Improve Conformal Coat On-Time Delivery

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Abstract *— The Conformal Coat area throughput time is 37 hours on average when their limit established by the business is 24 hours. This low performance is negatively impacting the on-time delivery metric for internal and external customers. The following activities were implemented in order to reduce the throughput time: cross training classes, line balancing analysis, empowering the operators to make decisions by themselves, controlling the input with a new system feature, managing the inventory by changing process dynamic and benchmarking with a company that has a similar area. The fusion of these activities has reduced the throughput time to 6 hours in average. Also, based on the line balancing analysis, the area can reduce a single full-time equivalent position, which is equal to $53K annual savings.*

Key Terms *— Inventory, On-Time Delivery, Throughput Time, Cross Training.*

INTRODUCTION

The Conformal Coat Area under evaluation in this project was born 4 years ago after an intensive investigation. The company was looking for a better way to protect the products from moisture. The customers install the company's avionics in their airplanes and whenever the aircraft is operating, the high pressure affects the moisture limits of the electronic components and a failure could occur with hundreds of people in a commercial flight. That is why all avionics need to be protected against moisture and it is why the Conformal Coat area is crucial for the assembling process.

The Conformal Coat area provides service for internal customers only. Whenever products are in the first manufacturing stage, they pass through the area to get moisture protection treatment and then they go back to their respective product lines to finish the assembly process and are then finally delivered to the external customer. The project is important for the business because if the product gets delayed in the Conformal Coat area, then the product line will be late to send it to the external customer. Not meeting the On-Time Delivery (OTD) for the external customer could mean that the airplane manufacturer will have airplanes stopped, waiting for avionics to be installed which can be equal to millions of dollars lost. If this happens, the company will have to pay very expensive fees and the relationship with the customer is affected dramatically.

After 4 years working on the process learning curve and gathering process data, the team determine there was room for improvement because the area was exceeding their throughput time limit of 24 hours. The average throughput time was 37 hours and was directly affecting their internal customer OTD metric. That is why the objective of the project was to reduce the throughput time so the area can start meeting their OTD metric and, as a consequence, decrease the risk of affecting external customer deliveries.

LITERATURE REVIEW

Lean Manufacturing was born after World War II when the Japanese found themselves in a dilemma about lack of efficiency in their factories. After many years Toyota created this production system, and now other manufacturers are also moving towards changing the way of thinking about how to do manufacturing. Lean manufacturing includes 7 wastes that need to be eliminated from any manufacturing area in order to

reduce high production costs. Over-production, defects, inventory, transportation, waiting, motion and over-processing are the variables attached to the lack of efficiency and effectivity in any manufacturing area. An interesting fact is that researches think that all types of wastes are dependent and they have influence on each other. From all of the dependency combinations that exist, five of them apply to this project. First of all, over-production affects inventory because it increases the work-in process (WIP) and as a consequence, the area needs more storage equipment. It increases the waiting of those units in WIP as well. High levels of inventory in the other hand, pushes the area to over-produce not according to the scheduled demand. Also as Khalil (2013) mentioned, "it increases the time for searching, selecting, grasping, reaching, moving and handling" which means that it adds a lot of motion to the process. Lastly, over-processing affects the waste of motion because if the process is not standardized, the operator will be doing unnecessary movements [1].

Because of the complexity of implementing and sustaining Lean Practices (LP), many companies fail in its implementation. Misunderstanding the concept, the scope, having no idea what Lean Manufacturing is or lack of top management support for the change delays the project implementation and it becomes a big issue. Lack of resources such as time, skilled workers and costs, are a very serious obstacle in project planning as well. To make the process smoother, is important to make the affected personnel feel like they are part of the project and encourage them to participate in the adoption of the new system. Involving them in the implementation and also, providing training courses help them to understand the whys and give them the set of skills to be accountable in the sustainability of it [2].

As mentioned previously, many companies around the world today are using and implementing Lean Manufacturing techniques and that is why it is sometimes recommended to do benchmarking against another company instead of trying to re-invent the wheel. Benchmarking is the dynamic of comparing another organization's process against your process to gain information that will help your organization to take action and improve performance if needed [3].

Continuous improvement using Lean Manufacturing is the key for success for many companies because customers have high expectations. Companies need to work on increasing product quality, reducing delivery time and minimize product cost. For instance, the reduction of production lead time helps to deliver products on time to customers. By reducing inventory, lead time can be reduced as well because the process is producing only what its customer needs when they need it. The technique of First In First Out (FIFO) is recommended from the literature and will be applied in the project with the follow inventory formula: cycle stock + buffer stock + safety stock = inventory [4].

METHODOLOGY

Cross Training

The area has 4 different processes (A, B, C and D) with different training requirements and certifications. Currently, if the operator in process B station has nothing in queue, he stays idle because he doesn't have the training to do process A, C or D which may have overflow in their input rack.

To eliminate the probability of this happening, the team proposed to start a cross training program where all the operators get certified to execute all four processes. The expectation is that this effort will also help whenever the Production Manager has people calling in sick or other absences.

Line Balancing

The manpower arrangement is currently based on point of views; it is not based on data. The intention of the team is to do a capacity analysis to conclude the optimum manpower needed in the area based on demand and process timing, and how they should be arranged to enhance their daily utilization.

Empowering Operators

The operators don't feel confident calling the shots themselves. If somebody has a question or a doubt in the area, they hesitate to answer it and continue the process. Instead, they stop the process until the engineer or the production manager are available to come to the area and assist them.

The Process Engineer wants to create a Standard Operating Procedure (SOP) to establish how processes should operate. He expects that the operators, with that document, will start feeling knowledgeable enough about their processes in order to make decisions and make them efficiently and effectively.

Controlling the Input

Internal customers drop off the units in the input rack and the operators start working on them applying the FIFO (First In, First Out) technique. Even if the area and operators are arranged based on the demand, the OTD metric is affected because the operators are not always working on what they should. For example: if the demand for a specific internal customer is 7 units per day but they are dropping off in the input rack 15 units on average, that means that those 8 extra units are delaying the schedule for the units from another internal customer after them that really are needed now in order to meet their OTD. Figure 1 shows the behavior of each customer. It can be seen that only two customers are actually checking in what they should.

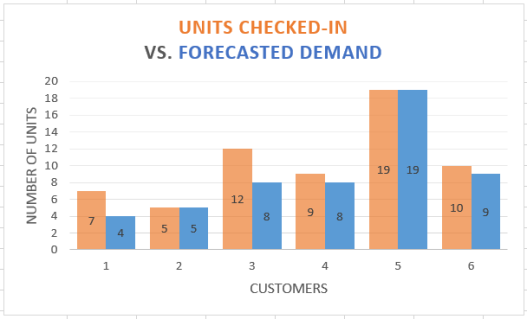

Figure 1
Units Checked-in vs. Forecast Demand

To correct this, a Software Engineer will add a new feature in the system used to control all the metrics in the area. The team will establish a limit per week of quantities that each customer can drop off in the input rack and the new feature will make sure that each customer doesn't exceed that limit. In this way, the customer will stop sending to the area units that are not really needed based on the demand forecast and are just delaying the schedule for the rest of the internal customers.

Managing Inventory Levels

Even having full staff working with healthy productivity levels, the area suffers from Work In Process (WIP) overflow which means that the storage racks are full and there are units on the floor. This is why the team wants to check if, even after balancing the line and controlling the input, there is still overflow and if so, what other technique or dynamic can be implemented in order to sustain lean inventory levels. Arena Simulation Software is the chosen tool to do this analysis.

Benchmarking

The team realized that sometimes companies don't need to re-invent the wheel because there are other companies that do the same kind of manufacturing and the knowledge can be shared.

The idea is to call several companies and check out who is available to facilitate a tour in an area similar to Conformal Coat. In this tour, the team will gather information about different ways that the company has managed similar issues and challenges.

RESULTS

Cross Training

The Process Engineer, together with the Training Department, developed the requirements to get an operator certified for all four processes. They decided to teach one process per week and to work on weekends to make up the output required.

Now, all the operators are capable to execute all four processes and are also trained on Lean

Manufacturing Basics. With the basic knowledge about Lean Manufacturing, the operators will be able to sustain all the changes implemented on this project and to identify new areas of opportunities themselves.

Line Balancing

Taking in consideration the forecast demand of 218 units per day and the process timings, the Process Engineer worked on the capacity analysis and also, on the line balancing. Table 1 shows the results of these analysis. The Production Manager needs only 12 operators instead of 13. Because they have all been cross trained already, operator #5 in process C can work on process D for 50% of his shift. This re-arrangement is equal to $53K in savings for the business because of Full-Time Equivalent (FTE) reduction.

Table 1
Capacity Analysis and Line Balancing Outcome

Capacity Analysis				
A	*B*	*C*	*D*	**Total**
4.51	1.90	4.41	0.49	**11.31**

Current Line Balancing				
A	*B*	*C*	*D*	**Total**
5	2	5	1	**13.00**

Proposed Line Balancing				
A	*B*	*C*	*D*	**Total**
5.0	2.0	4.5	0.5	**12.00**

Empowering Operators

The SOP was created, discussed with the operators and submitted as a reference document. After the submission, the Process Engineer audited the decision-making process for 3 weeks and provided feedback as needed. Currently, the operators have the knowledge and confidence to make decisions and continue the process.

Controlling Input

The team decided to allow the customer to check in 130% of their weekly forecast demand. The extra 30% is to allow them to work overtime just in case they are recovering from a bad previous month or if they have to expedite a customer order.

After 4 weeks, a feature demo was presented to all of the internal customers and implemented in production successfully. Now the operators in the area are working on the units that they should based on the demand forecast.

Managing Inventory Overflow

The Figure 2 shows how the simulation model looks using Arena. It was programmed using triangular distribution with 91% timing confidence level. The statistics were gathered after 10 runs of 30 working days including 1st and 2nd shift and manufacturing time of 440 minutes with no overtime included.

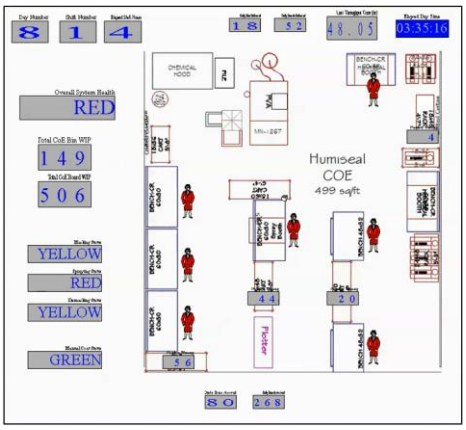

Figure 2
Simulation Model ilustration

The Process Engineer decided to evaluate the inventory levels of the storage racks using red, yellow and green as color codes. Red is when the rack is full, yellow is when more than the half is full and green is when less than the half is full. Table 2 shows the percentage of the time that each process was red, yellow and green for both, current and future cases.

Table 2
Current and Future Inventory Levels Outcome per Process

	Inventory Levels Color Codes		
Process	**Red**	**Yellow**	**Green**
A Current	0%	55%	45%
A Future	0%	67%	33%
B Current	91%	9%	0%
B Future	0%	0%	100%
C Current	0%	100%	0%
C Future	0%	0%	100%
D Current	0%	0%	100%
D Future	0%	0%	100%

The significant improvements showed in the simulation model for Process B and C occurred when the Process Engineer applied the following process dynamic changes:

- Process A operators will keep working on their regular task until Process B input rack is full. Once it is full, they stop doing Process A and will start helping Process C.
- Process B operators will keep working on their regular task until Process C input rack is full. Once it is full, they stop working on Process B and will start helping Process C.
- Process A and Process B operators will stop helping Process C once their storage rack is less than the half full.

These dynamic changes are essential to meet the objective of this project because they help to keep the inventory levels low which means that the customer is receiving the product back on time. By having operators with cross training, applying the recommended line balance, controlling the input and applying the above process dynamics, the simulation model shows that the throughput time can decrease from 37 hours to 6 hours.

Benchmarking

It was amazing experiencing a tour in another company. They shared knowledge and experiences about how they deal with changes and operators. For example, they have a system installed in all the operator's computers where the operator can write any feedback related to his area and the engineering staff meets weekly to read all those feedbacks and take action as needed. In that way, the operators feel heard and whenever there are changes, they are more open to follow instructions and cooperate. Lastly, the Process Engineer learned about different tools and manufacturing aids that they use for processes A and C.

CONCLUSION

This project's objective to reduce the throughput time of the area has been achieved. By combining cross training classes, line balancing analysis, empowering operators by creating the SOP, controlling the input with a new system feature and managing inventory with new process dynamics, the throughput time has been reduced from 37 hours to 6 hours.

The business impact is very significant. There is $53K in annual savings because there is a FTE that is not needed in the area anymore based on the line balancing analysis. Also, by starting to meet the OTD metric with the internal customers, the external customer's relationship is not at risk anymore. All this is great, but the business knows that there are more areas of opportunities. The facility site, has 4 more Conformal Coat areas in different organizations which are struggling in the same way. The next step would be to share all this knowledge with their respective Manufacturing Engineering teams and support them as needed during the implementation process.

REFERENCES

[1] Khalil A. El-Namrouty, Mohammed S. AbuShaaban.Seven Wastes Elimination Targeted by Lean Manufacturing Case Study "Gaza Strip Manufacturing Firms". *International Journal of Economics, Finance and Management Sciences*, Vol. 1, No. 2, 2013, pp. 68-80. doi: 10.11648/j.ijefm.20130102.12

[2] Manzouri, M., Ab-Rahman, M., Zain, C., & Jamsari, E.(2014). Increasing Production and Eliminating Waste through Lean Tools and Techniques for Halal Food Companies. *Sustainability*, 6(12), pp. 9179-9204. doi:10.3390/su6129179

[3] Carpinetti, L., & Martins, R. (2001). Continuous improvement strategies and production competitive criteria: Some findings in Brazilian industries. *Total Quality Management*, 12(3), pp. 281-291. doi:10.1080/09544120120034438

[4] Chadalavada, H., Raj, S., Kumar, A., & K, S. (2015). Production Lead Time Reduction in a Battery Manufacturing Unit using Lean Manufacturing. International Journal of Engineering Research and Technology, V4(04), pp. 842-847. doi:10.17577/ijertv4is040986