International Journal of Scientific & Technical Development
(A Peer-Reviewed Bi-Annual Journal) ISSN: 2348-4047

IMPLEMENTING LEAN TOOL: POKA-YOKE IN TRACTOR COMPONENT MANUFACTURING INDUSTRY

***Deepak Bubber **Gulshan Babber ***Rakesh Kumar Jain**
*Faculty of Engineering & Applied Science, Himalayan University, (Arunachal Pradesh) India 791111.
**Chitkara Business School, Chitkara University, (Punjab) India 14040.
***Faculty of Engineering & Applied Science, Himalayan University, (Arunachal Pradesh) India 791111.

Abstract
Several changes have occurred in the manufacturing industry since the post-liberalization after 1991. Original equipmentmanufacturers (OEMs) dominate the organized sectors. Moreover, companies of all sizes including micro, small and medium (MSME) act as mediators by supporting as Tier-1 and Tier-2 suppliers for these OEMs. The lifting of trade restrictions has been blessing in disguise for both Indian manufacturing industry as well as consumers. In recent times, the Indian subcontinent has seen a paradigm shift in manufacturing culture with the advent of many reputed global brands establishing their manufacturing facilities in India. As a result, India's manufacturing culture has adopted modern technological tools and techniques in place of traditional manufacturing methods. Component manufacturers have been forced to modify their working cultures to adapt and adjust to the dynamic requirements such as change in material specifications, tolerances and surface treatments like heat treatment, plating etc. The purpose of this case study is to gauge the outcome after the implementation of one of the lean tool: Poka-Yoke. This tool was invented by a Japanese industrial engineer in 1961, who specialized in quality control. He is also known for introducing various quality techniques, such as Just-in-time production (JIT), Single Minute Exchange of Die (SMED), Jidoka (building quality into the process), Kaizen (continues improvement) etc. Poka-yoke technique was applied in a tractor parts manufacturing company that is a Tier-1 supplier for an OEM. Although the company has achieved quality due to sophisticated technology and superior manufacturing capabilities, inadvertent errors due to human mistakes can still occur. This was resolved by changing fixture design, where human mistake is negligible. However, applyingpoka-yoke helped to eradicate these issues related due to human errors there by leading to reduction in overall customer complaint
Keywords- Poka-Yoke, Lean Manufacturing, Fixture Design, Customer Complaints

Introduction

AIndian manufacturing industry has seen a sea change after the post economic liberalization. Government of India (GOI) took many initiativesin the nineteen eighties, but it was not before 1991 that GOI laid a roadmap to facilitate a systematic shift towards more open economic systemat par with global practices. Furthermore GOI acted as a facilitator to empower private sector to meet global standards through hand holding by introducing schemes for up liftmen of MSME [1]. The Indian auto-components industry can be broadly categorised into organized and unorganized sectors. The organized sector mostly caters to original equipment manufacturers (OEMs) categorized as vendor or supplier. Now-a-days every OEM is having a vendor development cell(VDC) that comprises of specialized persons from design, purchase, quality, assembly etc. This roll of the team is to understand the manufacturing capability of the vendor based on the available plant and machinery, testing and inspection facilities etc. Moreover, this is important to know the capability/capacity of a vendor because the components are made according to the company's drawings and specification.The unorganized sector due to the limited resources focuses on products that caters mostly to the aftermarket category.

The automobile component industry's turnover was ₹3.40 lakh crore (US$ 45.9 billion) in FY21, a 3% decrease from the previous year and is expected to reach US$ 200 billion by FY26. Exports of auto components declined by 8.28% to ₹0.98 lakh crore (US$ 13.3 billion) in FY21, ₹1.02 lakh crore (US$ 14.5 billion) recorded in FY20. As per Automobile Component Manufacturers Association (ACMA), automobile components export from India is predicted to attain US$ 80 billion by 2026. Strong global demand and rejuvenation of the local original equipment and aftermarket segments are predicted to help the Indian auto component industry grow by 20-23% in FY22.
(https://www.ibef.org/industry/autocomponents-india.aspx).

2.ENTERY OF GLOBAL AUTOMOBILE COMPANIES

Globalization and easing trade restrictions had a positive effect on both Indian industry as well as consumers due to direct investments of many global players in the way of establishing manufacturing facilities pan India. Pre liberalization, the consumer had limited choices

due to limited brands available in automobile sector. The list of some global players that established their manufacturing facilities in India from early 1980's to late 1990's are as follows:

Table I
Details of Global Players

Year	Name of the Global Player	Country	Product
1982	Suzuki Motor Corp. Joint Venture with Govt. of India	Japan	Car
1982	Mitsubishi Motors Corp. Joint Venture Eicher Goodearth Ltd	Japan	Light Commercial Trucks
1983	Mazda Motor Corp. Joint Venture with Punjab Tractors Ltd	Japan	Light Commercial Trucks, Buses
1983	Nissan Motor Comp. Joint Venture with Hyderabad Allwyn Ltd	Japan	Light Commercial Trucks
1995	Honda Motor Company Limited	Japan	Cars
1995	Ford Motor Company	USA	Cars
1996	Hyundai Motor India Limited	South Korea	Cars
1995	Daewoo Motors	South Korea	Cars
1997	Toyota Motor Corp. Joint Venture with Kirloskar India Ltd	Japan	Cars
1997	Fabbrica Italiana Automobili Torino (F.I.A.T.)	Italy	Cars

Source: https://www.google.com

The success of these companies laid on the foundation of practicing tool and techniques such Lean manufacturing (replica of Toyota Production System developed by Taiichi Ohno and Eiji Toyoda in 1948 and 1975 respectively), Six Sigma (Introduced by American engineer Bill Smith working at Motorola in 1986), Total Quality Management (TQM was developed by William Deming, a management consultant).The requirement of meeting closer machining tolerances led to the adoption of these tested methodologies also in Indian components manufacturing industries.

3. METHODOLOGY OF THE STUDY

This case study is based on an Indian MSME that is a tier-1 supplier to a tractor manufacturing company based in the state of Punjab, India. The component under study is a DOL component against which a customer complaint was received through mail citing fitment issues at assembly line. The road map for the study is as follows:

4.COMPANY PROFILE

M/s BI Pvt. Ltd (a company), established in 1980, has earned a good reputation in manufacturing intricate and precise components. While catering to a growing OEM segment, company has achieved excellence through state-of-the-art technology, superior manufacturing capabilities and dedicated personnel. This makes them one of preferred supplier in the domestic markets. However, there are certain issues which act as bottle necks and catch the attention of top management.

The company is ISO: 9001:2015 certified with acceptance as a quality supplier among the auto component manufacturers. The company supplies components to many reputed OME's such as Manindra & Mahindra (Swaraj Tractors Div.), Mahindra & Mahindra (Farm Equipment Div.), Swaraj Engines Ltd., SML Isuzu Ltd, Indo Farm Equipment's Ltd etc. These OEM's are manufacturing Tractors, Harvester Combines, Tractor Engines, Cranes etc. The company started with basic manufacturing technology that comprised of conventional

machines such as lathe machines, universal milling machines, drilling machines, thread rolling machines, thread milling machines etc. The company upgraded its manufacturing setup by adding Computer Numerically Controlled (CNC) Lathe machines, Vertical milling machines (VMC), automatic band saw cutting etc. Post 2005 technological upgradation helped the company to meet customer demand with shorter lead time and enhanced component quality.

5.PROBLEM STATEMENT

The company manufactures around 150 odd components for different OEMs. The component selected for this study is an important child part of hydraulic control valve assembly that is used in tractor lift application. This assembly controls the hydraulic lift functions of the tractor. Presently, the company is suppling 8000 to 10000 pieces per month depending on the customer demand that are direct on line (DOL) assured. During the assembly one piece found out of spec. that lead to line stoppage due to fitment problem. An official mail was received from the ReceiptQuality Assurance (RQA), describing the problem and raising of Corrective action and Preventive action (CAPA) on supplier portal for investigation and closure. (Ref. Mailbox of deepakbubber).

6. LITERATURE REVIEW

6.1 Origins of Lean Manufacturing

Henry Ford, of the Ford Motor Company, and Alfred Sloan, with General Motors, shifted from craft manufacturing to the mass manufacturing in the early part of the twentieth century as a cost reduction approach. Ford's mass-production system focused heavily on production rate rather than the voice of customer. In the mid-twentieth century, the Japanese manufacturer Toyota developed more efficient production methodologies that were based on the deep analysis of western production systems. The Japanese industries lacked resources and their productivity was far less than their western counterparts. Taiichi Ohno, an industrial engineer is credited with developing a new production system that focused on cost reduction, waste elimination, first time right (FTR) by producing quantity as per customer demand [2]. The outcome of the new system made Toyota a pioneer in auto products through demonstration of world class quality at highly competitive prices. [3]. The term Lean became used for the first time in 1988, when an International Motor Vehicle Program was launched to understand the productiveness among Japanese and Western industries. The term was then popularized by Womack, Jones and Roos in their book "The Machine That Changed the World"[4]. The source of Lean Manufacturing came from the Toyota Production System.[5]. Lean is thus a weapon against waste elimination that focuses on both manufacturing inefficiencies and underutilization of people enterprise.

6.2 Lean Manufacturing Competitive Scheme

The GOI had setup "National Manufacturing Competitive Council (NMCC)" in the year 2004 under the Ministry of Micro, Small and Medium Enterprises (MSMEs) with the vision to motivate, facilitate and support the growth of manufacturing industries in India. Under this program following schemes were launched:

1. Technology and Quality Upgradation Support for MSMEs.
2. Credit Linked Capital Subsidy Scheme.
3. IPR Building Awareness On Intellectual Property Rights for MSMEs.
4. Lean Manufacturing Competitiveness Scheme for MSMEs.
5. Design Clinic Scheme for Design Expertise to MSMEs.
6. Incubation Centre Support for Entrepreneurial and Managerial Development of SMEs Through Incubators.
7. Zero Effect Zero Defect.

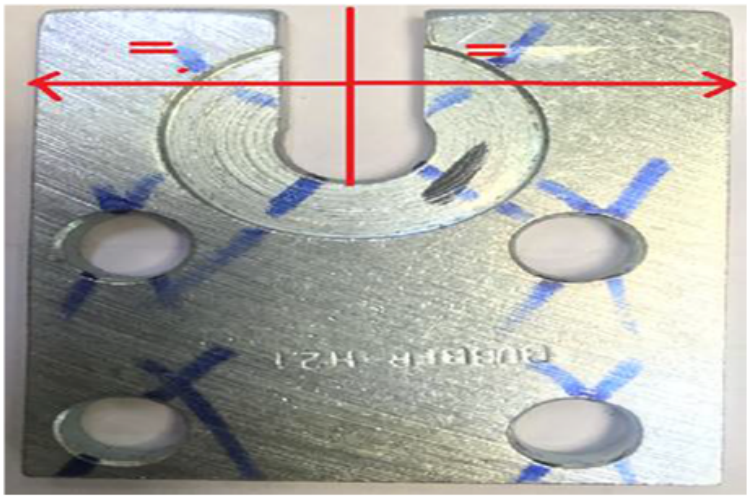
Mailbox of deepakbubber

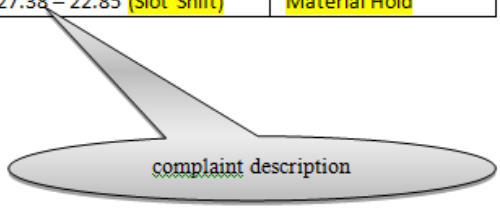
Subject: Fw: Hyd. Shop Issue-M/S- BUBBER INDUSTRIES PRIVATE LIMITED
From: bubber industries pvt ltd <info@bubberindustries.com>on Fri, 14 Jan 2022 14:12:31
To: "Deepak Bubber" <deepakbubber@rediffmail.com>
From: SINGH HARJOT – SWARAJ
Sent:Wednesday, October 6, 2021 4:50 PM
To: bubber industries pvt ltd ; Gulshan Babber
Subject: FW: Hyd. Shop Issue-M/S- BUBBER INDUSTRIES PRIVATE LIMITED
Dear Sir,
Kindly find below quality issue raised in Plant-1 by RQA team. Kindly send a representative for resolution of given issue.
Regards,
Harjot Singh

From: KUMAR JATINDER -KUMAR.JATINDER3@mahindraswaraj.com>

Sent: Wednesday, October 6, 2021 2:23 PM
To: KUMAR MAYANK - SWARAJ <KUMAR.MAYANK@mahindraswaraj.com>; BABBAR SUMIT - MVML 123152983@MAHINDRA.COM>; SINGH HARJOT - SWARAJ- <SINGH.HARJOT2@mahindraswaraj.com>
Cc: KAUL RAKESH <KAUL.RAKESH@mahindraswaraj.com>; KUMRA KRISHAN - SWARAJ <KUMRA.KRISHAN@mahindraswaraj.com>; BISHT ANKIT - SWARAJ <BISHT.ANKIT@mahindraswaraj.com>
Subject: Hyd. Shop Issue-M/S- BUBBER INDUSTRIES PRIVATE LIMITED
Dear Sir,
Hyd. Shop Issue of with details below:

Part no	Part Name	Supplier	Required	Observed	Remarks
P108208C	Front Plate for Control Valve	Bubber Industries Pvt. Ltd.	Equal Dim Required 25.00 mm	Equal Dim Observed 27.38 – 22.85 (Slot Shift)	Stock Qty. 2000 pcs, Material Hold





You are requested to take up the issue with supplier for necessary actions
Regards
Chandra Prakash Singh
RQA PLANT-1

The information contained in the mail as shown above have the type of quality problem and quantity laying at the customer end. As per mail around 2000 pieces were available for segregation i.e. the first step is to know the exact quantity of the faulty pieces laying in the assembly/store.

Lean Manufacturing Competitive Scheme is one of the salutaryfor the Indian MSME[6]. The objectives of this scheme is to reduce waste, increase productivity, promoting innovative practices for improving overall competitiveness, inculcating good management systems and imbibing a culture of continuous improvement. The scheme is operational since July, 2009. A three-tier structure is proposed for the implementation of the scheme with a group of ten MSME units, called a Mini Cluster. The scheme is being administer through nodal agency National Productivity Council (NPC), New Delhi as a coordinating body or National Monitoring and Implementing Unit (NMIU) and financially supported by GOI towards the cost of conducting awareness programs and implementation of LM techniques [7].

6.3 Lean Manufacturing: The Indian Scenario

Lately, India has become a preferred manufacturing hub for many reputed global brands that cater to domestic as well as global demands. The effects of this situation has helped Indian manufacturer to shelf orthodox production methodsand to adopt to the latest world class technology used for manufacturing [8].Lean manufacturing has become the most popular methodology among manufacturing and service industry that facilitate efficient working of the organization to produce world class quality at highly competitive prices[9][10].

Despite the overall benefits of implementing lean manufacturing
the success among Indian manufacturing industries still remains in the infancy stage, moreover Indian firms especially micro and smallenterprises are notable to reap the benefits derived from its applications due to lack of

resources and management commitments [10][11].
Many practitioners wrongly confine "lean" as an activity limited to the shop floor whereas lean is the way of thinking and attitude. The lean approach can be applied to every stage or situation in the company. The idea is to create a culture that promotes people to continuously innovate and improve their processes that are able to produce defect free products at globally commutative price[12][13].

7. LEAN TOOL: POKA-YOKE

Poka Yoke is another term that was conceived in Toyota, Japan. It was first coined in the 1961 by Shigeo Shingo, who was employed as an industrial engineer responsible for introducing popular systems such as Toyota Production System (TPS) and Just in Time (JIT) that created and streamlined processes to produce Zero defective components. The purpose of poka-yoke is to eliminate defects due to human negligence in products by way of prevention of mistakes in the process execution as early as possible. The original wording was Baka-Yoke is the Japanese term for fool-proofing which was retaliated by Japanese operators, as they seemed to be insulted by the word 'fool'. "In 1963, a lady operator at Arakawa body company refused to use Baka-Yokemethodology in her work station, because the term seemsdisgusting and offensive inkling" inviting Shingo, to rethink and rename the term Baka-Yoke that has the mass acceptance duly invented by him in 1961, keeping in mind the philosophy behind this concept[14].
The philosophythat drives the concept of poka-yoke methodology honors the human values, specifically human intelligence. In the process of repetitive operations which require beingvigilant and focused. Applying poka-yoke helps to reduce valuable human efforts due to occupancy that further is used to the utilize in creativity, innovation and overall value[15]. A defect exists in two states, firstly the defect either has already occurred, that is termed as defect detection, secondly that has the potential to occur in future that is called predictive defect detection[16].
Shingo conceptualized three types of poka-yoke methodology for detection and prevention of errors in a mass production system. The "control method"detects the defects in the product via shape, size, color, or other physical attributes. The "fixed-value method"is used where repetitive activities are made in production that is detected by sensors, counters etc. for missing movements. The "motion-step method"determines the adherence of prescribed steps as per defined process[17][18].

7.1 Examples of Poka Yoke

Poka-Yoke technique is used to eliminate mistakes due to human negligence. Figure 1(a) shows various designs of connectors and cables used in a computerapplication that are not interchangeable with each other i.e. specific connectors for specific applications and use. Figure 1(b) shows how wrong components are rejected through the application of online gauging installed on the conveyor. This process acts as a tollgate that only allows the right components reaches the next station

Figure. 1(a) Control Method.

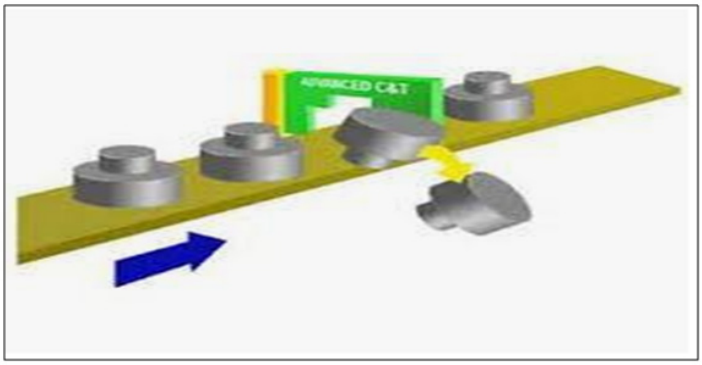


Figure. 1(b) Motion-Step Method

7.2 Mistakes vs Defects

Shingo differentiated mistakes/errors that are mostly inevitable and defect generators. These defects are further passed on through the system undetected that is eventually passed on to the end customers. Poka-Yoke thus acts as mainstay formistake preventionin the process.
The Poka-Yoke techniques are implemented to ensure idealistic conditions in processes by ensuring defect free components before the subsequent operations.The main focus of lean methodology is to avoid any type of wastes; human negligence is one of them i.e. taken care by implementing poka-yoke. In case a mistake or defect cannot be prevented from occurring, Poka Yoke can also be used to come across any defects and rectify them as soon as possible.

7.3Types of Errors in Manufacturing

Poka-Yoke techniques are used in situations or places

that are prone to possible mistakes/errors. Poka-yoke thus can be applied both in manufacturing or services effectively. Some of the possible errorsare as follows:

- Errors in processing.
- Errors with the set up.
- Errors due to missing parts in assembly or welding in manufacturing.
- Errors due to wrong parts used in manufacturing.
- Errors with measurements.

7.4 When to use Poka-Yoke?

There are various types of human errors, some of the error types are listed in Table II along with some potential safeguards.

Table II
Types of Human Errors

S. N	Type of Errors	Description	Safeguard	
1.	Forgetfulness	Sometimes we forget things when we are not concentrating e.g. A person forgets to set his/her alarm clock at night.	1.	Establish a routine which includes checking before going to bed.
2.	Errors due to a misunderstanding	Sometimes we make mistakes when we jump to the wrong conclusion before we are familiar with the situation e.g. A person not used to automatic transmission steps on the brake, thinking it is the clutch.	2.	Training, checking in advance, work standardization.
3.	Errors in identification	Sometimes we make mistakes when we view it too quickly e.g. A ₹10 note is mistaken for a ₹20 note.	4.	Training, attentiveness, vigilance.
4.	Errors made by amateurs	Sometimes we make mistakes through lack of experience e.g. New operator does not know the operation or is barely familiar with it.	6.	Skill building, work standardization.
5.	Willful errors	Sometimes we make mistakes when we decide we can ignore rules under certain circumstances e.g. Crossing a street against a red light because there are no cars in sight.	8.	Basic education and experience.
6.	Inadvertent errors	Sometimes we make mistakes without knowing how they happened e.g. Someone lost in thought tries to cross the street without noticing the light is in red.	Attentiveness, discipline, work standardization.	
7.	Errors due to slowness	Sometimes we make mistakes when our actions are slowed down by delays in judgment e.g. A person learning to drive is slow to step on the brake.	Skill building, standardization.	
8.	Errors due to lack of standards	Sometimes we make mistakes when there are no suitable standards or work instructions e.g. A measurement may be left to an individual worker's discretion.	Work standardization, work instruction.	
9.	Surprise errors	Sometimes we make mistakes when equipment runs differently than expected e.g. A machine may malfunction without warning.	Total Productive Maintenance, work standardization.	
10.	Intentional errors	Sometimes we make mistakes deliberately e.g. Crimes and industrial sabotage.	Fundamental education, discipline.	

8. CURRENT MANUFACTURING PROCESS

8.1 COMPONENT DRAWING

Company is manufacturing component based on the drawing supplied by the OEM. This drawing contains all the information of the component like component name, material, dimensions, tolerances etc. as shown in figure 2. The development process of the component starts with the submission of an estimated cost against a request for quote (RFQ).After the acceptance of the cost by the OEM,a development order (DO) containing terms and conditions such as annual requirement, warranty claims are listed i.e. accepted by both vendor and vendee. A formal purchase order (PO) is released by the OEM.

A joint activity between vendor, sourcing and supplier quality assurance is done i.e. properly called advance quality planning (AQP) that thoroughly reviews tolerances, critical parameters and checking methodology. Subsequently after the AQP closure the vendor has to submit Production Part Approval Process (PPAP). This is a set of documents as listed below:

1. Part Submission Warrant
2. Process sheet
3. Control Plan
4. Process Failure Mode Effects Analysis (PFMEA)
5. List of instruments and gauges
6. Calibration Plan
7. Process capability study
8. Material test report

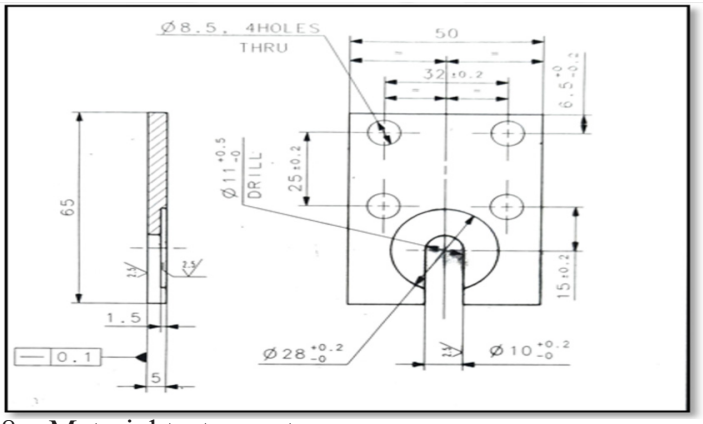


Figure. 2 Component Drawing

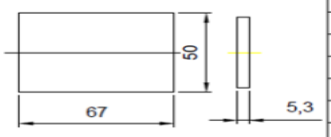
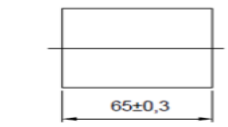
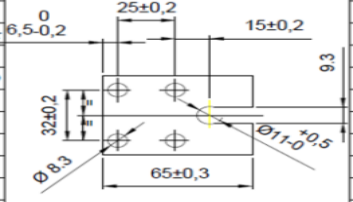
8.2 PROCESS SHEET

Process sheet is an important document which have all manufacturing related information's as shown in figure 3(a) and 3(b). This document is jointly signed by the company and the OEM.

The sequence of process consists of cutting on band saw machine, total length machining on lathe machine, punching holes on power press with the help of punching die (outside job work), thickness grinding on surface grinding machine, counter bore and key way machining on vertical machining center (VMC), deburring and vendor/lot/month code punching on pneumatic press, final inspection with gauge as well as visual for any defect and finally packing and dispatch.

BI Pvt. Ltd. | PRODUCT: Hydraulic Lift Assembly | MATERIAL : C-20 IS:2073 | SHEET No 1 of 2 | DATE: 20.02.2017

COMPONENT : Front Plate | STOCK NO : P 108208C | SOURCE:

OPN No.	Machine	SKETCH	OPERATION NO.	OPERATION	TOOLS NO.	TOOLS DESCRIPTION	GAUGES / INSTRUMENTS NO.	GAUGES / INSTRUMENTS DESCRIPTION
10	Band Saw		1	Flat Size 50 x 5.3	1	HSS Band Saw Blade	1	Vernier Calliper
			2	Total Length 67				
				[As per Sketch]				
20	Lathe Machine		1	Holding in Four Jaws Chuck	1	Turnning Tool	1	Vernier Calliper
			2	Total Length 64.7 - 65.3		[Brazed Tool]		
				[As per Sketch]				
30	Power Press (Outside)		1	Holding in Machine Vice	1	Punch and Die	1	Vernier Calliper
			2	Drill Dia 8.3 Thru at 4 Places				
			3	Dim 6.3 - 6.5				
			4	PCD 24.8 - 25.2				
			5	PCD 31.8 - 32.2				
			6	Dim 14.8 - 15.2				
			7	Drill Dia 11.0 - 11.5				
			8	Slot Width 9.3				
				[As per Sketch]				

Approved By OEM | Vendor

Figure. 3(a) Component Process Sheet

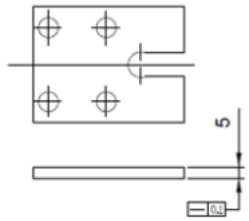
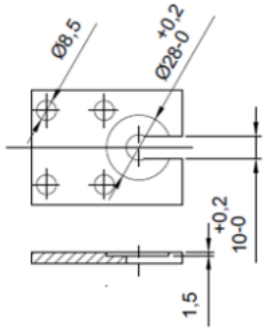
BI Pvt. Ltd.			PRODUCT: Hydraulic Lift Assembly		MATERIAL : C-20 IS:2073		SHEET No 2 of 2	DATE: 20.02.2017
COMPONENT : Front Plate			STOCK NO : P108208C		SOURCE:			
OPN No.	Machine	SKETCH	OPERATION NO.	OPERATION	TOOLS NO.	DESCRIPTION	GAUGES / INSTRUMENTS NO.	DESCRIPTION
40	Surface Grinding		1	Dim 5	1	Grinding Wheel	1	Vernier Calliper
			2	Streightness within 0.1			2	Feeler Gauge
				[As per Sketch]				
50	VMC		1	Holding in Drilling Vice	1	End Mill Ø28	1	Vernier Calliper
			2	Counter Bore Dia 28.0 - 28.2				
			3	Counter Bore Depth 1.5				
			4	Drill Dia 8.5 Thru at 4 Places				
			5	Slot Width 10.0 - 10.2				
				[As per Sketch]				
60	Bench		1	Deburring all Over			1	Visual
70	CNC Marking		1	Vendor Code Marking	1	Marking Tool	1	Visual
80	Bench		1	Oiling And Packing in Poly Bag			1	50 Pieces in a Bag
						Approved By OEM		Vendor

Figure. 3(b) Component Process Sheet

8.3 METHOD OF INSPECTION BEFORE DISPATCH

Final pre dispatch inspection (PDI) is done to ensure the detection of defects such as material fault (crack), missing operations, 100% fitment inspection with approved receiver gauge to ensure defect by SQA and designed by OEM's industrial engineering department is used as the part of quality assurance due to the component having a DOL status.

8.4 THE EFFECTIVENESS OF 100% INSPECTION

The least effective form of quality control is that of inspection by humans, monotonous and long working hours lead to low job engagement resulting in mistakes/ defect. However, that does not mean that operator inspection should be dismissed as being of no value, having each and every operator inspect the work that they receive before use and the work that they produce is still an effective way to reduce the possibility of defects reaching the customer, although it is not the best.

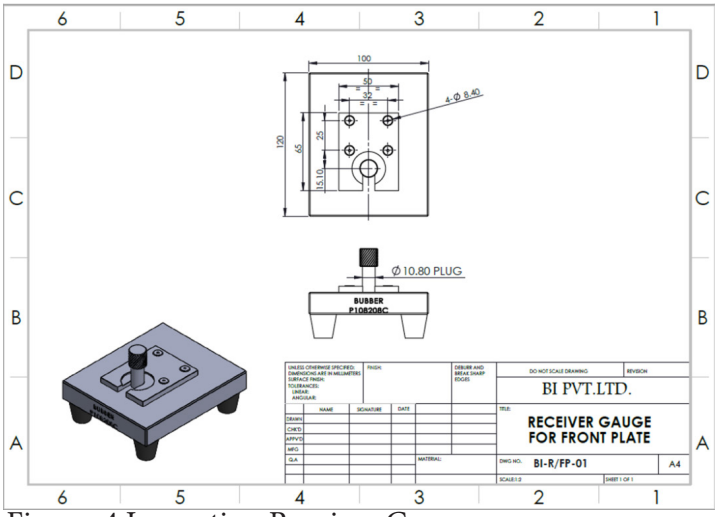


Figure. 4 Inspection Receiver Gauge

8.5 ROOT CAUSE OF REJECTION (COMPLAINT)

After the detailed analysis of the root cause based on the customer complaint a "why-why" analysis was done to analyze the occurrence, detection and the system fail-

ure. The outcome of the why-why analysis and the possible reasons are listed below:

1. OPN 50 (as shown in figure 3(b)) is the final machining of counter bore Ø28+0.2, depth 1.5, Drill Ø8.5 at 4 places and key way 10+0.2. It is observed that during the setting on VMC, first piece was shifted (as per first piece inspection report).
2. This setting piece was mixed with the entire lot due to operator mistake whereas it must be scrapped immediately or should have a red paint mark.
3. Design of final inspection receiver gauge checks only the PCD of holes and the slot.
4. The shift of the hole and slot w.r.t dim 50 i.e. width of the front plate cannot be checked with the receiver gauge (design fault).
5. Final inspection team have a mindset that no such problem observed earlier so they assume that lot is ok.

9. RESULTS AND DISCUSSIONS

9.1INSPECTIONFIXTURE DESIGN USING POKA-YOKE

The permanent solution of the problem is to make the process so mistake-proof which eliminates the human error. The new and improved design of the inspection receiver gauge that is able to detect shifting of 4 holes and the key way slot w.r.t to component width. Operator/Inspector has to place the component on the receiver gauge as shown in the figure5.Defective pieces will be rejected/detected by the receiver gauge.

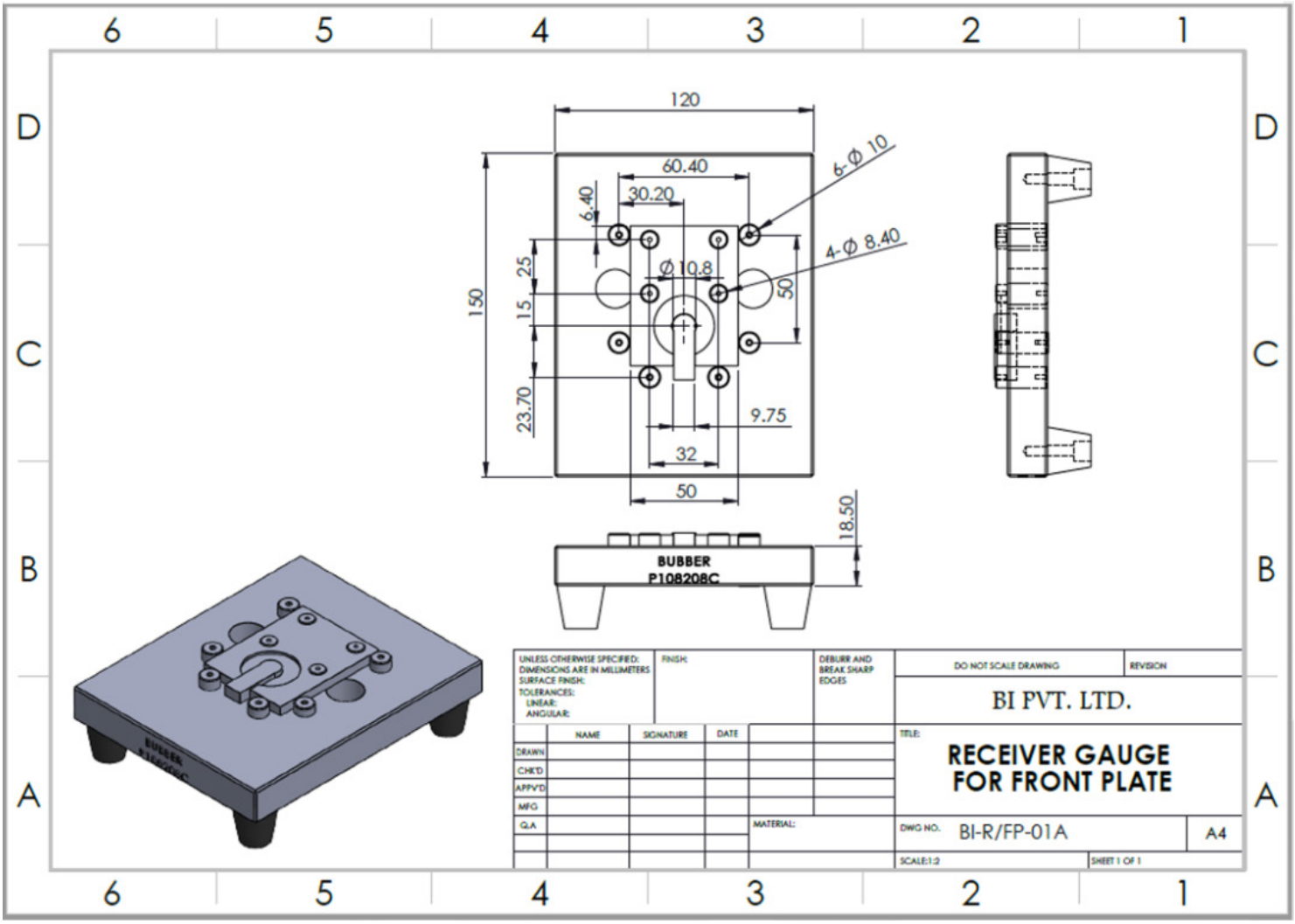


Figure. 5 Inspection Receiver Gauge

CONCLUSION

For the growth and sustainability of any organization, proper emphases have to be given to the voice of customer. The success of any manufacturing company is based on pillars of quality and competitive pricing that caters to the customer needs. The lean manufacturing tools and techniques are very effective use judiciously. In this tool kit, Poka-yoke is one of the most widely used and practiced tool that focuses on eliminating human errors. If a rejected component is returned by the

customer, it directly hits the companies' reputation and customer loyalty.

1-10-100 Rule

By this rule the cost for solve the defect is multiplying 10 times step by step;

1. If a defect found in a job at machine, then material and machining cost is waste.
2. Suppose at assembly station we found defect in the job then material, machining and assembly cost is waste.Which is approx. 10 times the defective job found at machining.
3. If customer found defect in the job then material, machining, assembly, logistic and profit is waste. Which is approx. 100 times the defective job found at machining and assembly.

Due to this we have to minimize the defect or error as early as possible. For that we have to implement proper poka-yoke atparticular stations where chances of errors are there due to mass production[19].

LIMITATION AND SCOPE OF THE FUTURE WORK

This study focuses on the effective use of Poka-yoke technique based on the customer complaint. The problem is solved bymodifying the design of the inspection receiver gauge using poka-yoke technique.

There is future scope to study the machining methods that will help to eliminate/minimize setup rejection caused by machine setters so that component quality is assured first time right and every time right.

REFERENCES

[1] M. S. Ahluwalia, "Economic reforms in India since 1991: Has gradualism worked?," J. Econ. Perspect., vol. 16, no. 3, pp. 67–88, 2002, doi: 10.1257/089533002760278721.

[2] A. G M, "A Brief Overview on Toyota Production System (TPS)," Int. J. Res. Appl. Sci. Eng. Technol., vol. 8, no. 5, pp. 2505–2509, 2020, doi: 10.22214/ijraset.2020.5415.

[3] J. Keyes, "The Need for Lean Training Background of Lean Manufacturing," J. Manag. Policy Pract., vol. 14, no. 3, pp. 78–83, 2013.

[4] D. Womack, J.P., Jones, D.T., Roos, The machine that changed the world. New York: Macmillan Publishing Company, 1990.

[5] M. Holweg, "The genealogy of lean production," J. Oper. Manag., vol. 25, no. 2, pp. 420–437, Mar. 2007, doi: 10.1016/j.jom.2006.04.001.

[6] "MSME Annual Report 2020-21," www.msmse.gov.in, 2021.

[7] S. J. Thanki and J. Thakkar, "Status of lean manufacturing practices in Indian industries and government initiatives: A pilot study," J. Manuf. Technol. Manag., vol. 25, no. 5, pp. 655–675, 2014, doi: 10.1108/JMTM-05-2012-0057.

[8] R. Narain, R. C. Yadav, and J. Antony, "Productivity gains from flexible manufacturing: Experiences from India," Int. J. Product. Perform. Manag., vol. 53, no. 2, pp. 109–128, 2004, doi: 10.1108/17410400410515025.

[9] P. Saraswat, M. K. Sain, and D. Kumar, "A Review on Waste Reduction through Value Stream Mapping Analysis," Int. J. Res., vol. 1, no. 6, pp. 200–207, 2014.

[10] R. Kumar and V. Kumar, "Lean manufacturing in Indian context: A survey," Manag. Sci. Lett., vol. 5, no. 4, pp. 321–330, 2015, doi: 10.5267/j.msl.2015.2.009.

[11] A. Agarwal, "Lean manufacturing in India," https://www.projectguru.in.

[12] D. Basak, T. Haider, and A. K. Shrivastava, "Lean Manufacturing – An Advanced Manufacturing Technique in Modern Operations Management," IJCSMS Int. J. Comput. Sci. Manag. Stud. ISSN 2231 –5268 www.ijcsms.com, vol. 13, no. 05, pp. 7–8, 2013.

[13] D. D. Hari Parshad , Rajesh Kumar, "Benefits of Lean Manufacturing System in Indian Industry-A Study," Int. J. Eng. Sci. Res. Technol., no. January, pp. 76–82, 2017. ISSN: 2277-9655

[14] P. Thareja, "Poka Yoke: Poking into Mistakes for Total Quality!," OmniScience A Multi-disciplinary J., vol. 6, no. 2, pp. 1–8, 2016.

[15] S. Patel, B. G. Dale, and P. Shaw, "Set-up time reduction and mistake proofing methods: An examination in precision component manufacturing," TQM Mag., vol. 13, no.3,pp.175–179,2001,doi: 10.1108/09544780110385528.

[16] M. Dudek-Burlikowska and D. Szewieczek, "The Poka-Yoke method as an improving quality tool of operations in the process Industrial management and organisation," J. Achiev. Mater. Manuf. Eng., vol. 36, no. 1, pp. 95–102, 2009.

[17] P. Parikshit, V. Nair, and P. Nikunj, "A Review on use of Mistake Proofing (Poka Yoke) Tool in Blow Molding Process," Int. J. Sci. Res., vol. 2, no. 2, pp. 2319–7064, 2013, [Online]. Available: www.ijsr.net.

[18] H. ewita, F. Ali Tosa, Y. Santoso, L. Herliani Kusumah, and H. yetti, "Application Poka-Yoke to Capture Defect (A Case Study in Industry Component Otomotive)," Int. J. Ind. Eng., vol. 6, no. 1, pp. 14–17, 2019, doi:

10.14445/23499362/ijie-v6i1p103.
[19] A. K. J. Sushant S Shrigadi, Shivalee P. Pol, "International Journal of Innovation in Engineering, Research and Technology," in Poka:Yoke:Mistake Proofing to achive Zero Defect, pp. 1–6, ISSN No - 2394-3696