator** or **ProModel** helps communicate how and why conventional processes fail and Lean works.
Project prioritization	Prioritize Lean manufacturing projects to maximize benefit.	ProModel's **Portfolio Simulator** allows you to quickly prioritize Lean projects based on simulated outcomes in terms of time, cost and resource commitment.
Value Stream Mapping	Document the current state of a process, analyze its problems and develop an improved future state.	**Process Simulator** allows value stream maps to be quickly created in Visio and then simulated to identify inefficiencies and determine the best remedial actions.
Kanban sizing	Find where kanban needs to be used and what kanban sizes should be.	**Process Simulator** helps identify critical disruptions in flow and enables different kanban sizes to be evaluated to see exactly what the tradeoffs will be in terms of cycle time, WIP, throughput and response time.
Ongoing improvement	Continue to find waste and effective ways to eliminate it.	**Process Simulator** or **ProModel** can help identify and eliminate waste. Once a model is built, it can be used on an ongoing basis to find problems and test solutions.

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Simulation-based Training and Enculturation

Instilling a Lean mindset and culture throughout an enterprise requires education and consensus building. This involves training and visioning where employees learn how Lean processes are distinguished from non-Lean processes and come to fully understand the benefits that can come from Lean.

Process Simulator provides an ideal tool for developing alternative process scenarios to help highlight current operational inefficiencies and see how they can be eliminated through the implementation of Lean techniques. For example, suppose an operations manager is having difficulty getting a particular production supervisor to reduce WIP in his work area because the supervisor is too worried he or she will run short on parts and have to face the consequences of missed quotas. A simulation model can help the supervisor see exactly what impact reductions in WIP would have on reaching quotas, while at the same time show the improved performance in defects and cycle times that can come with reduced WIP. Furthermore, worst-case scenarios can be run to show how long it would take the system to recover after major disruptions to flow. By actually demonstrating how the system would operate under a Lean scenario, the supervisor will not only understand how reducing WIP impacts production performance, but he will gain confidence by knowing how to respond under various disruptive situations.

As another example, a university professor used ProModel's customizable, interactive interface to build a Lean trainer for teaching Lean concepts. This is similar to many of the physical simulations being used in Lean training seminars only it is much more flexible and provides a more comprehensive look at a process. Realistic costs were associated with carrying inventory, rework, etc., so that students could get immediate feedback on their management decisions. By iteratively making production decisions, running the simulation, and evaluating the results, students got a good feel for the system dynamics and the cause-and-effect relationships underlying Lean approaches. It gave them a much better and quicker understanding of how Lean works than simply talking about it.

Simulation for Prioritizing and Scheduling Lean Projects

Becoming a Lean enterprise is itself a process that requires a Lean approach. Not every Lean initiative can be tackled at once so determining the order in which Lean initiatives should be conducted--based on available time, resources and anticipated benefits--is a crucial business decision. Remembering that the goal of Lean is to create the greatest value while making the best use of time and resources, what we would like to do is to develop an optimum schedule of Lean initiatives that has the greatest impact on bottom line.

ProModel's **Enterprise Portfolio Simulator** is the ideal tool for obtaining just such a schedule. Enterprise Portfolio Simulator provides a realistic look at resource and time requirements for alternative Lean project schedules and identifies the best schedule to follow. By performing "what-if" analyses on various project decisions such as which resources to use, whether to overlap projects, etc., Enterprise Portfolio Simulator can quickly get to an optimum prioritization and scheduling of Lean projects which will result in the greatest ROI in the shortest amount of time.

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As an example of how Enterprise Portfolio Simulator was effective in prioritizing multiple projects, one company's corporate IT Department was given an executive directive to Lean out their over 600 disparate software/database systems and support teams across the global enterprise in the next 18 months in order to achieve an IT resource consolidation and system standardization mandate. Additionally, management wanted a predictive strategic planning capability to evaluate and prioritize future IT project requests.

A simulation solution using Enterprise Portfolio Simulator technology was developed with the following primary functions:

- **Visualize** IT resource requirements versus capacity

- **Analyze** how alternative schedules could impact the consolidation initiative

- **Optimize** the consolidation process

In order to accomplish this mandate, the following methodology was followed:

- Create specific project templates representing the closing/consolidation of an IT software system (hardware, software and human resources) in project plans

- Enter actual FTE requirements and project timelines from their master project plan into an appropriate project template

- Publish these individual project plans to Enterprise Portfolio Simulator for cross project resource analysis

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This solution provided a basis for predicting, by quarter, the number and type of resources required as well as the prioritization sequence to attempt to meet the desired consolidation time frame (see Figure 2). It also provided a means to experiment with different consolidation scenario strategies.
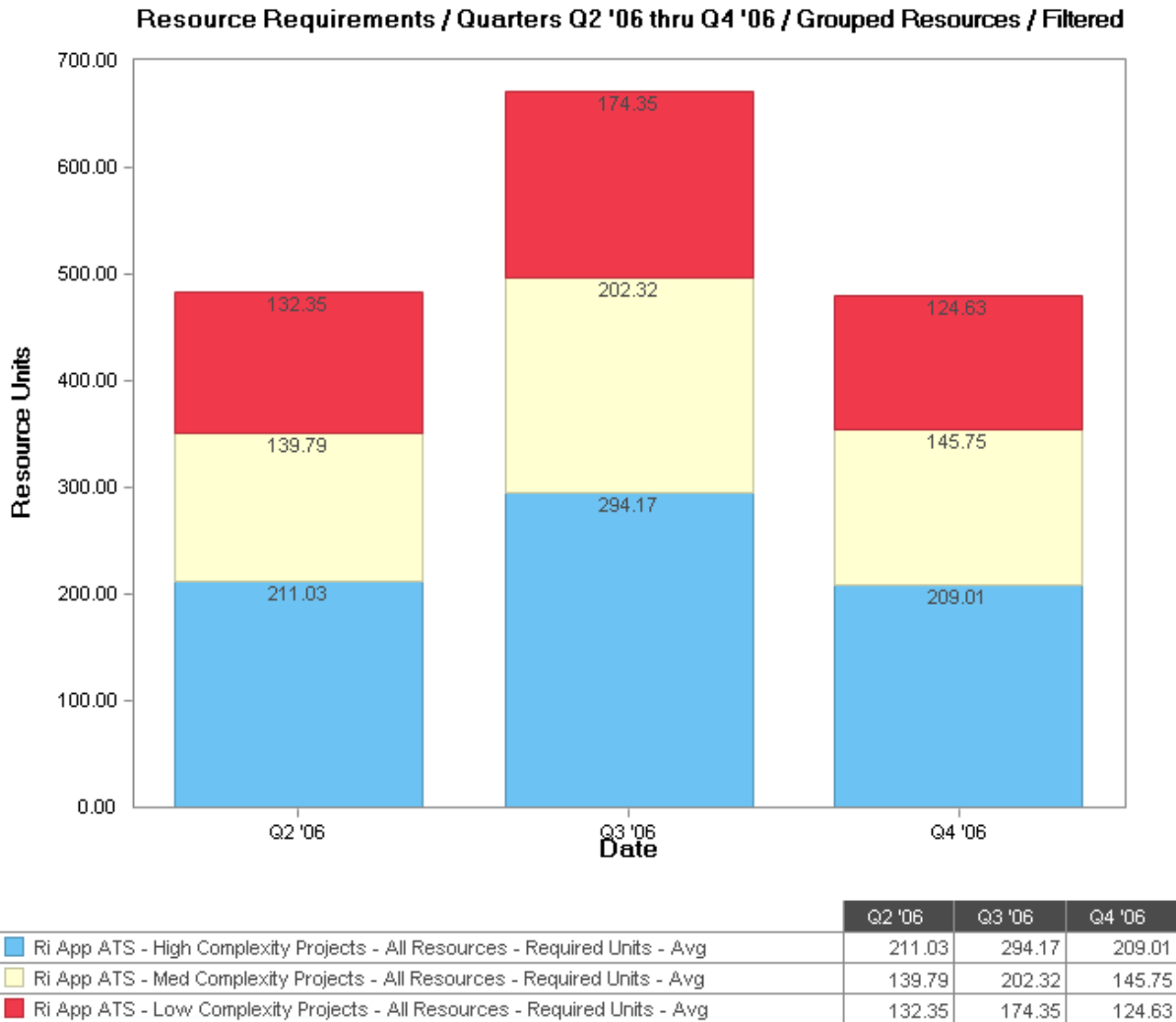

	Q2 '06	Q3 '06	Q4 '06
■ Ri App ATS - High Complexity Projects - All Resources - Required Units - Avg	211.03	294.17	209.01
□ Ri App ATS - Med Complexity Projects - All Resources - Required Units - Avg	139.79	202.32	145.75
■ Ri App ATS - Low Complexity Projects - All Resources - Required Units - Avg	132.35	174.35	124.63

Figure 2. Resources Allocated to Projects by Quarter

The predicted outcome from the analysis indicated the complete consolidation program would take longer than they had hoped, but gave them a realistic time frame and method with which to manage this massive strategic lean initiative. The actual consolidation was completed within 2 years as predicted by the Enterprise Portfolio Simulator solution.

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Simulation in Value-stream Mapping

A value-stream map (VSM) provides an effective way to visualize the logical flow of work and information in a process. Figure 3 shows an example of a VSM of a current process taken from the book *Learning to See*.[6] Notice that material flow is diagrammed left to right, while information flow generally goes right to left. The idea is to understand not only the sequence of material flow, but the informational links that trigger production and flow. From a VSM one can quickly get a general overview of the process including basic activity parameters (cycle time, changeover time, etc.), buffer levels, and a calculation of overall value and non-value added times.
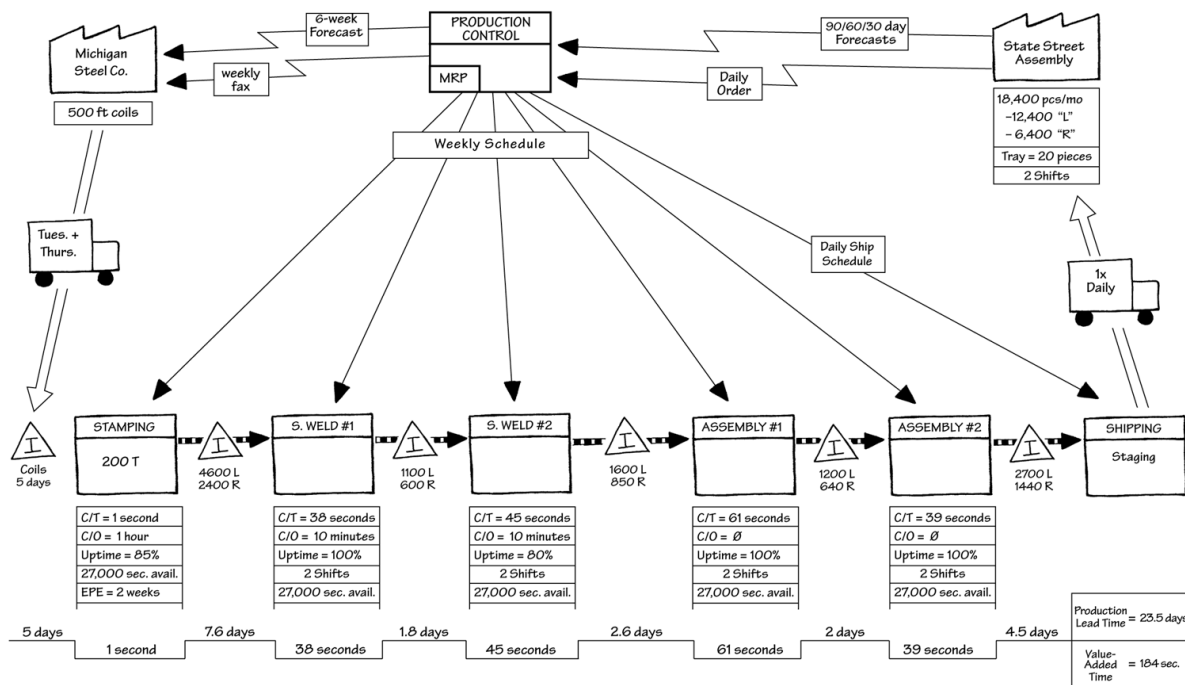

Figure 3. Current State VSM

Once a current state value-stream map is constructed, it is analyzed for areas of waste that can potentially be eliminated, especially as they impact overall flow. Improvements typically include inventory reduction, cell creation, batch size reduction, and a more pull-oriented production. The current-state VSM shown in Figure 4 illustrates how targeted areas and actions for improvement are identified.
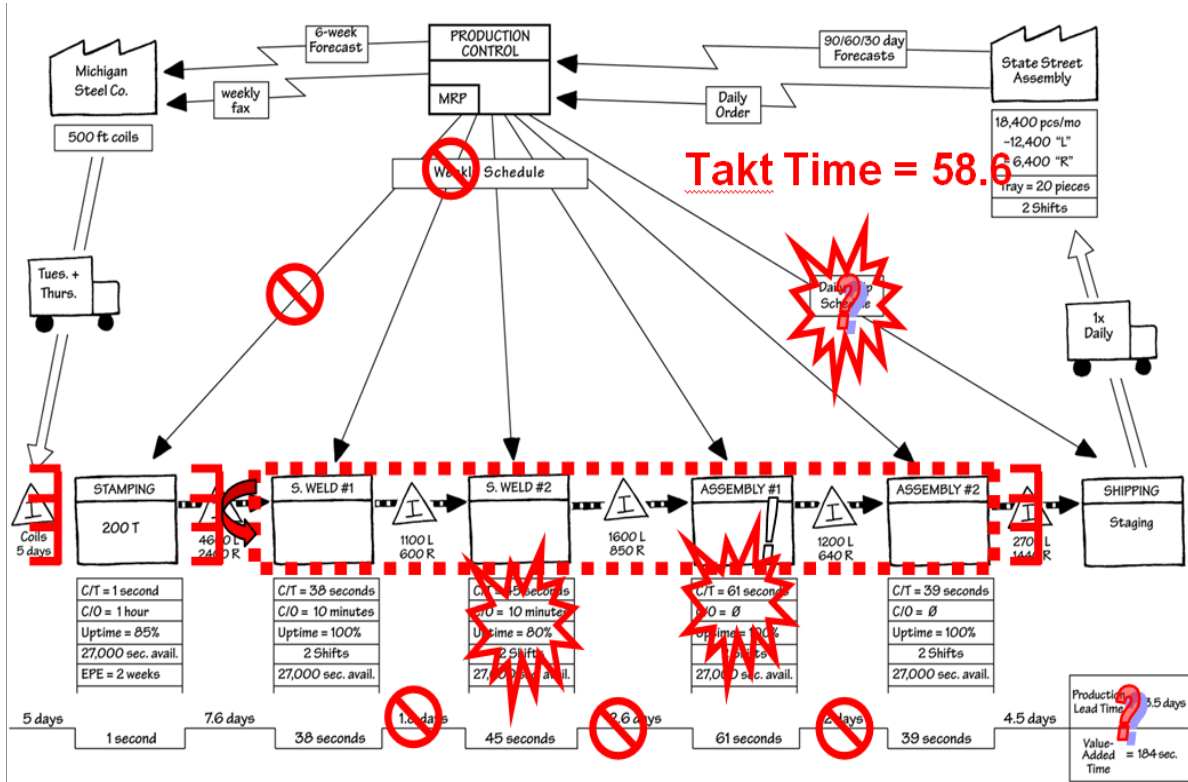

Figure 4. Current State VSM Analysis

The proposed improvements to the current state VSM are used to create a future state VSM which shows how the process could work better.

Note that in the future state map created for this product family (see Figure 5), four previously isolated welding and assembly processes have been placed in a continuous flow within a cell, and each process in the flow is now pulling material from the previous step (rather than depending on centralized, MRP-based schedules). As a result, inventories and throughput time are reduced by more than 75 percent without changing the product design or investing in expensive equipment.
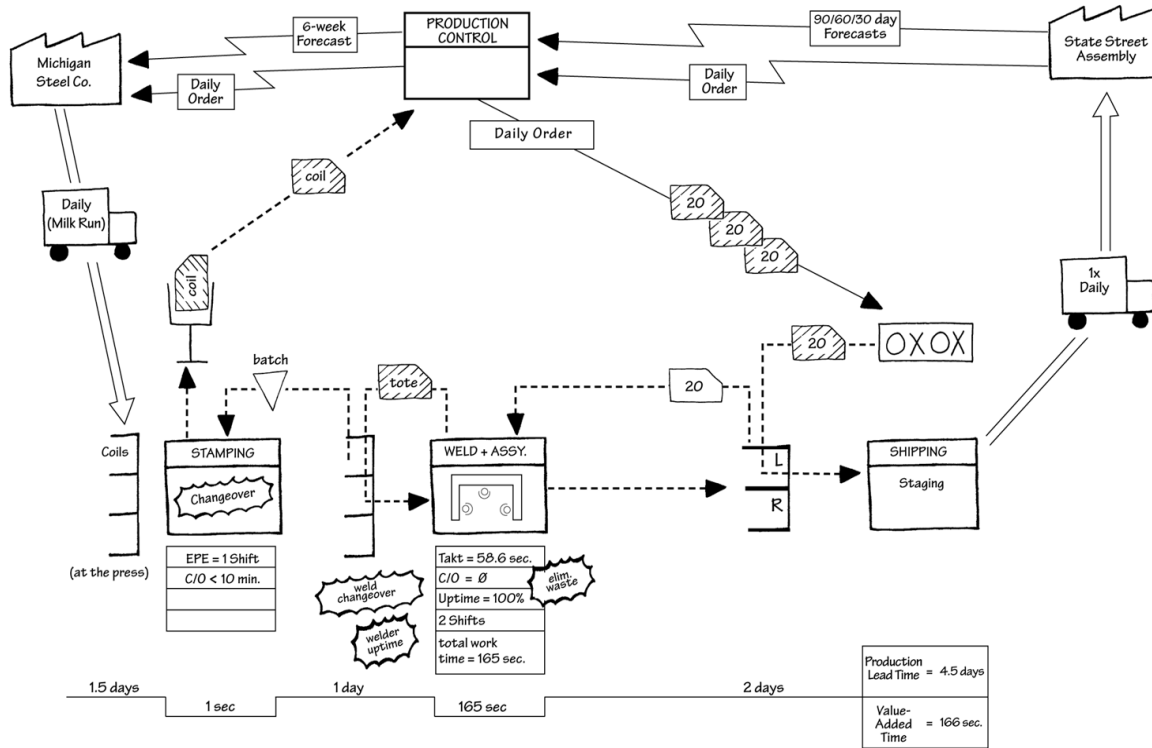
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Figure 5. Future State VSM Analysis

A VSM is effective for making tactical decisions such as whether continuous flow can be implemented and where "pull" needs to be used, but it is ineffectual in working out the operational details of the process such as allocating workers, prioritizing tasks and assessing the impact of variation on flow. Furthermore, a VSM is created for a single part or part family and therefore presupposes that resources are dedicated to this process. Often, however, resources (transport vehicles, maintenance crews, etc.) are used across multiple value streams. This certainly has an impact on process performance that should be taken into account.

A VSM presents only a static view—like a snapshot--of a process based on sketchy process information (e.g., operation times and setup times) and only basic performance data (e.g., cycle times and inventory levels). What it fails to capture is the statistical variability and detailed interactions in the process that often create almost unpredictable behavior. While this may be okay for a current-state map (because we have historical performance data to go on), consideration of these factors becomes essential if process changes are to be evaluated.

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Any systems analyst knows you can't analyze a dynamic problem using a static tool, nor can you accurately predict system performance using average behavioral estimates. This is where simulation fits in. Simulation adds real-world complexity to a system capturing the true interdependencies and statistical fluctuations. It also introduces a fourth dimension—time—which brings a VSM to life and shows how a process actually plays out over time. The animated visualization of the process engages interest and stimulates innovation that wouldn't otherwise occur. Simulation captures the actual dynamics of a process and allows one to conduct experiments to test the impact of alternative changes.

Simulation not only helps determine which improvements have the biggest impact on process performance, but it quantifies the amount of improvement one can expect. For example, it is generally conceded that a cross-trained team of operators working in a cell results in better cell performance than dedicated operators working in a cell. What is not so obvious is exactly how to allocate these flexible workers in a cell to achieve the best cell performance. Even less obvious is the amount of improvement that can be expected by alternative worker allocation schemes. This is the kind of insight and decision capability simulation brings to VSM.

Unfortunately, a VSM itself rarely contains sufficient information to run a simulation. For example, a VSM might show how many workers are used for an operation, but it doesn't show how these workers might also be shared between other operations, what their availability is, and what phases of each operation actually require the use of these workers. Simulation utilizes this information to accurately predict resource contentions, waiting due to worker unavailability and worker utilization. Fortunately, Process Simulator allows you to expand the information already captured in a VSM so that it contains the information needed to run a simulation. By adding increasingly more detail, increasingly more meaningful and precise information about the performance of a process can be obtained.

Remember, a future state map shows the *expected* improvement in cycle time for given improvements, but it is often just an educated guess. And what about other metrics that may be affected such as throughput, resource utilization, and stock-out situations? Simulation accurately predicts the level of improvement you can expect to achieve in all areas of performance.

In summary, a VSM is typically a quick glance at a process from the thousand-foot level looking at general flows and hand-off points. It looks at general fixes to the process, but doesn't directly address systemic issues. A VSM is simply not designed nor intended to look at a process with the same level of detail and in the same dynamic way as a simulation model. Simulation is an excellent follow-on activity to value-stream mapping because it can pick up where a VSM leaves off.

Simulation is a natural extension to value-stream mapping and provides additional valuable operational information that is unobtainable using VSM alone. Since Process Simulator runs as a Microsoft Visio® Plug-in, you can actually create the VSM, add the operational information, and perform simulation experiments in a single seamless environment. It is a way to make a VSM come alive.

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Kanban Sizing

One of the effective uses of simulation is in establishing kanban controls, whether it is for a super-market or a simple storage replenishment. Such storages are typically needed to buffer discontinui-ties in material flow, i.e., where you can't achieve continuous flow (see Figure 6).
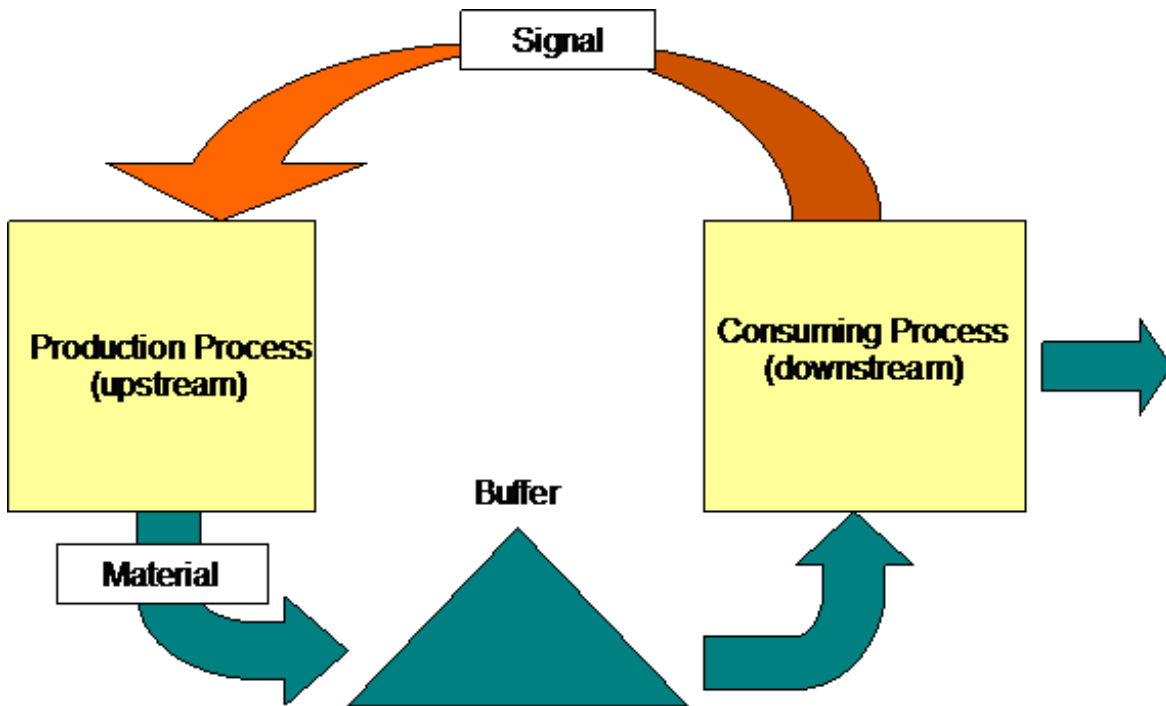

Figure 6. Kanban Control Loop

What you need to know when setting up a kanban control is (1) when to signal for more parts (i.e., the trigger level) and how much to signal for (i.e., the reorder quantity).

The kanban trigger level should be based primarily on two factors: (1) the usage rate, and (2) the response time or reorder time. The usage rate is the rate at which items are drawn from the storage and generally is based on the Takt rate (i.e., the rate of demand for the item). The response time for replenishing a kanban request is based on the cumulative time delays that occur for production of the items, transport of the items and any delays that occur due to other work being performed, equipment failures, operator unavailability, etc. Of course, you don't want to plan for an absolute worse-case scenario, but certainly a reasonably likely (say, at least a 95th percentile) delay scenario.

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The reorder quantity is typically going to look at the tradeoff between the fixed cost for processing a batch and the cost of carrying the inventory, sort of like when computing economic order quantity (EOQ). The difference is that Lean suggests that inventory be kept as low as possible.

Kanban control for a supermarket is a bit more complex, but follows the same concept as kanban control for storages. Supermarkets typically occur in mixed model processes or an assembly processes. For example, suppose you had an assemble-to-order process which pulls components from a supermarket. What you would like to know is the reorder point for supermarket items as well as the kanban size. Of course the reorder point is going to be based on the usage rate for the component which is dependent on the order mix. The kanban size will be determined largely by the lead time for replenishing a component.

Simulation can be extremely useful in establishing reorder levels and quantities, especially in any kind of complex production environment. By experimenting with different levels and quantities in a simulation model, it is easy to quickly come up with the best Kanban controls. Either **Process Simulator** or **ProModel Classic** can help evaluate alternative operating scenarios.

Ongoing Improvement

For ongoing improvement, simulation keeps the Lean transformation engine running. One of the greatest obstacles to sustaining Lean is complacency and lack of ideas. Simulation stimulates creative thought and engages planners and managers in innovative thinking that otherwise tends to fade and disappear. Simulation helps shake the bushes to discover the hidden waste that lies undetected and unchecked in every process. "The trick is to find waste, or *muda,*" states Shingo, "After all, the most damaging kind of waste is the waste we don't recognize."

In the first phases of Lean transformation, much of the waste is so glaringly obvious that the solution is almost self-evident. By reducing setup times and regulating flow through pull triggers, and implementing single-piece flow, work-in-process and cycle times can be greatly reduced. To achieve continual improvement, however, requires being somewhat of a sleuth or detective. This is where simulation modeling comes into play. Whether you're designing work cells, or streamlining a supply-chain, ProModel's simulation solutions put you on the fast track for achieving the ultimate Lean process.

Lean on Us

If you are reluctant to attempt simulation on your own, ProModel offers expert services in Lean simulation all the way from doing the complete simulation and Lean analysis to providing experimental models built to specification. With dozens of successful Lean simulation projects under our belt, we stand ready and able to provide you with the simulation support you need. Below is an example of

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a Lean simulation project that represents one of the many successful efforts to integrate ProModel solutions with Lean.

Major U.S. Appliance Manufacturer

Problem:

Throughput from the dishwasher tub line was not keeping pace with demand from the final assembly area. In order to increase the tub line throughput, the client added an extra shift at an annual cost of $275,000. The additional shift should not have been necessary given that the takt time for all tub operations was less than the required Takt time at final assembly.

Solution:

This project was completed in two weeks using ProModel software and services. By eliminating the additional shift, the company realized an annual savings of $275,000. The ROI in the first year alone from this project was % 1,100 and the payback period was less than 2 months.

Procedure:

First engineers sought to identify the reason(s) for the inability of the tub assembly area to produce at the rate required to feed the final assembly lines. After determining root cause, engineers attempted to test potential changes with the hope of identifying the most cost effective solution.

After months of traditional analysis with no definitive answer, ProModel was engaged to develop a simulation model to mimic the tub assembly operations, including the entire material handling system. The model was run under existing operational assumptions and found to be a valid representation of the actual system. Proposed changes to the system were then tested through "What If" scenario analysis and the most cost effective solution was found to relieve the problem

Tub Line Simulation Model Showing Conveyor Re-Circulation Loop Solution
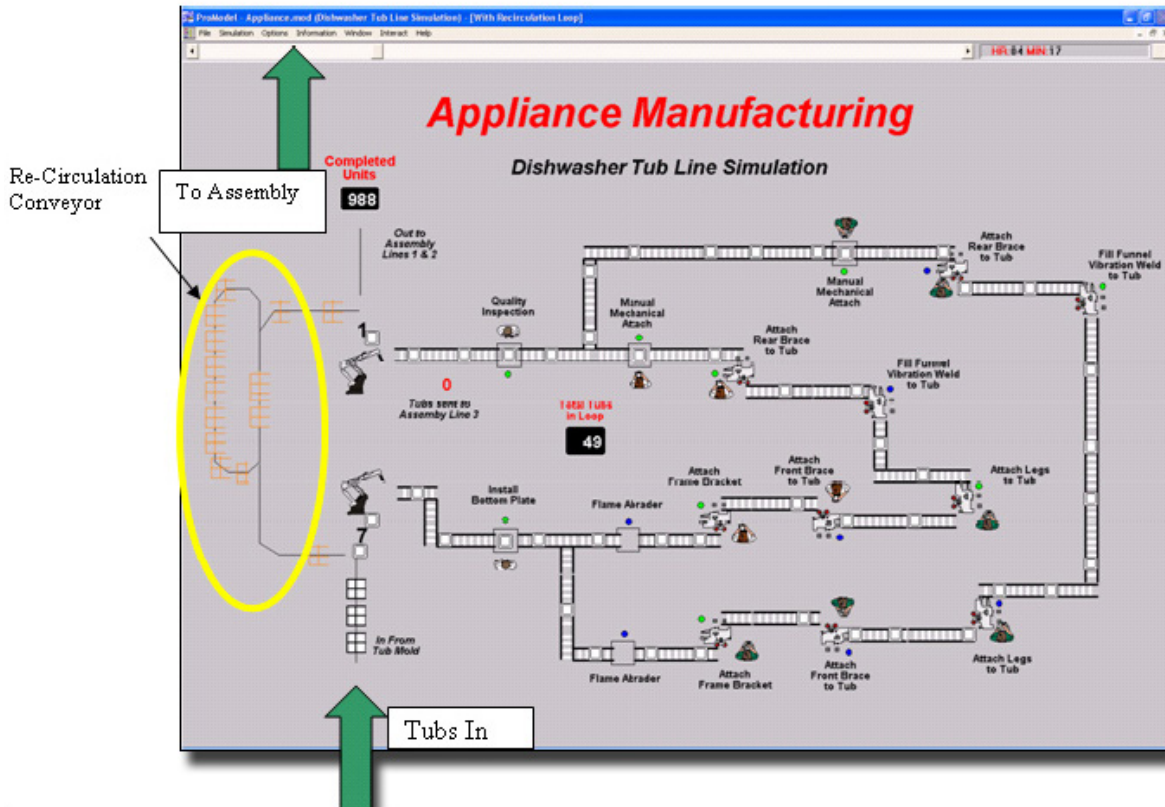
Counter-intuitive to expectations, no bottlenecks were found at the individual assembly stations, or in the material handling system which delivers raw tubs to the assembly line. However, a closer review of the material handling system showed that the loading process for placing raw tubs on the start of the conveyor line was constrained by a lack of space for empty carriers moving downstream to the "tub-to-final-assembly" loading station. A proposal was made to incorporate a previously used recirculation loop portion of the overhead conveyor system. The loop allowed additional empty carriers to queue between the raw tub unloading station and the finished tub loading station. This change effectively supplied more inventory to the parallel tub assembly lines, thereby increasing the utilization of the assembly stations and realizing the required system Takt time while eliminating the need for the additional shift.

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Comparison of Throughput & Work in Process
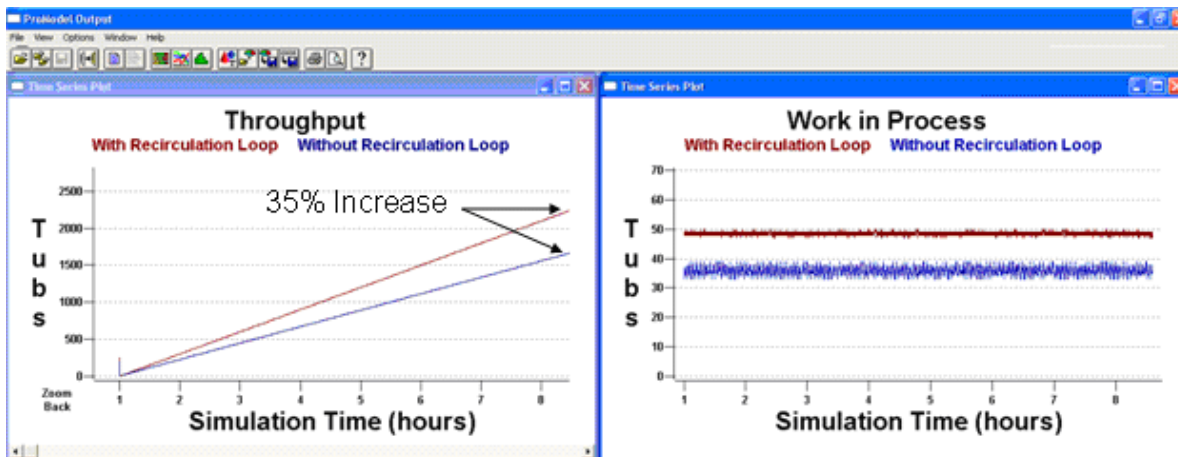
This project was completed in two weeks using ProModel software and services. By eliminating the additional shift, the company realized an annual savings of $275,000. The ROI in the first year alone from this project was 1,100% and the payback period was less than 2 months.

To learn more about our consulting services or to receive a quote on a project you would like to have performed, call us at **(800) 719-4972** send an email to saleshelp@promodel.com or visit promodel. com/Solutions/LeanSixSigma

SUMMARY

ProModel's state-of-the-art simulation technology provides you with the tools and services you need for all of your Lean modeling and analysis needs. Whether you select one of our easy-to-use tools to perform your own simulation analysis, or draw upon our expert consulting services, we can help you achieve Lean at any level of the organization. This includes strategic level planning by helping to establish a Lean culture and prioritizing Lean projects or more tactical and operational planning by determining the optimal process design and operating policies.

(Endnotes)

1. "What is Lean?" Lean Enterprise Institute, http://www.lean.org/WhatsLean/.
2. "Just-In-Time Inventory." http://www.providence.edu/acc/pae/ais/student/feene/feene.html. June 25, 2000.
3. Taiichi Ohno, *Toyota Production System—Beyond Large Scale Production*. Cambridge, MA: Productivity Inc. Published in Japanese in 1978; in English in 1988.
4. James P. Womack and Daniel T. Jones, *Lean Thinking* Free Press, 1998.
5. Jim Womack, "The Challenge of BP Transformation," *BP Trends*, January 2007, 1.
6. Mike Rother and John Shook, *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda,* Lean Enterprises, 1999.

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