Reduction of Finished Goods Inventory in Masterpact: Breakers and Cradles Lines

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Abstract *— At the moment, there is no trigger for internal demand or set capacity to build internal orders of breakers or cradles. This results in misuse capacity and high inventory levels of MPACT finish goods. The purpose of the project is to address these issues and reduce the inventory levels of breakers and cradles. To attain this the process was reviewed and Kanban principles were applied resulting in good flow of finished good product and reducing inventory. The introduction of web based tool was also introduced in order to demonstrate in what progress point an order was through the assembly process.*

Key Terms *— Finished goods inventory reduction, Kanban, Low voltage gear, Masterpact.*

INTRODUCTION

The Columbia Plant is the biggest engineer-to-order Schneider Electric's manufacturing plant. Over 85% of the products are reviewed specifically for the customers' needs mechanically and electrically and custom engineered. The primary manufacturing lines for circuit breaker distribution equipment are Switchboard (SWBD) and Low Voltage Switchgear (LVDO). Both product lines require the installation of cradles in their assembly process and the use of high current circuit breakers from 800 to 6300 A. The cradle and breaker combo are also known as Masterpact.

Switchboard

Switchboard product can be engineered to order or there is also the option for the customer to choose from standards Switchboards that allow for shorter lead times. The custom Switchboards provides the customer the ability to choose from special features that includes breakers with communications options. Switchboard follow UL standards and is common to say that their breakers follow a "sealed type" configuration by sharing an enclosure. The breakers can be mounted on the mechanical line (fixed breakers), and/or in test (draw out breakers), SWBD are front accessible and may be mounted against a wall. SWBD customers are often small- and medium-size commercial or institutional facilities. The breakers are manufactured in the MPACT line and then directly connected to the bus on the mechanical line. The breakers are not exposed to each other within the entire enclosure. Cable connections are made in the front of the board and because of this, Switchboards only requires front access and may be mounted against a wall. Customer for this type of gear are medium-size commercial or institutional facilities. Figure 1 shows a closed Switchboard gear with six (6) breakers.

Figure 1
Switchboard

Switchgear

Switchgear power distribution equipment is engineered to order, providing customers special features according to their needs. Switchgear, also known as Low Voltage Draw Out Gear (LVDO),

consists of compartmentalized draw out breakers. These breakers are always installed in test. There are physical barriers between breakers and between breakers and the bussing. Cable connections are made in the rear compartment and, therefore LVDO's are larger and require front and rear access. Switchgear follows ANSI standards. Customer for this type of gear are industrial and large commercial and institutional facilities. Figure 2 shows a closed Switchgear with one breaker and two prepared spaces for breakers that will be installed on the field. On each prepared space the cradle can be seen.

Figure 1
Switchgear

Masterpact

The Masterpact lines consists of Breakers, Cradles, CT's and Kits lines. The major components that are used in both gear product line are cradles and the breakers. The powered circuit breakers can be offered with drawability for both Switchgear and Switchboard, but only fixed breakers for Switchboard. The breaker and cradle combo, also referred as Masterpact, offers ranges in frame sizes and communications functions, all in optimized frame sizes: 3, 4, 6 and 8 pole. Masterpact is compatible with ANSI, UL and IEC standards. Figure 3 shows a Masterpact Combo; a 4-pole breaker already mounted into the cradle on a Switchboard.

Figure 2
Fixed breaker (inside a cradle) in Switchboard gear.

PROBLEM STATEMENT

There is a general concern with how orders are triggered for cradles and breakers for internal Switchboard and Switchgear. At the beginning of the project, the demand was people-dependent and triggered by an email. There was no set capacity for internal demand resulting on misused MPACT capacity. Because there is no standard process for following a schedule, the team would order excess breakers to pick and choose what order to build. High inventory levels of cradles and breakers resulted because usually not the correct breaker was ordered based on schedule.

Order Stage Gates

Is crucial to understand the order stage gates for gear and understand where Masterpact falls within this process and how the ordering process can be improved. There are 9 main gates for every order; these are explained below:

- Conversion: The order is converted to the plant and preliminary schedule is done
- Approvals: Approval drawings are created and sent to customer for review and returned to the plant.

- Engineering: Order is engineered and Bill of Materials is created and released for material procurement.
- Procurement: Materials is procured from internal and external suppliers
- Assembly: This gate is the focus of the project. The order is assembled at this gate. – Mechanical Structure, Bussing, Panel Wire, Structure wire, Masterpact assembly and installation of Masterpact in gear forms part of this gate.
- Testing: Mechanical and electrical testing are performed to ensure safety and quality
- Ship: Final packaging is completed and shipped to costumer
- Post ship support: Business sector takes over project and provide support during installation and future needs.

Schedule Current State

Both, SWBD and LVDO processes are similar, however MPACT components are assembled at different stages. For LVDO when a new order is scheduled it triggers Mechanical Line and Panel Wire to start. The Cradle is assembled into the structure at this stage. Once Mechanical Assembly of the gear is completed, it moves to cross bus and then to structure wiring. When completed, the lineup moves to test and the ships. Cradles are required at the mechanical line for both product lines and Breakers are required at the mechanical line (SWBD line only) if they are fixed breakers and at test if they are draw outs.

For Switchboard, the breaker is either mounted in the mechanical line or in test. For Switchgear, breakers are always draw out so they will get mounted in test. Cradles installation happened at the mechanical line for both product lines.

PROJECT SCOPE & PROPOSAL

This project is intended to improve the internal process of ordering breakers from the gear lines to Masterpact and the delivery of such in a way that reduces finished good inventory of both breakers and cradles. It can point out external areas for improvement, however the main purpose and scope of the project is to analyze the processes to determine best “Just In Time” strategy for breakers and cradles. It should also review the best possible lead time to reduce inventory of finished goods. Consequently, the project also intends to introduce a systematic trigger point where Breaker and Cradle Line will receive the order requests and with the help of the Systems Engineering Group create a tool where it can be managed and modified depending on delays during the manufacturing of SWBDs and LVDOs.

ANALYSIS & IMPLEMENTATION

When researching on how to reduce inventory, a key concept to be studied is lean manufacturing. This concept focuses on the reduction and consequently elimination of wastes, one of them being inventory which is the focus of the project. However, knowing the tools of waste reduction doesn’t always makes the process leaner. Before embarking on a lean effort, pausing to understand the type of problem that it’s been trying to be solve is the best practice suggested by Sarkar [1]. The lean tool assessed in the project was the introduction of Kanban Process practices.

Best possible lead time for Cradle line and Breaker lines was reviewed and set to two days. The reason is that once the order is entered, it needs to be released for kitting and brought to the line. The kitting process can last up to two shifts, depending on the complexity of the breaker to be built; this is also taking into consideration the time from the moment the ordered is released and brought to the first station for assembly. The assembly process from start to finish can be completed in a shift if expedited thru the line, however it was determined that the normal average time from start to finish would be two shifts, thus making the 2-day lead time for internal gear requests. The capacity for each product was determined and resulted in 20 daily breakers and 20 daily cradles maximum; this was approved by

management and the demand for gear was taken into consideration.

The ideal time to order Breakers and Cradles was reviewed by studying the Assembly process on LVDO and SWBD. Because MPACT components are assembled at different stages on both lines resulted that:

- For Switchgear – the breakers should be requested when the last section is scheduled in wiring and the cradle should be requested when the first section is scheduled to start in the mechanical line.
- For SWBD – both (fixed) breakers and cradles should be requested when the first section is scheduled to start in the mechanical line and only draw out breakers should be ordered when the last sections is scheduled to finish wiring.

The intention has been always to control the inventory for both cradles and breakers. Previous data collected by observation shows an average of seven pallets worth of breakers intended for the mechanical line only. Each pallet fits from three to six breakers. In a specific day, the average quantity of breakers in queue is approximately from 21 to 42 breakers. To control the excessive ordering and have a visual trigger it was decided to introduce the use of a Kanban system driven process. Five rolling carts where the minimum number of breakers that fit in it is two and the maximum is four was made available to the team, reducing the inventory to a minimum of 10 breakers and a maximum of 20. With the implementation of the Kanban system the systematic trigger can be called complete. The result was a reduction up to 52% of breaker queue for the mechanical line only.

The average daily demand and set capacity for breakers is a maximum of 21, however further analysis needs to be performed in order to determine how many of these are allocated to test and how many are allocated to mechanical line.

The breakers requested by test however, cannot be delivered in a Kanban system since their process is not a once piece flow like the mechanical line making it more complicated. To reduce inventory a tool called “Master Pact Schedule” was introduce. At the moment, stakeholders review on this tool the progress point of the gear at the manufacturing assembly twice a week. Once the last sections of a lineup is at wiring, the breakers are scheduled for testing. While there is no systematic trigger like in Mechanical line, the inventory has been controlled by reviewing the progress point of the line and requesting what is actually needed by the time when is needed.

The implementation of a systematic trigger for Cradles was completed for both LVDO and SWBD gears. The concept of a Kanban system was introduced. Before there was a queue of an average of 10 pallets holding up to three cradles each, for a total of 30 cradles on average on a single day. Now, the average demand for internal cradle is 11 a day. It was decided to implement 10 carts that holds up to 20 cradles in total – meaning that at a single time the mechanical line should never have more than two days’ worth of queue.

CONCLUSION

Further analysis and other alternatives would need to be reviewed in order to complete implementation of a systematic trigger with breakers required in test. Concerns are on how triggered by a process and not necessarily a human dependent tool. While the Systems Engineering Group collaborated in the creation of the tool implemented is still a manual process. This tool however, has the ability of showing the progress point of any order that is in the manufacturing process. It will advise information on each individual section making it easier to review when the breakers are needed instead of going physically or asking the team at what stage the section is. While the project hasn’t been completed on its entirety the reduction of inventory for both cradles and breakers has been significant – 52% and 33% correspondently. The process of Kanban is easy to comprehend and has been well accepted by the teams.

REFERENCES

[1] Sarkar, Debashis (2017) "Building a lean service enterprise: reflections of a lean management practitioner".