Improving Dilator's Line Capacity, Inventory, and Management Control

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Abstract *— This paper addresses operational challenges in Inari Medical's Dilator line, integral to Venous Thromboembolism (VTE) treatment devices. The project focuses on inventory control, line capacity, and management control to improve customer demand fulfillment. The analysis reveals issues in inventory replenishment, line efficiency, and communication forums. The literature review stresses the significance of inventory control systems, reduced manufacturing lead time, and tiered management. Utilizing tools like demand plans, production throughput measurement, and kanban formulas, the project achieves improvements, including a 300-second cycle time reduction and enhanced communication forums. These outcomes enhance overall operational efficiency, cost savings, and Inari Medical's industry position, ensuring timely product delivery and meeting high-quality standards.*

Key Terms *— Customer Demand; Kanban; Line Balancing; Tier Management.*

PROJECT BACKGROUND

Inari Medical is a medical device company with a mission-driven team of employees dedicated on developing purpose-built systems for the treatment of patients with Venous Thromboembolism (VTE). Treating patients in over 20 countries around the world, the company focuses on improving patients' life who have Pulmonary Embolism (PE) and Deep Vein Thrombosis (DVT).

The company has different innovative products on the market, as shown in Figure 1. Most of these products are assembled by multiple components and sub-assemblies. The Dilator line manufactures a critical component that complements all the company's products. The Dilator line contributes a big part of the manufacturing assemblies to build the finished different products on time. Currently, the line has experienced shortages in the inventory to make products based on the demand causing delays impacting patients. The build plan for the month set a target to make over 8,000 units, and the current line capacity is 480 units a day. Based on the current throughput, a gap of 280 units in a day is being identified due to line capacity and the lack of an inventory control system. On top of that, there is not a standard process to escalate issues and address their root cause at the right levels of the manufacturing line. Therefore, it is relevant to ensure lines performance to support productivity and future growth.

Figure 1
Inari Medical Products

PROJECT OBJECTIVES

Based on the organization and manufacturing needs for the Dilator line, the main objectives for the organization were to achieve customer demand, reduce lead time, and improve tier management and inventory control. To accomplish these objectives, it was required to improve multiple components that were behind to succeed. For this it was necessary to focus on inventory control, line capacity and management control.

Inventory Control

The Dilator line is experiencing some material shortage and is not able to meet in a timely manner

the customer demand. On the other hand, there are no inventory limits to determine when to continue or stop producing specific models. An inventory analysis was needed to identify the gaps and ensure the right product mix for packaging when they need it.

Line Capacity

The demand for the year 2024 increased, which made the focus of the project improving the line efficiency to reduce the previous gap of 20% versus the plan. The average output from the line was 187 out of the 257 units that were required per shift. In terms of cycle time, the line had counts with a Takt Time of 150 seconds per unit, and some stations were causing bottlenecks, hindering the achievement of the line's goal. Therefore, a Line balancing was performed to address the longest process cycle times for better capacity. Management control

The previous forums of communication were not aligned with the line's needs. There were no Key Performance Indicators (KPIs), and there was a lack of standards for problem-solving. The multiple meetings that occurred in production did not have the required functions necessary to identify the root cause of the daily problems. Additionally, the production team did not have a clear view of how the metrics looked in terms of Safety, Quality, Delivery, and Cost.

DILATOR LINE PROCESSES

Inventory Control

Dilator supplies four product lines including Packaging. There was a lack of signal to replenish the inventory. The demand for these products has been analyzed and it has been identified a monthly increase in the demand up to 10% as highlighted in yellow on Table 1. The Opex team evaluated the replenishment process flow as shown in Figure 2. The production team builds material, getting the signal from the planner but without having consideration the units on WIP.

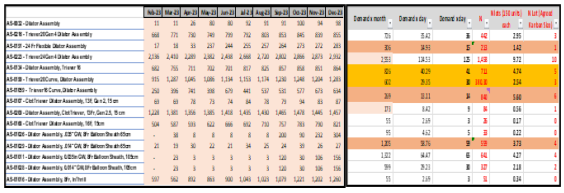
Table 1
Dilator Demand

Dilator AF-	Description	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24
A5-01259	Trieve® Curve, Catheter Assembly	750	750	750	750	600	600	600	600	600	600	600
A5-0139	Trieve® Curve, Dilator Assembly Gen 1	1,350	1,350	1,350	1,350	1,350	1,350	1,350	-	-	-	-
A5-0332	Trieve 2.0 Gen 3	300	300	300	300	300	300	300	1,200	1,200	1,200	1,200
A5-0326	Trieve 20, 2.1-101 (Gen 4)	600	600	600	600	600	600	600	600	600	600	600
A5-0131	Trieve 24, 2.0-101 (Gen 3)	750	750	750	750	600	600	600	600	600	600	600
A5-0223	Trieve 24, 2.1-101 (Gen 4)	2,100	3,150	2,750	2,750	2,750	2,750	2,750	2750	2750	2750	2750
ax-0209	ClotTrieve® Sheath, 19F, 90-101 (US)	1,050	1,050	1,500	1,500	1,500	1,500	1,500	1500	1500	1500	1500
A5-0168	ClotTrieve® Sheath, 19F, 15 cm (US)	1,050	900	750	600	750	600	750	750	600	600	600
A5-0134	Trieve® 16	1,200	900	750	750	750	750	750	750	750	750	750
A5-01016	Inthrill	300	150	150	150	150	300	150	150	150	150	150

Figure 2
Dilator Current Replenishment Process

Table 2 shows the top 5 frequent models that are highly requested from customers and product lines. Based on the top 5 models, the replenishment system is being developed by setting limits, usage, and safety stock.

Table 1
Dilator Product Mix



Line Capacity

Based on the gap of 20% vs the plan, the Opex team performed a time study for all the process stations. The Takt time for Dilator line is 150 seconds, which means that the line will run at that pace to build customer demand. Figure 3 presents the takt time identified as a green column and the process cycle times are the rows that help to graph by segregating each cycle time into the different categories of manual, auto, wait, walk. The dilator line was composed of 11 stations with a total cycle

time of 1,409 seconds to build a unit. This graph shows that some of the stations, such as 1, 3 and 6, were above the required cycle time. Some improvements were required to make a positive impact on the line.

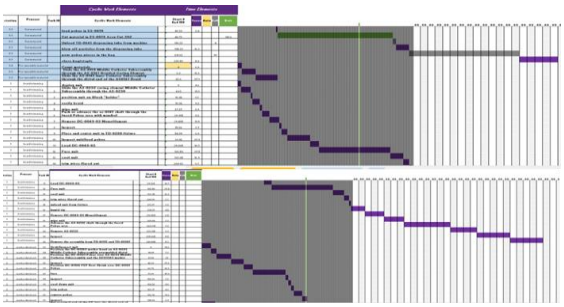


Figure 3
Current line balancing

Management Control

The planner conducts daily production meetings, all of which are listed in Figure 4. During these sessions, production output, difficulties, and other pressing matters were the topics of discussion. Two meetings a day with various functions and a weekly meeting with high management were held.

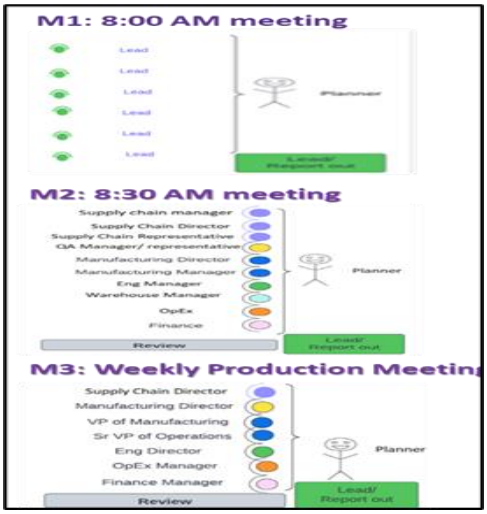


Figure 4
Current daily production meetings

PROJECT TOOLS

For the measurement of inventory at Dilator line, the Demand Plan and production throughput are the main spreadsheet that helps to interpret the data. In addition, the kanban formula described in Equation 1, helps to determine the signals.

$$N = DT (1+X) (1+Y) / C \quad (1)$$

where:

N = Number of kanban cards needed before replenishment
D = Demand (parts per day)
T = Lead time, length of production (begin-end)
C = Capacity of containers
X = Safety factor (Safety stock) %
Y =Variation factor (variation buffer) %

Stopwatches and video cameras were used to measure the times from each station, this helped to examine line capacity. The primary instrument for gathering data was the Opex forms to perform the analysis.

There was no tool used for tier management system measurement. Attendance at the associated sessions was mandatory to extract the lessons from the meetings and pinpoint areas that needed improvement.

IMPROVEMENTS

Inventory Control

With the help of determining the kanban size shown on Table 3, the result of the required quantity of kanban cards and lots can be obtained, which will predict the inventory limits based on the number of units that can fit in a work order and build plan.

Table 3
Kanban Size

N	N lots (150 units) each	N Lot (Agreed Kanban Size)
442	2.95	3
213	1.42	1
1,458	9.72	10
711	4.74	5
380.30	2.54	3
840	5.60	6
84	0.56	1
26	0.17	0
33	0.22	0
559	3.73	4
641	4.27	4
327	2.18	2
51	0.34	0

The production team is responsible for filling the required fields to enable communication. See kanban card in Figure 5.

Figure 5
Kanban card

The kanban formula generates the number of cards required for each model. The process shown in Figure 6 emphasizes the use of the kanban card as the main item for communication. Units are assembled and passed through quality control inspection with a kanban card. Once the units are being inspected, the kanban card will be along with the WO built. The units built will be placed on the rack with the kanban card visible. Once the team from Packaging picks material, they will place the kanban card in the card holder. The lead will be routinely checking the cards placed throughout the day and communicating with the planner to issue or request materials every time a kanban card is placed.

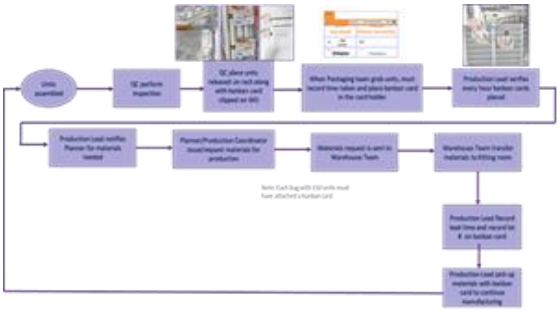


Figure 6
Improved kanban process

The Planner issue materials, a request will be submitted to the warehouse team. Production lead will record the info from the material received and

Line Capacity

To achieve customer demand, a line balancing for the stations was needed considering the cycle times obtained and takt time. Based on the balancing chart shown in Figure 7, will be required 12 stations to achieve customer demand. Station 1 will be assigned for production setup. Stations 3 and 6 will change their work content as one step will be consolidated into one operation where equipment will be duplicated. As a result, by cutting down on idle time, one of the stations will concentrate on 100% inspection. In the balancing the 'green bars' are the Automated machine that push above the purple bars. The manual cycle times will be reduced by the automated equipment.

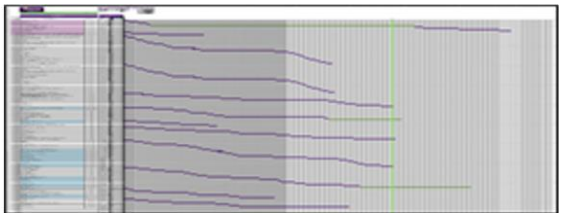


Figure 7
Improved Line Balancing

Tier Management

To enable problem solving and cross functional communication, Dilator will have daily tier meetings. At this meeting will be participating the Group leads, engineers, supervisor, and planners. The topics discussed at this meeting will be based on Key Performance Indicators. The meeting will be performed every morning at the line with the functions shown in Figure 8.

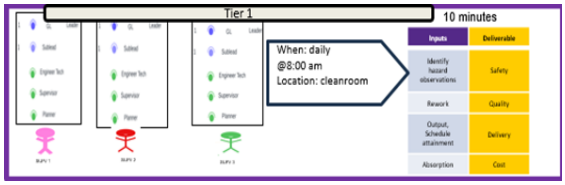


Figure 8
Dilator Tier 1

ACHIEVEMENTS & CONCLUSIONS

The Dilator project has achieved outstanding results, leading to significant improvements in overall operational efficiency and cost savings. As project savings, is the reduction of Cycle time of 300 seconds per unit, reducing material shortage

and improve communication forums with production.

Additionally, the dilator, engineering and Opex teams have worked successfully in a timely manner to complete the improvements made. The project is within the budget established primary of $27,500.

The duplication of equipment helped to reduce the manual time and improve line efficiency. On the other hand, the preparation of materials before running a product helped also with optimizing the line. In addition, the Kanban system helps to control the inventory and avoid material shortage along with the tier management.

The improvements demonstrated in Table 6 contributed to Inari Medical and the patient's life by delivering the product when is needed. Overall productivity, efficiency, and cost-effectiveness improved, strengthening the company's position in the industry and delivering high-quality products to customers.

Table 2
Improvements achieved

Improvement	Highlights	Impact
Inventory Control	Create a replenishment signal with inventory limits.	Reduced the risk of material shortage by 75%. Increasing the inventory levels considering WIP units for the next forecasted months.
Line Capacity	Rebalance the line for 12 stations, reduce idle time.	Improve CT by reducing 306 seconds of manual time
Tier Management	Establish key performance indicators and functions support for the line.	Communicate and solve problems effectively, by monitoring line performance.