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Accuracy Measurement by Using SQC chart for Bolt Manufacturing through Conventional and CNC Machining

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Abstract

Improvement of the process outputs quality by identifying and removing the causes of defects and variability in dimension in manufacturing process. In this project's in the manufacturing of bolt process variation have been observed in term of accuracy of the product, when we are using conventional machining. Hence after finding the root cause of the problem of the conventional machining through route cause analysis solution have been given and there after a remarkable improvement have been observed in terms of quality and accuracy in the bolt manufacturing in conventional machining process. There after instead of conventional machining process and Computer Aided Manufacturing (CAM) have been used for mass production. Compression shall be shown in Statistical Quality Control chart between the uses of two processes for accuracy with quality.

Keywords: *Accuracy, Conventional, Improvement, Quality, Specification, CAM.*

. *Introduction*

Production is a process by which raw material is converting to finished products or semi finished products. Hence the process may be defined as the different steps of operation or sequence of operation to be performed in manufacturing process.

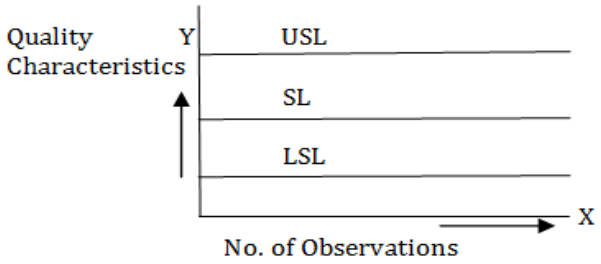
Process may be defined as the various steps of operations by which raw material converted into finished product or semi finished product. When we talk about finished product in terms of accuracy and quality, play a vital role in the manufacturing process in terms of accuracy of the product. Hence higher the accuracy of the product greater is the customer satisfaction where higher accuracy provided more reliable in terms of reliability of the product. Hence accuracy may be defined as the closer to the nominal value and it is concerned with work or job only. For an example small job having the specification of Ø10±0.1 mm then the upper specification limit shall be 10.1 mm and the lower specification limit will be 9.9 mm. But nominal value shall be 10mm only. This will have more accuracy to such product on the manufacturing process, when the product quality shall be towards the achieving of nominal value.

SQC: - Statistical Quality Control chart consisting of three horizontal line drawn on a graph. The upper horizontal line known as upper specification limit(USL), the middle one is known as specification limit(SL), and the lower one is known as lower specification limit(LSL). Hence the OX-Axis shows the no of observations and OY-Axis shows the Quality characteristics.

Lets the specification be 10±0.1

Where, USL=10.1, SL=10, LSL=9.9.

The graph shows:-



Business strategy that seeks to identify and eliminate causes of errors or defects, defined as anything which could lead to customer dissatisfaction[1] or failure in business process by focusing on outputs that are critical to customer[2] it was the normal distribution on a strong relationship between product non conformation (NCS) be defects and product yield reliability cycle time, inventory, schedule, schedule etc….[3] the activation of the process improvement or not limited to process or operation levels, but extended to all that levels of a enterprise to reduce cost and produce high quality product.

Process improvement has been widely adopted in a variety of industries as a proven management innovation methodology to produce high quality product at low cost (lean production) at all levels of an enterprises. On this

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work at firstly we have define the problem, then after measure the problem with help of statistical tool and there after analysis the problem with the help of pareto and cause effect analysis and improvement have been implemented for betterment of the product according with [4], the main key factor for a successful implementation of the program at first top management, involvement and commitment, understanding the methodology, implement that methodology is much important. Hence organizational infrastructure should change, project management, skill, training and linking it to employee is much important.

DEFINING THE PROBLEM:

In production process of bolts, it has been observed after taking measurements that there is wide variation in dimension with respect to specification. In the machining process machine vibrations, tool setting, tool error, and tool compensation errors comes is come intermittently. Not only these errors, but also effect of raw material, process error and machine errors /machine precision also much important for obtaining higher accuracy in terms of quality of product in manufacturing process.

In the manufacturing process by the use of pareto and ishikawa analysis main root cause of the problem have been find out and there after solution have been given and then the same process have been done for manufacturing process.

PARETO ANALYSIS*:*

Pareto analysis helps in the identification of vital few forms the trivial many at a glance. Pareto diagram is a column graph, drawn after data collection for the purpose of differentiation between the vital factors that contribute most to the unsatisfactory situation from other trivial ones. Normally this technique is being used for fixing priorities for selection of the problem to be taken up serially, listed after brain storming and data collection. It is also used for tackling the major factors responsible for any problem. In some cases the problems listed out may be grouped on the basis of their nature and their recurrence can be projected in terms of percentage.

ROOT CAUSE ANALYSIS (ISHIKAWA):

Kouru leshikaw introduced this diagram in 1943 at the Kawasaki iron works, Japan. A cause and effect diagram is an effective investigating tool for pictorial representation of various facts about the causes that result in a specific case. This diagram has become useful due to its visual impact. It provides to find the root cause of problem.

OBJECTIVES:

1. Elimination of the wide variation in dimension in terms getting the accuracy of the products.
2. Total Productive Maintenance (TPM) shall be implemented to prevent from the defects of the machines.
3. Instead of conventional machining, non-conventional machining shall be used to eliminate all variation in dimension as well as improved the quality as well as accuracy of the product for mass production.

First process: - (conventional machining process):

Fig -01: Lathe machine

Drawing of Bolt and its Dimensions:

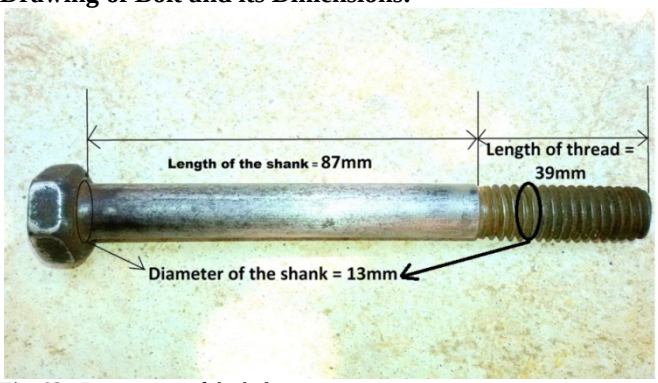

Fig -02: Dimensions of the bolt

Facing Operation*:*

In machining, **facing** is the act of cutting a **face**, which is a planar surface, onto the work piece. Within this broadest sense there are various specific types of facing, with the two most common being facing in the course of turning and boring work (facing planes perpendicular to the rotating axis of the work piece) and facing in the course of milling work (for example, face milling). Other types of machining also cut faces (for example, planning, shaping, and grinding), although the term "facing" may not always be employed there.

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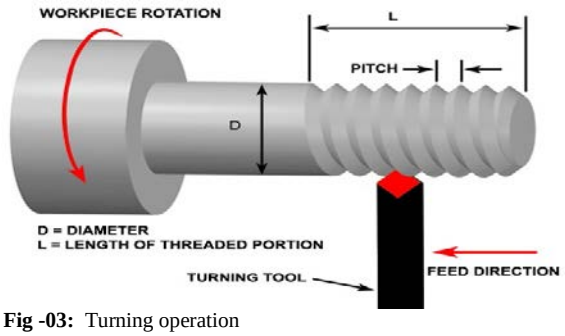

Fig -03: Turning operation

GROOVING OPERATION:-

Grooving or recessing operations, sometimes also called necking operations, are often done on work piece shoulders to ensure the correct fit for mating parts. When a thread is required to run the full length of the part to a shoulder, a groove is usually machined to allow full travel of the nut. Grooving the work piece prior to cylindrical grinding operations allows the grinding wheel to completely grind the work piece without touching the shoulder.

With face grooving operations the tool is fed axially rather than radically toward the end surface of the work piece. The tool must be adapted to the radial curve of the groove and the blade is therefore curved. When the machine spindle rotates in a counter-clockwise direction, a right-hand version of the tool is used and a left-hand version is used when the machine spindle rotates clockwise.

So that both insert and tool holder fit into the groove, both the outer and inner diameters of the groove must be considered. The diameter measured to the outside of the blade determines the limit for the smallest possible diameter which can be machined, and the diameter measured to the inside of the blade determines the limit for the largest possible groove diameter.

THREADING:-

In thread cutting operation the steps as follows:-

- ✓ Remove the excess material from work piece
- ✓ Make its diameter is equal to the major diameter of the thread
- ✓ Change gears of correct size which enable to fit the end of the bed between spindle and lead screw
- ✓ The shape of the threads depend upon the cutting tool to be used

(In case of metric thread the included angle of the cutting should be ground exactly 60^0)

- ✓ Ensure top of the tool nose should be set at the centre of the work piece
- ✓ The thread tool gauge (or) angle gauge is usually used against the turned surface.
- ✓ Speed of the spindle is to be reduced by ($\frac{1}{2}$) or ($\frac{1}{4}$)th of the speed required for turning operation.
- ✓ The depth of the cut given 0.1mm
- ✓ Till the tool has produced a helical groove up to the end of the work carry on doing the operation till end

Note*:* - measurements have been taken after the machining process. i.e: before the heat treatment, for finding out the quality of work in terms of accuracy of the product.

Fig -04: Threading operation on lathe machine

Taking the measurements:-

Overall length of the bolt specification 137±.1mm
(LSL=136.9mm, SL=137mm & USL=137.1mm)

For Head:

Width of the head is 11±0.1mm
Hexagonal head inside diameter = 21±0.1mm
Hexagonal head outer diameter = 23±0.1mm

For Shank:

Diameter of the shank specification 13±0.1mm
(USL=13.1mm, SL=13mm & LSL=12.9mm)
DATA: 12.54, 12.51, 12.54, 12.51, 12.49

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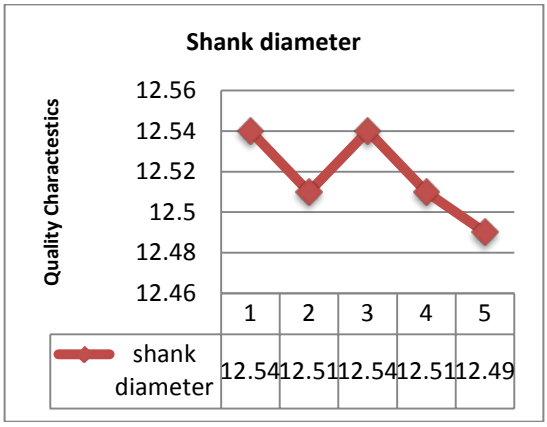

Chart -1: SQC chart for number of observations Vs quality characteristics

For Thread:

Diameter of the thread = 13±0.1, (USL=13.1, SL=13 & LSL=12.9)

Data: 13.01, 12.98, 13.01, 13.02, 12.99

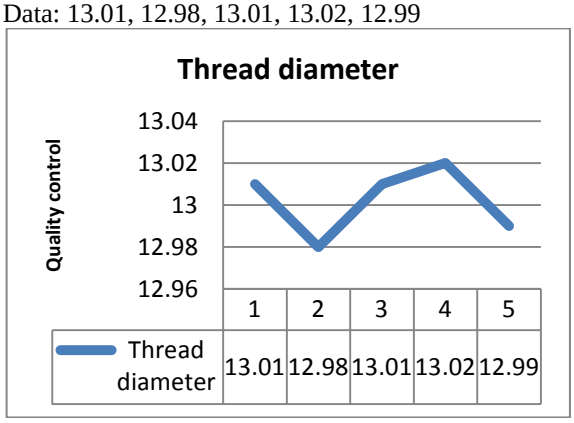

Chart -2: SQC chart for number of observations Vs quality characteristics

Observation from SQC Chart:-

There is a wide variation in dimension in terms of accuracy both shank and thread diameter

Problems Findings:-

Problem shown through Pareto analysis (vital few from trivial many), in the histogram and cause and effect analysis carried out for finding the root cause analysis.

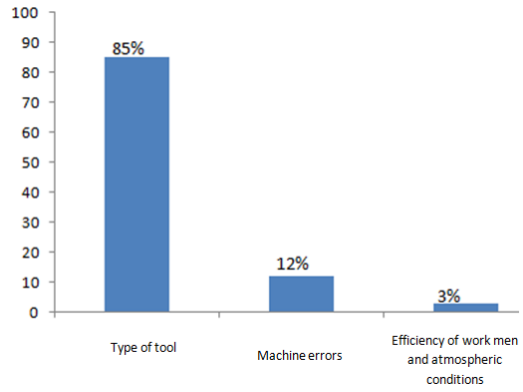

Chart -3: pareto analysis

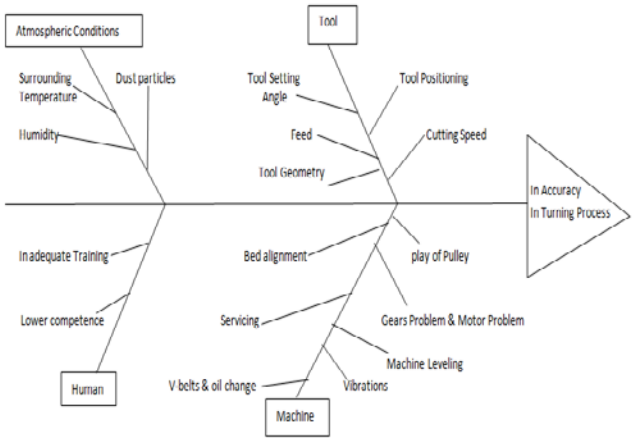

Fig -5: Cause and effect analysis (Fish bone diagram)

Improvement to be implemented:

Implementation of the solution of the problem:

1. For removal of machine problem following rectification to be carried out
   - Leveling checks with the help of sprit level
   - Bed inclination check
   - All other lubricant topping up
   - Check all the case for backlash in the gear
   - Check for proper coolant used in machine process
2. Check for tool for tool setting angle with respect to job.

Hence we want to get the greater accuracy of the product then we have to look into fallowing criteria also.

1. Correct raw materials and its specification which we can clarity from incoming material inspection

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2. Setting the sequence of operation with the help of work study(motion and time study)
3. Use of precession machine and tools answers as sophisticated measuring instrument.
4. Machine should be fully serviceable including no vibration should be allowed as well as should have proper leveling.
5. Bolt material should be used MS which should be maintain as per the required specification.
6. Ensure no backlash in the machines gear elements

   Note:-If the specification of the material is not known the proper heat treatment will not able to do as a result the defect of the products will get at the end.raw material shall be forged one.

Measure to be taken as follows before manufacturing process*:*

- Material selection as per the specification.
- Proper Speed and feed calculation.
- Sequence of operation.
- Check for tool for tool setting angle with respect to the job with the help of tool pre-setter.
- Use of Sophisticated measuring appliance such as Digital micrometer and V.C. (vernier calipers of L C 0.001 mm)
- Atmospheric condition of the workshop shall be maintain as follows:
  - I. Temperature should be maintaining 20-21 degree Centigrade.
  - II. Humidity should be maintaining 50% of the relative humidity.
  - III. Dust particles should not increase more than $3.3*10^5 m^3$/unit area.
- Drawing dimensions should be clearly known.

MEASUREMENT OF TOOL LIFE:-

Taylor's equation:-

$VT^0 = C$ Where, v= cutting speed, T= tool life

C= constant (fore cast iron 1/12, for carbide steel 1/7 to 1/8 and for steel 1/18)

The effect of feed and depth of cut on tool life is calculated as:-

Effect of feed and depth of cut on tool life is measure through =257/(tool life*feed*depth of cut)

Note:- we shall get the raw material as after forging process.

Process after Improvement: - (Conventional machining process):

Same operation been carried out as before in Conventional Machine

Plotting the data in the SQC chart (shank and Thread)

Shank Dimension:

DATA: 12.98, 12.97, 13.01, 13.02, 12.99

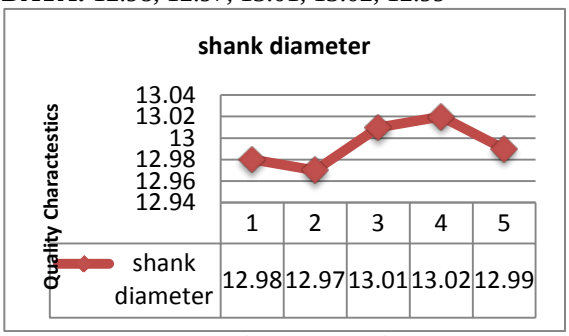

Chart -4: SQC chart for number of observations Vs quality characteristics

Thread Dimension:

DATA: 13.02, 13.02, 12.98, 12.99, 13

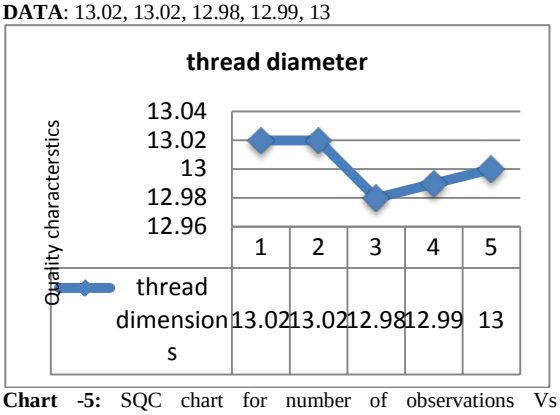

Chart -5: SQC chart for number of observations Vs quality characteristics

Observations:-

From **SQC** *chart fallowing observations are*

- Variation in dimensions has been reduced
- Accuracy of the product has been improved

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- Quality of the product has been achieved

Second Process: -(Uses of CNC Machines)

Facing and grooving & turning operation with the help of CNC programming

Taking the measurement and plotting the data in the SQC chart (shank and thread)

Shank data:

DATA: **13.01, 13.02, 13, 13, 13.01**

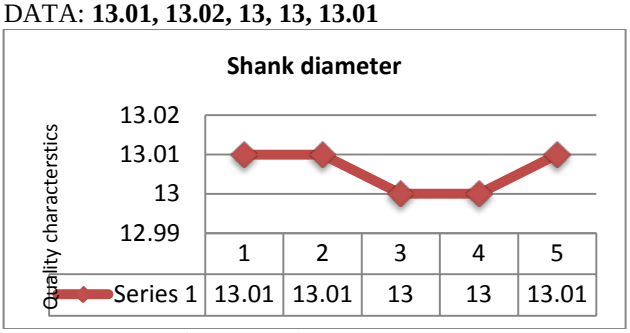

Chart 6: SQC chart for number of observations Vs quality characteristics

For Thread*:*

DATA: **13.02, 13, 12.99, 13.01, 13.01**

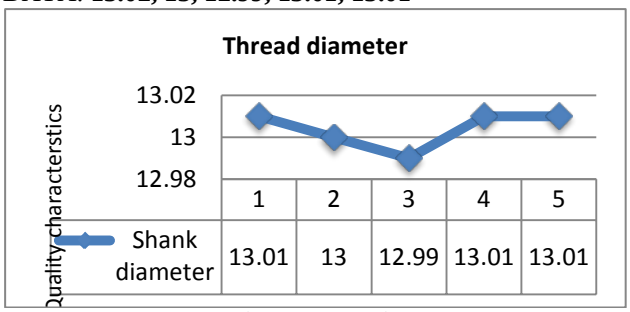

Chart -7: SQC chart for number of observations Vs quality characteristics

OBSERVATION AND COMPARISON BETWEEN TWO METHODS WITH SQC CHARTS:-

- Conventional machining process in the SQC chart, it has been observed before reconditioning the machine, the accuracy of the product not so good but after TPM carried in the machine, and maintaining shop floor condition the accuracy of the product has been improved.
- But when CNC machine has been used for the same operation and same material, higher accuracy with good quality with more productivity improvement have been achieved.
- CNC machine shall be useful when mass production is required along with achieving high quality with low cost (Lean Production).

CONCLUSIONS:-

- For achieving higher accuracy of the product before machining operation total productive maintenance (TPM) should be carried out for machine including Tool setting, proper speed & feed as well as use of coolant and atmospheric condition should be maintain for the shop floor.
- Precession component can be manufactured in CNC machine, where conventional methods cannot be employed.
- Use of harder material as raw material, higher material removal rate (MRR), non- conventional machining process can be obtained.

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