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# Development Of Kaizen A Lean Manufacturing Tool In Manufacturing Line To Improve Productivity & Safety : A Case Study

KEYWORDS: Kaizen, Low cost automation, productivity improvement, reduction of injury

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**ABSTRACT** Manufacturing organizations are currently encountering a necessity to respond to rapidly changing customer needs, desires and fluctuating market demand. Markets are affected by diverse customer needs, which demand higher quality, shorter delivery time, higher customer service level and lower prices. Many organizations have realized the need to improve the quality of products & services to compete successfully. To compete in this dynamic environment, these organizations must have to develop new methodologies allowing them to remain competitive and flexible simultaneously so that they can respond to the new demands. Process improvement becomes obligatory to gauge as well as improvise the current manufacturing scenario and hence advent of kaizen automation plays a chief role. This study is focusing on development of low cost automation system by using a lean tool, Kaizen: Continuous Improvement. In Japanese kaizen is for continuous automated improvement designed to eliminate waste on resources of manufacturing system i.e. machinery, material, worker and production methods. Here we will see that how a low cost automation in manufacturing industry can be useful for productivity improvement, fatigue reduction and reduce the chances of injury.

## 1. INTRODUCTION:

In recent years investigation of work related fatigue and discomfort of worker had attracted considerable attention, because of its importance in assessing ergonomics risk factor involved at industrial workplace. Manual material assembly involves the use of human body to lift lower loads or carry loads. Sometimes it also involves to push the material trolley or pull the material trolley according to workplace requirement. Most manufacturing industries require some manual assembly tasks. When perform incorrectly or excessively, these tasks may expose workers to physical risk factors, fatigue and injury. Manual material assembly is among the most frequent and most severe causes of injury all over the world. Highest weight limit can be defined as the weight which can be lifted comfortably. If the weight limit is more or inefficient automation for any assembly process then it don't only have ill effect on quality but it also affect the productivity of system, because productivity is directly related to worker's health.

## 2. Literature Review:

In any manufacturing organization, Productivity generally takes highest importance. Specifically productivity is mainly depend on net availability of resources, plant parameters and process capability. The main resources required are man, machine, method, material and money etc. Calculation of individual ratio of output with input gives us the productivity of system. (Murther R.-1973). Productivity improvement can be done by two different methods: Innovation and Continuous process improvements (Narkhede B. E.-2008). Continuous improvement process also known as Kaizen a Japanese term, is a tool of lean manufacturing which helps the organization to move forward to be more competitive in market. (Talwadekar S.- 1996). In any manufacturing industry employee work is based on the standards set by management. So the improvement refers to improve these standards. Improve standards means establish higher level standards (Talwadekar S.-1996). Kaizen starts with a problem or we can say that with identification of problem. Without problem there is no scope for improvement. Many times it is very difficult to observe the problem.

**3. CASE STUDY:** Case studies are very good method of portrayal of experiences out of a program and evaluation of effectiveness of the program as well as success and failure.

**4.PROBLEM-Identification & Definition:** This phrase consist the matter that why we select this problem, its brief description & its intensity that how it affected the organization with the help of its history.

**4.1. Problem Selected:** High cycle time of engine testing & chances of Injury because of hot water splashing from thermostat housing while manual air blowing after engine testing.

**4.2. Project Title i.e. Problem Definition:** To improve productivity by reducing cycle time and eliminate the chance of injury because of hot water splashing from thermosstat housing while air blowing after engine testing.

**4.3. History of problem:** We collected data of same problem from past experience which represented by fig 1


**Fig. 1: History of problem**

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**5. OBSERVATION –** The observation of problem consist of recognition of the features of problem. Here the detailed analysis of processes, symptoms & variation of problem is discussed.

**5.1. Observation of the Process:** Water used in Engine testing for Cooling purpose , Water cooling is a method of heat removal from engine so cooling systems can prevent premature engine failure. These are the following steps with which cooling takes place:

(I). Engine is mounted on testing bed.
(ii). All connection of water, diesel and lubrication oil are made as shown in fig. 2.

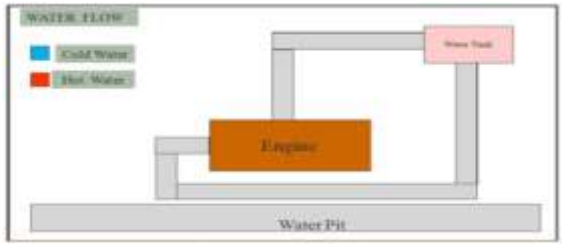


**Fig 2: Mounting of engine on test bed**

**(iii).** All cycles run and tappet setting was done after 3rd cycle. During engine testing cold water comes from water tank, enters into engine and becomes extremely hot due to high temperature of engine. Then this hot water moved out from the engine to water tank with help of water hose pipe connection as represented by fig. 2.

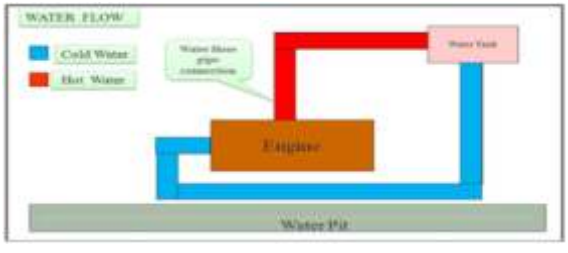


**Fig 3: Flow of cold water & Hot water into connections**

**(iv).** Sound, types of fume, leakage etc are critically observed.
**(v).** Removal of water hose pipe connection during which spillage of hot water occurs on floor of testing area as shown in fig. 4

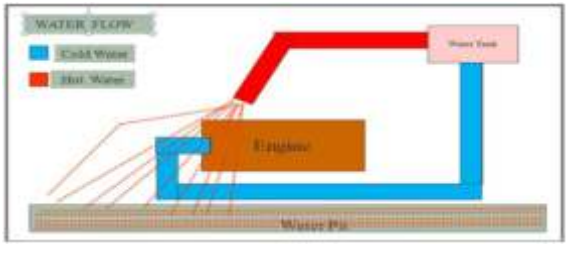


**Fig. 4: Spillage of water due to removal of hose pipe connection on floor of test bed**

**(vi).** Manual blowing of air with help of air gun, to remove hot water from thermostat housing after engine testing. As shown in fig. 5, removal of water from engine is very necessary because if any amount of water would be remaining in the engine then it will cause rusting action.
**(vii).** After removal of all hot water, engine dismounted from testing bed.

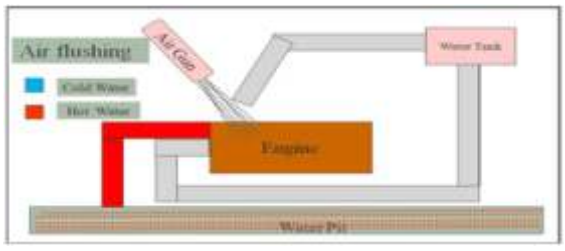


**Fig 5: Removal of hot water from engine by using air gun**

**5.2. Observation of Symptoms:** During process observation we found that the maximum time consuming (i.e. 23 seconds) during Hot water flushing after engine testing. We also found that during removal of water hose pipe connection, hot water splashing in Engine & Operators body.

**6. ANALYSIS –** Discovery of Main Root Causes: For the discovery of main root causes of problem identified, first of all we discussed with cross functional teams of manufacturing system such as production, maintenance, quality and others. On the basis of this discussion we analyzed list of possible causes into different categories of resources i.e. 4M: Man, Machine, Method & Material.

**6.1. Possible Causes:** The brain storming is carried out in CFT for all possible causes. Total 8 Possible causes were identified and then categorized in 4 M's: which are shown in following figure 6.

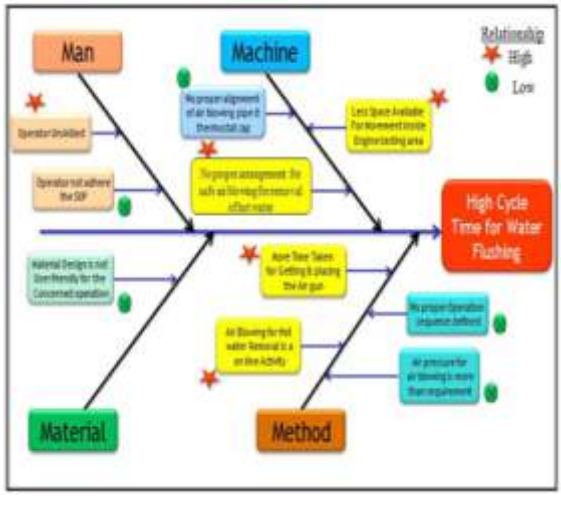


**Fig. 6: Categorization of Possible causes into 4M's**

**6.2. Probable Causes:** After discussion with different cross functional teams we rejected some possible causes, on the basis of their low priority index. Operator unskilled
- Less space available inside the engine testing area
- More time taken in getting and placing air gun
- Air blowing for hot water removal is an online activity.
- Air pressure for hot water blowing is more than required.

**Testing of Hypothesis**
**6.2.1. Probable Cause No. 1:** Operator Unskilled
**Result: -** We found that the operators deputed for engine testing are skilled as per skill matrix.
Hence this is an In-valid cause.

**6.2.2. Probable Cause No. 2:** Less space available inside the engine testing area
**Result:** We deployed different workers in different shifts for

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working inside engine testing area, then they found there is enough space for proper working at proper speed. Not only for the different assembly operation in engine testing but also there was enough space for moving back side for picking up various tools & torque wrenches from bin stage, so the operators feel no such difficulties.
Hence, this is an Invalid Cause.

**6.2.3. Probable Cause No. 3:** More time taken in getting and placing air gun
**Result:** On observation of complete process, we found that the activity of getting & placing the air gun consumed more time i.e. 23 sec/engine
Hence, this is a Valid Cause.

**6.2.4. Probable Cause No. 4-** Air blowing for hot water removal is an online activity.
**Result:** The manual arrangement not only causes extra time , but also this causes splash of water while blowing manually, because manually proper aligning and blowing is very difficult to do, while operator has not much time. This increases the chance of injuries and causes near misses
Hence, this is a Valid Cause.

**6.2.5. Probable Cause No. 5-** Air pressure for blowing is more than required.
**Result:** Initially we thought that air pressure for blowing is more than required due to which hot water splashed on the floor. But when we carefully observed the process of air blowing then we found that air pressure is sufficient to remove water but the manual arrangement causes problem.
Hence this is an In-valid cause.
**Root Causes:**
- **More time taken in getting and placing air gun.**
- **Air blowing for hot water removal is an online activity.**

**7. ACTION –** To eliminate each Root cause:
We undergone through a session of brainstorming as result of which we became able to take remedial action to eliminate each root cause.
**7.1. Why – Why analysis:** Why-Why analysis develops a common understanding regarding the action plan that in case of any individual root cause, what action should be taken. With the help Table 1 of Why-Why analysis we can correctively develop our action plan.

| S. N | Root Cause | Why ? | Why ? |
|---|---|---|---|
| 1. | More time in getting and placing the air gun | Gun location is away from operator reach | No space available for air gun within reach |
| 2. | Air blowing for hot water removal is an online activity | Operator get engaged during hot water removal process | No system available to blow air inside engine without manual intervention |

**Table 1: Why-Why Analysis to develop remedies**

**7.2. Development of Remedies :**
**Working of 3-Way Valve Arrangement:**
**(I).** We installed two 3-way valve arrangement in test bed area for eliminating the root causes. 1st, 3-way valve was installed in between engine and water tank which allows removal of hot water into water tank during engine testing. The 2nd, 3-way valve was installed in between engine and water pit whose function was to remove excess water remaining in the engine after engine testing. In the starting condition, as shown in the fig. 7 both the 3-way valves has been represented by green color boxes when the engine test bed idle.

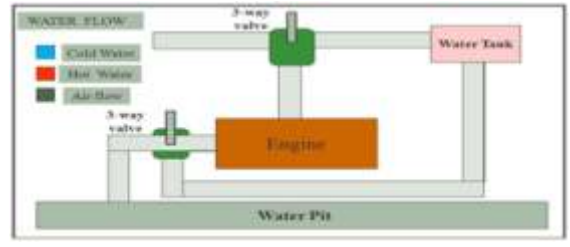


**Fig. 7: Initial stage of 3-way valve arrangement**

**(ii).** When engine testing started then cold water started to came from water tank and entered into engine. At this time we rotated the 3-way valve to extreme left which allowed the movement of cold water from water tank to engine and movement of hot water from engine to water tank as shown in the fig. 8:

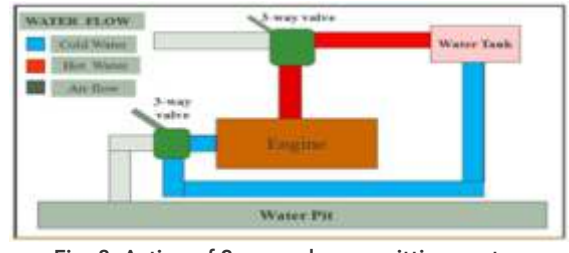


**Fig. 8: Action of 3-way valve permitting water movement only**

**(iii).** After completion of engine testing for the removal of remaining amount of water, we rotated both the 3-way valve up to extreme right which restricted movement of hot water and only allow passage of air at high pressure as shown in fig. 9.

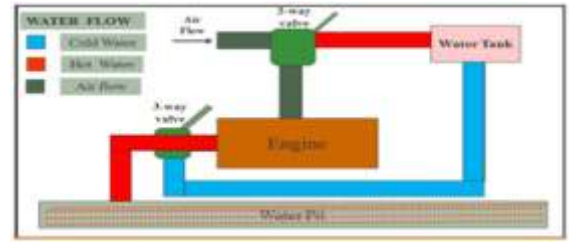


**Fig. 9: Removal of excess hot water from engine by air-blow action of 3-way valve**

**7.2.1. Root Cause No. 1:** More time taken in getting and placing air gun.
**Before Status:** As manual operation by operator for removing hot water from thermostat housing after engine testing takes extra time, operator has to do it fast, which causes injury.
**After Status:** There is no need of extra manual work as in three way valve arrangement operator just has to open the valve after engine testing . Thus this automation of blowing air has reduced the working time up to only 2 seconds from 23 seconds.

**7.2.3. Root Cause No. 2:** Air blowing for hot water removal is an online activity.
Before Status: After engine testing operator has to blow air

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manually to remove hot water from thermostat housing that causes chance of burning injury by hot water splashing
**After Status:** As three way valve is implemented, operator just has to open the valve after testing, thus no manual operation and chance of injury is eliminated.

**8. RESULT & DISCUSSION:**
As this study had been started in April 2010. From the starting the implementation of 3-way valve as remedy provided positive result and absolute elimination of accident as shown in fig. 10.

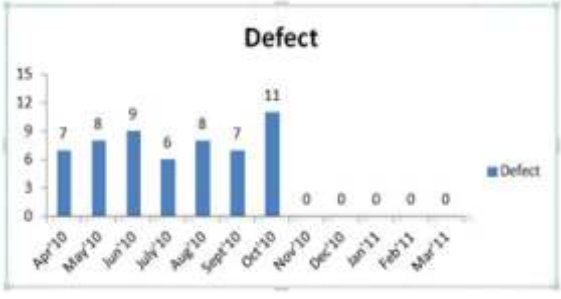


**Fig. 10: Results after implementation of remedies**

Implementation of this remedy also reduced the cycle time of air blowing for hot water removal drastically from 23 seconds to only 2 seconds as 91% reduction in cycle time.
Finally we can see from, that after implementing developed remedy the results are very encouraging.

**9. CONCLUSION:**
A healthy man can take healthy decision in a good proverb and also can give his performance in his best. If any person is not comfortable or unfit in his given conditions then his physical as well as mental power decreases for work. According to our study, a person starts giving low performance in his duty assigned if conditions are not favorable with his body requirement in both physically and mentally.

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