



Optimizing Production Line Efficiency through a Standardized Work Tool: A Case Study

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ABSTRACT

Lean methodology focuses on enhancing flow and resource efficiency by prioritizing customer value, eliminating waste, reducing variation, and fostering a culture of continuous improvement involving everyone in the organization. Implementing lean creates conditions that empower all employees to contribute to continuous improvement activities within the value stream. This approach not only lowers production costs, enabling reinvestment and employee engagement but also emphasizes professional development. This paper aims to maximize efficiency in seal production within a manufacturing industry by implementing lean tools such as standardized work and Kaizen. Standardized Work is a systematic method for producing parts or services centred on human motion. As a tool for ensuring quality, it defines efficient, safe work methods and helps eliminate waste, serving as the foundation for every operation. Once implemented, standardized work ensures that the same methods are repeated consistently, avoiding unnecessary motions, maintaining quality, ensuring safety, and preventing equipment damage. The consistent application of these methods improves product quality through standardized processes and procedures. By incorporating lean tools like defined worksheets and Kaizen, the production of seals in manufacturing industries can achieve significant productivity enhancements.

Keywords: Defined worksheet, Kaizen, Customer value, Continuous Improvement.

I. INTRODUCTION

Lean Manufacturing, derived from Toyota's practices, aims to maximize product value by minimizing waste. It focuses on eliminating non-value-added activities like transportation, inventory, motion, waiting, overproduction, over-processing, and defects through continuous improvement and aligning production with customer demand. Earlier



researchers have focused on several key elements for implementing lean manufacturing. Value Stream Mapping (VSM) defines the value stream as all activities required to convert raw materials into finished products, including both value-added (VA) and non-value-added (NVA) activities [2].

The push and pull system rely on customer demand in the pull system, whereas the push system relies on a predetermined schedule [1]. Cellular manufacturing groups facilities to minimize process time, waiting time, and transportation, improving line flow with U-line and line balancing concepts. Kanban, a Material Flow Control (MFC) mechanism, delivers the right quantity of parts at the right time [3]. One Piece Flow ensures just-in-time production, reducing interruptions, backflow, scrap, and risks of machine failures and operator mistakes [4]. Single Minute Exchange of Dies (SMED) and One-Touch Exchange of Die (OTED) reduce changeover time by converting internal setting time to external time and simplifying remaining activities [5]. Production levelling enhances production volume, mix, and efficiency by reducing waste, unevenness, and overburden, leading to the successful implementation of Every Part Every Interval (EPEI) concept [6]. Employee perceptions focus on belief, commitment, work method, and communication, highlighting the need for cultural change and motivation for lean transition.

The perfect strive of the manufacturing system can be achieved through the successful implementation of lean elements. The majority of the surveys on lean elements focus on only one or two elements or a combination of two or three elements. For successful implementation of lean, it is practically necessary to incorporate all lean elements and sequence the implementation tasks. This literature review explains the incorporation and sequencing of lean elements during the implementation period, along with implementation issues. Scheduling is essential for initializing the manufacturing system by defining a clear production plan, but this review does not focus on scheduling due to the availability of scheduling software. Employee perceptions are critical for successful lean transitions, as identified by Losonci et al. [7], who emphasize understanding the shop floor work environment and analyzing workers' cultural changes. The survey categorizes perception factors into critical intrinsic factors (commitment, belief) and external factors (lean work method, communication), suggesting that the success of lean transformation is influenced by employees' commitment levels, beliefs, communication, and work methods [7]. Armenakis et al. [8] highlight the role of belief as a conviction about the truth of something not readily obvious. David et al. suggest that employee perceptions can be shaped by belief, commitment, work methods, and communication, achievable through training and awareness [9]. Value Stream Mapping (VSM) maps material and information flows to coordinate activities and identify waste, with a future state map drawn for improvement [10]. Fawaz et al. [10] conclude that simulation models can evaluate performance measures before lean implementation, and simulation tools are necessary for predicting inventory levels during demand uncertainty



[11]. Takt time, the frequency a part must be produced to meet customer demand, varies with production demand, highlighting the importance of measuring Takt time due to costs and inefficiencies of producing ahead of demand, as suggested by Rahani et al. [12]. Identifying the bottleneck process is crucial as it determines the maximum cycle time and, consequently, the line capacity. If the bottleneck cycle time (C/T) is less than the takt time, customer demand is met; otherwise, it is not [12].

Group Technology, as suggested by Shunk et al.[13], involves grouping parts based on design and manufacturing attributes to enhance flexibility. Cellular Manufacturing (CM) groups dissimilar machines to form cells for part families, improving efficiency through U-shaped lines which enhance interaction and flexibility [10][14][16]. U-line manufacturing, with entrances and exits in the same position, reduces workstations and improves communication, quality, and material handling [18][17]. Line balancing addresses task time variability caused by human factors and process disruptions, aiming to minimize operator walking time and fluctuation in cycle times [18][19][20]. Flow Manufacturing principles, focusing on producing one item at a time at a cycle time rate, require U-line layout, multi-skill operators, standardized cycle times, and user-friendly equipment to ensure smooth mixed model flow and quick changeovers [21]. Flow Manufacturing produces an item at a rate equal to the cycle time, requiring a U-line layout, multi-skilled operators, standardized cycle time, and user-friendly equipment [21]. Quick Changeover or Single Minute Exchange of Dies (SMED), developed by Shingo [5], separates changeover time into internal and external set-up times, streamlining processes to reduce changeover to a single minute through standardization and parallel operations. Almomani et al. [22] suggest integrating Multiple Criteria Decision-Making Techniques (MCDM) with SMED to enhance system flexibility and productivity. Small lot sizes optimize buffer quantities, reducing lead time and quality issues [25]. Inventory, a significant waste source, is managed by controlling raw materials (RM), work-in-process (WIP), and finished goods (FG) through improved quality levels and implementing cellular manufacturing to reduce WIP [26][27][28]. The Pull System, driven by customer demand, supports one-piece flow and relies on Kanban signals for replenishment, levelling product mix and quantity over time, and reducing lead times [38][36][37][41][42].

Production Levelling (Heijunka) is essential in a volatile business environment to manage fluctuations in customer demand, which can lead to underutilized capacities or overburdened resources, causing quality issues and breakdowns [6]. Bohnen et al. [39] emphasize the importance of levelling low volume and high mix production through Group Technology, achieving a balanced workload using Every Part Every Interval (EPEI) concept. This method controls job arrival sequence variability, ensuring higher capacity utilization and preventing production schedule peaks and valleys [39][40]. Quality at source in lean manufacturing eliminates lot-based inspections, relying on poka-yoke and automation to stop the line when defects occur, enhancing quality by error-proofing



setup, loading, and unloading processes [19][35]. Continuous Improvement (CI), as described by Deming, focuses on reducing inefficiencies through root cause analysis and countermeasures, driven by management's commitment to cultural change and employee engagement [29][31][32][33][34]. Standardized Work, a key tool for CI, involves creating Standard Operating Procedures (SOPs) that detail the safest and most effective job methods, enabling adjustments to meet demand fluctuations and identifying waste through tools like Standardized Work Charts (SWC) and Standardized Work Combination Tables (SWCT) [1][9][30][31].

Successful lean implementation requires incorporating these interdependent elements, starting with Value Stream Mapping (VSM) to identify production gaps, followed by Group Technology, Cellular Manufacturing, Flow Manufacturing, SMED, lot size reduction, One-Piece Flow Pull System, quality control, Kanban, Production Levelling, and ongoing standardization and improvement, ultimately ensuring customer satisfaction through the EPEI concept.

The research gap identified in this study lies in exploring the integration of lean methodologies with automated machinery specifically tailored for seal production in manufacturing industries. While the work outlines the benefits of standardized work and Kaizen in enhancing efficiency and quality, there is a need to delve deeper into the optimal integration of these lean tools with automation to achieve maximum productivity gains while minimizing labour costs. The proposed work will focus on assessing the synergistic effects of standardized work, Kaizen practices, and automated machinery on seal production, aiming to optimize production processes, reduce waste, and improve overall operational efficiency.

2 EXPERIMENTATION

2.1 Implementation:

The study focuses on enhancing the production of seals in a manufacturing industry, particularly within the compression moulding channel. This channel serves as a critical production unit and a testing ground for implementing a Production System. One of the primary objectives is to establish defined work processes within this channel, as it lays the foundation for implementing Kaizen practices effectively. Defined work involves organizing and structuring worker movements to create a standardized baseline for evaluation. This standardization brings several advantages to the organization. Firstly, it improves efficiency and productivity by streamlining tasks and reducing errors, ultimately leading to shorter production times and increased output. Secondly, it enhances quality control by ensuring consistent product standards, thereby improving customer satisfaction.



Thirdly, it helps in identifying and eliminating waste and errors, such as overproduction or excess inventory, contributing to overall operational excellence.

2.2 Problem Definition and Methodology:

The problem statement revolves around identifying solutions to reduce line delays, address unbalanced workloads, optimize work distribution, and minimize changeover and cycle times. The implementation of visual boards and line balancing techniques is also a key focus area.

The methodology adopted includes Gemba walks to understand the production processes and address manufacturing challenges using lean concepts. A standardized work tool called Defined Work, along with MS Excel templates like Defined Worksheets, is used for recording and documenting findings through time and work studies.

The study involves selecting suitable moulds, conducting process mapping through Gemba walks, and analysing motions, times, and process flows using tools like spaghetti diagrams and Standardized Work Combination Tables. Various charts are generated to assess elements such as value-added time, non-value-added time, setup time, and workforce count. The aim is to identify and implement lean tools that can enhance process efficiency and productivity across different stages of seal production within the compression moulding channel.

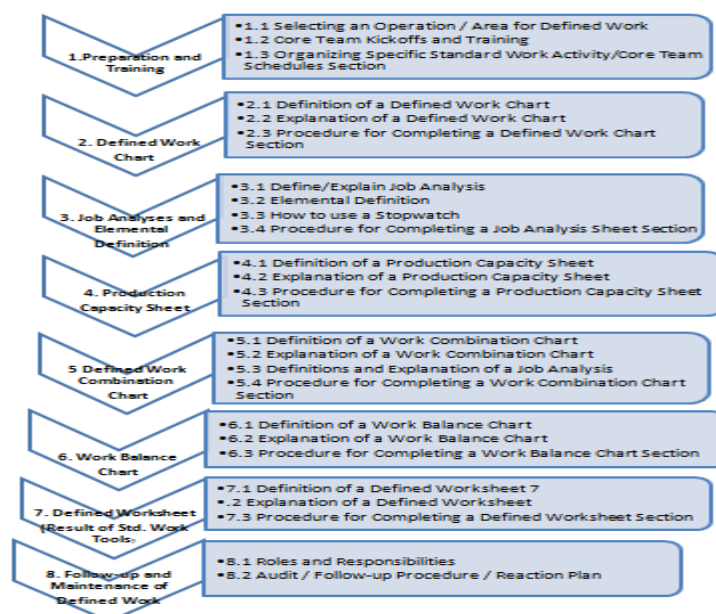


Fig 1: Outline for the implementation of Defined work



2.3 Procedure involved in production of seals

In the production process of seals, several components are utilized, including the compound or preform and stampings, which are metal rings. The production process is structured into five key steps to ensure efficient manufacturing. Firstly, the process begins with the mixing of polymers and assorted chemicals according to a specific recipe to create the preform. Following this, the stampings undergo phosphating to prepare them for further processing. The preform is then extruded and cut to the required dimensions in the extrusion block. Subsequently, the preform is either compressed or injection moulded onto the stampings, a crucial step that takes place in the compression moulding channel or Channel 9.

After moulding, the compressed seals undergo thorough inspection to ensure quality standards are met. Finally, the inspected seals are packed and boxed for distribution. Each step in this process is assigned to specific blocks, such as the Compression Moulding Channel (Channel 9), Phosphating Block, Mixing Block, Extrusion Block, and Cementing Block, where simultaneous operations pertaining to that block are carried out efficiently.

2.4 Defined worksheets

The study included the creation and utilization of Defined Work Sheets, which documented the working steps and relevant data observed during the research period. The focus was on four key sections: Channel 9 (Compression Moulding Channel), Phosphating Block, Extrusion Block, and Mixing Block, with particular emphasis on Channel 9 for this project. The Defined Worksheets serve as a visual representation of information collected through Defined Work Tools, aiding supervisors and production associates with visual control and quick reference. These worksheets illustrate work sequences, process layouts, act as training documents, assist in worksite management, and capture current best practices. Additionally, Standard Work Combination Sheets were used to combine human and machine movements based on Takt Time, visually displaying operator activities (working, walking, waiting), automatic machine times, and comparing Cycle Time to Takt Time, helping identify waste within the cycle. Worksheet examples include a defined worksheet at the channel level (Worksheet 1) and a standard work combination sheet for Channel 9 with suggestions for improvement (Worksheet 2).



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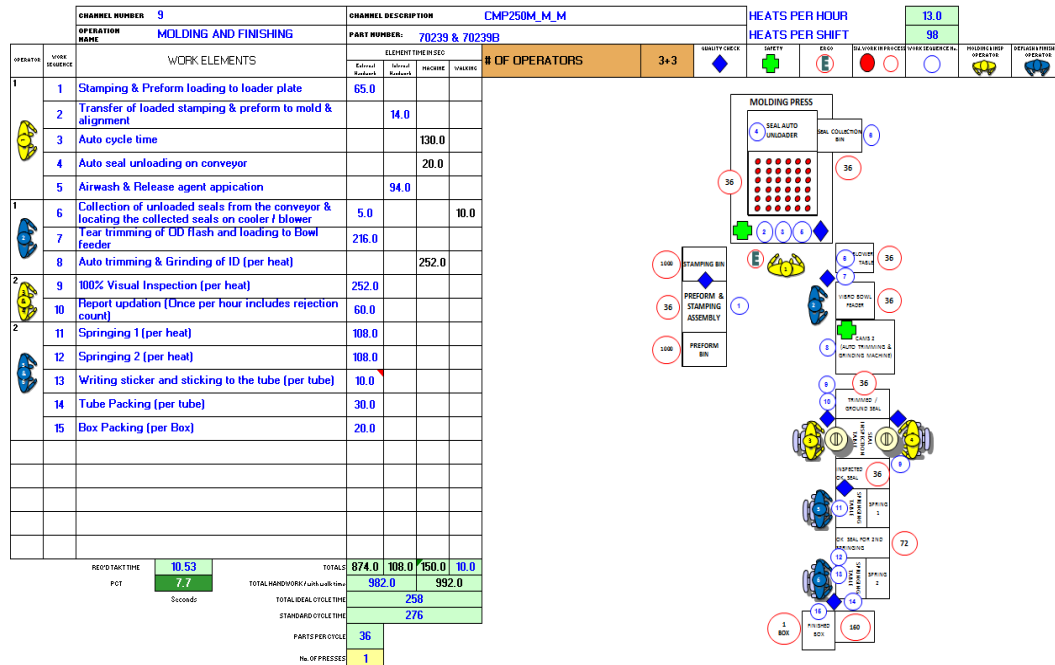


Fig 2: Worksheet 1: Defined worksheet channel level

Standard Work Combination Sheet

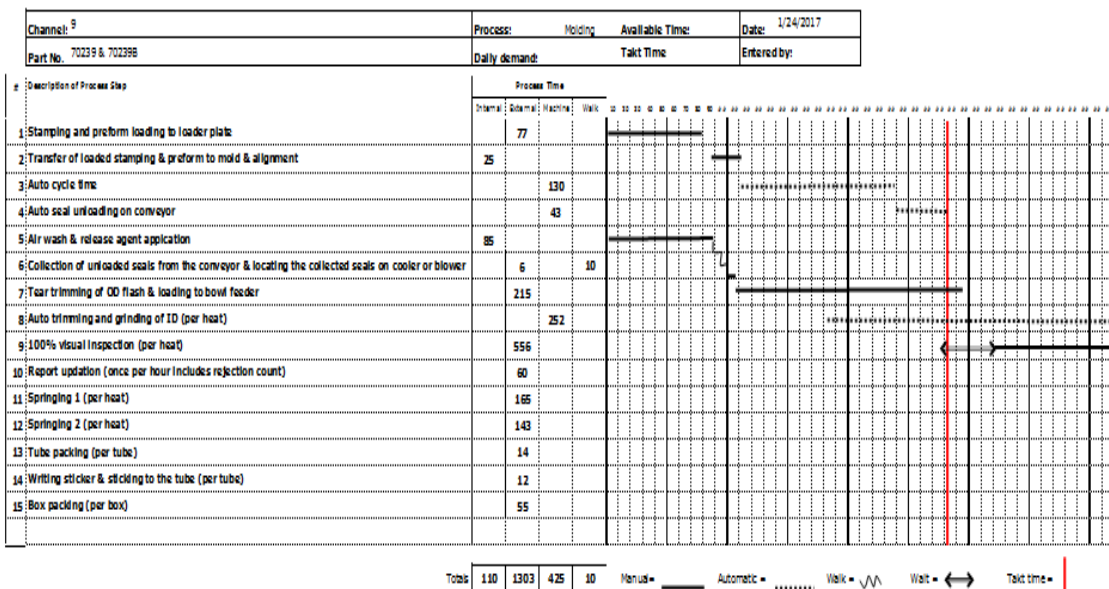


Fig 3: Worksheet 2: Standardized worksheet for channel 9

2.5 Work Balancing Sheet



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Activity / Work	Operators					
	1	2	3	4	5	6
Auto cycle time	0.0	0	0	0	0	0
Air wash & spray release agent to the upper plate	0.5	0	0	0	0	0
Press the green button	0.0	0	0	0	0	0
Centre plate moves forward	0.0	0	0	0	0	0
Airwash & spray release agent to the centre plate	0.6	0	0	0	0	0
Press the green button- Centre plate moves back & inverts back to position	0.2	0	0	0	0	0
Airwash & spray release agent to the lower plate	1.0	0	0	0	0	0
Open the molding press	0.2	0	0	0	0	0
Wear helmet and hand gloves	0.0	0	0	0	0	0
Lift the loader plate	0.0	0	0	0	0	0
Place it on the mold	0.0	0	0	0	0	0
1 Transfer all the preforms and stampings onto the mold	0.1	0	0	0	0	0
Withdraw the loader plate to its home position	0.1	0	0	0	0	0
Check for proper alignment of preforms & stampings	0.2	0	0	0	0	0
Press the green button to close the mold press	0.0	0	0	0	0	0
Take handful of stampings & place it on the loader plate	0.1	0	0	0	0	0
Place them face-side up in each slot	0.9	0	0	0	0	0
Take handful of preforms	0.2	0	0	0	0	0
Place the preforms along with stampings in each slot	0.9	0	0	0	0	0
Mold press opens automatically	0.0	0	0	0	0	0
Centre plate lifts up, moves back horizontally & plate inverts	0.0	0	0	0	0	0
Unloader moves down vertically & pushes the seals down to conveyor	0.0	0	0	0	0	0
Seals are transferred to the bin through the conveyor	0.0	0	0	0	0	0
Walk upto the bin containing molded seals	0.0	0.1	0	0	0	0
Pick the bin & bring it to the blower table	0.0	0.1	0	0	0	0
Place all the seals onto the blower table and let it cool	0.0	0.0	0	0	0	0
walk to the collection area & place the bin	0.0	0.2	0	0	0	0
1 Pick each seal after the seals are cooled	0.0	1.3	0	0	0	0
Tear ID & OD flash & Put the waste in the dustbin	0.0	1.7	0	0	0	0
Place the trimmed seals onto the vibro bowl	0.0	1.2	0	0	0	0
Auto trimming & Grinding of ID (per heat)	0.0	0.0	0	0	0	0
Place the bin on the inspection table after airwash	0.0	0.0	0	0	0	0
Inspect each seal visually for abnormality & Remove excess flash	0.0	0.0	7.6	7.6	0	0
2 Place the seals in the bin for spring process	0.0	0.0	0.4	0.4	0	0
Reject the seals which do not satisfy the predefined standards & tabulate	0.0	0.0	0.1	0.1	0	0
Pick up inspected seals one by one	0.0	0.0	0.0	0.0	1.09	0
1 Insert spring one to the back side of the seal	0.0	0.0	0.0	0.0	2.31	0
Stacking each seal in bin	0.0	0.0	0.0	0.0	1.52	0
Pick the stacked seals one by one	0.0	0.0	0.0	0.0	0.0	1
Invert the seal and insert spring 2(face side)	0.0	0.0	0.0	0.0	0.0	2
Stack the assembled seal onto the tube	0.0	0.0	0.0	0.0	0.0	3
Cover the tube with packaging cover	0.0	0.0	0.0	0.0	0.0	0
1 Remove the seals along with the cover from the tube	0.0	0.0	0.0	0.0	0.0	0
Tie the mouth of the package with binding wire	0.0	0.0	0.0	0.0	0.0	0
Write name and date on the white sticker and stick green sticker on it	0.0	0.0	0.0	0.0	0.0	1
Stick the sticker on the tube	0.0	0.0	0.0	0.0	0.0	0
Place the packed seals in the box (25 tubes/box)	0.0	0.0	0.0	0.0	0.0	0
Movement of box to Final audit area	0.0	0.0	0.0	0.0	0.0	0
Waiting time / NYA	2.5	3.0	-0.5	-0.5	2.8	0.7
PCT (Bottleneck Cycle Time / Seal)	7.7	7.7	7.7	7.7	7.7	7.7
Total VA VC / Seal	5.20	4.64	8.17	8.17	4.92	6.98
MOP / Shift in mins	305	272	479	479	289	409
Human Efficiency per shift in %	68%	60%	107%	107%	64%	91%
Measure of Performance	372.2					
Human Efficiency	83%					
Manpower Required	4.96					

Fig 4: Worksheet 3: Work balance sheet for channel 9 – Activities listed



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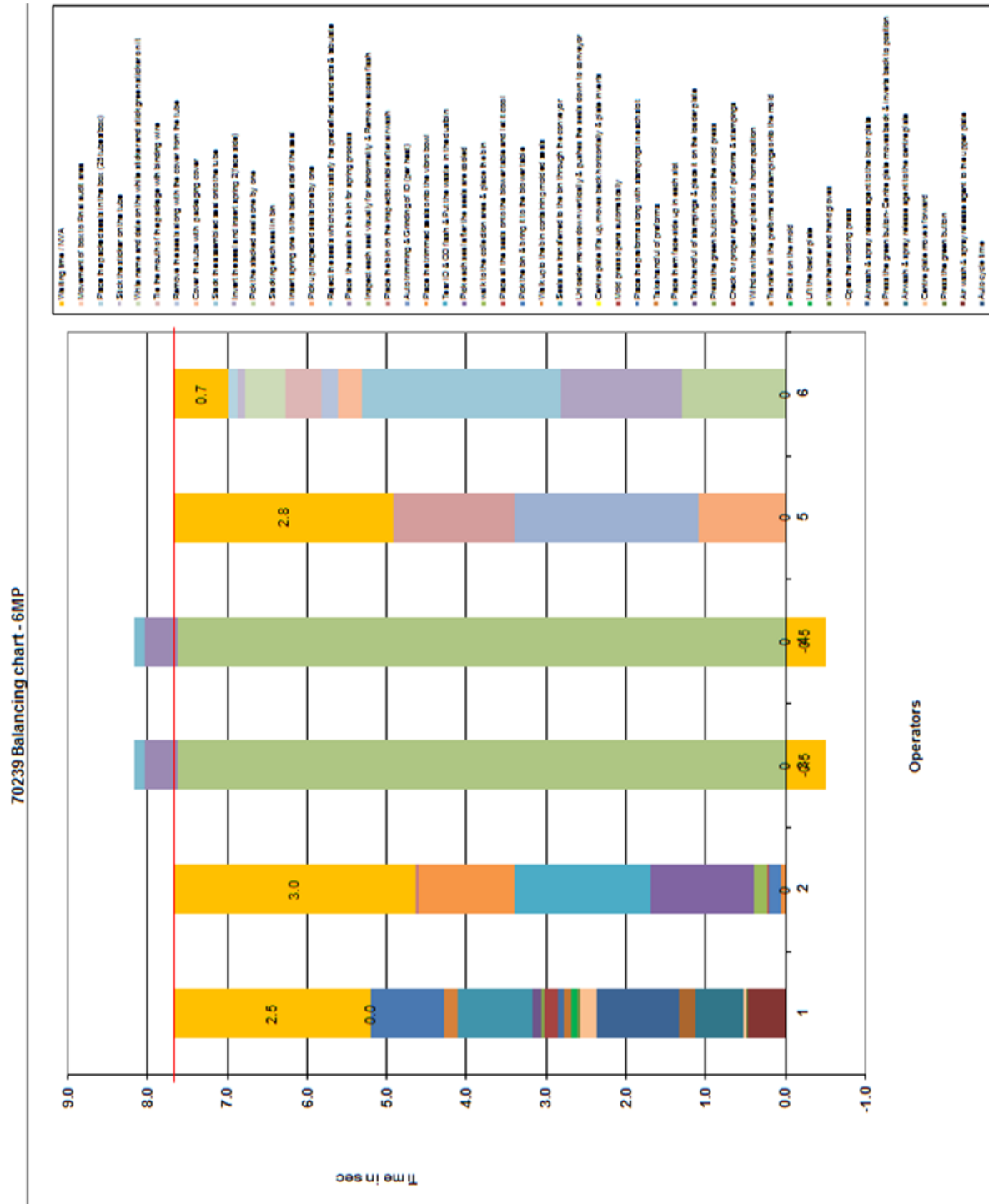


Fig 5: Worksheet 3.1: Work balance sheet for channel 9 – work load per operator shown



3 RESULTS AND DISCUSSION

3.1 Kaizens Proposed

Throughout the research journey aimed at achieving the set objectives, the study underwent a rigorous series of sessions and in-depth analyses to derive meaningful conclusions and progress towards implementing the proposed Kaizens effectively. The implementation phase focused primarily on Channel 9, where a range of Kaizen initiatives were introduced to enhance the production process. These Kaizens were carefully selected based on their potential to improve efficiency, reduce waste, streamline operations, and enhance overall productivity within Channel 9.

	A	B	C
1	Observation	Suggestion	Block
2	Transfer of unloaded seals on to Blower Table		Channel 9
3	The seals that fall off during unloading		
4	Auto-trimming and grinding surface check		
5	Operation at the Springing 1 desk	Lighting to be improved	
6	Shape of loading bin		
7	Solvo-cleaning		Phosphating
8	The stampings that fall off		
9	Transfer of stampings between the machine and solvo-cleaning area	Roller Conveyor	
10	Movement of the barrel		
11	Open mill safety bar		Extrusion
12	No place for tool trolley	Repositioning of openmill by 28 inches	
13	The seals that fall of while transfer	Reduce the distance between conveyor and Vibro-cooler	
14	Safety precautions at Barwell Extruder area	Exhaust vent	
15	Congested layout	Re-allocation of the empty bins and layout management	
16		Safety Mask	
17		Dust-Bin	
18		Calibrated containers and ladles	Mixing
19		Indicators to suggest the empty bins	

Fig 6: List of Kaizens implemented in Channel 9

After the implementation of Kaizens, significant improvements were observed in the production process, particularly in the elimination of bottlenecks and the restructuring of the production line. This restructuring involved redistributing work tasks among operators and introducing an automated workstation. Specifically, a conveyor system is currently being implemented to collect moulded seals and transfer them to the blower table, streamlining the production flow. Additionally, an automated inspection workstation is being set up, which includes seal inspection and spring inspection stations. This automation will facilitate the redistribution of work content, leading to the elimination of one inspector



and one spring assembly person. The details of these findings and developments are elaborated upon below.

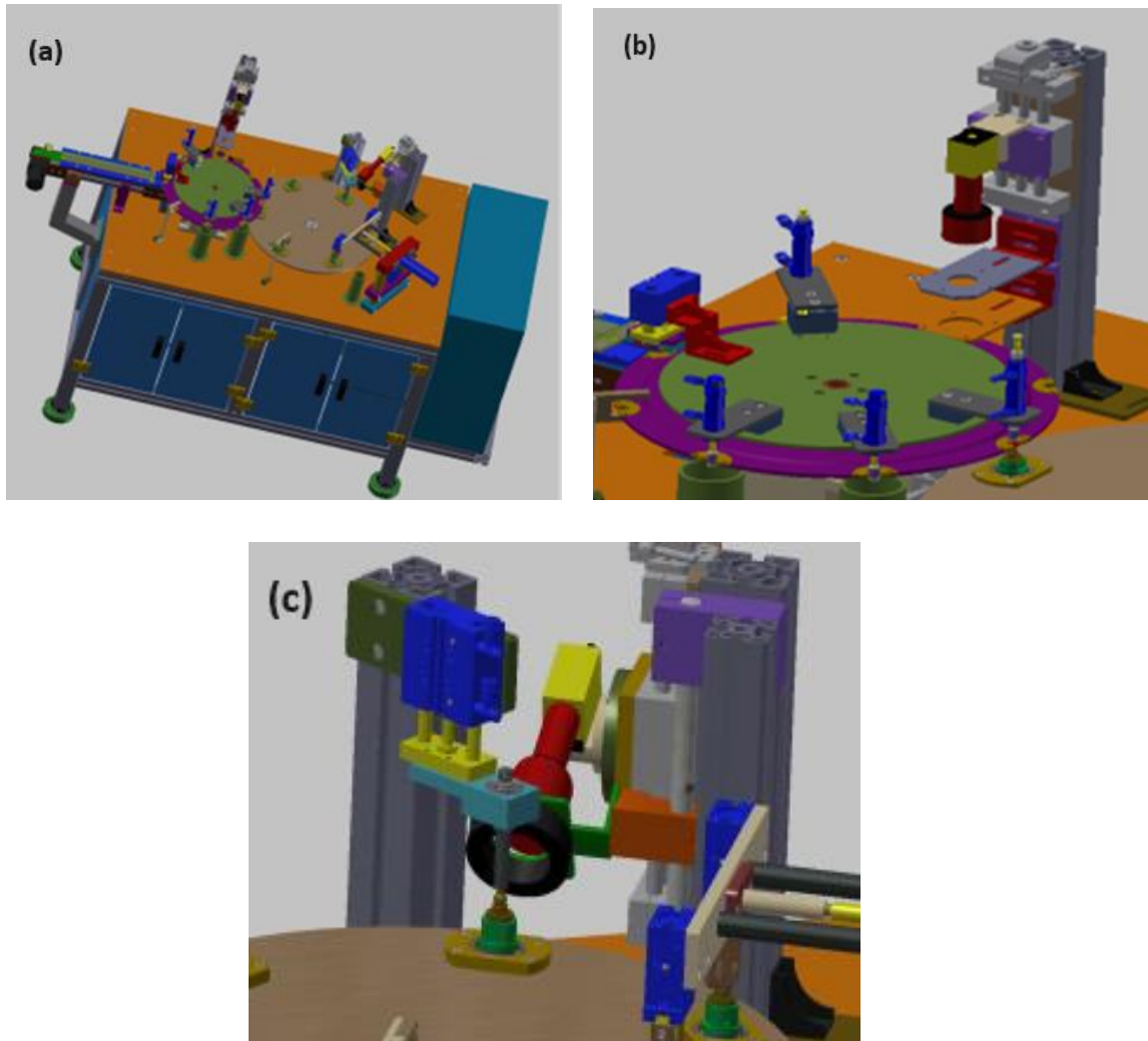


Fig 7: a) Complete inspection table b) Seal inspection c) Spring inspection

3.2 Defined Worksheets

Worksheets 4-9 provide a clear demonstration of the changes observed after the successful implementation of Kaizen initiatives. These defined worksheets showcase the revised work processes for each individual operator following the introduction of the automatic conveyor system.



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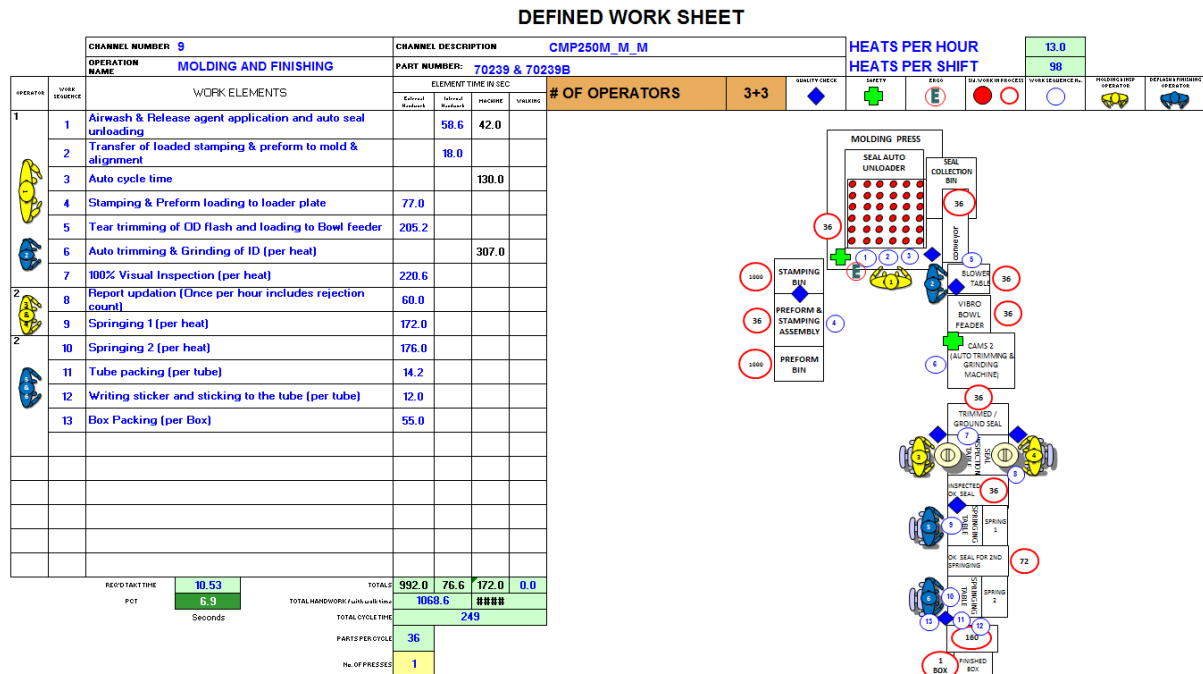


Fig 8: Worksheet 4: After implementation of the automatic seal collection conveyor system

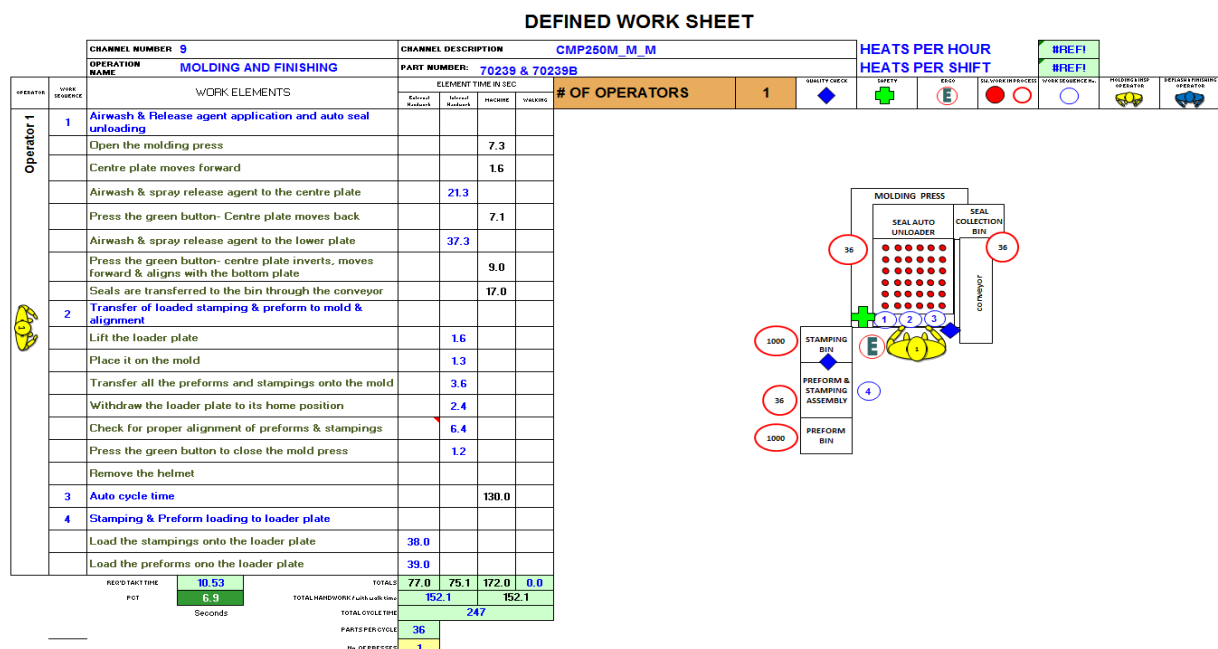


Fig 9: Worksheet 5: Steps carried out by operator 1



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DEFINED WORK SHEET

CHANNEL NUMBER 9		CHANNEL DESCRIPTION CMP250M_M_M		HEATS PER HOUR		#REF!
OPERATION NAME MOLDING AND FINISHING		PART NUMBER: 70239 & 70239B		HEATS PER SHIFT		#REF!
OPERATOR	WORK SEQUENCE	WORK ELEMENTS		# OF OPERATORS		1
		ELEMENT TIME IN SEC		QUALITY CHECK		SAFETY
		External Handwork	Internal Handwork	MACHINE		WALKING
	5	Tear trimming of OD flash & loading to bowl feeder (per heat)				
	a	Pick each seal after the seals are cooled		46.8		
	b	Tear ID & OD flash & Put the waste in the dustbin		61.2		
	c	Place the trimmed seals onto the vibro bowl		43.2		
REGO TAKT TIME		10.53		TOTALS		151.2 0.0 0.0 0.0
PCT		0.0		TOTAL HANDWORK / with walk time		0.0 0.0
Seconds				TOTAL CYCLE TIME		0
				PARTS PER CYCLE		36
				No. OF PRESSES		1



Fig 10: Worksheet 6: Steps carried out by operator 2

DEFINED WORK SHEET

CHANNEL NUMBER 9		CHANNEL DESCRIPTION CMP250M_M_M		HEATS PER HOUR		#REF!
OPERATION NAME MOLDING AND FINISHING		PART NUMBER: 70239 & 70239B		HEATS PER SHIFT		#REF!
OPERATOR	WORK SEQUENCE	WORK ELEMENTS		# OF OPERATORS		2
		ELEMENT TIME IN SEC		QUALITY CHECK		SAFETY
		External Handwork	Internal Handwork	MACHINE		WALKING
	6	Auto trimming & Grinding of ID (per seal)				
	a	Seals from camera moves to the flipping station				2.0
	b	Flipping station to the conveyor end				7.7
	c	Arm picks the seals from the conveyor				5.3
	d	Another arm picks the seals for grinding				4.0
	e	Grinding & dropping down into the bin				6.0
	7	100% Visual Inspection (per heat)				
	a	Place the bin on the inspection table after airwash		15.0		
	b	Inspect each seal visually for abnormality & Remove excess flash		208.6		
	c	Place the seals in the bin for spring process		15.0		
	8	Report updation (Once per hour includes rejection count)				
	a	Reject the seals which do not satisfy the predefined standards & tabulate		60.0		
REGO TAKT TIME		#REF!		TOTALS		296.6 0.0 25.1 0.0
PCT		0.7		TOTAL HANDWORK / with walk time		296.6 296.6
Seconds				TOTAL IDEAL CYCLE TIME		25
				STANDARD CYCLE TIME		27
				PARTS PER CYCLE		36
				No. OF PRESSES		1

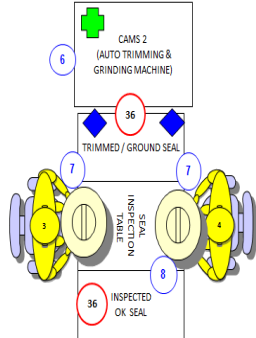
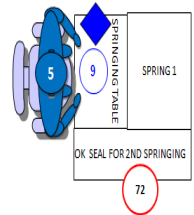


Fig 11: Worksheet 7: Steps carried out by operators 3 & 4

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DEFINED WORK SHEET

CHANNEL NUMBER		9		CHANNEL DESCRIPTION				CMP250M_M_M				HEATS PER HOUR				#REF!			
OPERATION NAME		MOLDING AND FINISHING				PART NUMBER:				70239 & 70239B				HEATS PER SHIFT				#REF!	
OPERATOR	WORK SEQUENCE	WORK ELEMENTS				ELEMENT TIME IN SEC.				# OF OPERATORS	2	QUALITY CHECK	SAFETY	ERGO	S/W WORK IN PROCESS	WORK SEQUENCE N°	MOLDING PREP OPERATOR	DEFINITION FRESHING OPERATOR	
		External Handbook	Internal Handbook	MACHINE	WALKING														
	9	Springing! (per heat)																	
	a	Pick up inspected seals one by one				39.2													
	b	Insert spring one to the back side of the seal				83.2													
	c	Stacking each seal in bin				54.7													
REQ'D TASK TIME		#REF!		TOTALS		177.1	0.0	#REF!	0.0										
PCT		#REF!		TOTAL HAND/WORK / With walk time		177.1	177.1												
Seconds				TOTAL IDEAL CYCLE TIME		#REF!													
				STANDARD CYCLE TIME		#REF!													
				PARTS PER CYCLE		36													
				No. OF PRESSES		1													



SPRINGING TABLE

SPRING 1

OK SEAL FOR 2ND SPRING

72

Fig 12: Worksheet 8: Steps carried out by operator 5

DEFINED WORK SHEET

CHANNEL NUMBER		9		CMP250M_M_M		HEATS PER HOUR		HEATS PER SHIFT		#REF!		#REF!														
OPERATION NAME		MOLDING AND FINISHING		PART NUMBER: 70239 & 70239B		ELEMENT TIME IN SEC		# OF OPERATORS		1		QUALITY CHECK		SAFETY		ECHO		2-H WORK IN PROCESS		WORK SEQUENCE		HOLDING STEP OPERATOR		DEGLASS FRESHING OPERATOR		
OPERATOR	WORK SEQUENCE	WORK ELEMENTS		Entered Handwork	Entered Handwork	MACHINE	WALKING																			
	10	Springing 2 (per heat)																								
	a	Pick the stacked seals one by one		46.8																						
	b	Invert the seal and insert spring 2(face side)		54.7																						
	c	Stack the assembled seal onto the tube		90.0																						
	11	Tube Packing (per tube)																								
	a	Cover the tube with packaging cover		6.0																						
	b	Remove the seals along with the cover from the tube		4.0																						
	c	Tie the mouth of the package with binding wire		9.0																						
	12	Writing sticker and sticking to the tube																								
	a	Write name and date on the white sticker and stick green sticker on it		10.0																						
	b	Stick the sticker on the tube		2.0																						
	13	Box packing																								
	a	Place the packed seals in the box (25 tubes/box)		55.0																						
	RES'D/TACT TIME		#REF!		TOTALS		277.5	0.0	0.0	0.0																
	PCT		0.0		TOTAL HANDWORK / with walk time		277.5		277.5																	
Seconds				TOTAL IDEAL CYCLE TIME		0																				
				STANDARD CYCLE TIME		0																				
				PARTS PER CYCLE		36																				
				No. OF PRESSES		1																				



OK SEAL FOR 2ND SPRINGING

72

SPRINGING TABLE

10

12

160

11

13

FINISHED BOX

1 BOX

Fig 13: Worksheet 9: Steps carried out by operator 6



Standard Work Combination Sheet

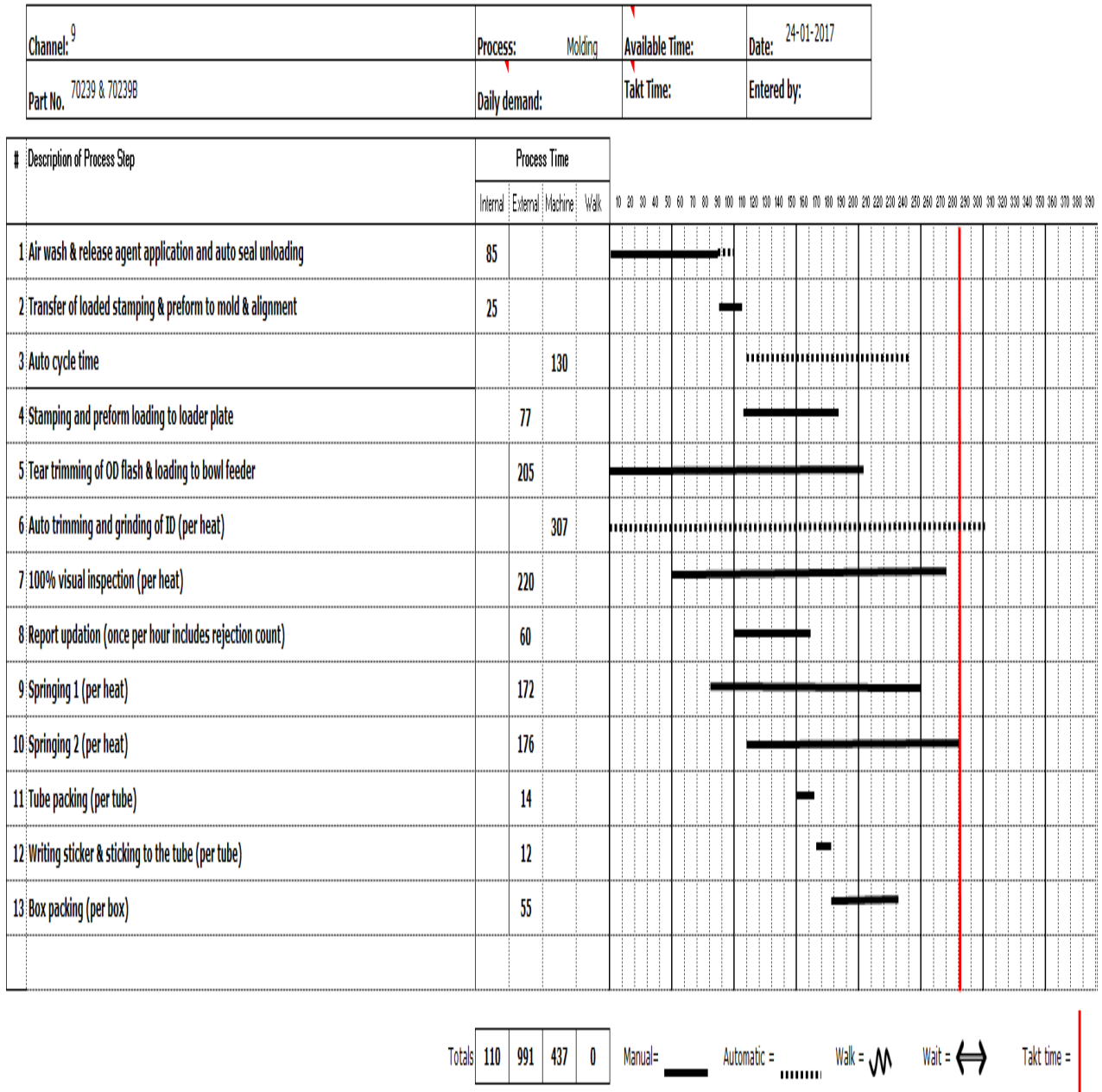


Fig 14: Worksheet 10: SWC sheet after improvement



3.3 Work Balance Sheet After Improvement

	Activity / Work	Operators					
		1	2	3	4	5	6
	Auto cycle time	0.0	0	0	0	0	0
	Air wash & spray release agent to the upper plate	0.5	0	0	0	0	0
	Press the green button	0.0	0	0	0	0	0
	Centre plate moves forward	0.0	0	0	0	0	0
	Airwash & spray release agent to the centre plate	0.6	0	0	0	0	0
	Press the green button- Centre plate moves back & inverts back to position	0.2	0	0	0	0	0
	Airwash & spray release agent to the lower plate	1.0	0	0	0	0	0
	Open the molding press	0.2	0	0	0	0	0
	Wear helmet and hand gloves	0.0	0	0	0	0	0
	Lift the loader plate	0.0	0	0	0	0	0
	Place it on the mold	0.0	0	0	0	0	0
1	Transfer all the preforms and stampings onto the mold	0.1	0	0	0	0	0
	Withdraw the loader plate to its home position	0.1	0	0	0	0	0
	Check for proper alignment of preforms & stampings	0.2	0	0	0	0	0
	Press the green button to close the mold press	0.0	0	0	0	0	0
	Take handful of stampings & place it on the loader plate	0.1	0	0	0	0	0
	Place them face-side up in each slot	0.9	0	0	0	0	0
	Take handful of preforms	0.2	0	0	0	0	0
	Place the preforms along with stampings in each slot	0.9	0	0	0	0	0
	Mold press opens automatically	0.0	0	0	0	0	0
	Centre plate lifts up, moves back horizontally & plate inverts	0.0	0	0	0	0	0
	Unloader moves down vertically & pushes the seals down to conveyor	0.0	0	0	0	0	0
	Seals are transferred to the bin through the conveyor	0.0	0	0	0	0	0
	Walk upto the bin containing molded seals	0.0	0.1	0	0	0	0
	Pick the bin & bring it to the blower table	0.0	0.1	0	0	0	0
	Place all the seals onto the blower table and let it cool	0.0	0.0	0	0	0	0
	walk to the collection area & place the bin	0.0	0.0	0	0	0	0
1	Pick each seal after the seals are cooled	0.0	1.3	0	0	0	0
	Tear ID & OD flash & Put the waste in the dustbin	0.0	3.2	0	0	0	0
	Place the trimmed seals onto the vibro bowl	0.0	1.2	0	0	0	0
	Auto trimming & Grinding of ID (per heat)	0.0	0.0	0	0	0	0
	Place the bin on the inspection table after airwash	0.0	0.0	0	0	0	0
	Inspect each seal visually for abnormality & Remove excess flash	0.0	0.0	5.7	5.7	0	0
2	Place the seals in the bin for spring process	0.0	0.0	0.4	0.4	0	0
	Reject the seals which do not satisfy the predefined standards & tabulate	0.0	0.0	0.1	0.1	0	0
	Pick up inspected seals one by one	0.0	0.0	0.0	0.0	1.09	0
1	Insert spring one to the back side of the seal	0.0	0.0	0.0	0.0	2.31	0
	Stacking each seal in bin	0.0	0.0	0.0	0.0	1.52	0
	Pick the stacked seals one by one	0.0	0.0	0.0	0.0	0.0	1
	Invert the seal and insert spring 2(face side)	0.0	0.0	0.0	0.0	0.0	2
	Stack the assembled seal onto the tube	0.0	0.0	0.0	0.0	0.0	3
	Cover the tube with packaging cover	0.0	0.0	0.0	0.0	0.0	0
1	Remove the seals along with the cover from the tube	0.0	0.0	0.0	0.0	0.0	0
	Tie the mouth of the package with binding wire	0.0	0.0	0.0	0.0	0.0	0
	Write name and date on the white sticker and stick green sticker on it	0.0	0.0	0.0	0.0	0.0	1
	Stick the sticker on the tube	0.0	0.0	0.0	0.0	0.0	0
	Place the packed seals in the box (25 tubes/box)	0.0	0.0	0.0	0.0	0.0	0
	Movement of box to Final audit area	0.0	0.0	0.0	0.0	0.0	0
	Waiting time / NYA	2.5	1.7	1.4	1.4	2.8	0.7
	PCT (Bottleneck Cycle Time / Seal)	7.7	7.7	7.7	7.7	7.7	7.7
	Total VA VC / Seal	5.20	5.98	6.26	6.26	4.92	6.98
	MOP / Shift in mins	305	350	367	367	289	409
	Human Efficiency per shift in %	68%	78%	82%	82%	64%	91%
	Measure of Performance	347.9					
	Human Efficiency	77%					
	Manpower Required	4.64					

Fig 15: The various steps carried out the different workstations and their respective



Time taken per heat (36 seals)

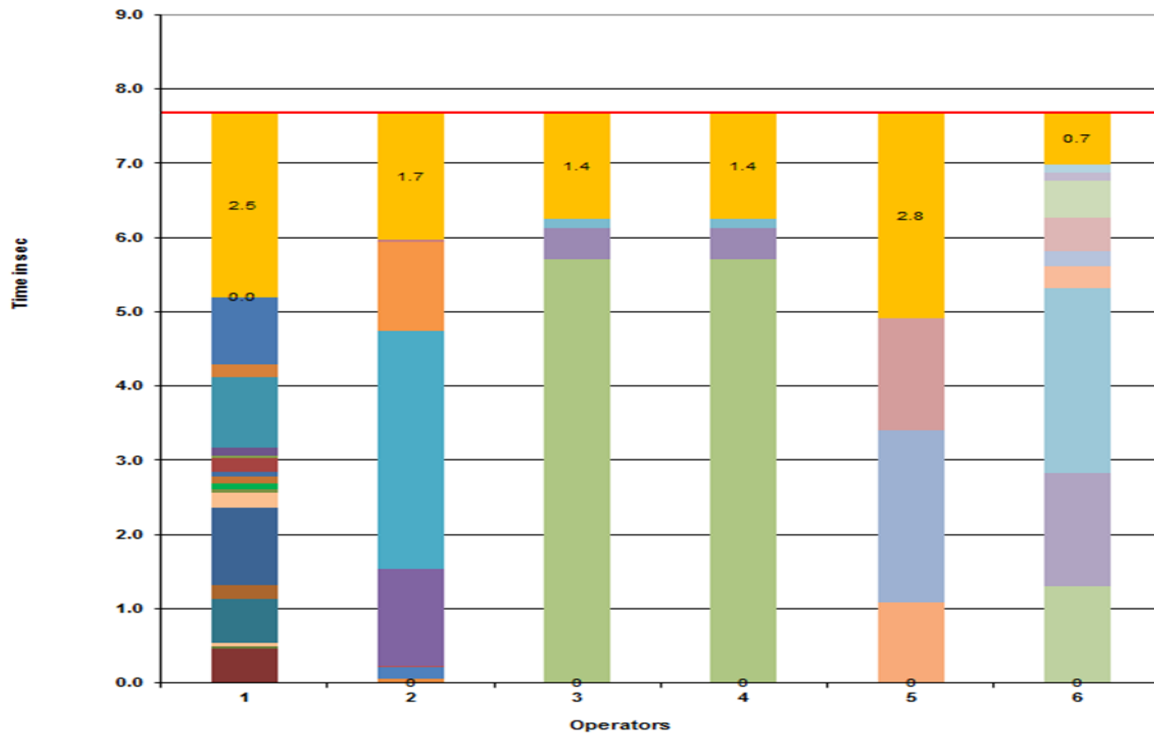


Fig 16: Worksheet 11: The total work content per operator after improvement

After the introduction of the conveyor system, a noticeable shift in work content distribution among operators occurred. Operators 3 and 4 experienced a decrease in their workload, while operator 2's workload increased. This adjustment led to a more balanced distribution of tasks among the operators.

Previously, operator 2 was responsible for manually collecting and transferring seals from the moulding machine to the blower table. However, with the conveyor system now handling this task, operator 2's time was freed up. This newfound time was then utilized by operator 2 for ID and OD deflashing of the seals, which were previously tasks carried out by operators 3 and 4. Consequently, the workload of operators 3 and 4 decreased.

Further enhancements can be achieved through the implementation of an automated inspection work station, which would include air leak testing. This addition would eliminate the need for 2 operators, thus saving on manpower. Additionally, if an automated springing station is introduced, it could further reduce the workforce by eliminating 2 more operators. This transformation would effectively reduce the total workforce from 6



operators to just 2 operators, significantly streamlining operations and increasing efficiency.

This restructuring also resulted in a change in the sequence of operations carried out, optimizing the workflow and improving overall productivity.

3.4 Summary

Table 1: Summary table

Areas of Improvement	Before	After
Defined work sheet	Block level sheet	Block level and also for individual operators
Standardized work combination	Processes were not under takt time	Processes are under takt time and under control
Line balancing sheet	Operators 3 & 4 were doing more work leading to bottleneck situation	Work distributed to operator 2 and hence 3 & 4 are burden free
Man power	6 operators	4 operators (After implementing automatic inspection and springing system)
Work content	Total work content is concentrated and unevenly distributed Work content operator 2-60% Work content operator 3-107% Work content operator 4-107%	Total work content is almost evenly distributed Work content operator 2-78% Work content operator 3-82% Work content operator 4-82%
Number of operations	15 operations	13 operations

4 CONCLUSION

In conclusion, the implementation of lean methodologies, particularly standardized work and Kaizen, has significantly improved the efficiency and productivity of seal production within the manufacturing industry. The shift from block-level defined work sheets to individual operator-level sheets, along with the adoption of standardized work combinations under takt time control, has brought the processes under better management and control. This has resulted in a more balanced workload among operators, particularly



alleviating the burden on operators 3 and 4, leading to line balancing and the elimination of bottlenecks.

Furthermore, the reduction in manpower from 6 operators to 4, achieved through the implementation of automatic inspection and springing systems, has not only lowered production costs but also enhanced both quality and efficiency. The incorporation of automation into the production lines has streamlined processes, minimized unnecessary motions, and prevented equipment damage. This has facilitated higher-volume production and positioned for continued success in meeting customer demands.

Overall, the successful integration of lean tools and automation has optimized the production line efficiency, ensuring that processes remain within designated takt times while achieving control and balance. This has not only lowered labour costs but also enabled larger production volumes, reinforcing the commitment to delivering high-quality products efficiently.

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