PRM Operations Cores Cell Takt Time Kaizen

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Abstract *— This article refers to, how UTAS handles the optimization of a CORE a cell in the manufacturing process. Companies have waste that can be reduce with an optimization of the manufacturing process. Steps to accomplish a reduction are: educate the employees to raise awareness of the significance of Waste, align the processes of dispatch in the manufacturing area, continuously measure performance of production, have a TPM program, and perform audits. To carry out the study, the technique of DMAIC was implemented. In the end, the project was to obtain the support from the plant personnel and work together to improve the company's culture.*

Key Terms *— ACE, CORE Cell, DMAIC, Takt Time.*

PROJECT STATEMENT

Current work load at PR-5 Core is not balanced to meet Takt time; it also has several turn backs that affects the operations. Planner requests are not aligned to the amount of fixtures available and lean principles are not implemented. Current state map does not exist; it is required to depict the complexity of the process.

RESEARCH DESCRIPTION

The Kaizen Event will focus in the proposal improvement of takt time for operations – production demand in the Cores Manufacturing Cell at PR5 building to meet customer demand.

RESEARCH OBJECTIVES

The Kaizen objectives are divided into two main areas that will address in the event: Align cell takt time, and floor plan lay out.

RESEARCH CONTRIBUTION

With the Kaizen event completion the PR-5 Core cell should have a balance processes to takt time, a one piece flow achieving 25% WIP level reduction, 30% reduction in cycle time, process variation and walking distances, and achieve 21% improvement in On Time deliveries.

Literature Review

United Technologies Aerospace Systems has a variety of products for the Aerospace industry, which are manufactured all around the world, and are distributed to different clients around the world as well.

The demand of such products is already established in an MRP (Materials Requirements Planning), there are products that are manufactured consistently on a daily basis, due to their high demand. Their volume allows the capability to be balanced the manufacturing cell in terms of workload, machine capacity, man power capacity, and are operated on a Lean principle.

Is easier to maintain a cell specialized in one product, than a cell with a high mix of products varying in production volume as well. With a high mix of products cell, the MRP (Materials Requirements Planning) is more complex since there are products that have different demands, but uses the same equipment as the high demand products, creating sometimes a bottleneck, if the manufacturing cell is not balanced to sustain a constant flow of the manufactured parts.

Every manufacturing plant has its own demand calculated by Operation Management based on the Customer's requirements or the market's demand. To meet such demand, the production floor must manufactured and/or assembly a certain number of products in their available production time per day, from the start of the process to a finish good.

Therefore the companies have a "Takt Time", defined as available time (1 shift, 2 shifts, 3 shifts, etc. the shifts hours would vary per company as desired) over customer's demand.

UTAS is no exemption of the Takt Time idea in its processes, except that every manufacturing cell has its own Takt Time, because every cell manufactures different products and not every product has the same manufacturing process. Products that have similar processes are grouped in product families, to design a more efficient manufacturing production line.

In an effort to reduce the challenges above, and achieve the customer's demand within the established Takt Time, a Kaizen event has being created to balanced out the production at UTAS manufacturing site located in Puerto Rico (PRM). The PRM site has four manufacturing buildings where different products are shipped out to the Aerospace customers around the world. At building PR-5, the client is internal. So, PR5 manufactures product to feed the process of other buildings.

The importance of achieving the customer's demand on time for PR5 is vital for the business, since its products are awaiting another process, and it could have a major impact in UTAS end customer. On time delivery for each of PR-5 manufacturing cell is a critical key for other buildings meet their demand as well.

In order to maintain low cost, meet our customer's demand, and management cost goals, many areas of opportunities have being identified in a Lean exercise to find improvement areas. The initiative was started when PR5 started to fall short on OTD (on time delivery). PR5 started to balance their production lines by adding more shifts to meet the customer's demand, but as an effect, the cost started to increase as well.

With a goal of OTD (on time delivery), and budget restraints, a Lean transformation team was developed to look for areas of improvements. The team's goal is to study the PR5 operation logistics, manufacturing process flow, shop floor lay out, and process improvement overall. The Lean transformation team will work closely with the Planner, QE (Quality Engineer), ME (Manufacturing Engineer), OCM (Operation Chief Manager), and Operators to collect all the require data.

A Kaizen event at UTAS is the deployment of different tools to implement a change seeking improvement in the leanest possible way. The tools used in these events are established by UTAS Quality Management System, ACE (Achieving Competitive Excellence). The event is lead by an ACE Leader (an expert in the ACE tools), to guide the groups in the event step by step, and to ensure that each step is completed successfully within the scope of it.

PR-5 Kaizen event consisted on balancing the Manufacturing CORE Cell, which it included the shop floor lay out, operations work load balance, process flow, and other areas of opportunities as they were found in the Kaizen event.

After the completion of the event, an out brief is presented to management (consisted of: Operational Chief Manager of PRM5, PRM Director, and PR Director) and the team. The purpose of the out brief is to summarize the worked done in the event at a high level for management, and most important to present the need for capital budget for the implementation, as well as other ideas that will be implemented.

As a requirement, a simulation will be presented to management (consisted of: Operational Chief Manager of PRM5, PRM Director, and PR Director). Management will share their feedback based on the simulation.

METHODOLOGY

The ACE program uses the DMAIC concept to approach this king of events. In the DMAIC, the ACE program has already a format for each section of the DMAIC.

Each section was analyzed using the formats provided, and deployed with the data collected from the CORE Cell.

The DMAIC concept is divided into five sections that will help Define the problem, Measure

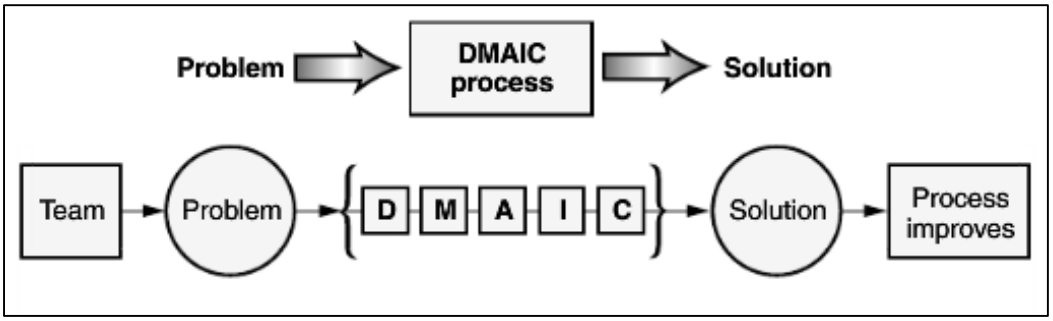

Figure 1
DMAIC Process Breakdown

the data, Analyze new changes, Implement the changes proposed, and Control the outcome of the changes. This concept has a wide variety of application in the Quality field, but for this case is being used to improve a production line.

In the Define phase of the DMAIC [1] concept a PQ analysis, Process Matrix and Part Family Definition was used to complete this phase.

- The PQ analysis was used to determine the production volume of the Parts, to help determine the product families.
- The Process Matrix is a tool that enables you to group processes in families per Part Numbers; the processes mostly shared by the parts are a group of processes, this will help in the layout of the floor.
- Part Family Definition is the combination of the high runner parts, were it was determined with a 80/20 (80% of the production is 20% of all the parts) with the process matrix group to create a Part Family group, where most of the parts have most of the processes in that production line, but a slightly difference in the design.

In the Measure phase a Spaghetti Diagram, and Operations Bar Chart were deployed to collect the data to be evaluated.

- For process plants, one method is to lay the plant out so that the material flow follows the process flow diagrams [2]. The Spaghetti Diagram is used to measure the flow travel of the part in the production line. This is used to determine the actual state of the production flow, and to measure how much distance the operator is traveling.
- Operations Bar Chart is analysis of how long the operations take based on the high runner part of one specific product family. The purpose of this analysis is to balance the operation based on the Takt time, to determine if a specific operation needs more than one shift to meet the customer's demand.

In the Analyze phase, the data collected was used to calculate the optimum Takt time.

- Takt time is the rate at which a finished product needs to be completed in order to meet the customer's demand [3]. In this case, the Takt Time was calculated for one to three shifts, per each product family.

The Improve phase is where all the ideas were implemented by Eliminating Waste, Balancing Operations, Optimize Operators and Choose Concept.

- Eliminating Waste was a series of findings during the Gemba Walk, where most of the actions were done instantly and didn't required major analysis.
- To Balance the Operations the Operations Bar Charts were used to determine how many shifts were going to be used to achieve the Takt Time, and prevent a bottleneck in operations where the average time was above the Takt Time proposed.
- To Optimize Operators every operator that had minimum touching time to the part, and assigned an automated operation, was used to

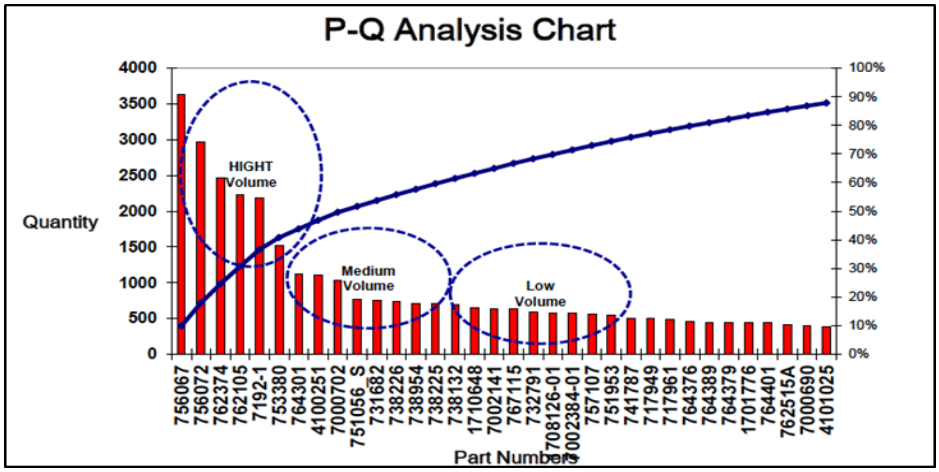

Figure 2

P-Q Analysis Chart for all PNs in PR

operate the next operation in his/her cell, while the automated operation is in progress.

- Choosing a Concept consisted on how the floor lay out will be re-distributed to achieve the new Spaghetti Diagram proposed in the Design & Simulate section. The floor could be laid out in a U-shape, mini-cells, straight flow, and other plans.

The Control Phase is based on a Simulation of the Spaghetti Diagram chose in the Improvement Phase.

- Design & Simulate is the proposal of a new floor design and simulation of it to validate the reduction of distance travel.

RESULTS & DISCUSSION

In this chapter the techniques explained in Chapter 3 will be displayed with results using the Lean Six Sigma tool of DMAIC (Define, Measure, Analyze, Improve, and Control). The ideas proposed will be simulated to validate the proposals.

Define Phase

In order to define which area the team will focus on working to achieve the 25% WIP level reduction, 30% reduction in cycle time, process variation and walking distances, and achieved 21% improvement in On Time deliveries. The Define phase used three sections to identify the top offenders, and concentrate in the Part Numbers that will have the highest impact on metrics if they are improve.

Define Phase: P-Q Analysis

The P-Q Analysis is used to identify the 80% of production volume with only the 20% of the Part Numbers. Once this 80/20 correlation has being defined, the rest of the analysis will be based on them. This technique is used to ensure the high volume parts or the parts that are worked on a daily basis, are improved because this group is the most consistent in production.

Define Phase: Process Matrix

Inside the Top 5 PNs, each PN has its differences in regards of manufacturing process. They are all similar in fit, form, and function, but their manufacturing process is different. To define their similarities with the rest of the groups the Process Matrix will help identify the similar process in a visual way. Once all parts are marked with their processes it will be simpler to assign Family Codes to groups, and balanced the production lines.

The Process Matrix helped identified the similarities between the parts in terms of processes. With this information the part families can be defined into the necessary groups to be segregated in the floor lay out.

Define Phase: Part Family Definition

The Part Family Definition phase is the last but not least important. In fact is the one that will help shape the layout of plant floor. With all parts divided into groups of families that share 80% of their processes and no more than 30% on time differences is how the groups are segregated.

The Part Families turned to be divided into 3 groups, CR1, CR2 & CR3. Each group has a set of parts that considered the high runners, which it has at least one part in the top 5 high runners of PR5 production. The part family division can be seen in the chart below.

Measure Phase

The Measure Phase is where data is collected to analyzed it, and make decision based on the data measured. It will determine the current state of the studied processes. This data will be collected from the three part families defined previously. The flow path of each part family will be measured, and the operation load of a high runner part for each part family will be measured to determine the current work load.

Measure Phase: Spaghetti Diagram

The manufacturing floor is divided into the 3 part families, but its actual layout is not a lean one due to the location of certain machines. The actual process is not a one flow as expected to be, therefore the actual path of a high runner part for each part family was traced to map out the flow path of the parts, during its manufacturing process.

When the parts travel through excessive turn around and not a one-path flow, it will bring waste to the production process. So, the scope of this map is to identify areas of opportunities to re-map the plant floor for a better flow or the most close to a one-path flow.

Measure Phase: Operations Bar Chart

Each part family has its set of parts that are considered the “high runners” which are the parts that are mostly manufactured, or basically is the 80% of the demand of that part family. For CR1, Part Number 756067 was chosen, for CR2 Part Number 762105, and for CR3 Part Number 762374. With the Operations Bar Chart the work load for each PN can be measured to determine which process has to be addressed to balance out the work load and achieved the proposed Takt Time.

The operations exceeding the Takt Time of 1 shift will be balance out, per machine-process. Each of those processes depend from a machine that has a certain speed, and volume, so the balancing has to be done for that operation for all parts that use that machine-process, this will be calculated in the Analyze Phase.

Analyze Phase

The data measured in the previous section will be analyzed in this section, to determine the strategies of improvements. During this Phase, calculations are made to design the best improvement with the data collected and having in consideration the capabilities of the plant.

Analyze Phase: Takt Time

In the Measurement Phase the Takt Time for each part family was measured to determine the load of each part family. In this Phase a new Takt Time is to be analyzed to balance out the operations that are over loaded in each part family. The optimal Takt Time for each part family will be used for that process line, because those operations that are over loaded, will be a bottle neck for any part number since, they are shared operations among most part numbers. So, having an optimal Takt Time for those operations where the actual Takt Time is not being meet, will be improved by a new Takt Time.

In this analysis the available working time per shift has being increased to three shifts, this will allow some operations to allocate more time to balanced out that operation. The objective to have operations meet a certain Takt Time is to have available product for the next operation, and avoid bottlenecks.

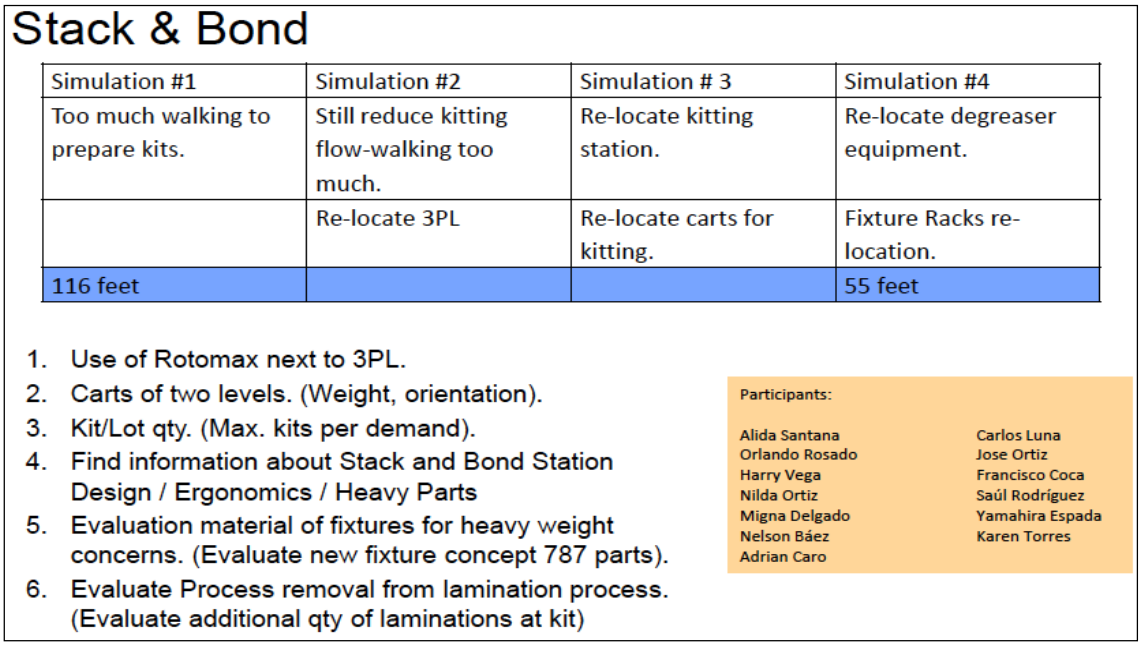

Figure 3

Control – Stack & Bond Simulation Results and Observations

Analyze Phase: Spaghetti Diagram

For the Spaghetti diagram the best routes were analyzed, and the relocation of some equipment as well. With this new lay out, the flow path should reduce the turnaround during the manufacturing process, sustaining a lean principle.

Improvement Phase

In this section the ideas reviewed and analyzed will be improved to be incorporated in the actual process. Here is where the processes see the impact of the project, and results are obtained based on what was improved.

Improvement Phase: Eliminate Waste

In this project a Gemba walk was performed with the group with the purpose to pick up findings from out siders of the operation. Is always good to have an out sider walk the process to catch possible areas of improvements. The following table is a list of areas that were improved

Improvement Phase: Operations Bar Chart

With the new Takt Time calculated in the Analyze Phase, the main operations (operations that are shared in the 80% of the parts) for each part family were balanced out based in the new Takt time, to have a continuous flow of material for the other operations, and achieved the customer's demand.

In the next charts, Part Families CR1, CR2, and CR3 will have a Takt Time of 1shift, and others of 3shift. The operations that are near the 3shift line will be operating on 3 shifts a day to meet the demand, and sustain a continuous flow.

Improvement Phase: Spaghetti Diagram

The lay out of the plant was improved to reduce waste, and improve material flow with the constraints of the plant and equipment size, which is including some equipment that will replace the actual ones, with the same functionality, but more efficient, and updated technology, the efficiency improvement can be shown in figure 3.

Control Phase

For the Control Phase a simulation was used to test the improvement in lay out for the plant. The improvement was measured in distance, when a part starts and finishes its manufacturing process. A simulation for the Stack & Bond section was done as one individual section, because every part goes

through this section. The CR1, CR2, and CR3 were simulated individually.

CONCLUSION

In order to measure the objectives proposed with real data, the changes will have to be implemented. With the proposed changes the goal for the Takt Time will be achieved. To implement the changes proposed in this Kaizen approval form Management is required, new equipment has to be install, and organizational changes are to be done. For presentation purposes it was accepted until the proposal status due to the time that will take the implementation of the proposal.

In support of the Takt Time, wastes were identified that will help reduce bottle-necks and help sustain the 95% goal of On Time Delivery. The waste elimination helped improved other areas that weren't contemplated in the objectives, but were catch in the Gemba Walk, and are considered now great areas of opportunities.

The layout of the production floor was simulated with outstanding results of an average reduction of 76% in ft traveled for each production cell. The layout was simulated using a correlation of each feet traveled horizontally will be real time, and vertically will be three times in real time. For previous cases at UTAS, this same simulation has resulted accurately.

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