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Variation Reduction in Plate Weight By Using Variable Search Method in Batterries

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***Abstract*:-- :- Highly diverse customer demand has changed the way of doing business. Modern business model are working with new economy. This project work gives an account of variation reduction in Plate Weight by using Variable Search method. Based on previous months analysis of data, it was found that major rejections are due to the variations of grids produced in the strip pasting .The root causes are to be found out by using the variable search method and the results are to be validated .With the results of this approach, modifications are to be carried out .The ultimate aim of this project is to reduce the rejections drastically from 35% to 7% ,and thereby improving the overall productivity of the plant. In the present case study, Variable search technique has been applied to Plate Weight rejection.**

Index Terms- Overall Productivity, Variable Search Method.

1. INTRODUCTION

Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by engineers Harry while working at Motorola in 1986.[1] [2] Jack Welch made it central to his business strategy at General Electric in 1995.
It seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.
The term Six Sigma (capitalized because it was written that way when registered as a Motorola trademark on December 28, 1993) originated from terminology associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a sigma rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects (3.4 defective features per million opportunities). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.

1.1. FEATURES OF SIX SIGMA

- Six Sigma's aim is to eliminate waste and inefficiency, thereby increasing customer satisfaction by delivering what the customer is expecting.
- Six Sigma follows a structured methodology, and has defined roles for the participants.
- Six Sigma is a data driven methodology, and requires accurate data collection for the processes being analyzed.
- Six Sigma is about putting results on Financial Statements.
- Six Sigma is a business-driven, multi-dimensional

structured approach for –

o Reducing costs
o Increasing customer satisfaction
o Increased profits

The word Sigma is a statistical term that measures how far a given process deviates from perfection. The central idea behind Six Sigma: If you can measure how many "defects" you have in a process, you can systematically figure out how to eliminate them and get as close to "zero defects" as possible and specifically it means a failure rate of 3.4 parts per million or 99.9997% perfect.

1.2 KEY CONCEPTS OF SIX SIGMA

At its core, Six Sigma revolves around a few key concepts.

- ***Critical to Quality*** − Attributes most important to the customer.
- ***Defect*** − Failing to deliver what the customer wants.
- ***Process Capability*** − what your process can deliver.
- ***Variation*** − what the customer sees and feels.
- ***Stable Operations*** − Ensuring consistent, predictable processes to improve what the customer sees and feels.
- ***Design for Six Sigma*** − Designing to meet customer needs and process capability.

Our Customers Feel the Variance, Not the Mean. So Six Sigma focuses first on reducing process variation and then on improving the process capability.

1.3 MYTHS ABOUT SIX SIGMA

There are several myths and misunderstandings surrounding

- Six Sigma. Some of them few are given below −
- Six Sigma is only concerned with reducing defects.
- Six Sigma is a process for production or engineering.
- Six Sigma cannot be applied to engineering activities.
- Six Sigma uses difficult-to-understand statistics.
- Six Sigma is just training.

1.4 BENEFITS OF SIX SIGMA

- Six Sigma offers six major benefits that attract companies
- Generates sustained success
- Sets a performance goal for everyone
- Enhances value to customers
- Accelerates the rate of improvement
- Promotes learning and cross-pollination
- Executes strategic change

1.5 ORIGIN OF SIX SIGMA

- Six Sigma originated at Motorola in the early 1980s, in response to achieving 10X reduction in product-failure levels in 5 years.
- Engineer Bill Smith invented Six Sigma, but died of a heart attack in the Motorola cafeteria in 1993, never knowing the scope of the craze and controversy he had touched off.
- Six Sigma is based on various quality management theories (e.g. Deming's 14 point for management, Juran's 10 steps on achieving quality).

1.6 PROJECT SELECTION FOR SIX SIGMA

One of the most difficult challenges in Six Sigma is the selection of the most appropriate problem to attack. There are generally two ways to generate projects –

- Top-down − This approach is generally tied to business strategy and is aligned with customer needs. The major weakness is they are too broad in scope to be completed in a timely manner (most six sigma projects are expected to be completed in 3-6 months).
- Bottom-up − In this approach, Black Belts choose the projects that are well-suited for the capabilities of teams. A major drawback of this approach is that, projects may not be tied directly to strategic concerns of the management thereby, receiving little support and low recognition from the top.

1.7 SIX SIGMA METHODOLOGIES

Six Sigma has two key methodologies −

- ***DMAIC*** − It refers to a data-driven quality strategy for improving processes. This methodology is used to improve an existing business process.
- ***DMADV*** − It refers to a data-driven quality strategy for designing products & processes. This methodology is used to create new product designs or process designs in such a way that it results in a more predictable, mature and defect free performance.

There is one more methodology called DFSS − Design for Six Sigma. DFSS is a data-driven quality strategy for designing or redesigning a product or service from the ground up.

Sometimes a DMAIC project may turn into a DFSS project because the process in question requires complete redesign to bring about the desired degree of improvement.

DMAIC Methodology

This methodology consists of the following five steps.

Define --> Measure --> Analyze --> Improve -->Control

- ***Define*** − Define the problem or project goal that needs to be addressed.
- ***Measure*** − Measure the problem and process from which it was produced.
- ***Analyze*** − Analyze data and process to determine root causes of defects and opportunities.
- ***Improve*** − Improve the process by finding solutions to fix, diminish, and prevent future problems.

- ***Control*** − Implement, control, and sustain the improvements solutions to keep the process on the new course.

We will discuss more on DMAIC Methodology in the subsequent chapters.

DMADV Methodology

This methodology consists of five steps −
Define --> Measure --> Analyze --> Design -->Verify

- ***Define*** − Define the Problem or Project Goal that needs to be addressed.
- ***Measure*** − Measure and determine customers needs and specifications.
- ***Analyze*** − Analyze the process to meet the customer needs.
- ***Design*** − Design a process that will meet customers' needs.
- ***Verify*** − Verify the design performance and ability to meet customer needs

DFSS Methodology

DFSS is a separate and emerging discipline related to Six Sigma quality processes. This is a systematic methodology utilizing tools, training, and measurements to enable us to design products and processes that meet customer expectations and can be produced at Six Sigma Quality levels.

This methodology can have the following five steps.
Define --> Identify --> Design --> Optimize -->Verify

- ***Define*** − Define what the customers want, or what they do not want.
- ***Identify*** − Identify the customer and the project.
- ***Design*** − Design a process that meets customers 'needs.
- ***Optimize*** − Determine process capability and optimize the design.
- ***Verify*** − Test, verify, and validate the design.

1.8 SIX SIGMA - TECHNICAL TOOLS

In this an overview of the 10 most important technical tools, which a Six Sigma team member needs to master as they progress through the DMAIC methodology. While these tools are considered technical in nature, most of them are relatively easy to learn and apply. They are covered in the order they are used in the DMAIC methodology.

Tool #1 - The Critical to Quality (CTQ) Tree;

The critical-to-quality tree is used during the design phase of DMAIC. It is used to brainstorm and validate the needs and requirements of the customer of the process, targeted for improvement.
The steps in creating a CTQ tree are as follows −

- Identify the customer of the process targeted for improvement.
- Identify the need of the customer.
- Identify the first level of requirements of the need, that is, some characteristic of the need that determines whether the customer is happy with the need.
- Drill down to more detailed level(s) of the requirement if necessary.

Tool #2 - The Process Map;

During the Define phase, the project team creates the first of several process maps. A process map is a picture of the current steps in the process targeted for improvement. A process map has five major categories of work from the identification of the suppliers of the process, the inputs the suppliers provide, the name of the process, the output of the process, and the customers of the process. Each of these steps is summarized as SIPOC to indicate the steps to the team that must be conducted to complete a process map.

Tool #3 - The Histogram;

This tool is used during the Analysis stage of DMAIC. The project team reviews data collected during the Measure stage of DMAIC.
It is often suggested that the data be organized into graphs or charts, which makes it easier to understand, what the data is saying about the process.
Data is of two types - Discrete data (go/no go, fail or pass) and Continuous data (time, height etc.).

Tool #4 - The Pareto Chart;

Histogram is useful for continuous data, same way when the data is discrete, most teams create a Pareto chart. Discrete data is counted data - go/no-go, off/on, yes/no, and defect/no defect type data.
An Italian economist Vilfredo Pareto, in the sixteenth century proved mathematically that 80 percent of the world's wealth was controlled by 20 percent of the population. This 80-20 rule eventually proved applicable in arenas other than economics.

When dealing with discrete data, the project team should create reason codes for why a defect occurs, and count and categorize the data into these reason codes and a pareto chart should be prepared.

Tool #5 - The Process Summary Worksheet;
The goal of a Six Sigma project team is to improve effectiveness and efficiency. Efficiency is measured in terms of cost, time, labor, or value.
The process summary worksheet is a "roll-up" of the sub process map indicating which steps add value in the process and which steps don't add value.

Tool #6 - The Cause-Effect Diagram;
The most important tool to assist the project team in determining root causation is the cause-effect diagram. This tool captures all the ideas of the project team relative to what they feel are the root causes behind the current sigma performance and finally help in finding a root cause of the problem.

Tool #7 - The Scatter Diagram;
Once ideas have been prioritized after use of the cause-effect diagram, the most important thing the project team does is to validate the remaining ideas with fact and data.
The scatter diagram takes an idea about root causation and tracks corresponding data, in the response the team is trying to improve. The team can validate an idea about root causation through one of the three methods. Using basic data collection, a designed experiment, or through the scatter diagram.

Tool #8 - The Affinity Diagram;
An affinity diagram is used to help sort and categorize a large number of ideas into major themes or categories. It is especially useful when the team is ready to brainstorm solutions in the Improve stage of DMAIC. The steps in creating an affinity diagram are ,

- Have each team member write one idea per Post-it note and post on a wall randomly.
- As ideas are read off for clarification, sort ideas into similar groups.
- Create a 'header' card for each general category of ideas below it.

Tool #9 - The Run Chart
We have discussed the histogram and Pareto chart. Think of both of these tools as similar to a camera where a snapshot of the process has been taken. But the run chart is similar to a camcorder, recording some process element over time.

Tool #10 - The Control Chart
Similar to a run chart, a control chart uses the data from a run chart to determine the upper and lower control limits. Control limits are the expected limits of variation above and below the average of the data. These limits are mathematically calculated and indicated by dotted lines.

2. CASE STUDY IN BATTERY MANUFACTURING INDUSTRY

INTRODUCTION:
This case study is carried in one of leading battery manufacturing industry. Plate width variations in X-Met pasting machine the production rate is less in that industry. Variable search method is used to reduce the rejection rate. Variable search method is one of tool used in six sigma method.

DESCRIPTION OF THE PROBLEM:
Each and every Rejection in the line will be recorded and cause for the Rejection also will be analyzed .Major causes listed for the problem/Rejections as follows:

- List of Problems to be solved to achieve the target
- Paper Filling
- Plate Width Variation
- Plate bend
- Plate crush

Lack Of Training:
As the Smaller Battery Division (SBD) is the new plant and new X-Met Pasting Line, no adequate training provided for the mechanics on

- Problem Solving Techniques
- Inventory Planning
- Preventive maintenance
- Pasting maintenance
- Corrective maintenance
- Trouble shooting guide lines

No infrastructure:
Infrastructure is the main input to the pasting line section, without proper infrastructure pasting equipment too difficult .presently no sufficient man power available in the pasting line section, Manufacturer Manuals, Catalogues and Specialized tools etc not maintained. Critical pasting Spares are also not maintained.

No methodology:
No Proper System available for
1) Record the pasting line

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2) Analyze the problem
3) Types of action to be taken for rectification of Problem.

DETAILS OF THE PROBLEMS:
Historical Perspective:
The following are the major equipment's available in the line

- Paper Filling
- Plate Width Variation
- Plate bend
- *Plate crush*

Criticality of the problem:
The Excessive down Hours in pasting line leads to
1) Low Production
2) Low Productivity
3) Less Employee Morale
4) Less Availability of equipment
5) High Maintenance Cost
6) Unsafe condition
7) Low uptime

3. CALCULATIONS AND ANALYSIS:

DMAIC Methodology:
1. DEFINE
Final list of Suspected Sources of Variation (SSV's) for the physical phenomenon of the problem

No	***Suspected Sources of Variation (SSV's)***	***Design SSV or Variation SSV***
1	Variation due to blade life	Variation SSV
2	Measurement system for operator to operator	Variation SSV
3	Index wheel slippage and Guiding	Design SSV

2. MEASURE AND ANALYSIS;
Table 1;

Machine /Tool Condition	***Standard***	***Observed***
Feeding Index	AS per drawings	OK
Strip Punching Male & Female Blocks	AS per drawings	OK
Cutting Blade	AS per drawings	OK
Strip Dimension	AS per drawings	OK
Machine leveling	Should be level	Good
Bearing conditions	No vibration	Good

Table 2;

Process parameter	**Standard**	**Observed**	**Conclusion**
Air pressure	>5 kg/cm2	5.6 kg/cm2	OK
Servo Movement	48.7	Un Known	To be Checked
Plate Width	48.70+ 0.5 mm	46.71 to 50.15 mm	Not ok
Strip Width	187 + 0.5 mm	187.3	Ok

3. IMPROVEMENT

Before Implement: Servo Motor and index wheel connected with coupling. Shown in Figure below

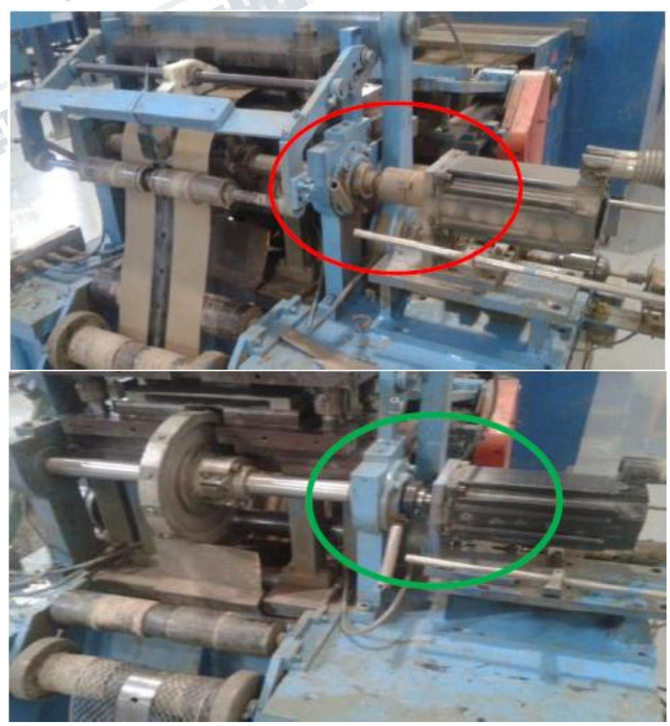

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Figure: Before there is coupling between the servo motor and index wheel shaft at that time index wheel shaft getting play

After Implement: index wheel soft directly connected to servo motor. Shown in below figure

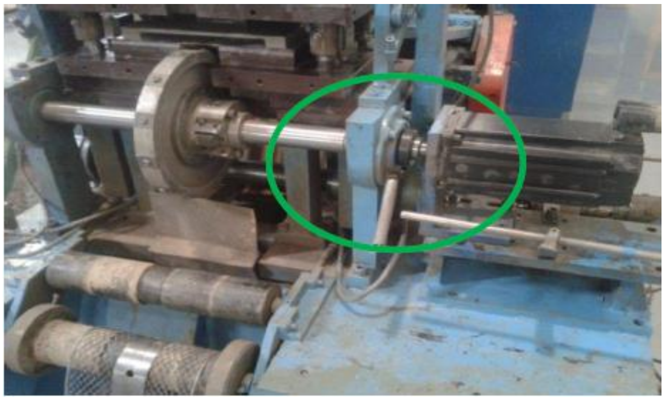


Figure: Now the shaft of the index wheel is designed like to move with the servo motor directly without coupling. Now width variation is decreased to 3.2mm to 2mm

4. CONTROL

Result verification for the problem After improvement

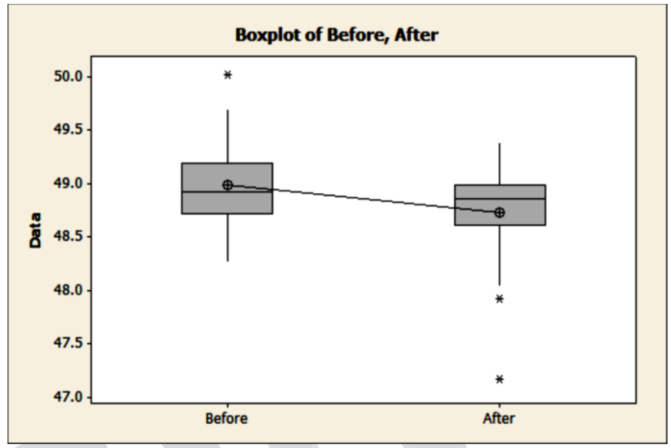
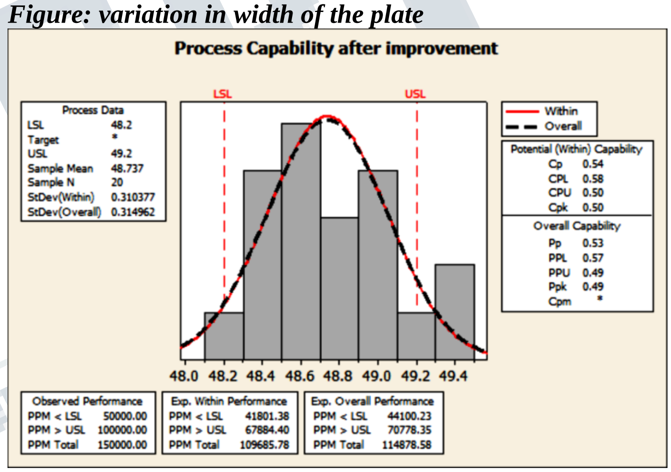
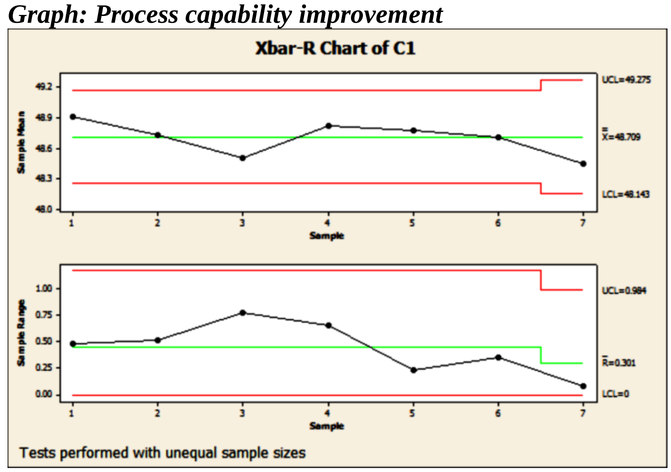


Figure: variation in width of the plate



Graph: Process capability improvement



Graph: Width variation in plate analysis

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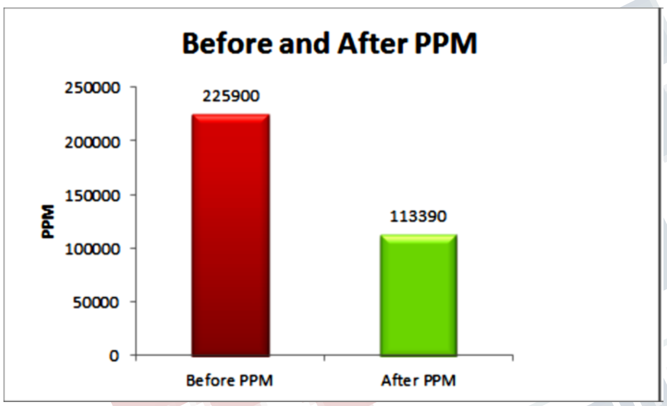
4. CONCLUSION

	Nos	PPM
Rejection above USL	14,836	148,360
Rejection below LSL	7,640	76,400
Total	22,476	224,760

Table: above table shows no.of rejection before implementation

	Nos	PPM
Rejection above USL	9,291	92,910
Rejection below LSL	1,785	17,850
Total	11,076	110,760

Table: above table show no.of rejection after improvements



Graph: No.of plate rejection before and after implementation

CONCLUSTION:

From the above graph we can conculed that after implementation of the project we have reducing the no. of rejections in the x-met pasting line from 36% to 7%.

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