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ORGANISATION OF COMMON VOSS ASEMBLY STATION FOR AUTOMOTIVE BRAKING VALVES WITH POKA-YOKE

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Abstract: The research focuses on study in Knorr-Bremse, a market leader in braking systems in both rail and commercial vehicles. In-house innovation is always required due to growing competition. Voss connectors are one of the major components of assembly in products of the valves manufactured here and each product has a separate Voss assembly station. This operation is critical with point of product and many a times a bottle neck in the assembly flow. The cost has been saved by setting a common Voss assembly station which would help to improve the efficiency of the plant, making assembly line lean and making the system error free, i.e., implementing Poka-Yoke. The valves could be then sent to the assembly lines for further operations. With the present work the company would reduce to 3 assembly station from 13 and the cost would be saved on operators, inventory, cost of maintaining spares and floor space consumed. The savings then could be past to product which would help to fight the market share.

Keywords: Competition, Costing strategies, Common Assembly Station, Poka-Yoke

1. INTRODUCTION

Knorr-Bremse ("Bremse" meaning brake) is a manufacturer of braking systems for rail and commercial vehicles that has operated in the field for over 100 years. It has been a world leader with many big brands like Bendix, Hasse and Wrede, Merak, New York Air Brake, Sigma, Zelisko and many more under a roof. The research mainly focuses on the cost incurred in assembly of Voss Connectors to various valves, manufactured at Indian production unit at Pune.

It has always been a fight for the market share and the ways to survive the competition. Many a times, product reaches its maturity level and there is no scope in the product modification except doing the VAVE analysis or finding the internal costs to overcome competitors pricing strategy.

Customer satisfaction and deliver to shareholder to survive and prosper are the aims of any business. Thus the challenge is to attain maximum profit in short period and not raise the prices. To attain cost saving, it is important to eliminate inefficiencies involved in supply chain and look for solutions beyond their respective operations (Chen and Jack, 1997).

For successful supply chain management coordination plays a major role. It is found that recently there is growing interest from industry and researchers regarding particularly potential coordination mechanisms available to eliminate sub optimization within supply chains (Graham C, 1989).

Forging company research mainly focused on implementation of lean philosophy by radial forging production flow lines. The motive was to eliminate the waste on the shop floor (Ajit Kumar Sahoo and M.K Tiwari, 2008).

Lean manufacturing is a multi-dimensional management practice including just in time-quality systems, work teams, cellular manufacturing, supplier management etc. The popular definition of Lean Manufacturing and the Toyota Production System usually consists of the following, Lean is the systematic approach to identifying and eliminating waste through continuous improvement by flowing the product or service at the pull of your customer in pursuit of perfection. (Burkitt, K.H., Mor, M.K, 2009).

Minimizing the number of stations on the line is done using line balancing. The sequencing technique provides uniform parts usage, which is a typical goal in just in time production systems. The sequential methodologies aim at minimizing the rate of incomplete jobs and WIP. (Bukchin, J., Dar-El, 1999)

Replacing the assembly lines from the mass production to make to order reduces the customer lead-time, and is expressed in a random arrival sequence of different model types to the line. Additional common characteristics of such mixed model lines in a make-to-order environment are: small numbers of work stations, a lack of mechanical conveyance, and highly skilled workers. (Bukchin, J, 2002). To fight the cost, implementation of the flexible manufacturing system plays a major role. Thus, mixed-model assembly lines are employed, where setup operations are reduced to such an extent that various models of a common base product can be manufactured in intermixed sequences. (Boysen, N., Fliedner, M, 2009)

A research on implementation of Poka-Yoke in motorization companies has shown that the quality tool can been used as mistake proofing as a prevention strategy improving each element and operations in process. (Erlandson, R, Noblett, M, 1998) It is found that Poka Yoke has been used diversely in the modern production system. The case study was done to evaluate total cost of defect in production to Poka Yoke implemented. The results showed that it is a cost effective tolls giving satisfactory returns over a period of time depending on the type of investment. (Tsou, J, Chen, J., 2005)

The Voss connector is the design of the VOSS Company and we are sourcing it for our requirement. The Voss push-in connection system 230 permits the rapid joining of nylon tubes. Merely a wrench is needed to undo the connection. The VOSS 230 also consist three sub types, i.e., NG 6, 8 and 12 of which KB uses only NG 8 and 12 for applications.

At present there are 13 different types of valves majorly produced here on different assembly lines and each assembly line has a separate Voss Assembly station having the combination of both NG8 and NG12 assembled depending on the variants required. Thus there is an additional cost to the product being transferred thus losing a competitive advantage making it costlier to manufacture.

1.1. Components of Voss Connector

The Voss push-in connection system 230 consists of four components: plug with fir-tree, male fitting, retaining clip and spring element as shown in Fig. 1

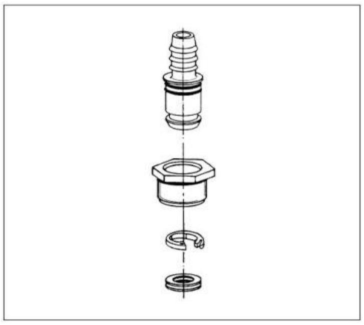

Figure 1: Components of Voss Assembly
Source: Product Brochure (http://www.vossusa.com/about-voss)

1. The plug has a wide holding groove in which the retaining clip engages during assembly. Two other grooves accommodate O-rings. The first O-ring seals the connection against the medium. The second O-ring prevents the ingress of the foreign matter. At the same time, its red color serves as a visual check to indicate correct assembly.
2. The male fitting is screwed tight into the brake unit. The stud thread is sealed by an O-ring.
3. The plastic retaining clip is open on one side and is opened by the tapered tail of the plug during assembly. After insertion of the plug this clip engages the holding groove. The retaining clip is self- centering.
4. The rubber spring element is inserted into an annular compartment at the base of the formed bore. The design of the spring element causes the plug to be placed under axial stress after the retaining clip has engaged.

1.2. Operations and Plant Layout

Operations and plant layout are the factors which are often missed out. Many research in past have showed that the process time is just the small part of total lead time on an assembly line. It is to reduce process cost by various investments, automation, but the major factors like waiting time on workstation, Bottle neck in the assembly line leads to huge loss and have high potential for the saving in long run. Proper line balancing and ensuring that no work station and labor is idle helps to run a plant with high efficiency.

2. DETAILS EXPERIMENTAL

2.1. Primary Research

The primary Research was done on the shop floor by collecting data at various points at the assembly line to get the realistic data. The worker utilization was measured and actual the time taken by worker to assemble the Voss was calculated. It was found that at many points this operation was a bottle neck and hence was keeping the worker idle.

2.2. Secondary Research

Secondary Research for the system was done by collecting the data from various support departments like Production, Purchase, Sales and Stores. The data was later analyzed using excel functions of filter and sort and mathematical formulas.

2.2.1 Volume Data

The data for the volumes was very crucial as it would have direct impact on the number of workstations to be calculated. The sales data for last year and the planning was considered to find out the average monthly consumption of calculated.

2.2.1 Line Balancing and Capacity Utilization

The inputs like time taken to assemble the Voss connectors to valve, actual man hours available and cost of the workstation were provided by the Industrial Engineering department. The hourly labor rate and the line balancing data was used as a reference to ensure the plant utilization is maximum.

3. RESULTS AND DISCUSSION

3.1. Reduction of Voss Assembly station

Considering the assembly time for a Voss is 20 sec using skilled labor and 25 working days.

Actual available time can be calculated as (445 min × 2) – Total Change Over Time 890 – 120 = 770 min

Table1: Annual Volumes and Cost

Sr. No	Product Name	NG12/Month	NG8/Month	Total Assembly Time (Monthly)	Total Assembly Time(Daily)	Change Over Time
1	HBV	5000	5000	3333.3	133.3	5.0
2	FBV	8000	4000	4000.0	160.0	5.0
3	QRV	7500	0	2500.0	100.0	5.0
			7500	2500.0	100.0	5.0
4	RV	24000	8000	10666.7	426.7	5.0
5	LSV	4000	12000	5333.3	213.3	5.0
			4000	1333.3	53.3	5.0
6	ALSV	200	0	66.7	2.7	5.0
			10000	3333.3	133.3	5.0
7	PLV	200	0	66.7	2.7	5.0
			10000	3333.3	133.3	5.0
8	3/2 Valve		1000	333.3	13.3	5.0
9	ACRV	150	0	50.0	2.0	5.0
			100	33.3	1.3	5.0
10	SCV	1000	0	333.3	13.3	5.0
11	SBA	6000	0	2000.0	80.0	5.0
12	FCA	14000	0	4666.7	186.7	5.0
		500	0	166.7	6.7	5.0
13	Air Dryer	3500	3500	2333.3	93.3	5.0
14	ARV	1500	500	666.7	26.7	5.0
15	PCV	2000	0	666.7	26.7	5.0
		4000	0	1333.3	53.3	5.0
16	LACV	2500	7500	3333.3	133.3	5.0
			10000	3333.3	133.3	5.0
	TOTAL				2228.7	120

Number of Machines Required (Total Time Required daily) / Actual Available Time i.e. 2228.67 min/ 770 min = 2.8 machines

As per the calculations the assembly stations reduced to 3 to 13, i.e. saving 10 assembly points. Cost of each assembly station is INR 3 lakhs.

The saving here would be 10 × 300000 = INR 30 lakhs

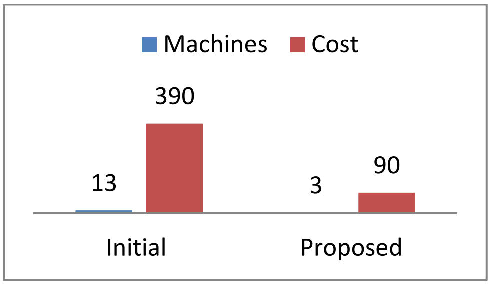

Figure 2: Machines and cost Comparison

3.2. Poka-Yoke of Common Assembly Station

The new assembly station would be Poka-Yoke systems. The fixtures are designed in such a way that any missing component would not allow the assembly to proceed.

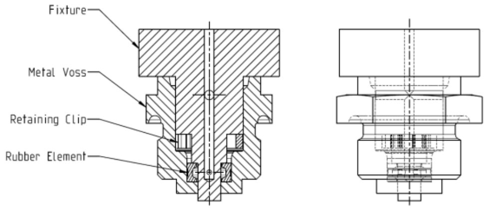

Figure 3: Correct sequence of the assembly
Source: Image created using assembly in ProE

The possible errors could be:-
1) Missing out Rubber element
2) Missing out of the Retaining clip

Figure 4: Poka-Yoke Voss Assembly Station
Source: Pictures clicked at Knorr-Bremse CVS plant, Pune

3.2.1 Poka-Yoke for missing out Rubber element

It is important for the assembly to have all the 3 components, i.e., Metal Voss, retaining clip and rubber element in sequence respectively. The Poka-Yoke is designed so that the order of the assembly cannot be changed. For example: if the rubber element is missed out, the other child parts would fall down and the operator would not be able to assemble it to the valve.

3.2.2 Poka-Yoke for missing out of the Retaining clip

The possible failure also could be operator missing out the middle part, i.e., retaining plastic clip and arrange the other two parts on the fixture. In this case the assembly won't fall down and hence to avoid this kind of failure a concept of backpressure is applied.

A small hole is made on the fixture at an area where the Metal Voss and the rubber element is fixed. These holes are blocked if the assembly is correct. The system is set to a pressure of 6 bar. The backpressure here is set via program in a range of 4-4.5 bar which activates the gun. As a result the back pressure allows the gun to move down and the operation is preceded. If the middle component is missing, the hole at the Metal Voss area will be open to atmosphere and the pressure would be released. Thus there will be no back pressure being developed blocking the operator to move the gun down.

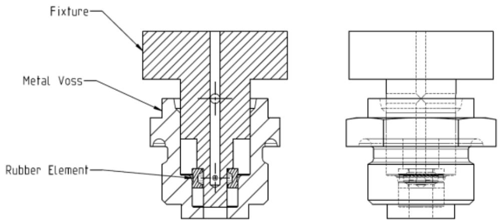

Figure 5: Assembly with missing retaining clip
Source: Image created using assembly in ProE

3.3 Reduction in the cost of labors working on station

As the numbers of assembly lines are reduced, there would also be the saving in the cost of the salary to them. The savings for this can be calculated workers for the 3 shifts at 10 assembly points at INR 20000 per month.

10 x 3 x 20, 000 = INR 6 lakhs

i.e., INR 72 lakhs annually

3.4 Other hidden cost savings and benefits

As the numbers of the assembly stations are reduced, the cost associated to the space and the area consumed would come down. The spares associated with the assembly lines and the maintenance would come down helping in saving substantial amount.

CONCLUSIONS

With the implementation of the Common automated Voss assembly station, company has saved cost without making much investment. The capacity utilization of the assembly lines is maximum with no idle capacity. This has helped finally to reduce the cost on the valves which gives an edge to Knorr-Bremse to fight the existing competitors passing the advantage to the customers if required.

The above research would be limited if there is sudden fluctuation in the demand and the production changes beyond the safety level considered while calculating the new assembly.

ACKNOWLEDGMENTS

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