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Improving process : reduction of WIP and increased throughput

John P. Zielke

NORTHERN ILLINOIS UNIVERSITY

Improving Process: Reduction of WIP and Increased Throughput

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By
John P. Zielke

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Student Name:	John P. Zielke
Approved by:	Dr. Thomas M. Galvin
Department of:	Operations Management Information Systems
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ABSTRACT:

An in depth study of an automotive sensor manufacturing line for the improvement of throughput and the reduction of Work-In-Process (WIP). The use of a simulation software package (Witness) will be used to model the production area and perform alternative methods to improve the process. The flow of material in and out of the area is another concern that will be addressed in the study.

Recommending improvement of material flow into the department with the implementation of Just-In-Time (JIT) on all component items. JIT will reduce the amount of Work-In-Process (WIP) by releasing orders minutes before production occurs, unlike the current standard of hours. Different alternatives will be evaluated for implementation to improve material flow through the department as well as reducing WIP and increasing throughput.

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Purpose/Goals

The purpose of the project is to evaluate the process and recommend process improvements that decrease WIP (work in process), improve the material flow in and out of the department, and increase throughput. The production line to be evaluated is a single item automotive sensor that has only one external customer.

Analysis

The analysis of the process improvement was broken down into two categories; external and internal. The external analysis of the material (sub-components) was conducted coming into the department and material (final product) shipped out to inspection and stockroom. The internal analysis consisted of the process used to manufacture the parent item.

External Analysis

As goals were identified the external analysis was started with a count on WIP (components in process) and inventory (components in stock) in all departments that consist of components for the parent item. Calculating the total cost for each component within each department determined where the highest cost was. The parent item consisted of 5 major components and a calculation of each department for these components was conducted. The highest total cost was identified in the production line of the parent item.

The study of the department processes for releasing orders and receiving stock was evaluated. This department had 3 shifts that worked 5 days a week (Monday through Friday). Orders are released during the first shift for the day's requirements. With the stockroom only working first shift, parts had to be requested early for delivery to the department for all shifts. This causes an increase in WIP for all orders that are started on second and third shift.

Evaluating the inspection for the final product revealed there was a need to improve the quality.

With the rejections of orders due to operator errors, inaccurate counts, and missed visual checks indicated a need for an improvement of the visual station in the process. The ability of eliminating the inspection department would decrease WIP by more than a half day.

Internal Analysis

The use of a simulation software program was used to determine new alternatives for better flow of the material through the department and to identify bottlenecks that can be improved. The ability to perform "What if" scenarios on a computer simulation program is much less costly then on the floor. This will give us the opportunity to simulated and address any ideas for improvement in the department.

Time studies were conducted on each operation in the department, which included breakdowns, rates of each machine, and replenishment of inventory. A histogram for each time study was calculated and programmed into the simulation for lead-times and run-times. A random variable was also added to each histogram for a true world evaluation on the cycle run.

The simulation was used to improve the throughput, decrease WIP by the number of orders in WIP, and the length of time the orders are in WIP (Lead-time). The model assumptions are as follows:

- 1 unit in the model is 1 tray in the production area. Each tray consists of three rails with 8 parts per rail.
- Model is in minutes.
- Breakdowns of machines over 30 minutes was not included in the breakdown histograms.
- No meeting times or personal down time are used in the model.
- There is no time accounted for operators moving from one machine to another.
- Two breaks are given: 1 ten minute and 1 twenty minute per shift.
- Schedule maintenance is performed on weekends and not factored into the model.
- Shifts
  - 4 employees on 1st
  - 4 employees on 2nd
  - 3 employees on 3rd
- Orders are released every 12 hours, with 2 assembly machines, giving a total of 4 orders per day.
- Orders are allowed 15 minutes for inventory to arrive and production to start.
- Orders are allowed 20 minutes for delivery to the stockroom without inspection.

Description of Simulation

Figure 1 in Appendix A, is the base model of the simulation that was used to evaluate the internal analysis of the department. Starting on the left of Figure 1 the orders are released (REL_ORD) and put into the system to the corresponding assembly machine (ASSY1 or ASSY2). As the trays are produced they are stacked on the racks (LD1_OVEN or LD2_OVEN) until the rack is full with 36 trays. When the racks are full they move to the OVEN for a 3-hour cure time. The OVEN is displayed as two ovens for receiving racks are different times during the assembly process. After the OVEN processes each rack they are sent to TESTBUF1 or TESTBUF2 for a 30-minute cool-down and then to the testing station (TEST1 or TEST2) depending on which assembly machine produced the component. Each testing station has a feeder rack that is filled by the lead-operator. TEST1 has the capacity of holding 18 rails and TEST2 has the capacity of 21 rails. The last station of the process is the visual and pack station (VISPACK1 and VISPACK2.) As the trays are removed from the testers they are visually inspected and packed into containers for shipment to the customer. Once the skid (SKID1 or SKID2) reach the customer quantity of 111 trays then the skid are shipped to inspection. Looking at the lower left corner of Figure 1 you see the 3 shifts of labor used to run the production line. The 1st two columns are the assembly operators that operate ASSY1 and ASSY2. The 3rd column indicates the operator that performs the visual and pack station. Finally the 4th column, the GoFer (lead-operator), used only in the first two shifts, for paperwork, loading testing stations, communication of information within the department from supervisor, stocking component parts within the department, and delivery of finished components to inspection and stockroom.

The Desk was setup in the model to account for paperwork, request for component parts from the stockroom, and computer processing. Computer processing would include reviewing schedule requirements, tracking of inventory of component parts, setting up meeting, and monitoring E-mail.

Evaluation of Alternative Models

Once the model was verified and validated, 8 alternative models were run for improvements in the process and material flow. Table 1 below shows the areas that were address in each alternative model. The bold areas under each column are the areas that were improved for each alternative model.

Table 1

Alternative	Tester 1	Tester 2	Oven	Visual/Pack*	No. of Rack	Avg Orders in WIP	Avg Time orders in WIP
Normal	18 rails	27 rails	1	1 employee	3	5.39	26.66
1	18 rails	27 rails	**2**	1 employee	3	5.61	27.55
2	**27 rails**	27 rails	1	1 employee	3	4.12	21.15
3	18 rails	27 rails	1	**1/ Assy help**	3	3.3	18.03
4	**27 rails**	27 rails	1	**1/ Assy help**	3	3.18	17.36
5	18 rails	27 rails	1	1 employee	**2**	6.34	31.98
6	**27 rails**	27 rails	1	1 employee	**2**	5.33	26.04
7	**27 rails**	27 rails	1	**1/ Assy help**	**2**	3.56	19.4
8	-	-	**Conveyor**	**1/ Assy help**	3	2.42	13.23

**** 1 employee equals one employee plus Go-Fer assisting at downtime***

Table 1 is the results of the validated model with an average number of 5.39 orders in WIP on a given day. The average length (lead-time) for each order is 26.66 hours from release to delivery to the stockroom and an average output of 19 orders per week. The bottleneck has been identified as the visual and pack station.

Alternative 1 is adding a second oven. This caused an increase in WIP and a reduction of throughput, due to the bottleneck or congestion at the tester stations.

Alternative 2 shows an improvement in WIP and throughput with a change in the capacity of the feeder belt for tester 1. The change is to increase the capacity of the belt that feeds the rails into the tester, which will decrease the time the Go-Fer has to load the tester and more time to assist at the visual and pack station (the bottleneck operation).

Having the assemblers move to the visual and pack station will improve the throughput and decrease WIP, as shown in Alternative 3. There were constraints given to the assemblers before they could assist in the visual and pack area; the oven had to be full and one rack had to be waiting to enter the oven. Also if there were no orders open at the assembly machine the assemblers would also move to the Visual and pack station.

Alternative 4 is the combination of Alternative 2 and 3.

Alternative 5 has the order divided into two racks that will enter the oven. The orders presently are divided into three racks. This has caused a bottleneck at the tester, as did the second oven. Alternative 6 and 7 are variations using the 2-rack system and a decrease was shown in table 8 using the assemblers to help visual and pack.

Alternative 8 shows the biggest improvement in the process by adding a conveyor with an inline oven. This alternative will reduce the number of orders in WIP down by 3 and cut the time the orders are in WIP by half. The throughput will increase if the time between orders is shorten for release.

Recommendations

External Recommendations

The first external recommendation is to improve the quality of the finished orders to inspection. A query was perform on inspection's database that showed 76 percent of the orders are being rejected for reasons such as split seal (a visual check) and missing parts (operator's miscount). Improvements to reduce the amount of orders being rejected will need to be established before this operation can be eliminated from WIP. One improvement for the missing parts is a color strip to be put into the trays. This strip could consist of a sticker that is bright in color, when the color is seen a part is missing and corrected prior to shipment to inspection. Another method, used by some of the operators, would be to visualize/pack in groups of three parts. With the rows consisting of 21 parts there would be a large gap of three parts missing and could be corrected prior to shipment.

The situation with the seals is beyond control of the department because the type of material and molding process used to produce the seals by the supplier is incorrect. Engineering is in contact with the supplier and is trying to correct the problem with a new design for the molding and the correct material.

The second external recommendation would be the implementation of JIT for the 5 major components of the department. The housing, PC board, IC chip, magnets, and pole piece are the major components. Other material used for production is; epoxy, solder and packaging material, which are used by multiple departments. Contact with the supplier should be the first step in the process for implementing the JIT system.

There are many items that should be addressed during the movement into a JIT setup. What is the process time for the component from the supplier (how long does it take to make the component)? How long is the component in transit from dock to dock? What type of shipping will be used (UPS, FedEx, Land, Air)? What will be the pull signal for the floor; number of boxes, reels, or card? Is there going to be a safety stock at the supplier and at what quantity? Most importantly utilize feedback and keep the floor informed.

Internal Recommendations

Without any question alternative 8 is by far the best improvement for reducing WIP and increasing throughput. If the amount of time between order is shortened (10 hours between orders instead of 12), the throughput will increase. Performing an evaluation on reducing labor and a project cost estimate for the conveyor setup (alternative 8) should be the next step in the process. Until the evaluation and estimate is finished I would have to go with alternative 4, asking the department to set constraints for the assemblers to assist in the visual and pack

Appendix A

Simulation base Model
Figure 1

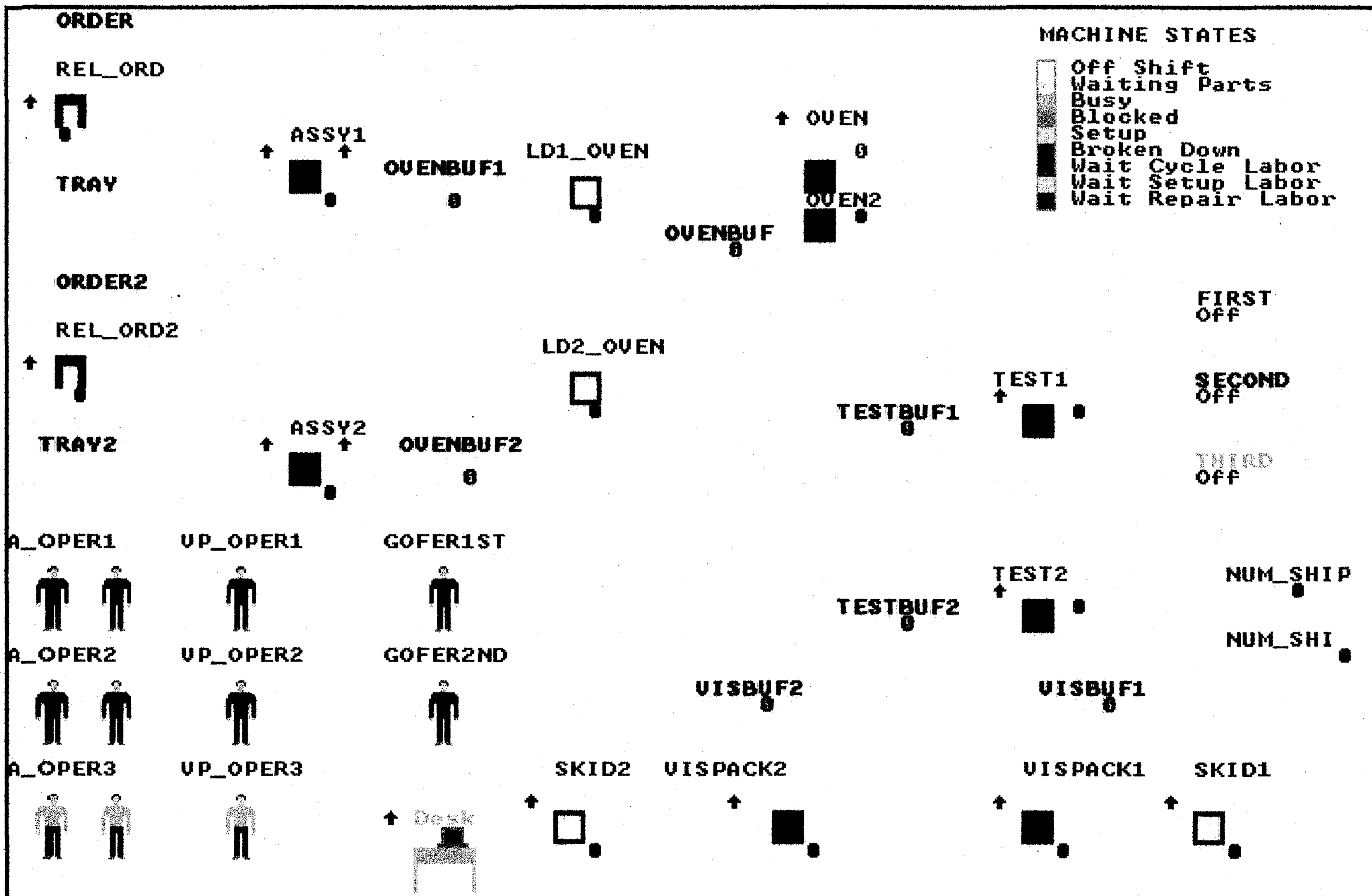
ORDER
REL_ORD
TRAY
ASSY1
OVENBUF1
0
LD1_OVEN
OVEN
0
OVEN2
OVENBUF
0
MACHINE STATES
Off Shift
Waiting Parts
Busy
Blocked
Setup
Broken Down
Wait Cycle Labor
Wait Setup Labor
Wait Repair Labor
ORDER2
REL_ORD2
TRAY2
ASSY2
OVENBUF2
0
LD2_OVEN
FIRST
Off
SECOND
Off
THIRD
Off
TEST1
TESTBUF1
0
A_OPER1
VP_OPER1
GOFER1ST
TEST2
TESTBUF2
0
NUM_SHIP
NUM_SHI
A_OPER2
VP_OPER2
GOFER2ND
VISBUF2
0
VISBUF1
0
A_OPER3
VP_OPER3
Desk
SKID2
VISPACK2
VISPACK1
SKID1

Figure 1