PRODUCTIVITY IMPROVEMENT USING "POKA-YOKE" CONCEPT

Vishal Navnath Raut (vishalraut95@gmail.com), Pranjal Yuvaraj Patil (pypatil94@gmail.com)
Harshad Chandrakant Patil (harshadpatil211@gmail.com), Ramanand Arun Talwadekar (ramanandt9@gmail.com),
Prof. N. Ram Prakash

Suman Ramesh Tulsiani Technical Campus Faculty Of Engineering

ABSTRACT

Poke-Yoke is a Japanese term that means "mistake-proofing". A Poke-Yoke is any mechanism in a lean manufacturing process that helps an equipment, operator to avoid (yokeru) mistakes (poka). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The concept was formalized, and the term adopted, by Shigeo Shingoas part of the Toyota Production System. It was originally described as baka-yoke, but as this means "fool-proofing" (or "idiot-proofing") the name was changed to the milderpoka-yoke.

I. INTRODUCTION

Poka-Yoke is a quality management concept developed by a Matsushita manufacturing engineer named Shigeo Shingo to prevent human errors from occurring in the production line. Poka-Yoke (pronounced "poh-kah yoh-kay") comes from two Japanese words - "yokeru" which means, "to avoid", and "poka" which means "inadvertent errors." Thus, Poka-Yoke more or less translates to "avoiding inadvertent errors".

Some people as "fool-proofing" sometimes refer to Poka yoke in English. However, this doesn't sound politically correct if applied to employees, so the English equivalent used by Shingo was "error avoidance." Other variants like "mistake proofing" or "fail-safe operation" have likewise become popular.

The main objective of poke yoke is to achieve zero defects. In fact, it is just one of the many components of Shingo's Zero Quality Control (ZQC) system, the goal of which is to eliminate defective products.

Poka-Yoke is more of a concept than a procedure. Thus, its implementation is governed by what people think they can do to prevent errors in their workplace, and not by a set of step-by-step instructions on how they should do their job.

Poka-Yoke is implemented by using simple objects like fixtures, jigs, gadgets, warning devices, paper systems, and the like to prevent people from committing mistakes, even if they try to! These objects, known as Poka-Yoke devices, are usually used to stop the machine and alert the operator if something is about to go wrong.

Anybody can and should practice Poka-Yoke in the workplace. Poke yoke does not entail any rocket science; sometimes it just needs common sense and the appropriate Poka-Yoke device. Poka-Yoke devices should have the following characteristics:

1. Useable by all workers;
2. Simple to install;
3. Does not require continuous attention from the operator (ideally, it should work even if the operator is not aware of it);
4. Low-cost;
5. Provides instantaneous feedback, prevention, or correction

Of course, error proofing can be achieved by extensive automation and computerization. However, this approach is expensive and complicated, and may not be practical for small operations. Besides, it defeats the original purpose of Poka-Yoke, which is to reduce defects from mistakes through the simplest and lowest-cost manner possible.

II. PROBLEM STATEMENT

Jig

At S. R. Engineers Pvt. Ltd. the problems of miss-loading occur frequently due to full proof system was not incorporated to the production jigs. This lead to occurrence of products rejects and machine down time as a result of miss loading. To solve these problems, many company implements this full proof concept that called Poka-Yoke. Evidence shows, it have a lot of improvement after the implementation of that system.

Layout

Max time is required for production of Spline Shaft Because of some difficulties like improper arrangement of machines, some dead machine, etc. To solve this problem S. R. Engineers decided to change the arrangement of machines means to change the layout of axle line.

III. OBJECTIVES

The Objectives of this study are

•To improve the degree of quality performance and production efficiency by eliminating miss-loading using Poka-Yoke concept.

•To minimize the effect of manufacturing variability using Poka-Yoke concept.

•To minimize the time required to handling the job from one operational machine to another.

•To achieve more productive facilities.

•Layout improvement for spline shaft line for productivity improvement.

•Maximize utilization of space.

•Provide safety and comfort to employees.

IV. SCOPE OF PROJECT

This project focuses on introduction and implementation of Poka Yoke concept to a selected production line at S. R. Engineers Pvt Ltd. This research merely focuses on the production of jig used for manufacturing of one kind of automotive component. Based on previous industrial experience by many companies, it is strongly believed that reject rate would be reduced when there is no more part miss loading cases. Ultimately the production efficiency would increase when there is no more down time spent for the production of defective part that are caused by miss-loading, machine setting time and jig setting time.

V. METHODOLOGY

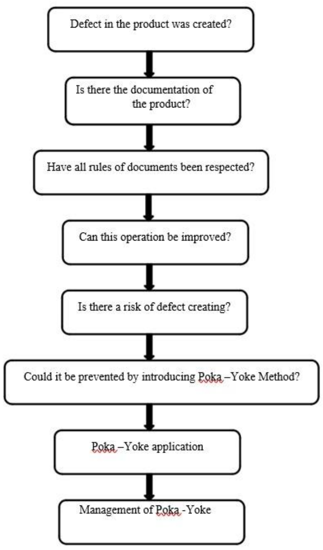


Fig: Approach to realization Poka-Yoke according with organization's proceeding.

VI. LITERATURE REVIEW

Poke-Yoke was coined in Japan during the 1960s by Shigeo Shingo who was one of the industrial engineers at Toyota. Shigeo Shingo is also credited with creating and formalizing Zero Quality Control (Poke-Yoke techniques to correct possible defects + source inspection to prevent defects equals zero quality control).The initial term was baka-yoke, which means „fool-proofing‟. In 1963, a worker at Arakawa Body Company refused to use baka-yoke mechanisms in her work area, because of the term‟s dishonorable and offensive connotation. Hence, the term was changed to Poke-Yoke, which means „mistake-proofing‟ or more literally avoiding (yokeru) inadvertent errors (poka). Ideally, poka-yokes ensure that proper conditions exist before actually executing a process step, preventing defects from occurring in the first place. Where this is not possible, poka-yokes perform a detective function, eliminating defects in the process as early as possible.

While visiting the Yamada Electric Plant in 1961, Shingo was told of a problem that the factory had with one of its products. Part of the product was a small switch with two push-buttons supported by two springs. Occasionally, the worker assembling the switch would forget to insert a springs under each push-button. Sometimes the error would not be discovered until the unit reached a customer, and the factory would have to dispatch an engineer to the customer site to disassemble the switch, insert the missing spring, and reassemble the switch. This problem of the missing spring was both costly and embarrassing. Management at the factory would warn the employees to more attention to their work, but despite everyone's best intention, the missing spring problem would eventually re-appear.

Shingo redesigned a process in which factory workers, while assembling a small switch, would often forget to insert the required spring under one of the switch buttons. In the redesigned process, the worker would perform the task in two steps, first preparing the two required springs and placing them in a placeholder, then inserting the springs from the placeholder into the switch. When a spring remained in the placeholder, the workers knew that they had forgotten to insert it and could correct the mistake effortlessly. Shingo distinguished between the concepts of inevitable human mistakes and defeatism the production. Defects occur when the mistakes are allowed to reach the customer. The aim of Poke-Yoke is to design the process so that mistakes can be detected and corrected immediately, eliminating defects at the source.

Examples of 'attention-free' Poke Yoke solutions:

1. A jig that prevents a part from being misoriented during loading

2. Non-symmetrical screw hole locations that would prevent a plate from being screwed down incorrectly

3. Electrical plugs that can only be inserted into the correct outlets

4. Notches on boards that only allow correct insertion into edge connectors

5. A flip-type cover over a button that will prevent the button from being accidentally pressed

Three levels of Poka-Yoke:

1. Elimination of spills, leaks, losses at the source or prevention of a mistake from being committed

2. Detection of a loss or mistake as it occurs, allowing correction before it becomes a problem

3. Detection of a loss or mistake after it has occurred, just in time before it blows up into a major issue (least effective)

Although many techniques have been developed to prevent or control mistakes, most of these techniques are relatively ineffective. Effective mistake proofing cannot be developed without a sound understanding of the true characteristics of mistakes. A mistake occurs when a required action is not performed or is performed incorrectly, a prohibited action is executed, or information essential for an action is not available or is misinterpreted.

There are a number of characteristics associated with poka yoke techniques that makes it more effective than other techniques. This includes:

1. Mistake proofing requires 100% inspection. It is impossible to detect and control rare random events with sampling inspection. Since, 100% traditional inspection is too expensive and not 100% effective in detecting nonconforming product, mistake-proofing methods based on Poka-Yoke are essential and the only practical solution.

2. Mistake proofing must be inexpensive. Because mistakes are rare events and many different types of mistakes must be controlled, companies cannot afford to spend large sums of money on each mistake-proofing device.

3. Many mistake-proofing devices are needed. Toyota has an average of 12 mistake-proofing devices at each workstation.

4. Outcome intervention is best. The best mistake proofing physically prevents errors or detects when a mistake is about to occur or has occurred. Thus, these techniques intervene to block undesired outcomes rather than controlling casual factors.

5. Prevention is better than detection. Preventing mistakes is better than detecting mistakes, which is better than detecting defects. If a mistake is not detected until a defect is generated, rework will be required or the hardware must be scrapped. Thus, where possible, it is always better to detect or control the mistake before a defect is generated. Similarly, there will be less wasted effort if mistakes are prevented rather than detected.

6. Control, Shutdown, or Warn. Because resources may be wasted if a process is shutdown, it is better to control mistakes. If a process is shutdown, however, the problem must be addressed to proceed. Hence, shutdown provides a more positive control of mistakes than warnings, which can be ignored.

7. The Most Important Quality Initiative. Only mistake-proofing effectively controls mistakes. Significant quality initiatives other than mistake proofing have marginal impact on the customer perception of quality since mistakes are the dominant source of customer problems.

I. Mr. Parikshit S. Patil, Mr. Sangappa P. Parit, this paper introduced Poka-Yoke is a concept in total quality management which is related to restricting errors at source itself. It deals with “mistake-proffing”

II. M. Dudek-Burlikowska ,D.Szewieczek,this papers deals with imporatance of quality philosophy Zero quality Defects with usage of the Poka-Yoke method.It explains that approach and design methodology of usage of mistake proofing device is connected with monitoring and improvement of operations in the process.

III. Puvanasvaran, A.P., N. Jamibollah & N. Norazlin, this paper discussed the Failure Mode & Effect Analysis.FMEA is one of the requirements which was required by the Automotive Industries Action Group (AIAG) to all the automotive suppliers and manufactures worldwide through the

TS16949 Quality System.

IV. Mr. Parikshit S. Patil, Mr. Sangappa P. Parit, “Poka Yoke: The revolutionary Idea in Total Productive Management” Reserch Inventy: International Journal of Engineering & Science : 2278-4721, Volume 2, Issue (2 February 2013),Pp. 19-24.

V. The Design and Need for Jigs and Fixtures in Manufacturing The paper gave a detailed definition of jigs and fixtures, and also identified the numerous advantages that are associated with the use of jigs and fixtures in manufacturing to include: production increase, cost reduction, interchangeability and high accuracy of parts, reduction of the need for inspection and quality control expenses, reduction of accident as safety is improved, automation of machine tool to an appreciable extent, easy machining of complex and heavy components, as well as low variability in dimension which leads to consistent quality of manufactured products.

VI. Dr.Anand k. Bewoor Indusrtial Engineering

From these book,we studied layout arrangement of machines and all other factors related to layout. We also studied all type of layout and process planning required for layout .

VII. IMPLEMENTATION OF POKA-YOKE

This problem occurred while dealing with manufacturing of shaft of tractor called "Spline Shaft". This Spline Shaft (Ø61mm) made of single rigid forged shaft. The drilled Hole (Ø 7mm) slightly diverted from the pcd (Ø 36mm) of the shaft. Figure shows the actual position of the drilled hole (Ø 7mm) and diverted position of the drilled hole (Ø 7mm).

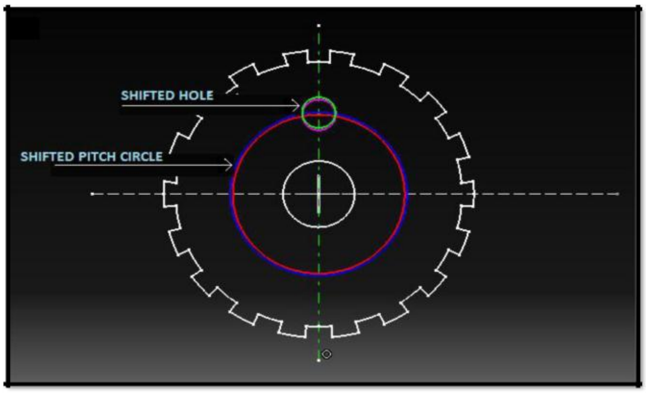


Fig: Problem Defination

Red colored circle (Ø 36mm) is the required position of the pitch circle.

Purple colored circle (Ø 7mm) is the required position of the drilled hole.

Blue colored circle (Ø 36+0.452 mm) is the shifted position of pitch circle.

Green colored circle (Ø 7mm) is the shifted position of the drilled hole.

In S. R. ENGINEERS, Pvt Ltd. While manufacturing the spline shaft of tractor, the sequence of operation of drilling the hole (Ø 7mm) on pitch circle of (Ø 36mm) is at the last. After drilling the hole (Ø 7mm) on the shaft the following inspections carried out:

1. Measuring diameter of drilling the hole (Ø 7mm) by GO & NOGO gauge.
2. Measuring depth (16mm) of drilling the hole (Ø 7mm) by depth gauge.

Fig: Depth check by Depth Gauge

After inspection finished product directly dispatched. There was no inspection carried out to check off set. This finished spline shaft has been supplied to Indian Tractor Manufacturing industries such as Ford, Mahindra. Some of the spline shaft has been exported to Italy, Canada, Germany, Africa, etc.

These finished shaft directly used in assembly of Tractor. During assembly of Ford Tractor, Some of the shafts from lot of 1000 spline shafts not properly assembled. Due to misalignment of shaft whole lot of 1000 shaft rejected and Ford tractor fined the credit to S. R. ENGINEERS, Pvt Ltd of some of lakhs rupees.

Basically if the drilled hole (Ø 7mm) slightly diverted from the pcd (Ø 36mm) of the shaft, the spline shaft not properly assemble. Figure shows the part like assemble part of spline shaft. In actual different complicated part inserted but overall looking of part like shown part.

If the actual position of the drilled hole (Ø 7mm) is diverted from required position of the drilled hole (Ø 7mm), above two parts casing & spline shaft not proper assembled. While mounting the casing on spline shaft we observed that while drilling the hole (Ø 7mm) on pcd of (Ø 36mm) there was dislocation. In simple words the offset distance from the center of shaft and center of drilling the hole (Ø 7mm) is varied and not in tolerance zone.

3.2 Need for the solution

Management of the S. R. ENGINEERS, Pvt Ltd had been warned the employees to pay more attention to their work. But despite everyone"s best intentions, the problem would eventually re-appear. So was immensely required to find out some solution as the whole lot of 1000 products got rejected because of few faulty products.

Procedure Used to find out the correct solution for Problem

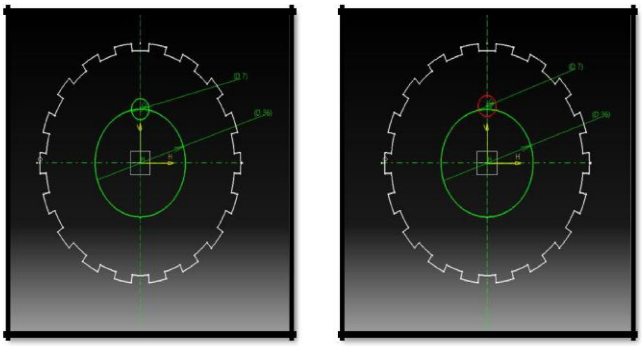
To find out remedy for such problem with engineers of company we go for using full proof methodology named "POKA- YOKE". In this method we find out such solution that with help of that solution problem never occurred. If the worker wants to create the problem again, this methodology never happen this problem.

Steps to Implement POKA-YOKE:

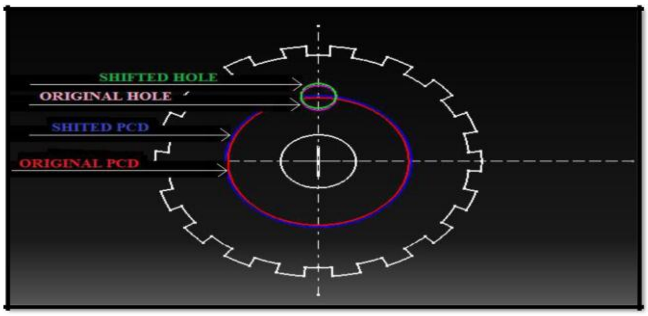
1. Identify the problem.
2. Observation at workstation
3. Brain storming for ideas
4. Select best idea
5. Implementation plan
6. Monitor and sign off.

Identify Problem

This problem occurred while dealing with manufacturing of spline shaft of tractor. The drilled hole (Ø 7mm) slightly dislocated from the pcd (Ø36mm) of the shaft. Figure shows the actual position of the drilled hole (Ø 7mm) and diverted position of drilled hole (Ø 7mm).



Left: Hole of Ø7mm on pcd of Ø36mm
Right: Hole of Ø7mm dislocated from on pcd of Ø36mm



Drilled hole position problem
Fig. No. 3.3 Identify Problem of Key Hole

If the drilled hole (Ø 7mm) slightly diverted from the pcd (Ø 36mm) of the shaft, the spline shaft not properly assembled. In simple words if the offset distance from the center of shaft and center of drilling the hole (Ø 7mm) is varied and not in tolerance zone, then the spline shaft not properly assembled during assembly and assembly line gets stopped. This wastage of working cycle time decreases the production rate of whole assembly line also increases delay time. If delay time of any product increases in workstation, it slightly effects on the productivity and hours of work.

VIII. OFFSET MEASUREMENT BEFORE POKA YOKE IMPLEMENTATION

While dispatching spline shaft offset inspection carried out following table show the

first 100 shaft offset measurement by trimos during one shift of company

JOB COUNT	OD OFF SHAFT (61.1±0.08)	TOLERANCE(±0.080)	OFF SET (36.000±0.200)		TOLERANCE (±0.200)	REMARK
			ON TRIMOS	ON CMM		
1	61.175	+0.075	36.125	36.1240	+0.125	C
2	61.031	-0.069	36.082	36.0825	+0.082	C
3	61.124	+0.024	36.013	36.0129	+0.013	C
4	61.138	+0.038	36.055	36.0552	+0.055	C
5	61.151	+0.051	36.144	36.1443	+0.144	C
6	61.035	-0.065	36.039	36.0390	+0.039	C
7	61.128	+0.028	36.163	36.1632	+0.163	C
8	61.164	+0.064	36.012	36.0119	+0.012	C
9	61.137	+0.037	36.104	36.1041	+0.104	C
10	61.029	-0.071	36.133	36.1332	+0.133	C
11	**61.173**	**+0.073**	**36.452**	**36.4523**	**+0.452**	**R**
12	61.049	-0.051	36.162	36.1624	+0.162	C
13	61.157	+0.057	36.002	36.0017	+0.002	C
14	61.033	-0.067	36.086	36.0875	+0.086	C
15	61.090	-0.010	36.155	36.1552	+0.155	C
16	61.116	+0.016	36.125	36.1249	+0.125	C
17	61.154	+0.054	36.194	36.1942	+0.194	C
18	61.149	+0.049	36.058	36.0575	+0.058	C
19	61.037	-0.063	36.024	36.0248	+0.024	C
20	61.161	+0.061	36.906	36.9054	-0.094	C
21	61.153	+0.053	36.096	36.0964	+0.096	C

JOB COUNT	OD OFF SHAFT (61.1±0.08)	TOLERANCE(±0.080)	OFF SET (36.000±0.200)		TOLERANCE (±0.200)	REMARK
			ON TRIMOS	ON CMM		
22	61.048	-0.052	36.113	36.1125	+0.113	C
23	61.152	+0.052	36.138	36.1379	+0.138	C
24	61.119	+0.019	36.168	36.1689	+0.168	C
25	**61.021**	**-0.079**	**36.693**	**36.6925**	**-0.307**	**R**
26	61.035	-0.065	36.028	36.0282	+0.028	C
27	61.149	+0.049	36.142	36.1419	+0.142	C
28	61.056	-0.044	36.183	36.1827	+0.183	C
29	61.029	-0.071	36.004	36.0038	+0.004	C
30	61.146	+0.046	36.153	36.1524	+0.153	C
31	61.132	+0.032	36.094	36.0938	+0.094	C
32	61.176	+0.076	36.023	36.0234	+0.024	C
33	61.063	-0.037	36.115	36.1148	+0.115	C
34	**61.152**	**+0.052**	**36.398**	**36.3976**	**+0.398**	**R**
35	61.115	+0.015	36.899	36.8991	-0.101	C
36	61.104	+0.004	36.163	36.1635	+0.163	C
37	61.135	+0.035	36.136	36.1342	+0.136	C
38	61.111	+0.011	36.121	36.1209	+0.121	C
39	61.023	-0.077	36.965	36.9645	-0.035	C
40	61.153	+0.053	36.918	36.9172	-0.082	C
41	61.101	+0.001	36.050	36.0498	+0.050	C
42	61.048	-0.052	36.866	36.8621	-0.134	C
43	61.116	+0.016	36.029	36.0298	+0.029	C
44	61.154	+0.054	36.124	36.1236	+0.124	C
45	61.149	+0.049	36.911	36.9108	-0.089	C
46	61.132	+0.032	36.072	36.0723	+0.072	C

Table: Offset Measurement Before Poka-Yoke Implimentation

JOB CORRECT=C
JOS REJECTED=R

From above table one fact found that after using modified fixture engineers of company had been pay more attention to drill key hole. but despite everyone‟s best intentions while drilling key hole problem of offset would eventually re appear so that it was necessary to take some action to solve this problem of offset management of the S. R. engineers pvt limited had been called the engineers to pay more attention to that whole lot of 100 products would be rejected because of six faulty products .

During meeting with engineers of company again whole process of manufacturing shaft was analyzed while analyzing the drilling of key hole process some fact was observed that as follows:-

- If the outer diameter of shaft decreasing than actual value with in tolerance while shaft loading on v block clamp for drilling key hole shaft hole move inward to machine cause improper positioning of key hole.

- If the outer diameter of shaft increasing than actual value with in tolerance while shaft loading on v block clamp for drilling key hole shaft hole move outward to machine cause improper positioning of key hole.

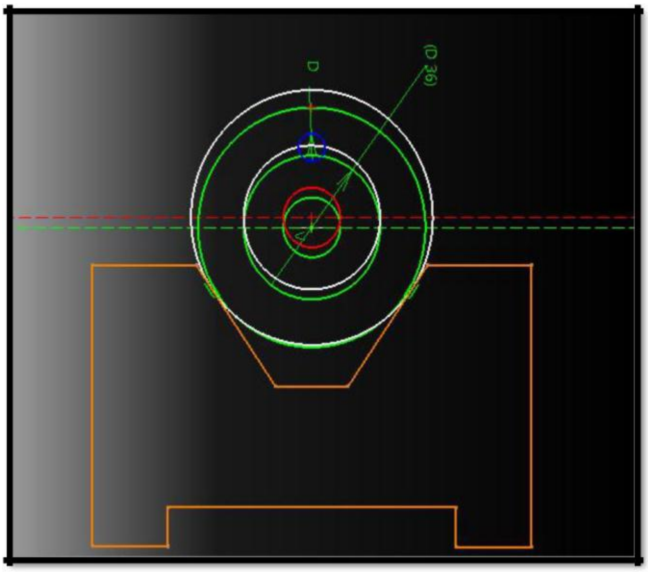


Fig. No. Incresing Diameter of Shaft

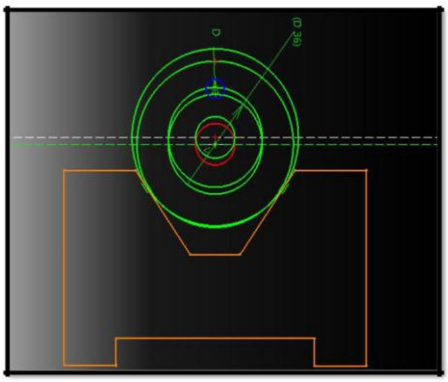


Fig. Decreasing Diameter of shaft

Fig.No.3.10 Improper Position of Key Hole due to decreasing & increasing diameter of shaft

Above fig shows the improper position of key hole due to decreasing & increasing diameter of shaft.

Green & White color circle is the actual required position of shaft loading

Red color circle is the shifted position of shaft due to decreasing & increasing diameter

Blue color circle is the shifted position of hole due to decreasing diameter .

If the outer diameter of shaft decreasing than actual value with in tolerance shaft rest on v block slightly closer to center of machine than actual required position due to that drilling of key hole through fixture fixed jig slightly closer to center also pcd of key hole shifted closer to center . it cause the offset of key hole from center is decreasing than 36 mm.

If the outer diameter of shaft increasing than actual value with in tolerance shaft rest on V block slightly outer to center of machine than actual required position due to key hole shifted outer to center it cause the offset of key hole from center also pcd of key hole shifted outer to center it cause the offset of key hole from center is decreasing than 36 mm.

From above we concluded that modified fixture is one of the solution of problem improper positioning of key hole but it is not full proof solution which vanished problem to avoiding issue of increasing & decreasing diameter we would be go for full proof solution because by paying more & more attention operator cannot achieve exact diameter of shaft problem of shaft problem of offset would eventually re appear due to issue of tolerated diameter

During selection of possible solution we could made all passible changer in fixture but full proof solution not found out so this time with engineers of company we decide to make changes in jig used in drilling of key hole because each time jig attached to fixture remain constant only shaft position vary.

Due to varying shaft position & constant jig position key hole varied during meeting we were decided to eliminate that problem by removing fixed jig attached to fixture & attached to shaft due to that if shaft tilted or diameter varied each time operator should locate drilling point before drilling key hole to locate drilling point operator should manage the center of drill bit & center of jig hole.

IX. Implementation of Best Solution

After selecting best idea to solve the problem of improper of positioning of key hole next step of implementing Poka-Yoke was implementation of that selected best idea the stepwise procedure was follow by operator to implement Poka-Yoke for eliminating problem of key hole.

Step 1: While implementing solution shaft was inspect for outer diameter check.

Step 2: Before shaft would loading on fixture modified jig was fixed on central drill

of shaft

Step 3: After tightening the jig into shaft central drill shaft was loaded on fixture of drilling machine

Step 4: Initially operator was locate the drilling point on shaft & mark it on shaft

Step 5: Then machine switched ON and operation of drilling key hole performed

Step 6: After drilling key hole shaft was unloading from fixture

Step7: When shaft unloaded from fixture shaft was going to inspection for offset distance.

X. JIG OBSERVATIONS

After successfully implementing solution for single piece of spline shaft & offset in

tolerance zone solution implemented for all jobs & observation recorded.

JOB CORRECT=C

JOB REJECTED=R

JOB COUNT	OD OFF SHAFT (61.1±0.08)	TOLERANCE(±0.080)	OFF SET (36.000±0.200)		TOLERANCE (±0.200)	REMARK
			ON TRIMOS	ON CMM		
1	61.152	+0.052	36.138	36.1379	+0.138	C
2	61.119	+0.019	36.168	36.1689	+0.168	C
3	61.021	-0.079	36.893	36.8925	-0.107	C
4	61.035	-0.065	36.028	36.0282	+0.028	C
5	61.149	+0.049	36.142	36.1419	+0.142	C
6	61.056	-0.044	36.183	36.1827	+0.183	C
7	61.029	-0.071	36.912	36.9126	+0.088	C
8	61.146	+0.046	36.153	36.1524	+0.153	C
9	61.132	+0.032	36.094	36.0938	+0.094	C
10	61.176	+0.076	36.023	36.0234	+0.024	C
11	61.063	-0.037	36.115	36.1148	+0.115	C
12	61.063	-0.037	36.920	36.9206	-0.080	C
13	61.031	-0.069	36.115	36.1148	+0.115	C
14	61.124	+0.024	36.103	36.1035	+0.103	C
15	61.138	+0.038	36.941	36.9146	-0.059	C
16	61.151	+0.051	36.064	36.0641	+0.064	C
17	61.063	-0.037	36.147	36.1469	+0.147	C
18	61.041	-0.059	36.964	36.9636	-0.036	C
19	61.146	+0.046	36.021	36.0214	+0.021	C
20	61.132	+0.032	36.139	36.0135	+0.139	C

from above table of observations we understood that none of job rejected due to problem of improper positioning of key hole. We would confidently said that problem of improper positioning of key hole was successfully

Force Analysis

The standard formulae for the various forces associated with the operations of jigs and fixtures are explained below

JOB COUNT	OD OFF SHAFT (61.1±0.08)	TOLERANCE(±0.080)	OFF SET (36.000±0.200)		TOLERANCE (±0.200)	REMARK
			ON TRIMOS	ON CMM		
21	61.059	-0.041	36.042	36.0417	+0.042	C
22	61.095	-0.005	36.909	36.9086	-0.091	C
24	61.135	+0.035	36.166	36.1653	+0.166	C
25	61.111	+0.011	36.972	36.9718	-0.028	C
26	61.023	-0.073	36.112	36.1116	+0.112	C
27	61.126	+0.026	36.004	36.0043	+0.004	C
28	61.103	+0.003	36.166	36.1657	+0.166	C
29	61.058	-0.042	36.953	36.9528	-0.047	C
30	61.173	+0.073	36.011	36.0109	+0.011	C
31	61.121	+0.021	36.152	36.1516	+0.152	C
32	61.243	+0.0143	36.138	36.1379	+0.138	C
33	61.056	-0.044	36.869	36.8687	-0.131	C
34	61.056	-0.044	36.918	36.9179	-0.082	C
35	61.173	+0.073	36.166	36.1659	+0.166	C
36	61.107	+0.007	36.084	36.0842	+0.084	C
37	61.031	-0.069	36.178	36.1775	+0.178	C
38	61.124	+0.024	36.056	36.0562	+0.056	C
39	61.116	+0.016	36.914	36.9146	-0.086	C
40	61.105	+0.005	36.004	36.0039	+0.004	C
41	61.025	-0.075	36.037	36.0373	+0.037	C
42	61.037	-0.063	36.947	36.9466	-0.053	C
43	61.151	+0.051	36.098	36.0977	+0.098	C
44	61.176	+0.076	36.025	36.0249	+0.025	C
45	61.175	+0.075	36.125	36.1240	+0.125	C

Formulas used

1) Torque = K × A× f × 0.8 × d × 1.8

2) Thrust = 2 × K × B × f × 0.8 × d × 0.8 + K × d × 2

3) Stress (σ)= Sut/3

Where d is the diameter of the drill. A, B, E, and K are constants.

Given Data:-

Diameter of Drill=7mm

Feed Rate=0.17mm/revolution

Hardness = 300 BHN
Sut=700 N/mm2 w/d =0.175 (approx.)

Sr. No.	Work Material	K
1.	Steel, 200BHN	24,000
2.	Steel, 300 BHN	31,000
3.	Steel, 400 BHN	34,000
4.	Most aluminum alloys	7,0

		00
5.	Most magnesium alloys	4,000
6.	Most brasses	14,000
7.	Leaded brasses	7,000
8.	Cast iron, 165 BHN	15,000
9.	Free-machining mild steel	18,000
10.	Austenitic stainless steel (Type 316)	34,000

Table No. 3.4 The work material constants for Torque and Thrust calculation

Operation Time For Product

Sr. No.	Operations	Operation time in min	Sr. No.	Operations	Operation time in min
1.	Facing & Centering	3.19	2.	1St side finish	6
3.	2nd side finish	10.50	4.	Drilling & Reaming	2.21
5.	Hobbing	4.22	6.	Hardening	3.18
7.	Tempering	0.25	8.	Centre rework	3.30
9.	Grinding	4.30	10.	Reaming & Drilling	8.55
11.	7 mm drill	4	12.	Final Inspection	60

Operation Time For Product

Total time for operation = 51 ½ minute

Operations	Operation time in min	Operations	Operation time in min
A	1	B	½
C	5	D	7 ½
E	5	F	½
G	1	H	1
I	½	J	½
K	½		

Total time for handling =23 Minute

Where,

A = Time between Facing & Centering AND 1st Side Finish

B = Time between 1st Side Finish & 2nd Side Finish

C = Time between 2nd Side Finish & Drilling

D = Time between Drilling & Hobbing

E = Time between Hobbing & Hardening

F = Time between Hardening & Tempring

G = Time between Tempering & Centre Rework

H = Time between Centre Rework & Grinding

I = Time between Grinding & Reaming & Drilling

J = Reaming & Drilling & 7mm Of Hole

K = 7mm of Hole & Final Inspection

XI. RESULTS

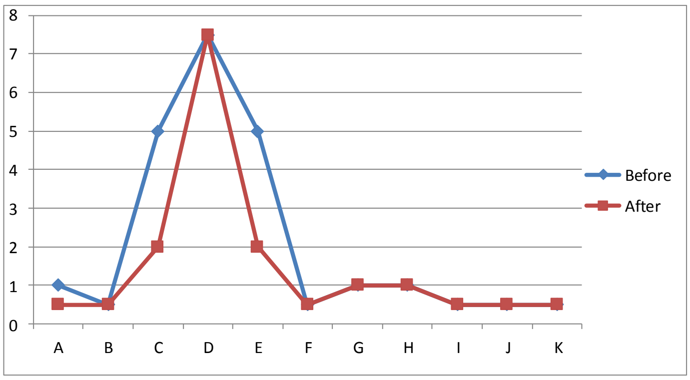


Fig: Graph of time between two operation Vs Handling time in min

- X axis : time between two operation
- Y axis : Handling time in min

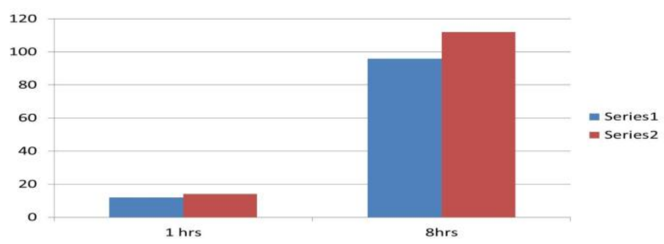


Fig: Graph of Number of jobs Vs Time in hour

- X axis : Number of Jobs
- Y axis : Time in hour

GROWTH

Before		After	
Hours	Jobs	Hours	Jobs
1	12	1	14
8	96	8	112

Table : Result Table

After changing the layout It observed that productivity increased by 2 jobs per hours and 16 jobs per 8 hours

XII. CONCLUSION

By enormous effort and several trail taken and finally found the solution for this above prescribe problem which eliminated possibilities of errors. In addition to that loss of company due to job rejection was recovered. Before implementing Poka-Yoke lots of 100 jobs was rejected which lead to high percentage economical loss for the company. The hectic burden of reworking, changing the sequence of operation, manufacturing methods are eliminated. Along with that it saved the time which was the biggest benefit. The company's demand of space utilization has been thoroughly justified in the project work. Greatly reduction in material handling time.

XIII. REFERENCES

[1] Y. Zhu and F. Wang, "Study on the general plane of log yards based on systematic layout planning," IEEE. Computer Society, vol. 4, pp. 92-95, December 2009.

[2] W. Wiyaratn and A. Watanapa, "Improvement plant layout using

systematic layout planning (SLP) for increased productivity," in Proc World Academy of Science, Engineering and Technology, vol. 36, pp. 269-273, December 2010.

[3] P. N. Suwadee and C. Chonthicha, "Using Promodel as simulation tools to assist plant layout design and planning case study plastic packaging factory, "Songklanakarin J. Sci. Technol, vol. 30, pp. 117-123,January-Febuary 2008.

[4] S. K. Deb, "Computerized plant layout design using hydrid methodology under manufacturing environment," IE (I) Journal-PR, vol. 85, pp. 46-51, March 2005.

[5] P. Jaturachat, N. Charoenchai, and K. Leksakul, "Plant layout analysis

and design for multi-products line production," in Proc IE-Network conference pp. 844-849, October 2007.

[6] M. Khansuwan and C. Poowara, "A study on plant layout improvement a case study at Kritichai mechanical company ltd.," A Project for

Bachelor‟s Degree in Industrial Engineering, Faculty of Engineering,

Thammasat University, 1999.

[7] A. Watanapa and W. Wiyaratn, "Systematic layout planning to assist
plant layout: case study pulley factory," in Proc 2nd International
conference on Mechanical, Industrial, and Manufacturing
Technologies, MIMT, vol. 1, pp. 550-552, February 2011.