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The attached educational project, by, ARNOLD BATI entitled THE VALUE OF CELL MANUFACTURING, when completed, is to be submitted to the Graduate Faculty of the University of Wisconsin- Platteville in partial fulfillment of the requirements for the (MASTER OF SCIENCE IN INTEGRATED SUPPLY CHAIN MANAGEMENT) degree.

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MASTER OF SCIENCE IN INTEGRATED SUPPLY CHAIN MANAGEMENT

By

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Abstract

This seminar paper will examine the importance of implementing a cell manufacturing one-piece-flow. The current process of handling customer return referred to as Production Return Order (PRO) is very ambiguous because the products do not have their designated cell. The lean manufacturing concept and tools will be utilized throughout the process to arrive at its future state. The idea of creating a designated cell for the PRO units will be tested to ensure that it is the solution to ensure the return of the units to its' owner on time.

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THE VALUE OF CELL MANUFACTURING

Introduction

A culture of continuous improvement is crucial to organizational performance and survival (Power, 2012). Companies must review their processes to make sure that they are robust and are updated to support the voice of the customer. The voice of the customer help defines customer expectation, desires, and concern. Many customers have voiced their concern on how Honeywell plant 1017 is handling or the lack there of Production Return Order (PRO). PRO units are any end units or detail units that are returned by the customer due to rejection of deficient material, damage by the customer, modification or upgrades, and engineering programs that require material to be returned for investigation, repair or upgrade of new units. **The current PRO process was created to track the units in their initial stage but not the flow through product completion. The design, planning, and operation of a supply chain have a strong impact on overall profitability and success (Chopra & Meindl, 2013). Once the products are received and transferred to the cell for testing and evaluation, the products are put aside because priorities are given to new assemblies that will add revenue to the plants' bottom line. The lack of importance and priority have resulted in multiple letters of concern from various customers demanding their paid units be reworked and return as soon as possible.**

The current process does not have cell ownership. The PRO unit must be returned to its original cell and wait on availability, which rarely happens because of prioritization or lack of detail parts. This is an ongoing problem and must be resolved to reestablish customers' trust and improve the plants reputation in the organization.

Assumptions

When evaluating the design of a supply chain, it is essential first to recognize customer demands and use that knowledge to formulate a supply chain strategy to meet those demands (Crandall, Crandall & Chen, 2010). To ensure the plant successfully meet customer requirement on PRO units, a new cell manufacturing (CM) must be designated to rework the PRO units. Cellular manufacturing integrates machinery and a small team of staff, directed by a team leader, so all the work on a product or a part can be accomplished in the same cell, which eliminates resources that do not add value to the product (Wang, 2015).

Methodology

The primary approach to the need and design of cellular manufacturing system is based on PRO cell data collection, lean concepts, one-piece-cell strategy, JIT, and theories in building customer trust. Kaizen events assisted in identifying current and future state of the cell.

Literature Review

Manufacturing plant must be flexible to support the changes and challenges that come with customer expectation. Although many theories and applications are available, companies are employing the concept of Cell Manufacturing (CM). Literature refers to cellular manufacturing as Lean manufacturing, one-piece-flow, or Just-in-time (JIT) and is often terms that used interchangeably. CM is the most advanced application of group technology (GT). GT is an approach to manufacturing that seeks to maximize production efficiencies by grouping similar and recurring problems or tasks (Hyer & Wemmerlov, 1984).

Companies that are looking at improving their current processes need to carve large unit into small subsets that could focus on one component or a narrow family of components, thus adopting the theories of cell manufacturing. When a cell is designated to process a family of products, it makes it easier for the supply chain to manage and support its requirement. Hewlett-

Packard, Kodak, Control Data, and Westinghouse are among other large companies that are breaking up functionally organized production centers and rearranging resources into a focused cell manufacturing (Schonberger, 1987).

Focusing on company objectives and the concept of cell manufacturing have also resulted in a reduction in setup times, material handling, work-in-process, cycle time, and tooling requirements. One U.S. manufacturer, EG&G Sealol in Warwick, Rhode Island, found that after producing 900 parts (representing about 30% of all standard hours in the factory) in manufacturing cells, work in the process dropped by 20% to 30% and the need for floor space declined by 15%. For one example, Sealol turned out 324 parts in one cell with seven machines, whereas before the parts had been routed to 22 machines. All of these improvements contributed to a 150% rise in total output (Klein, 1990).

Lean manufacturing strategy process has helped many small businesses to be competitive in today's market. The philosophy of lean manufacturing helps new small business owners to define strategies that aides in pursuing a clear path that involves continually changing direction to take advantage of new opportunities (Collis, 2016). The process starts with the business owners creating the company's vision and translating it to critical steps that lead to the company's success. New ventures of all kinds are attempting to improve their chances of success by following lean principles (Blank, 2013).

Several studies have also shown that there is a correlation between employee satisfaction and lean manufacturing (Vidal, 2007). Companies that are transparent and have employee involvement during the initiation to the completion phase of the cell manufacturing stage have experienced positive changes in employee morale. A survey conducted showed that cell employees are more receptive to changes, identity as part of the group, communicate better, and

ranked “teamwork” as one of the most essential human-related factors in cellular manufacturing companies (Alony & Jones, 2008).

A company’s success is measured not only by its financial success but also on how it handles external regulations and the environment, especially when outsourcing overseas. Cellular Manufacturing is now being viewed as potentially beneficial to the environment according to the Environmental Protection Agency because CM helps eliminate overproduction and reduce waste (Witt, 2006). CM is also being acknowledged for reducing red tapes at developing countries. A recent study conducted with Nike manufacturers in developing countries suggests that the transition from mass production to cell manufacturing resulted in compliance with labor standards. On average, a serious violation of labor standards fell by fifteen percent points, from 40% of factories to 25% (Distelhorst, 2016).

Research and studies of lean manufacturing have shown positive results to organizations, workforce, stakeholders, and its environment (Yang et al., 2011). The lean concept has taken the manufacturing world by storm and has dominated the manufacturing world for the last twenty years or so (Liker, 2004).

Discussion

Additional Background

Most companies continue to view returns as a costly nuisance, and few have formal strategies for dealing with products (Connell, 2007). Honeywell plant 1017 is currently carrying $12.5 million in an inventory of product return order (PRO) due to lack of priority, process, and capacity. Based on a report published daily by the PRO lead, the plant is carrying unit that is over 500 days old. The plant current PRO process is not robust and has gaps within the steps to support the objective of re-building the units under the contract written against each PRO unit.

Lead time is assigned to each PRO unit based on the item criticality and past-due status of the Original Equipment Manufacturer (OEM) unit. Based on the data reviewed, the plant has not shipped any PRO unit within its requested delivery window. Companies that serve customers who are in a state of stress are especially vulnerable to losing customers' trust when they perform poorly (Berry, 2017). Customer complaints have increased with the plants' OEM on-time delivery of ten percent, and PRO on-time delivery of zero percent. The management team needs to allocate resources to review current processes to improve its dismal relationship with its customers.

Manufacturing executives need to understand and resolve the gaps within their processes. Managing the flow of finished products back into the company can be an essential profit driver, writes Vaidyanathan Jayaraman and Yadong Luo, of the University of Miami School of Business Administration, in a recent issue of the Academy of Management Perspectives (O'Connell, 2007). When customer returns are handled correctly, and on time, the business will flourish because of customer satisfaction. However, when customers are not satisfied, they will make their voices heard and could affect the viability of the company. The customers have voiced their concern to the customer management team that escalated the plants' failure to meet customer delivery on time to the corporate executive team. The concern was not taken lightly because of the declining future orders. The forecast for the coming year based on the purchase orders from customers have declined from the prior years. Customers have shared their voice, and they are very "unsatisfied." The customers are asking for their PRO units to be processed and return to them as soon as possible. The PRO units are paid customers products and are returned because they did not pass the test at the customers' site. These units have no-fly time associated with

them, therefore, consider as new units. The customers do not receive credit when they return these units; thus, the urgency of wanting them back based on the lead time given on the contract.

The escalation of the customer management team has resulted in a corrective action preventive action (CAPA) being issued to the plant. CAPAs are issued to an entity that has an issue that proves to be repetitive and systemic, or it is something that is quite severe (Speer, 2017). The plant director, along with the quality, production, supply chain management has agreed that a lean manufacturing process with dedicated one-piece flow cell must be created to support the reduction of PRO units.

One-piece flow is driven by the needs of the customer and exists when products move through process one unit at a time continuously without unplanned interruptions and without lengthy queue times (Wang, 2015). A focus on flow has been the foundation for Toyota's success globally in the 21st century (Liker, 2004). Therefore, a designated cell with dedicated lead, planner, and technicians will reduce past due PRO units, and shipping them on time per contractual agreement.

Lean Manufacturing

The Lean principle has been the success of many companies. The five principles of Lean thinking are associated with these five-step process: (1) defining customer value, (2) defining the *value stream,* (3) making it *flow*, (4) *pulling* from the customer back, and (5) *striving for excellence* (Womach & Jones, 2003).

(1) *Value* is defined by the end customer – they are the ones determining what is of importance to them. For example, a planner who is dedicated to the PRO cell would be of value because someone will be able to identify, allocate, and issue parts needed to fix the unit. (2) *A value stream* is the path the product follows from raw material to finished product. At this stage of the

process, the goal is value-added in every step of the way. An added value to the customers' perspective. For example, a PRO unit sitting on a shelf for an extended period is not considered value-added. Time is being wasted while the customer waits for the return of the unit. (3) Making it *flow* refers to the value stream as a constant flow. Lean production is concerned with making sure the process flows from one to the next. For example, if the PRO unit is waiting for a raw material or test result, it must be processed once an operator becomes available. (4) *Pulling* from the customer back means production order is only created when there is a customer order in the system. For example, do not start processing a PRO unit until after the customer has approved the quote. (5) *Striving for excellence* means always doing the right thing for the customer. For example, if a PRO is considered critical and causing a line down, meaning an aircraft is down because of the PRO unit, the company should try to fix it and put the unit ahead of regular units.

The lean principles have one goal – to eliminate waste in the chain or process by cutting excess capacity or inventory and removing non-value-added activities (Krajewski et al., 2016). According to Krajewski et al., the following waste must be identified and eliminated when implementing leans systems. Waste and definition are defined below.

(1) Overproduction – Manufacturing an item before it is needed, making it difficult to detect defects and creating excess lead times and inventory.

(2) Inappropriate processing or extra-processing – Using expensive high-precision equipment when simpler machines would suffice. It leads to overutilization of expensive capital assets. Investment in smaller flexible equipment, immaculately maintained order machines and combining process steps where appropriate, reduce the waste with inappropriate processing.

(3) Waiting – Wasteful time incurred when the product is not being moved or processed. Long production runs, poor material flows, and processes that are not tightly linked to one another can cause over 90 percent of a product's lead time to be spent waiting.

(4) Transportation – Excessive movement and material handling of product between processes, which can cause damage and deterioration of product quality without adding any significant customer value.

(5) Motion – Unnecessary effort related to the ergonomics of bending, stretching, reaching, lifting, and walking. Jobs with excessive motion should be redesigned.

(6) Inventory – Excess inventory hides problems on the floor, consumes space, increases lead times, and inhibits communication. Work-in-process inventory is a direct result of overproduction and waiting.

(7) Defects – Quality defects result in rework and scrap and add wasteful costs to the system in the form of lost capacity, rescheduling effort, increased inspection, and loss of customer goodwill.

(8) Underutilization of talent – Failure of the company to learn from and capitalize on its employees' knowledge and creativity impedes long-term effort to eliminate waste.

A just in time (JIT) system organizes the resources, information flows, and decision rules that enable a firm to realize the need for continuous improvement in quality and productivity (Krajewski et al., 2016).

One-Piece-Flow

Companies that attain one-piece flow are setting in motion numerous activities to eliminate all muda (waste) (Liker, 2004). Liker also identified the following benefits of one-piece flow.

(1) Build-in Quality. It is much easier to build in quality because every operator is an inspector and works to fix any problems in the station before passing them on.

(2) Creates Real Flexibility. Lead time is shorter; therefore, more flexibility is available to respond and make what the customer wants.

(3) Creates Higher Productivity. It is easier to measure productivity because the operation is organized by family. Machine utilization and operator utilization are measured effectively because there is very little non-value-added activity, such as moving materials around.

(4) Free up Floor Space. When equipment is organized by department, there is plenty of space wasted between equipment. Inventory also take space while they wait to be labored on.

(5) Improve Safety. Small batches mean getting rid of forklift trucks, which are the primary cause of accidents. Smaller kits and small containers of raw material with a focus on flow translate to ongoing safety without putting much attention to it.

(6) Improve Morale. Operators do much more value-added activities, and results are immediate, which give them both a sense of accomplishment and job satisfaction.

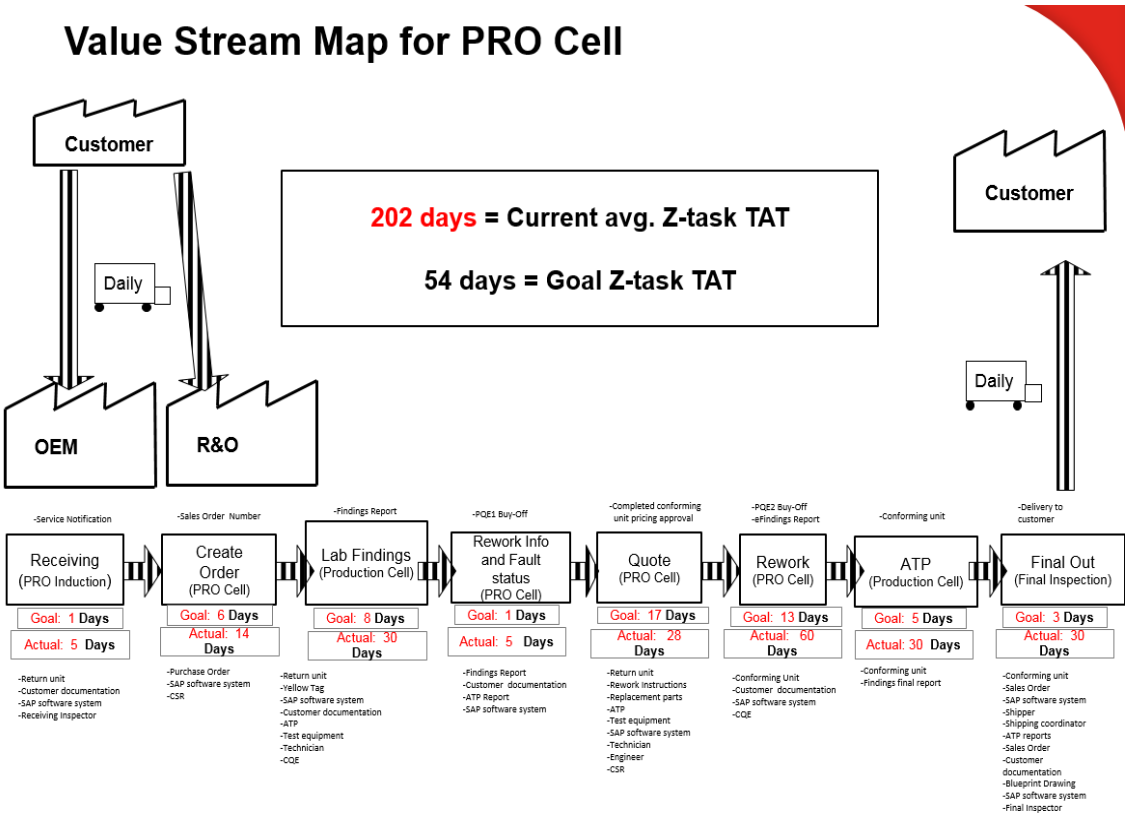
(7) Reduce Cost of Inventory. There is less investment in inventory and inventory obsolesce goes down.

One-piece flow manufacturing has many advantages but creating one is very difficult because flow tends to force the implementation of a lot of other lean tools and philosophies such as preventive maintenance and built-in quality (jidoka) (Liker, 2004). Companies must embrace and create continuous process improvement within the chain.

The Plants' Actions

Implementation stage

The plant performed three-day kaizen (continuous improvement) workshop to identify ways to improve the current process. Value Stream Mapping (VSM) is a widely used qualitative lean tool aimed at eliminating waste. VSM is helpful because it creates a visual map of every process involved in the flow of materials and information in a products value chain (Krajewski et al., 2016). A team was chosen before the kaizen event. The personnel were selected because of their familiarity with the processes and their can-do attitude. The workshop was attended by the OEM cell leads along with operators who have handle PRO units, two representatives from the quality team, two engineers, and two personnel from the supply chain group. The author was assigned as the VSM leader who will be responsible for the product family where the VSM process is carried out. The VSM leader will be responsible for providing the required data and information and for the leading the cell creation. Below is the value stream map created based on data available during the workshop.



In the current process, the PRO units are returned to its original cell and compete with the OEM units. The OEM units are given priority over PRO units due to the financial impact they bring to the company. The PRO units only deliver a fraction of what an OEM unit add to the financial success of the company. The plant management believed that meeting the monthly financial goal leads to the success of the plant and the company. This is not true in this case because the customers have voiced their concern and are being heard.

The VSM identified the following critical paths below as well as the average turnaround time (TAT) associated with each process. The critical path is referred to as Z-task.

1. Receiving (PRO induction). At this process stage, the unit is inspected for damages during the freight, documentation validated and returned in the system. The current average TAT is five days.

2. Create Order. A request is submitted to the Customer Service Rep (CSR) in India to create a purchase order. The current average TAT is 14 days.

3. Lab Finding. The PRO unit is sent to the test cell to evaluate the unit. A test technician, Customer Quality Engineer (CQE) and Aerospace Manufacturing Engineer (AME). The current average TAT is 30 days.

4. Rework info and Fault Status. At this stage, the AME determines if the product returned is customer fault (customer responsible and pays for rework, or scrapping of the product; the plants fault (plant is responsible for fixing return); or no fault found (negotiates with customer on how to handle PRO unit). The current average TAT is 5 days.

5. Quote. A completed quote must be submitted to the CSR team that shows the itemized work and supplies needed to perform the rework of the PRO unit. No quote is needed if it is the plants'

fault. When the quote is approved, the CSR will ask the customer to approve. The current average TAT is 28 days.

6. Rework. The operator adjusts the PRO unit based on the findings. The current average TAT is 60 days.

7. Acceptance Test Procedure (ATP). The rework PRO unit is retested to validate that it is now a confirming unit. The current average TAT is 30 days.

8. Final Out. A final inspection is performed by quality inspectors to ensure that the PRO unit is acceptable based on current quality guidelines. The current average TAT is 30 days.

Note: The data collected only represented was only for two months because data collection did not exist.

The VSM team reviewed the current PRO open order report to understand the severity of the situation and how to handle to situation. The following data (Table 1) is collected to show the family distribution and the average age of each outstanding unit.

Family	Number of units	Avegae age of units
C01	218	137
C03	22	143
C04	118	245
C05	14	601
C06	1	53
C08	5	61
C10	14	381
C12	132	216
C07	34	182
Grand Total	559	198

Table 1. Total PRO units

The VSM team will create a one-piece-cell that will resemble the current family distribution. The cell will consist of three station and three operators. The family distribution will be as follows: Family 1: C01/C04/C08; Family 2: C03/C05/C08; and Family 3: C07/C10/C12.

The customers that are a member of the Defense system and have orders that are flagged Defense Priorities and Allocation System (DPAS) will be given priority. DPAS is used to prioritize national defense-related contacts/requests throughout the U.S. supply chain to support the military, energy, homeland security, emergency preparedness, and critical infrastructure requirements (Freeman, 2018). DPAS units are more complicated than regular units because of the new processes created for them by the government. Table 2 below summarizes the number of units associated with DPAS orders that will process ahead of other orders.

Family	Number of DPAS units	Average age of units
C01	2	175
C03	8	155
C04	0	0
C05	2	165
C06	0	0
C08	1	45
C10	0	0
C12	30	312
C07	2	150
Grand Total	45	112

Table 2. DPAS orders

Creation of One-Piece-Cell

Centralized location was chosen to minimized transit times. The VSM team chose this location because it is located near the shipping and receiving warehouse, next door to final inspection and engineers, and the test cell where the incoming and final ATP test is conducted. The 14x30 location is big enough to support the current requirements. The allocation of resources to modify the existing infrastructure of the cell location took about two weeks. The stations were set up,

bins that will separate the PRO units based on their current Z tasks, and a whiteboard that will act as the visual management system.

Due to the complexity of the PRO units, the plant transferred a supervisor who has been part of the quality system for the last fifteen years. Three of the most experienced operators who are very knowledgeable about the ERP, and quality system were also chosen to be part of the PRO cell. A planner has been hired and is in training currently. The pictures below show the current state of the cell.

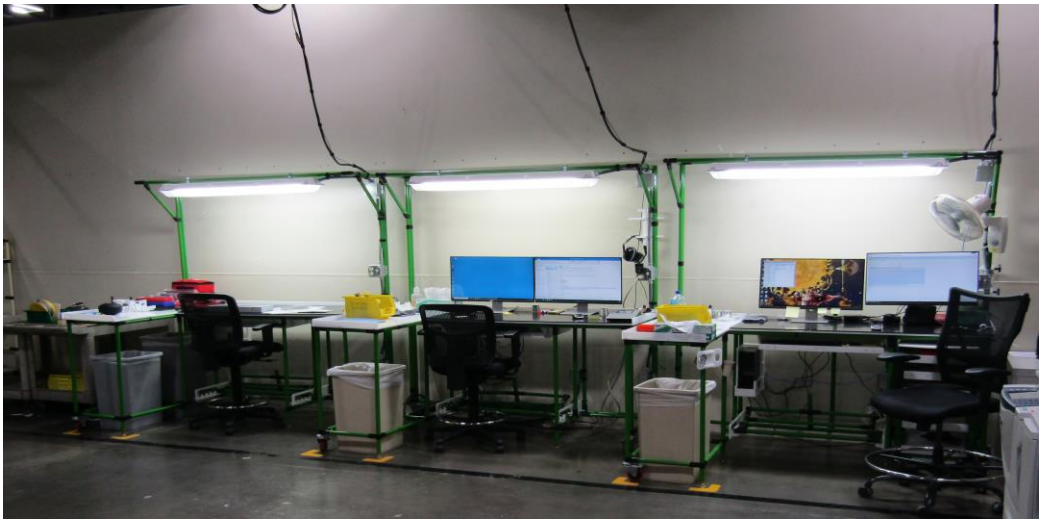


Figure 1. Three different station based on family distribution

Figure 2. Visual management system to capture metrics and problem escalation

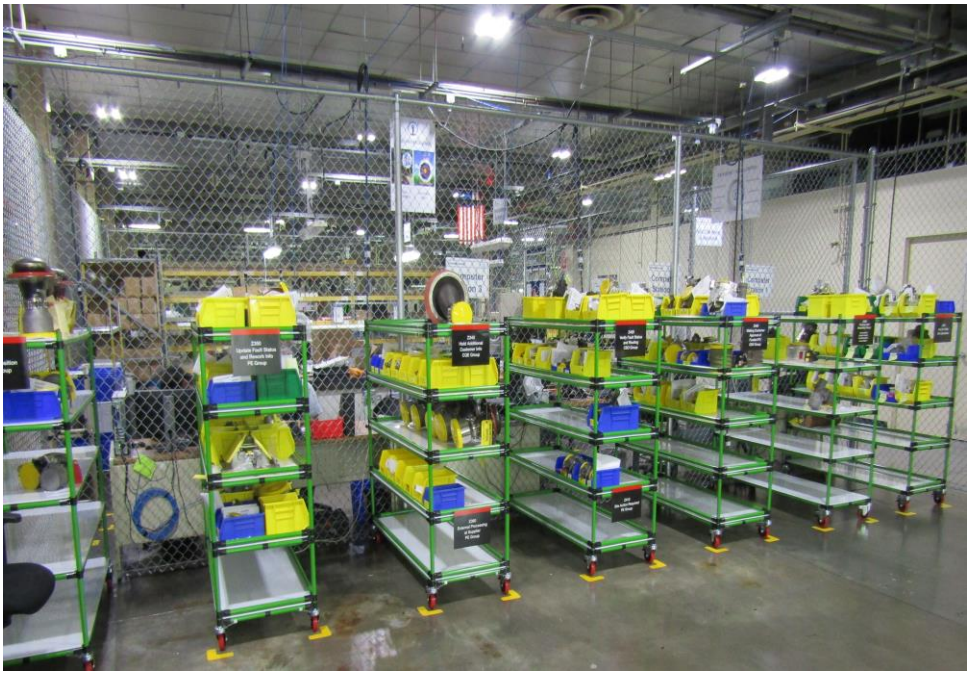


Figure 3. PRO unit storage based on Z-task status

Initial Results

The PRO cell operators were motivated and were eager to complete their first challenge. The VSM team has decided that DPAS orders will be given priority due to product difficulty and contract sensitivity. The cell's current goal is to complete ten units per week. The PRO units were prioritize based on its criticality received from the customer. Since the planner is in training, the senior production control analyst took charge of expediting material requirements. The DPAS rule was put in place, and all available units were assigned to the PRO units instead of the OEM units. Table 3 shows the improvement of the PRO processing after the cell was created. The decision to allocate raw materials to PRO units ahead of the OEM was a monumental decision that was necessary to ensure the success of the cell. The aerospace industry is very competitive and many large organizations are vying for the same suppliers.

Family	Number of DPAS units	Average age of units	TAT after the PRO cell
C01	2	175	2
C03	8	155	5
C04	0	0	0
C05	2	165	2
C06	0	0	0
C08	1	45	1
C10	0	0	0
C12	30	312	14
C07	2	150	1
Grand Total	45	112	25

Table 3. Result after the cell

The old process resulted in shipping two PRO units' week, and the new method resulted in shipping three PRO units per day, which is an increase of 87%. The cell cleared all of the 45 units associated with DPAS orders in about nine days.

Future state

Due to the initial success of the PRO cell, the VSM team has decided to create a swimlane diagram for the future state. A swimlane diagram provides a visual representation that groups functional areas responsible for different subprocess into lanes and is most appropriate when the process spans several department boundaries (Krajewski, et al, 2016).

The swimlane has the same task as the original values stream map except that goals have improved immensely from where the project started. The initial finding of 202 days to ship a PRO unit to the goal of 54 days has now been moved to 25 days. Table 4 and table 5 are the swimlane diagrams created to support the project.

PRO Process	Induction	PRO Cell (Day 1)	Lab Findings (Day 2)	Post Lab Findings (Day 5)	Pricing (Day 16)	Rework (Day 18)	ATP (Day 20)	PRO Cell (Day 21)	Final Inspection (Day 23)	Source/Ship (Day 25)
QA	1. Confirm Escape 2. Initiate Car 3. Implement Stop Ship 4. Deliver PRO to PRO cell 5. Add Cross functional team into CAR 6. Notify cross functional team of stop ship via email and request ECD for lab finding 7. Move to Z300		1. Factory QE/EMT witness lab findings	1. Confirm Data 2. Correspond with customer 3. Attend Huddle meeting 4. Ensure rigor in CAR response 5. Lift stop after CAR response completed and Z350 dispositioned 6. Notify customer of aging response 7. NOE to customer Hand off to IRB, NFF team 8. Owns-02 CAR lead if initiated to supplier	1. Inform customer of aging response to quote				1. Address QN issues 2. Inspects unit 3. QNs for issues 4. Move unit to source or shipping shelf 5. Move unit to QN shelf	1. Customer approval to ship 2. Inspect unit 3. QN for issues 4. Move unit to QN shelf 5. Move unit to shipping shelf
AME	1. Do completion 2. Purge as required 3. Verify reason for return if provided			conduct tear down/witness 2. Disposition unit 3. Move out of Z350 4. Enter containment/CAR response 5. Attend Huddle meeting 6. Input hours, rewor, etc. for pricing 7. Purge inventory if necessary 8. Issue-02 CAR 9. Request engineering input 10. Move to 345 for more infor from customer	1. Fix site action if necessary 2. SCRAP unit if necessary 3. Update scrap comments in QN 4. If too big take to bins outside				1. Address QN issues	1. Address QN issues

Table 4 QA and AME actions throughout the process

PRO Process	Induction	PRO Cell (Day 1)	Lab Findings	Post Lab Findings	Pricing (Day 16)	Rework (Day 18)	ATP (Day 20)	PRO Cell (Day	Final Inspection	Source/Ship
OPS	1. Check WIP and shipped for PN put into CAR		1. Schedule test 2. Conduct test 3. Notify engineering if unit fails 4. Info into ship pass down NOT work accomplished 5. Move to Z350	1. Attend Huddle meeting 2. Help determine cause and fill cause chain 3. Purge WIP on floor	1. Dissamble and place on PRB/scrap 2. SAP Scrap		1. Runs ATP 2. Set schedule for ATP 3. Deliver finished unti to PRO cell 4. Fail ATP code back to Z300		1. Address QN issues	1. Address QN issues
MAT						1. Order Parts if needed 2. Sets priority for part delivery				
PRO Cell		1. Conduct Pre Lab 2. Visual Inspection 3. Input info to SAP 4. Deliver unit to Production cell		1. Conduct teardown 2. Attend Huddle meeting	1. Move according to Zcode	1. Rework unit 2. Updates Z9 work accomplished 3. Move unit to ATP		1. Move unit to Z660 2. Delivers unit to final inspection		
CSO/CSR/PRO	1. Create PO				1. Submit quote to HON or Cust 2. Send back for site action 3. Send SCRAP approval to AM				1. Fixes pricing blocks 2. Fixes various holds	
CAR Response	1. D0 Completion			1. Containment Submitted 2. CAR response submitted 3. Cause chain attached	1. SPOC approval 2. Lead approval			1. Owner Implementation submitted 2. Objective evidence attached		1. Follow up review submitted

Table 5 OPS, Materials, PRO Cell, CSO and CAR actions throughout the process

CONCLUSION

Companies must continually improve their process to ensure that customer needs are being satisfied. Supply chain management is in constant change that is causing the non-stop evolution of customer requirement. The principle of Lean Manufacturing, Cell Manufacturing, One-Piece-Flow, or “Just-in-Time” is to ensure that wastes are eliminated and that customer needs are the primary concern of the company. The creation of the One-Piece-Flow cell, along with the necessary lean principles, has resulted in improving turn-around time (TAT) and customer satisfaction. The project started on June 15, 2019, with 559 open PRO orders and an average depth of delay of 198 days. The result has been astounding because the PRO units on open orders dated July 10, 2019, was 400 units with an average depth of delay of 75 days. The cell is a success because the actions that were taken to resolve the CAPA is monumental. Many customers have complained in the past about their past dues, but this is the only time where a tangible solution was put in place. The systemic issue is no longer a problem, and customers have given praise to what was done to ensure that their PRO units are being returned to them at a pace they have not experienced before. So yes, the idea of creating a cell designated to PRO units has improved customer on-time delivery as well as rebuilt customer trust.

References

Alony, I. & Jones, M. (2008). Lean Supply Chain, JIT and Cellular Manufacturing – The human side. *The Journal Issues in Informing Science and Information Technology,5, 166-174.* Retrieved from https://pdfs.semanticscholar.org/ce0b/4663d2818102fb1eb34ae9ee15912feb16a9.pdf

Berry, L. (2017, April). How Service Companies Can Earn Customer Trust and Keep It. *Harvard Business Review.* Retrieved from https://hbr.org/2017/04/how-service-companies-can-earn-customer-trust-and-keep-it

Blank, S. (2013, May). Why the Lean Start-Up Changes Everything? *Harvard Business Review.* Retrieved from https://hbr.org/2013/05/why-the-lean-start-up-changes-everything

Chopra, S., & Meindl, P. (2013). *Supply Chain Management. Strategy, Planning, and Operation.* (5th ed. pp. 6-7). United States of America: Pearson.

Collis, D. (2016, March). Lean Strategy. *Harvard Business Review.* Retrieved from https://hbr.org/2016/03/lean-strategy

Crandall, R., Crandall, W., & Chen, C. (2010). *Principles of Supply Chain Management.* (1st ed. pp. 136-137). Boca Raton, FL: CRC Press

Distelhorst, G. (2016, May). Can Lean Manufacturing Put an End to Sweatshops? *Harvard Business Review.* Retrieved from https://hbr.org/2016/05/can-lean-manufacturing-put-an-end-to-sweatshops

Hyer, N. & Wemmerlov, U. (1984, July). Group Technology and Productivity. *Harvard Business Review.* Retrieved from https://hbr.org/1984/07/group-technology-and-productivity

Klein, J. A. (1990). *Revitalizing Manufacturing Text and Cases.* (1st ed. pp. 391). United States: Manufacturer: Technological innovations

Krajewski, L.J., Malhotra, M.K, & Ritzman, L.P. (2016). Operations MANAGEMENT Process and Supply Chains. (11th ed.). United States of America: Pearson

Liker, J. (2004). *The Toyota Way. 14 Management Principles.* (1st ed.). United States of America: McGraw – Hill

O'Connell, A. (2007, Nov). Improving Your Return on Returns. *Harvard Business Review.* Retrieved from https://hbr.org/2007/11/improve-your-return-on-returns

Power, B. (2012, Sep). Understanding Fear of Process Improvement. *Harvard Business Review.* Retrieved from https://hbr.org/2012/09/understanding-fear-of-process-improvement

Schonberger, R. (1987 Sep). Frugal Manufacturing *Harvard Business Review.* Retrieved from https://hbr.org/1987/09/frugal-manufacturing

Speer, J. (2017, April). CAPA: When to Take Corrective Action or Preventive Action? *Quality Management System (QMS).* Retrieved from https://www.greenlight.guru/blog/capa-corrective-action-or-preventive-action https://hbr.org/2007/11/improve-your-return-on-returns

Vidal, M. (2007, March). Lean Production, Worker Empowerment, and Job Satisfaction: A Qualitative Analysis and Critique. *Research Gate.* Retrieved from https://www.researchgate.net/publication/200552324_Lean_Production_Worker_Empowerment_and_Job_Satisfaction_A_Qualitative_Analysis_and_Critique

Wang, J.X. (2015). *Cellular Manufacturing* (1st ed.). New York, NY: CRC Press

Witt, C. (2006, Dec). Benefits of Cellular Manufacturing. *Material Handling & Logistics.* Retrieved from https://www.mhlnews.com/facilities-management/benefits-cellular-manufacturing

Womack, J. P., & Jones, D. T. (2003). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* (1st ed.). New York, NY: Free Press.

Yang, M. & Modi, S. (2011, Feb). Impact of Lean Manufacturing and Environmental on Business Performance: An Empirical Study of Manufacturing Firm. *International Journal of Production Economics.* Retrieved from https://www.researchgate.net/publication/264623122_Impact_of_Lean_Manufacturing_and_Environmental_Management_on_Business_Performance_An_Empirical_Study_of_Manufacturing_Firms