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TOTAL QUALITY MANAGEMENT THROUGH PRODUCTIVITY IMPROVEMENT & REWORK EASING @WIPRO LIGHTNING DIVISION

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Abstract*— Root-cause identification of production and rework related problems are key issues for manufacturing processes. It has been a very challenging engineering problem particularly in a multistage manufacturing of Lighting Division, where maximum number of processes and activities are performed. The contributing rework factor is usage of burner part (glass) at maximum stages of manufacturing process. Market Share of Lighting Products is 10% of total Wipro Market Value. However, it may also be implemented with ease in each and every individual set up and activities in the manufacturing process. In this project, root-cause identification methodology has been adopted to reduce the visual and operational defects in rework process of Assembly line in CFL to control/reduce the rework timing on an average, which is 31% according to observation. Rework of lamps consumes time of the workers which directly affects the regular assembling of lamps at the Finished Goods Section. DMAIC process is used to the assembly by which a detailed experimental study of the assembly line along with Pareto analysis (80 percent of the defects are made by 20 percent of the process) is made to identify and reduce the process attributes.*

Keywords*— Root cause analysis, defects, light, Wipro.*

COMPACT FLUORESCENT LAMP

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light, and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent lamp; some types fit into light fixtures formerly used for incandescent lamps. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and a compact electronic ballast in the base of the lamp.

CFLs radiate a spectral power distribution that is different from that of incandescent lamps. Improved phosphor formulations have improved the perceived colour of the light emitted by CFLs, such that some sources rate the best "soft white" CFLs as subjectively similar in colour to standard incandescent lamps.

CFLs have two main components:

- Magnetic or Electronic Ballast
- A Gas-Filled Tube (also called bulb/burner).

PRODUCTION AND DEFECTS

Production is defined as the process of manufacturing of products which in-turn holds an extra or inappropriate functional attribute which is known to be as defects.

TYPES OF DEFECTS

A defect may be defined as any characteristic of a product which hinders its usability for the purpose for which it was designed and manufactured.Defects in CFL Burner Manufacturing are broadly classified into two: INOPERATIVE DEFECTS and OPERATIVE DEFECTS. An Inoperative Defect is such that the burner can no longer be used for generating discharge path of ionized gases due to various reasons such as Leakage of Gas, Crack at Fusion location, Only Three Wires, etc.,

An operative Defect is one which burner functions, emitting light but has defects when compared to]normal functionality which hinder the quality, such as powder off the burner, bad coating, electrode touching shell, etc.,

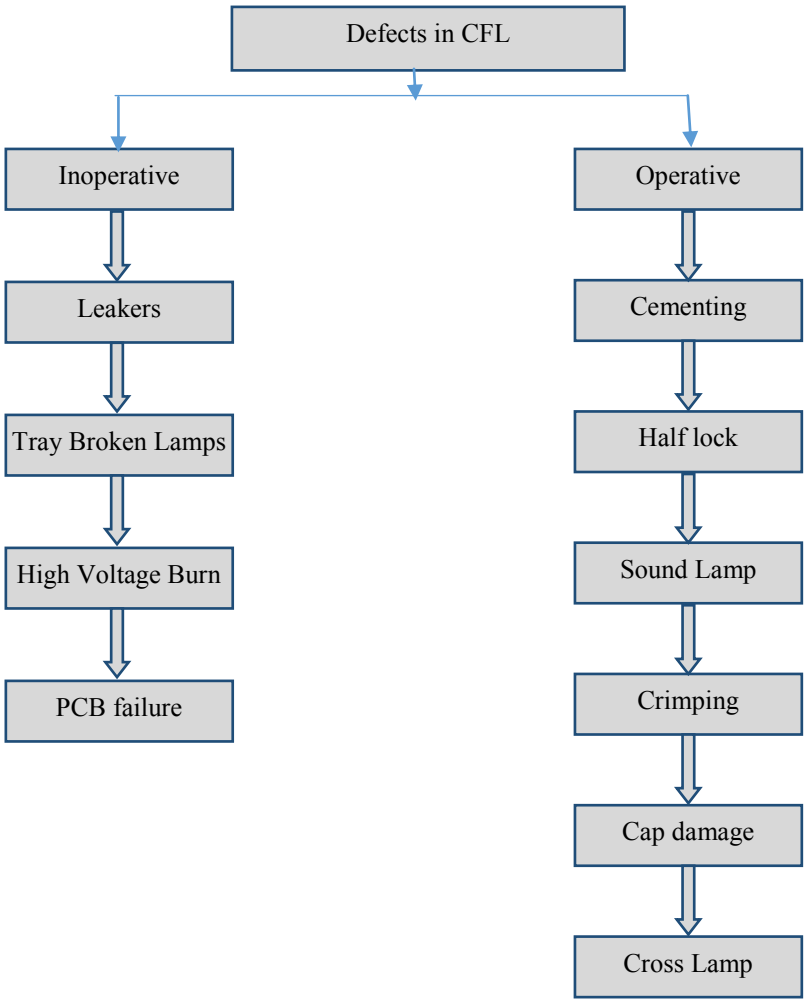

Fig. 1

DATA ANALYSIS THEORTICAL DEFINITIONS

Problem Identification

In Root Cause Analysis (RCA) is the process of identifying causal factors using a structured approach with techniques designed to provide a focus for identifying and resolving problems. Tools that assist groups or individuals in identifying the root causes of problems are known as root cause analysis tools. Every equipment failure happens for a number of reasons. There is a definite progression of actions and consequences that lead to a failure. Root Cause Analysis is a step-by-step method that leads to the discovery of faults or root cause. An RCA investigation traces the cause and effect trail from the end failure back to the root cause. It is much like a detective solving a crime.

To meet up the high changing market demands along with high quality at comparable prices, one shall have to identify quickly the root causes of quality related problems by reviewing an event, with the goals of determining what has happened, why it has happened and what can be done to reduce the likelihood of recurrence.

Objective and Outline of the Study

There are varieties of problems related to product quality and productivity in industries due to varying degrees of abnormality and inefficiency which ultimately causes rejection. Root-cause identification for quality-related problems is a key and necessary step in the operations of manufacturing processes, especially in high throughput automated processes.

This is predominantly true for the multistage manufacturing processes, which is defined as a process that produces the products under multiple setups. The quality information flow of the product in a multistage manufacturing system and the interaction between the process faults and the product quality characteristics are very complicated. In multistage

process, the identification of process root cause is also not simple. It has been observed that the implementation of Root Cause Analysis in a particular single individual setup has simplified the problem.

OBSERVATION OF DEFECTS BEFORE PROJECT

Table 1: Assembly Rework Analysis

Observed Value		
Total	*3900*	*%*
Inoperative	123	3.154
Bad stamping	176	4.513
Half Lock	468	12.000
Cementing	313	8.026
Sound Lamp	12	0.308
Cross Lamp	38	0.974
Crimping	44	1.128
Cap damage	56	1.436
Total Defects	1230	31.538

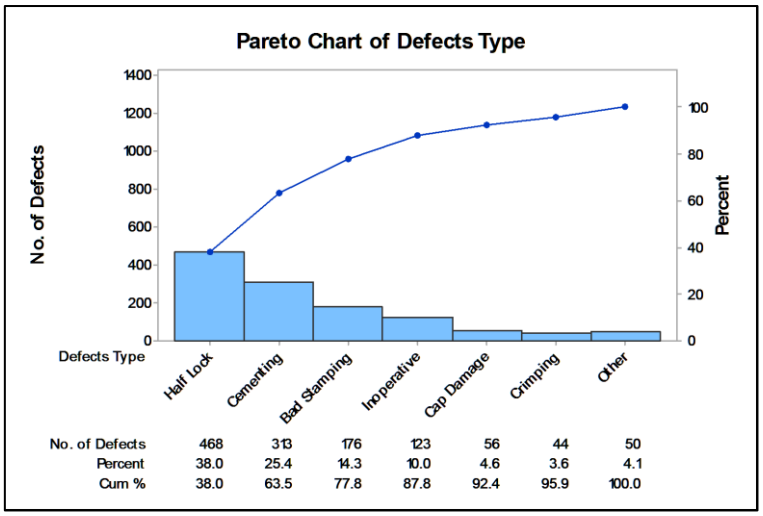

Fig. 2: Pareto Diagram

Table 2: Rework Man Hour Calculation

Defect Type	*Quantity in No's/Day*	*Rework time required in seconds*	*Total seconds*	*Total Hours*
Inoperative	123	14.87	1829	0.51
Half lock	468	4.81	2251	0.63
Bad Stamping	176	4.55	800.8	0.22
Cross Lamp	38	12.5	475	0.13
Cap Damage	56	12.5	700	0.19
Cementing	313	3	939	0.26
Total				1.94

NOTE: 1.94 hrs is the rework man hours for 1.5 hrs packing line production. For entire day it is approx. 10 man hours spend on rework.

ROOT CAUSE ANALYSIS AND SUGGESTIONS

Inoperative— Inoperative are defects which may be due to the following scenarios.

- Burner Failure
- PCB Failure
- Wire Cut within Solder

It states that, the completed lamp won't function after the ageing process at the final table check due to any of the above reasons. To overcome this defect monitoring and identification of defects at the time of loading and unloading in the ageing machine should be processed.

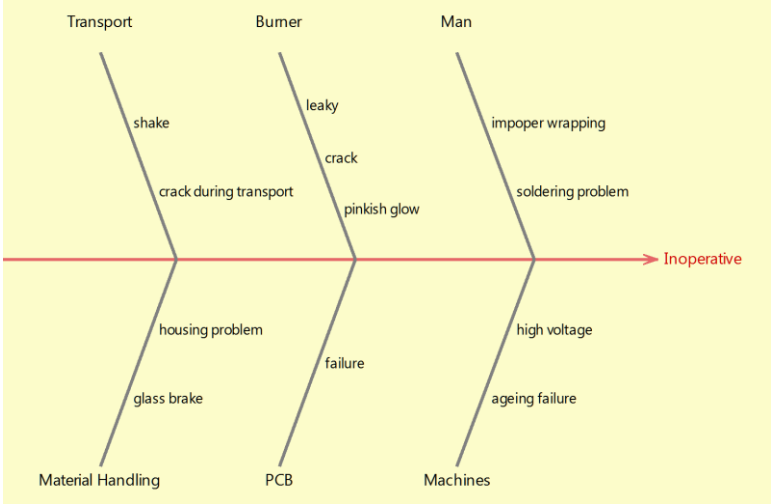

Fig. 3: Imperative Fishbone

Suggestions

Inoperative Defects

- Burner must be checked properly using test before the process of cementing.
- Ageing machine should be repaired, so that ageing process can be carried out properly.
- Instead of one person, two should be used in the unloaded section of ageing so that check for defect can be better.
- In the table, of assembly the final step of housing must be carried out along with holder check.
- Housing must be proper and it should be checked, so no foreign material go in or cap and burner gets separated during the time of travel and soaking.

Table 3: Failure rate between burner and PCB

Total Sample Size	577		%
PCB Defects	373		64.64
PURI		155	41.55
NTL		56	15.01
WIPRO		162	43.43
Burner Defects	184		31.89
OK LAMPS	20		3.47

AGEING MACHINE REPAIR WORK

Improper ageing is the prime cause for inoperative defects, thus the holders in the ageing machine (377*6) has been check and spotted for errors immediately. A logical method which compositional holds coloured ceil tapes and marker to identify the defective holders is carried out manually.

- Blue – Broken Holder
- Yellow – Brass Damaged

- Red – Spring Loose
- Black – Screw not available

Table 4

Blue	123
Yellow	303
Red	270
Black	16
Total	712

- Approximately 32% of the holders are defective.

Table 5: Observation after suggestion implementation

No. of samples	*Defects*	*Defect Percentage*
2550	41	1.6 %

Further monitoring and strict validation in loading and unloading of lamp in ageing process is imposed and the final evaluation is calculated as below

FINAL OBSERVATION AFTER THE SUGGESTION IMPLEMENTATION

- Out of 450 sample pieces only 1 inoperative was spotted out, which show cases a huge difference in the defect rate from actual observed value before the implementation of the project.

Table 6

No. of Sample	*Defects*	*Defect Percentage*
450	1	0.20 %
800	2	0.25 %

Sound Lamp— Sound Lamp is a type of defect which is caused by improper solder process, which also includes hand solder problem and jerk off index and solder level variation

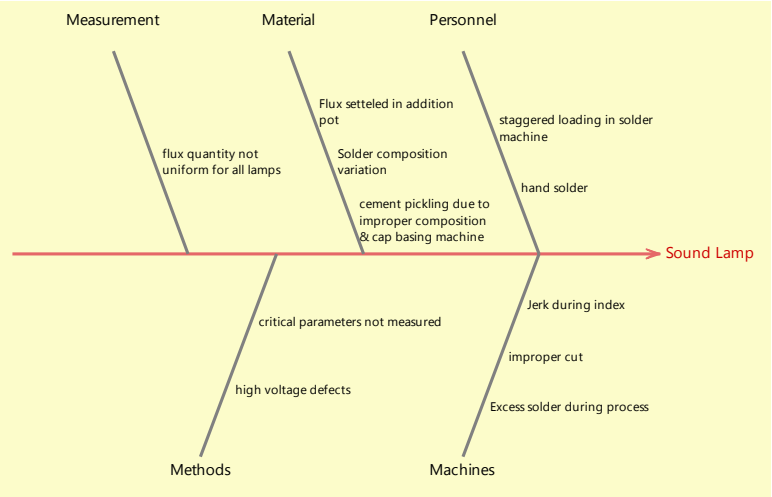

Fig. 4: Soundlamp

Suggestions

Sound Lamp

- After soldering, during the time of loading lamps to ageing machine sound lamps must be checked. Thus it would be better 2 persons load in ageing process.

- Once again during unloading check for sound lamp and back spot must be carried out by the human in-charge.

Cross Lamp— Cross lamp are defect which is because when the burner is not fitted to the surface of the base cap, it looks quite slanting.

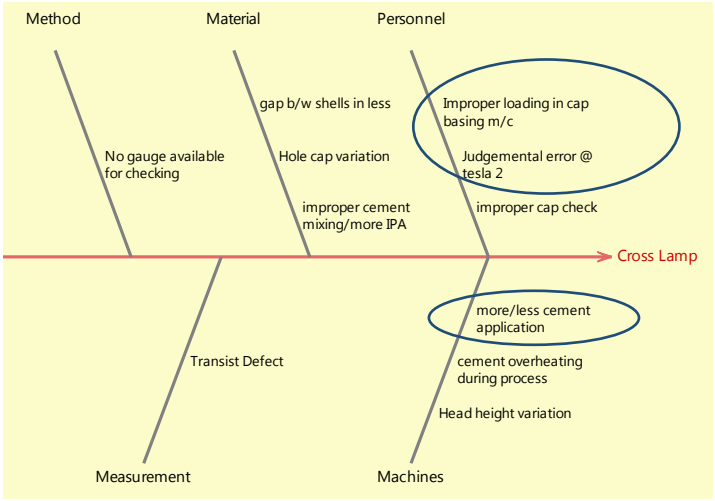

Fig. 5: Cross Lamp

Suggestions

Cross Lamp

- Use of V-shaped steel tube to avoid cross lamps.
- After soaking, during the time of tesla cross lamp defects must be identified
- After the assembly table, during the final stage of housing cross lamp must be identified and reworked.
- Crates with lamp must be moved with help of wheel based mover and it should not be dragged along the floor.

Bad Stamping— It is a type of error which is cause to improper stamping in the surface of the lamp piece. Methods can be plotted to reduce these error and also check for stamping quality can be reconsidered to a limitation.

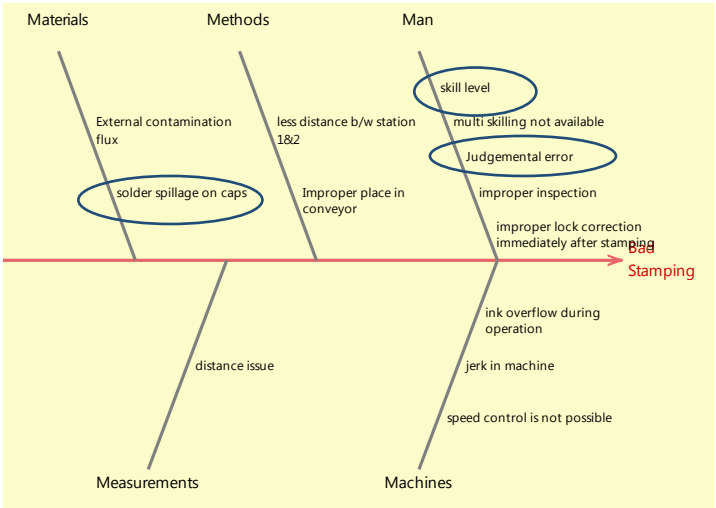

Fig. 6: Bad Stamp

Suggestions

Bad Stamping

- According to observation, bad stamping is mainly due to the machine involved in the process which is quite old and need frequent change of ink.

- The distance between the stamping machine 1 and stamping machine 2 can be further increased so that the speed can be reduced and one man power can also be reduced.
- If the old machine is replaced with Modern Automated machine, the process would be still fine with very low error.

FUTURE SCOPE

- Numbers engraved in lamps can used to track defect rate of bad stamping each month as an advance methodology.

GAUGE R&R

Gage R&R, which stands for *gage* repeatability and reproducibility, is a statistical tool that measures the amount of variation in the measurement system arising from the measurement device and the people taking the measurement.

CUMULATIVE COMPARISON SHEET USING GAUGE R&R

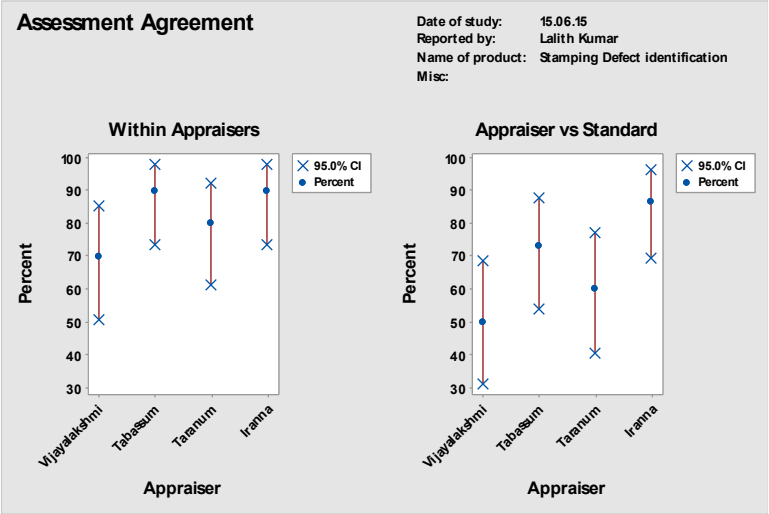

Fig. 7

- Training as been provided to the stamp quality checker as per the regulation and stands specified.
- Difference in option can be limited by repeated training and skill development process.

GAUGE R&R POST TRAINING RESULTANT GRAPH

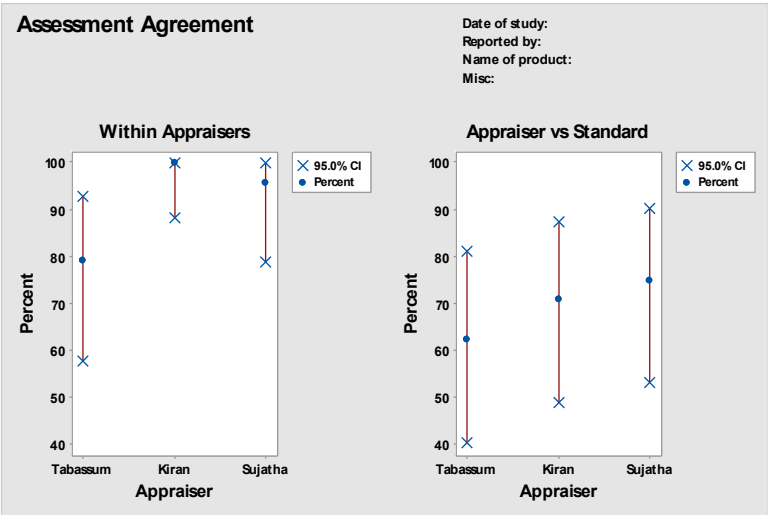

Fig. 8

According to the observation there is an improvement in the checker perception towards stamping bad defect. Effectively the rate of change as happened from 60 % to 73 % in the overall performance and comparatively consistency has been shown by the Appraisers.

Half Lock— Improper lock done by the people during the time and assembling and during the time of checking after the assembling process. It is type of operative defect which can be reduced to very minimal if proper flow technique and spacing is allotted to the assembling people

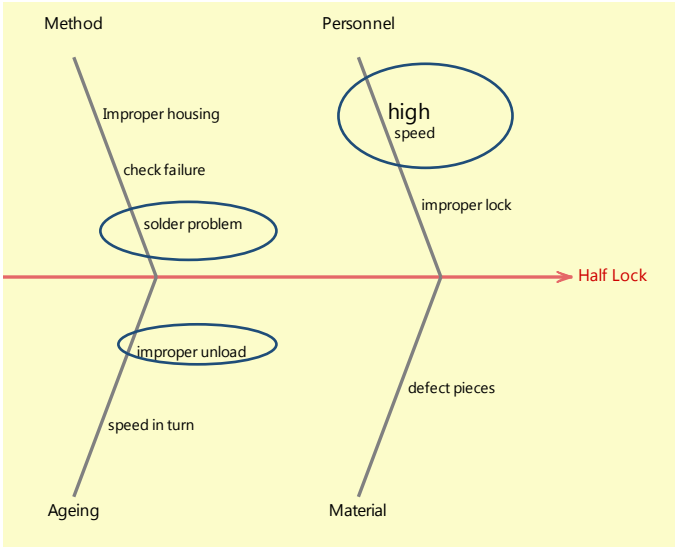

Fig. 9: Half Lock

Suggestions

Half Lock

- Check for lock at the time of assembly is required is must.
- During the time of loading and unloading check for improper lock must be processed.
- Speed control is mandatory in this process.

GENERAL SUGGESTIONS

Operative Defects

Soldering Ooze

- This defect is mainly due to hand soldering, where more man power and energy is required to solder material (Automatic machine is available).
- The solder also spreads in the surface of the burner.
- It cause PCB defect at times.

Loose Base

- Loose Base must be checked after the process of assembly table process, since already 3 persons are allocated to cut the excess wire from the lamp.
- Cross Lamp can also be checked during this process.
- Housing/fitting of lamps should be process in systematic way, instead of doing it in a random mechanism (by which they miss at least 2 to 3 in a crate).

Crimping Bad

- Must be checked during the time of table assembly itself.
- If not it must be checked during late housing process.

FUTURE SCOPE

- Inoperative flow must be reduced from the initial stage of each unit, thus flow monitoring at each and every step of production line must be imposed to reduced defects further.
- Excess operators can be removed from line, by control monitoring system and variant technique.
- Data sheet from manually to automatic is must to improvised the productivity rate and rework reduction.

CONCLUSION

The overall productivity of the company could be increased by reducing the defective components. In this project, the company has faced a large number of rework due to negligence and low monitoring of labour force. The reason behind the rework, wastage and negligence by labours have been studied, analysed and a feasibly solution has been recommended at each stage of the process. A major problem faced by the Wipro is Operative Defects in the Production line of CFL. The cause for this problem has been analysed using cause and effect analysis and the important cause for both the Inoperative and Operative Defects is identified. The causes for Inoperative and Operative Defect are further analysed using advanced quality control tools such as affinity and relationship diagram and identified the root cause for the overall Problem faced. Thus the project is concluded with the observed data of deceased in defect rate of inoperative and techniques/suggestions to control other types of defects in production line of Lightning Division, which directly helps to increase the rate of productivity and quality of CFL Produced. Lean Manufacturing Concept like Colour Defect Identification Methodology, Gauge R&R is done to analyse the factors that has a significant relationship in defect analysis and to provide appropriate solution to the same which increases the efficiency in the production line.

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