Proceedings of the 2009 Winter Simulation Conference
M. D. Rossetti, R. R. Hill, B. Johansson, A. Dunkin and R. G. Ingalls, eds.

IDENTIFYING COST REDUCTION AND PERFORMANCE IMPROVEMENT OPPORTUNITIES THROUGH SIMULATION

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ABSTRACT

During difficult economic times, companies have few positive cost reducing options that simultaneously improve operational performance. This paper addresses how Deloitte Consulting partnered with Simio LLC to model multiple process improvement opportunities for a HVAC manufacturer in order to reduce the facility's operating costs. Through the use of simulation, the team was able to determine the impact of reducing the cost burden for the HVAC company by minimizing WIP inventory, eliminating over-time labor and increasing throughput. Four separate improvement opportunities were modeled independently and conjointly to provide insight into the size of the savings opportunities as well as to enable the prioritization of those efforts.

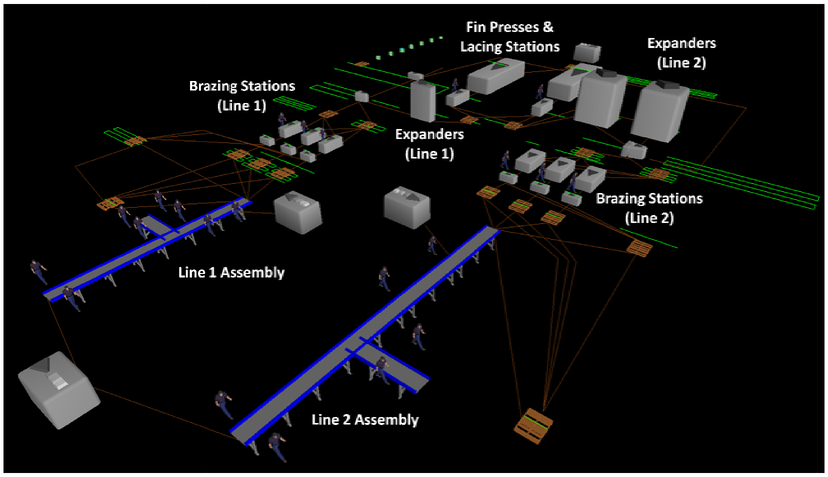
1 INTRODUCTION

During difficult economic times, companies have few positive cost reducing options that simultaneously improve operational performance. The ability to identify cost reduction opportunities through improving operational efficiencies provides companies with the ability to reduce costs while maintaining service levels, to increase production with the same level of resources (thereby spreading the cost burden over a greater volume of product), or a combination of the two results.

Facing the need to increase production capacity while reducing costs from the process, a major HVAC manufacturer hired Deloitte Consulting to identify opportunities for improving the throughput of one of their production lines. During this time, Deloitte was introduced to Simio's simulation package and the opportunity was presented to use simulation as a basis for identifying improvement opportunities, as well as quantifying the degree of potential improvement in terms of increased throughput or decreased operating costs. Through the use of Simio and supporting analysis, the Deloitte team determined that the opportunity existed to improve throughput by 41% and reduce work-in-process by 36%.

2 THE MANUFACTURING PROCESS

Figure 1: 3-D version of the production line model



The production line that was modeled assembles evaporators, the size of which depends on the number of fans included. The evaporator product can contain 1-6 fans and the width of the unit is increased by 16 in. per fan. On the most simplistic level, an evaporator contains an evaporator coil (a structure made from rectangular sheets of metal “fins” through which copper tubing is fed. As coolant flows through the coil tubing, it extracts heat from the air around it and the fins help to increase the surface area and extract the heat. Attached to the unit are the fan(s), the required wiring harnesses and a motor to control the unit.

The production process begins with the fabrication of the fins. A steel roll feeds a press machine that cuts the sheet vertically into rows, and a die punches through the sheet metal making the individual fins. The die also creates holes through which the copper tubing will be threaded. These fins are made from four separate types of alloy, so fin production is scheduled to avoid costly changeovers from one alloy to another.

Once the fins are punched, the operator (the Lacer) collects a stack of fins equal to the number of fins necessary for the size of unit being manufactured. At the next step, the Lacing Station, the stack of fins is laid horizontally and copper tubing is fed through the fin holes. The copper tubing is bent in a u-shape so that one end is enclosed while the other end is open. Once all necessary tubes are threaded, the end product (called a “slab”) is placed into an Expander. The Expander is a vertical machine that forces metal rods through the copper tubing so that the tubing expands, fitting securely within the individual fins. Once the expansion is completed, the slab proceeds to a brazing station where copper end caps are added to enclose the open side of the slabs. Additional components requiring brazing are added to the unit and the final product (called a “coil”) goes through a high pressure air and helium test to ensure that the unit is properly sealed and not leaking. Once tested, the coil is sent to the assembly line. A metal housing assembly is created and the fan blades and motor are installed. Mid-way through the assembly line, the housing assembly and the coil are united, assembled together and the final product is tested to ensure that the electrical components work properly. The finished unit is then packaged for delivery.

For the line that was simulated, the operations are split beginning at the Expander. One and Two-fan units are produced on one part of the production line (Line 1) and Three to Six-fan units are produced on the other part of the production line (Line 2). While the fin presses and lacing stations are shared, both Assembly 1 and 2 have dedicated expanders, brazing stations, and assembly lines.

The manufacturing lead-time is seven days and is divided into three segments. Two days are allotted for slab production (fin press through the expanders), three days for coil fabrication (brazing and test) and two days for final assembly. Orders print for production seven days before they are due. When those orders print, a copy of the order goes to the Kitting department within the warehouse. The Kitting department is responsible for kitting any purchased part that is consumed during assembly. Generally, the kitting department takes one day to kit all necessary parts and then sends the kits to Tube fabrication. Tube fabrication develops any special parts that are added to the component during the brazing process. The complete kit is then sent to the brazing station staging area to be consumed by that operation. Slabs from the fin press / expander have to be matched with their respective kits before progressing to the brazing station.

3 COMPLEXITIES OF MODELING THE PRODUCTION LINE

Modeling this production line posed several unique modeling issues:

- ***Multiple production schedules are utilized***: while a ship list stated which product should ship each day, the manufacturing process ran from three separate schedules. The kitting process determined the schedule by which parts would be picked, slab production would develop the order in which slabs would be created to gain efficiencies in that area, and final assembly would be scheduled so as to have the product family sequenced for efficiency during assembly.
- ***Kitting units***: While a slab could be used in several different SKUs, the kitting process was tied directly to an order. Any kits not picked complete or on time would be unavailable for pairing with the correct slab causing production delays when the unit was not brazed on schedule.
- ***Assembly line moved at the pace of the slowest unit on the line***: Time studies had been completed to determine the length of time each product should spend in a particular assembly area. Products were grouped by family and a priority ranking was established from the fastest moving family to the slowest moving family. Because the final assembly line was on a belt conveyor, the speed of the entire line was set by the slowest processing time at any given station. The processing time was dependent upon the family and size of the product being assembled.
- ***Some resources were shared between pieces of equipment***: One worker, called a Lacer, operated the fin press machines as well as manned the Lacing table and was responsible for threading the copper tubing. Also, each brazing station had one operator that was responsible for retrieving the slab and associated kit, brazing the unit, and then

testing the unit. A brazier had to be viewed as "occupied" from the time that a slab was chosen for brazing until the brazed product was finished testing.

- ***Differing processing times***: The length (fan size) and type of product determined the processing time in several areas. The length was correlated to the number of fins consumed for the slab, and the processing time of the assembly line was also determined by the length of the unit as well as the type (complexity) of the unit.
- ***Varying hours of operation***: The plant operated two shifts with some equipment operating during both shifts, some operating both shifts with a reduced work force during the second shift, and some only operating during the first shift. It was necessary to control each of the operations for the varying levels of availability to determine the correct utilization of resources during simulation.

4 HYPOTHESIS FOR MODELING

Five different scenarios were modeled over the course of the project:

- ***Operations Baseline***
  Developed a functional model that resulted in the throughput and utilization levels expected. Time studies were conducted to baseline the value-added activity performed at each area as well as the duration of changeovers. Due to the infrequency of unscheduled downtime, the short period available for time studies, and the fact that breakdowns affected non-bottleneck operations, break downs were not built into the simulation.
- ***Schedule Integration***
  Simulated the impact of all aspects of the production line operating from one schedule sequenced for assembly. As previously stated, three separate production schedules were utilized on the production line, one for kitting (purchased parts and tube fabrication), one for coil fabrication (fin press, lacing, expanding and brazing), and one for assembly. Each day, a shipping report would be printed which listed the units that would be shipped over the following seven days. The assembly line would schedule those units by the preferred sequence, sequencing product families from the fastest produced family to the slowest. The Kitting department picked purchased part kits as they printed each day, sending them to the tube fabrication area to obtain in-house produced parts. Two days were allotted from when the list printed before the picked kits needed to arrive at the brazing stations. The third schedule was the one established by the fin press operations. Because of the time required for changing over the metal alloy coil as well as programming the fin presses for the type of fin being produced, the fin presses would generally produce batches of product. Usually, if operators were about to run a job, they would look over the next couple of days' demand to determine if the same fin would be required again and would couple that demand requirement with the one about to be produced. While efficient, it did result in batches of fins that did not match the sequence of production that the assembly line had developed for the order in which the units should be brazed and assembled.

  The Scheduling Integration scenario forced all three operations to run on the same schedule as the one dictated by the assembly line. Orders for the day were ordered by the speed of assembly (from fastest to slowest) and were fabricated in that order.

- ***Kitting Availability***
  Simulated the impact of all material (purchased parts, tube fabrication, assembly line) kitted complete and on-time to the line. Undisciplined kitting had resulted in picks being delayed or kits moved forward incomplete. Kitting carts were not moved according to schedule and some kits piled up at cart locations, obscuring the priority in which they were supposed to be completed. Standardizing the production schedule increased the likelihood of having required parts on hand and reduced the number of expedited picks that could at times consume the material meant for another unit. Increasing the frequency of pick deliveries (thereby reducing the number of picks each round) reduced the work-in-process and made the kit transfer process more manageable as well as making it easier to find the required kit.

- ***Part Presentation***

  Simulated the efficiencies gained by having material kitted directly to the point of use in the sequence in which it was to be consumed. Originally, completed kits were delivered to mini-supermarkets in two designated areas, one from which braziers pulled material and one from which the assembly line pulled parts. Due to the parts being grouped all together without assigned positions and because the scheduling process made it difficult to forecast what was going to be produced, operators were continuously looking for parts and consumables. Two efficiency improvements that were modeled were kitting material directly to the point of use as well as increasing the frequency of kit deliveries so fewer hours of material were on the floor at any given point. Both improvements reduced the amount of time spent looking for parts.

5 MODELING THE BASELINE

The baseline model was developed entirely from the pre-built “Standard Library” (Figure 2) designed by Simio. The pre-built objects allow for a more “plug-and-play” programming experience, with no true coding required to build either 2-D or 3-D models. By selecting an object placed into a model, a properties window was made available to set the properties of that specific object. The data inputs available differed depending on the type of object that was selected.

In the object properties displayed to the right (Figure 3), 1st and 2nd shifts were modeled by altering the reliability of the object. The benefit of Simio is that there are generally multiple approaches that can be taken to model a particular scenario. Resources available only during the first shift would have an up-time of 460 minutes (the duration of shifts in minutes). After 460 minutes had passed, the equipment would then go down for the next 460 minutes, thereby differentiating those resources that were available the entire 920 minutes from those only available for 460 / day (Note that in the final Simio release, schedules were added to provide a more straightforward way to model off-shift time).

Figure 2: Standard Library

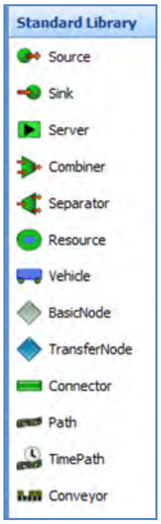
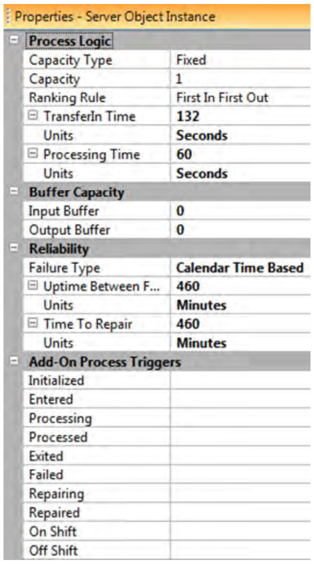


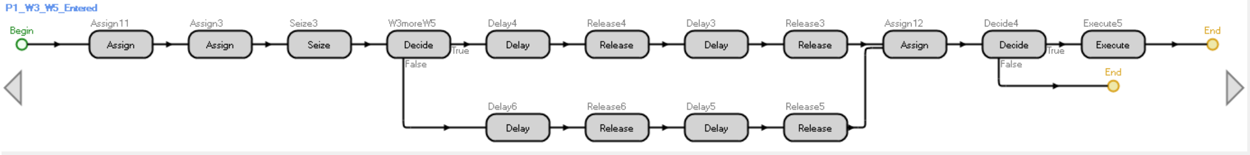
Figure 3: Object Properties


Properties - Server Object Instance

Process Logic	
Capacity Type	Fixed
Capacity	1
Ranking Rule	First In First Out
TransferIn Time	132
Units	Seconds
Processing Time	60
Units	Seconds
Buffer Capacity	
Input Buffer	0
Output Buffer	0
Reliability	
Failure Type	Calendar Time Based
Uptime Between F...	460
Units	Minutes
Time To Repair	460
Units	Minutes
Add-On Process Triggers	
Initialized	
Entered	
Processing	
Processed	
Exited	
Failed	
Repairing	
Repaired	
On Shift	
Off Shift	

The other strength to modeling within Simio stemmed from the use of “Add-on Processes” available within each object’s properties window. Add-on processes enable different events to be triggered depending on the event that activates the trigger. Using the same “drag-and-drop” modeling approach that is available from the Standard Library, it is possible to develop elaborate processes to alter the Standard Library object to act as necessary in that specific instance. The process listed below (Figure 4) is an example of the alteration required to model the process accurately.

Figure 4: Add-on Process Example



On the assembly line, there were multiple stations all connected by a belt conveyor. The station modeled above was one where two resources were utilized within the station. Depending on which product was being assembled, either worker #1 or worker #2 could take longer than the other. In this process, the first step acted as a counter to keep track of whether there were any units currently on the assembly line that were being assembled within a workstation.

> Once a unit entered any workstation on the line, the counter was incremented by one. Then, the conveyor into that station was shut-down. The third step seized both worker #1 and #2 for the operation. A decision was then made to determine which worker had the longer assignment for the specific unit being assembled. The process was delayed by the fastest worker's activity time and then that worker was released. The process was then delayed again by the difference between the slower worker and the faster worker, and then the second worker was released. In the third to the last step, the unit counter was decremented by 1 to demarcate that the unit was completed and ready to proceed to the next stage. The penultimate step was a decision object which determined if the counter was equal to "0", meaning that all units within workstations were complete and ready for the next stage of assembly. If that was true, then the final step turned on the belt conveyor and the units moved on to the next stage.

The first challenge with modeling the baseline was replicating how each of the three main areas of the process prioritized unit production differently. The process (Figure 5) began with the FamilyDefinition (1) object randomly producing all of the "orders" that would be consumed by the process over the simulation's run length. The orders were generated from a data table located within Simio which had the frequency of which units were ordered. The Daily_Orders queue (2) allowed only the appropriate number of orders in per day. The Fin Presses would then pull orders into the system by ranking orders by the coil type and number of rows (rows of holes punched in the fins for threading copper tubing), thereby limiting the amount of time spent on Fin Press changeovers each day. When orders entered the Daily_Orders object, a copy of that unit was sent to the Kitting area node (3) which then kitted the orders as they entered the system. Orders could be filled by either Fin Press and Lacing Table combination, but starting with the Expanders, orders were dedicated to Line 1 or Line 2 depending on the size of the unit (Figure 6: Line 1 assembled 1-2 fan units, Line 2 assembled 3-6 fan units).

Figure 5: Model of Process Beginning

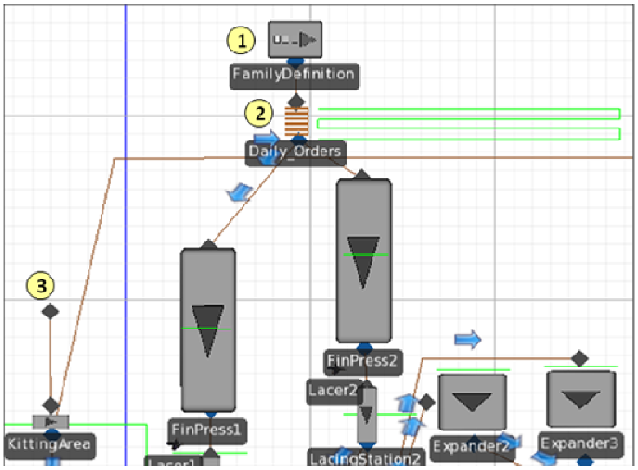
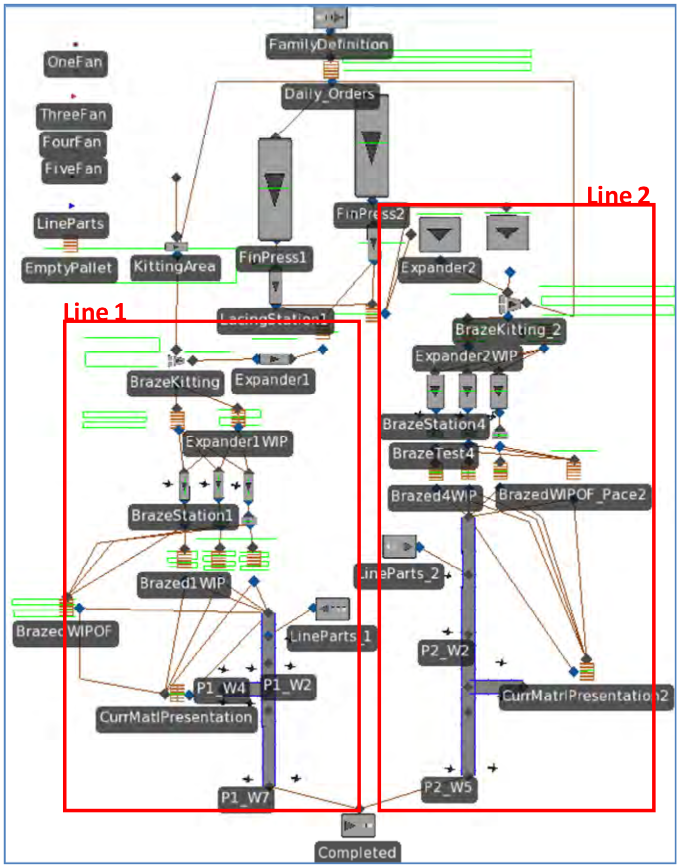


Figure 6: Layout of the Production Line



Orders being assembled were matched to their respective picked kits at the BrazeKitting objects. Only when the "slab" and the matching kit had arrived would the unit be advanced to the Expander WIP queue to await an available brazing station. To mimic reality, all kits were held for a period of one day to model the time required to advance from the kitting area, through tube fabrication, to the production line. Once brazing was completed, the unit advanced to the assembly queue. If there was no wait, the unit was immediately assembled. If there was a queue, orders were fed to the assembly line with priority being given to product families in relation to the speed of assembly – faster ones being first.

The Baseline accurately modeled current production performance averaging 202 units / day with an average WIP of 566 units. In order to have a consistent model and accurately assess the impact of different scenarios to the model, all processing and transfer times were static so that any improvement or detriment could be attributed to the change in the model versus input variables. While using inputs with some degree of deviation would have resulted in a more realistic baseline, it was deemed more important to develop a model that simulated the process relatively well, and to be able to assess with more certainty the impact that could be attributed to proposed changes to the process.

6 MODELING SCHEDULE INTEGRATION

One of the key hypotheses for reducing WIP from the system and increasing the throughput was alignment of the production schedules. As previously stated, the kitting, coil fabrication and assembly processes were all utilizing different priorities to determine the order for addressing orders. The separate areas were prioritized for local efficiencies instead of being aligned for the efficiency of the entire production line. Simulating the improvement was a simple task because the prioritization of each sub-process had already been modeled for the Baseline version. As before in Figure 5, the FamilyDefinition object created all of the orders that would feed through the model over the course of the situation, and the Daily_Orders object only allowed a day's worth of orders to enter the model.

The next step was to ensure that all processes prioritized orders the same way. The ranking rule for the beginning of each sub-process was altered from the locally efficient rule to the family sequence identified so that the fastest family was produced, followed by the second fastest, etc. By ensuring that the fin presses and kitting process prioritized orders correctly and similarly, the slabs and kits were able to be matched more consistently in the pre-brazing stage and less WIP occurred in the system. While difficult to model, the decreased variability of slabs ready for brazing reduced the need to expedite parts through kitting and tube fabrication in order to be matched with delayed slabs. Braziers were required to spend less time looking for slabs that could be produced, which increased the throughput of the bottlenecked resource and thereby increased throughput for the entire assembly line. Simulated scheduling improvements increased the model's throughput 22% to 247 units, while reducing WIP by 37% to 358 units.

7 MODELING KITTING AVAILABILITY

Many approaches were recommended to improve the kitting performance in order to increase the accuracy of on-time and in-full arrival. Increasing kit delivery frequency reduces the batch size of orders picked so less inventory is stored on the production line. This in turn decreases the amount of time individuals spend looking for parts because fewer options are available and the kits are concentrated in a smaller space. New standards were proposed to prohibit kits that were not complete from advancing from the current station until all parts were picked. This would keep incomplete kits from advancing to the production line causing workers to then search for parts to assemble the slab that was scheduled. The change would also allow those kits that were ready for advancement to continue on instead of all kits being delayed. Additionally, visual controls were developed to do a better job of signaling issues with material availability, quality, etc. When implemented appropriately, those visual controls will signal an issue before that issue halts assembly. To model the impact of these changes, the simulated time spent looking for parts at the brazing stations and the assembly line were removed. This improvement increased throughput by nearly 10% to 271 units, while only increasing WIP to 361 units. While kitting improvements helped the production line be leaner and have less waste, WIP actually increased in this model. This increase was correlated to the increase in throughput. As more product was able to be made, more inventory was held on-hand at the pre-brazing stage while the associated kits were being produced.

While difficult to model, one hypothesis for incomplete kits was stock-outs of inventory caused by expedited kitting. If a kit was not complete (or available) for a slab that needed to be produced, then picks were expedited to get the necessary parts to the production line for that unit. The hypothesis was that this at times caused kits that were in the process of being produced in either the kitting or tube fabrication areas to become obsolete because the slab they were intended for had already been produced with expedited parts. Because this duplicative picking could affect the inventory on hand or safety stock for an item, parts were not always on hand when expected. The opportunity for this disruption would be lessened by the implementation of the scheduling and kitting availability recommendations.

8 MODELING PART PRESENTATION

To further improve upon kitting availability, the team modeled the improvement of not simply material being available to the production line, but the benefits associated with directly kitting material to the point-of-use and arranging that material so that it can be pulled in the order in which it is consumed. One of the kitting improvements suggested was increasing the frequency of kitting deliveries so that smaller bins could be used to kit the products directly to the point in the production line where the material would be consumed. Percentage improvements achieved by doing this work in other plants (including those within the same company as the client) were factored into the model by reducing value added activity (processing) time by the estimated percentage of improvement.

Additionally, the original assembly line had the coils being placed on the ground in stacks until they were fed onto the assembly line mid-way through the process. The team simulated the improvements gained by rearranging material flow so that coils were fed directly to the beginning of the line, thereby reducing the handling time associated with the additional non-valued added touching. All together, these part presentation improvements resulted in a final improvement opportunity to increase throughput by 5%, to 285 units (41% improvement overall) while increasing WIP <1% to 363 units (a total reduction of 36%).

9 MODELING WORKFORCE REALIGNMENT

One of the lessons for the client stemming from the simulation was the utilization of employees on the assembly line. Workers had always appeared so busy that the effort had not been spent to determine the extent to which time being spent was productive, or whether it was wasted on non-value added activities. By simulating the utilization of employees on the assembly line, it was determined that the staffing levels were high on both Line 1 and Line 2. The improved production line was modeled utilizing two fewer employees on Line 1 and one fewer employee on Line 2, for a total reduction in assembly line workforce of 21%. The simulation demonstrated that the production line had no trouble keeping up with anticipated volumes with the reduced workforce, and it was felt that those employees could be reassigned to bottleneck areas within the facility.

10 RESULTS OF THE SIMULATION PROJECT

Prior to this project's launch, the client was struggling to meet production targets while increasingly larger amounts of capital were being consumed as work-in-process. Overtime was becoming more frequent and morale was down as the production line struggled to meet the weekly production goal of 220 units / day. The economic state had reduced demand which alleviated some production problems, but the plant was facing increased cost accounting challenges as expenses were allocated to a decreased volume of product.

Due to poor prior experience, many members of the management group were disenchanted with simulation because models could be "bent" to deliver desired results and the modeling tools available were cumbersome and not intuitive. The simulation effort using Simio proved to be a valuable method for presenting baseline operations and identifying opportunities for improvement. While considerable more effort could have been put into perfecting this model, the constrained time horizon for this project demonstrated not only the ease of using Simio, but the lessons that can be learned from building predictive models. While additional effort would still need to be spent before 285 units / day was the unanimously agreed upon potential capacity of the production line, there was considerable learning taken from this four week engagement. Primarily, what was considered by management to be the absolute bottleneck, the assembly line itself had a modeled utilization of ~25%. What was readily noticeable was the negative impact of the schedule misalignment which prevented slabs from being united with their respective kits, which in turn caused production delays and forced workers to scramble for parts.

The immediate result of the project is that the scheduling issue is being resolved so that all process areas operate using the same order priority structure. This has been aligned to the assembly line, which should remove the current bottleneck. Once in place, the scheduling improvement opportunity is expected to increase throughput more than necessary to relieve current overtime requirements. Additionally, as the scheduling improvement is made, excess assembly line headcount can be removed from the line and applied to other constrained areas within the facility.

While not modeled as an improvement initiative, the model raised the question why the assembly line had to be structured as a belt conveyor, forcing all unit movement to occur at the same time. Going forward, the client's plan is to remove the belt and proceed with a roller conveyor. The Deloitte team is developing a cross-training policy so that assembly line workers will be cross-trained in the assembly positions immediately upstream and downstream from their assigned positions. This will allow workers to help other assembly areas in the event that they do not have a unit to be assembling. This helps capture lost productivity and will further reduce the throughput time for units.

The simulation demonstrated that the majority of WIP in the system is due to the kitting process lead-time and the lead-time allotted to the fin presses so that local efficiencies can be gained. Further effort is being spent to determine the extent to which manufacturing lead-times can be reduced and how sales, engineering, procurement and manufacturing can work together to reduce the levels of raw, WIP and finished goods inventory. Additionally, because the start of the production process (fin presses and kitting process) is tied to the final assembly schedule, only that material which is required for finished goods assembly will be released to the line, further decreasing work-in-process. Kanban carts are being implemented to signal when action is required from individual portions of the production process. The Deloitte team will be utilizing downtime to increase focus on TPS, 5S and cross-training efforts so that workers are trained to operate on either Line 1 or Line 2 and can be shuffled as necessary to respond to short-term production issues.

11 UTILIZING SIMIO

This simulation project was performed over a time span of four weeks and overcame many obstacles, those being 1) using a brand new client operational environment for the basis of simulation, 2) utilizing a team with extremely limited modeling experience and 3) modeling the scenarios with a software that was in a pre-beta stage and still working through multiple initial issues. The level of sophistication that was achieved with a team that was learning the software, working through bugs, and learning about the client's production process speaks to the abilities of the Simio and the ease of use of this simulation product.

The free-form structure of Simio provides users with multiple options for simulating different scenarios. The predefined Standard Library of modeling objects allows for near 'plug-and-play' modeling and allows for highly customized modeling through the properties of each library object. The ability to develop add-on processes further expands the realm of simulating possibilities and provides a wide-range ability to develop multiple solutions. Even when multiple Standard Library objects were not yet completed, the use of processes enabled the team to customize other object programming to achieve the desired approach. The same free-style approach is available for defining simulation KPIs. While a limited set of KPIs are available for immediate use, all of the data is captured and the user is for the most part simply limited by their imagination in terms of developing the desired simulation approach or KPIs. Additionally, the GUI-based approach to programming results in users not having to specifically write code or learn a programming language.

While not used to a great extent, two other features of Simio stood out as impressive offerings. An "experiment" tool allows users to identify multiple model variables and track the impact of those variables against defined KPIs. This allows users to model multiple inputs separately, in unison, or in groups. For this simulation, the prioritization of improvements was straight forward. Improving kitting or part presentation did very little to improve the situation if the assembly line, kitting process and fin presses continued to operate from differing schedules. Similarly, presenting kits to the line did not work accurately if those kits were filled incompletely or held up within the kitting or tube fabrication process. However, being able to model improvements, multiple approaches to the same problem, or varying inputs for a given approach is definitely helpful. For instance, it would be very easy to use the current model's experiments to continue to increase the daily production target to determine at what volume the current layout reaches production capacity and throughput plateaus.

Additionally, the ability to turn models into objects in other models is extremely helpful. A modeled piece of equipment or process could be duplicated multiple times if it existed more than once in the modeled environment (i.e. similar production lines within a plant, planes within an airport, etc.). Each model could still utilize unique local variables and produce independent variability, saving a great deal of time and strengthening the accuracy of multi sub-component simulations.

12 USE OF SIMULATION IN A CONSULTING ENVIRONMENT

While this project resulted in a successful project for Deloitte's client and a successful demonstration of Simio's capabilities, the use of simulation in a consulting environment posed several challenges. Before confidence can be placed in predictive simulations of future improvements, a baseline must be constructed that demonstrates the current state in order to achieve buy-in that the simulation works as expected. Delivering a baseline model that can then be used to develop solutions, within the normally shortened window of consulting engagements, is a tough undertaking. Developing a model that is impenetrable to inquisitive review is yet another challenge. Doing so in a shortened period of time in a foreign operating environment does not have considerably high odds.

Several actions can increase the chances of acceptance so users can begin to focus on the strengths of simulation and the improvement opportunities at hand:

1) White-board the model and walk client participants through the approach. This will allow them to understand and support or discredit assumptions that are being made. Communicating the data inputs that will be used and explain-

ing how the model will function will gain client support and will decrease the speculation in the end of how the model is producing the observed results.

2) Incorporate local programming talent to review the white-boarded approach as well as the model as it is developed. Start at a higher, more simplified level and build a functional model, developing ever increasing levels of complexity and depth as the model progresses. This will allow others to better understand the approach that is being taken and provide input on potentially better approaches.
3) Utilize formerly constructed client simulation models that have already gained acceptance. Even if the simulation is not built in the package being used, constructing a similar looking model that accurately models the baseline can be a good step toward gaining acceptance.

The important aspect to consider when utilizing simulation to identify and prioritize improvement opportunities is that models can always be improved. Additional levels of complexity can always be added to produce a more “realistic” simulated environment. However, as Simio’s basic approach supports, while a detailed model is nice, a more simplistic version can often be enough to identify the opportunity and lend supportive evidence to begin the conversations necessary to develop solutions. It could be that the more simplified model could result in an improved process before the detailed model is through development…much less validation.

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