Productivity Improvement in CNC Machining Process by using DCMT 11 T304 Tool Bit

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***Abstract*—** Productivity improvements in terms getting high quality at low cost with greater accuracy are much important in the global market competition. In these empirical study at first conventional machining process been carried out for step turning operation with the help of HSS tool bit, where the accuracy of the product and quality is not been achieved. After the root cause analysis improvements has been done with the machine and there after the tool bit has been changed to DCMT11T304. Both the process after collecting the data in SQC charts has plotted and shown where a remarkable improvement has been achieved in terms of accuracy, quality and productivity.

Keywords- Accuracy, CAD, CAM, Feed, machining, productivity, Speed.

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I. INTRODUCTION

Production may be defined as the process of raw materials converted to finished or semi-finished products. Hence process is the various steps of operations such as facing, turning, milling, grinding and heat treatment etc. Productivity is the ratio between output and input.

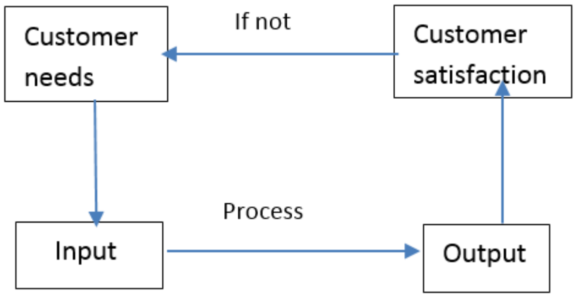


Fig.1 customer satisfaction management

$$\text{Productivity} = \frac{output}{input}$$

Input=man, material, machine, method.

II. COMPUTER AIDED DESIGN

CAD is the process of converting three dimensional object or idea into a numerical computer model. CAM utilizes NC to generate a physical part. Currently manufacturing businesses are integrating these two systems to shorten product development process. The benefits of CAD/CAM system include decreased time to market, lower development and design cost, and the ability to rapidly translate ideas into models. It is the integration these two systems that allows the engineer to increase the rate at which high quality products are designed and produced. CAD allows a design to be produced with the combination of both computers and the engineer (or designer).

It is defined as the use of computer program to assist in the creation, modification, analysis or optimization of the design. To accomplish the task of CAD process, CAD tools are to be utilized. CAD tools can be defined as the intersection of three sets –

Geometric modeling, Computer graphics and design tools.

III. COMPUTER AIDED MANUFACTURING

The design which is developed by CAD is used by CAM for the manufactured of the components according to design. CAM Deals with different functions of production planning and control. It includes the use of NC machines, industrial robot and other automated system such as AGV for manufacturing on line production. CAM also includes CAPP, GP, and Production scheduling and manufacturing flow analysis. CAPP means the use of computer to generate process planning for the manufacturing of different products. The manufacturing environment is increasingly complex. The need for CAD and CAM tools by the manufacturing engineer, NC programmer or machinist is similar to the need for computer assistance.

A. G-codes

G-code is a language in which people tell computerized machine tools how to make something. The "how" is defined by instructions on where to move, how fast to move, and what path to move. The most common situation is that, within a machine tool, a cutting tool moved according to these instructions through a tool path and cuts away material to leave only the finished work piece.

COMMON G CODES (GEOMETRIC CODING)

G00 - Positioning at rapid speed; Mill and Lathe
G01 - Linear interpolation (machining a straight line); Mill and Lathe
G02 - Circular interpolation clockwise (machining arcs); Mill and Lathe
G03 - Circular interpolation, counter clockwise; Mill and Lathe
G04 - Mill and Lathe, Dwell
G09 - Mill and Lathe, Exact stop
G10 - Setting offsets in the program; Mill and Lathe
G12 - Circular pocket milling, clockwise; Mill
G13 - Circular pocket milling, counterclockwise; Mill
G17 - X-Y plane for arc machining; Mill and Lathe with live tooling
G18 - Z-X plane for arc machining; Mill and Lathe with live tooling
G19 - Z-Y plane for arc machining; Mill and Lathe with live tooling
G70 - dimensions in inches
G71 - dimensions in metric
G90- absolute programming
G91- incremental programming

B. M-codes

M-codes (general codes) actually operate some controls on the machine tool and thus affect the running of the only one m code is supposed to be given in a single block. However some controllers allow or two or more m codes to be given in a block, provided these are not mutually exclusive, e.g., coolant on and off cannot be given in one block.

COMMON M CODES (MISCELLOUS CODING)

M00 - Program stop; Mill and Lathe
M01 - Optional program stop; Lathe and Mill
M02 - Program end; Lathe and Mill
M03 - Spindle on clockwise; Lathe and Mill
M04 - Spindle on counterclockwise; Lathe and Mill
M05 - Spindle off; Lathe and Mill
M06 - Tool change; Mill
M08 - Coolant on; Lathe and Mill
M09 - Coolant off; Lathe and Mill
M10 - Chuck or rotary table clamp; Lathe and Mill
M11 - Chuck or rotary table clamp off; Lathe and Mill

IV. SPEED AND FEED

The phrase speeds and feeds refer to two separate velocities in machine tool practice, cutting speed and feed rate. They are often considered as a pair because of their combined effect on the cutting process. Each, however, can also be considered and analyzed in its own right.
For a given surface speed the following formulae may be used to estimate this value.

The exact RPM is not always needed, a close approximation will work (using 3 for the value of π).

$$\text{Speed} = \frac{\pi \times D \times N}{12}$$

However, for more accurate calculations, and at the expense of simplicity, this formula can be used:

$$\text{Speed} = \frac{\pi \times D \times N}{60}$$

A. Tool Life Expectancy

The **Taylor's Equation for Tool Life Expectancy** provides a good approximation.

$$V_c T^n = C$$

A more general form of the equation is

$$V_c T^n \times D^x S^y = C$$

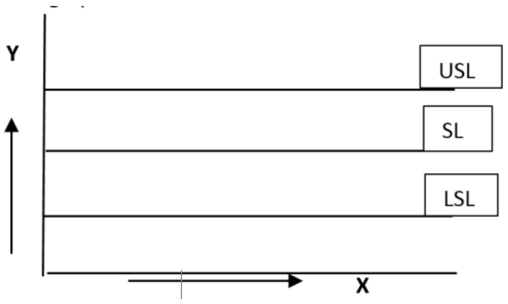
Where

- V_c = cutting speed
- *T*=tool life
- *D*=depth of cut
- *S*=feed rate
- Experimentally N and C are constants

V. Statistical Quality Control

Statistical quality control consists of the three horizontal lines drawn on a graph. The upper horizontal line known as an 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 number of observations and OY-axis shows the quality characteristics.
Let's the specifications be 10±0.1
Where, USL =10.1, SL=10, LSL =9.9

The graph shown



X-axis: Numbers of observations
Y-axis: Quality characteristics
business strategy that seeks to identify and eliminate causes of errors are defects, defined as anything which could lead to customer dissatisfaction or failure in business process by focusing on outputs that are critical to the customer it was the normal distribution on a strong relationship between product non confirmation (NCS) be defects and product yield reliability cycle time, inventory, schedule, etc... The activation of the process improvement are not limited to process or operation levels but extended to all that levels of enterprise to reduce cost and to produce high quality production.

Step Turning Operation with HSS Tool bit

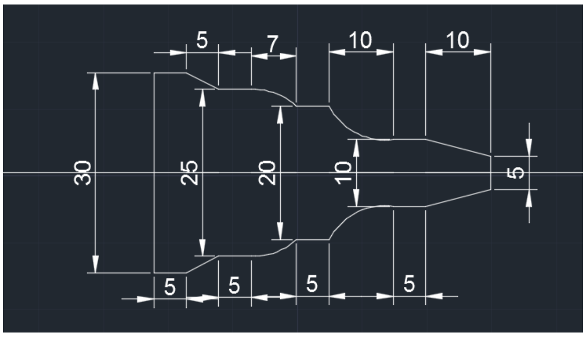
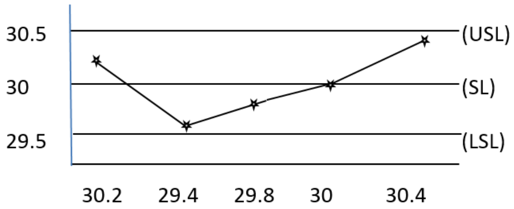
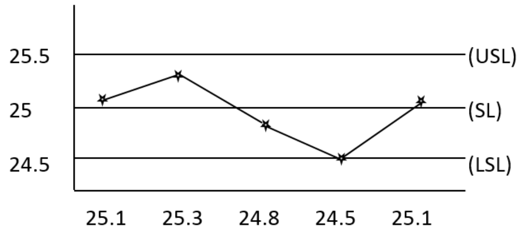


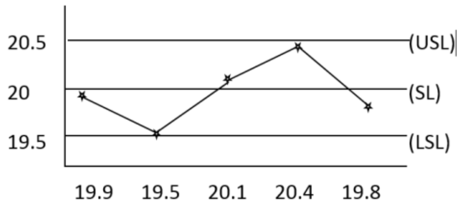
Fig.2 Step turning operation with dimensions in mm

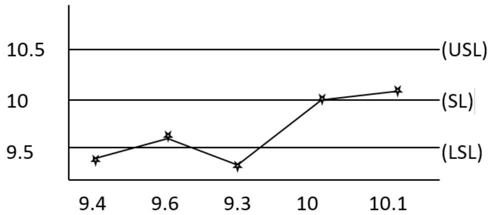
MATERIAL USED: Aluminum
Dimensions with Specifications: ø30±0.5mm
Data Collection:
Obtained Data: 30.2, 29.4, 29.8, 30, 30.4
Dimensions Specifications: ø250±0.5mm
Obtained Data: 25.1, 25.3, 24.8, 24.5, 25.1
Dimensions Specifications: ø20±0.5mm
Obtained Data: 19.9, 19.5, 20.1, 20.4, 19.8
Dimensions Specifications: ø10±0.5mm
Obtained Data: 9.4, 9.6, 9.3, 10, 10.1
Dimensions Specifications: ø5±0.5mm
Obtained Data: 5.5, 5.3, 5, 4.7, 5

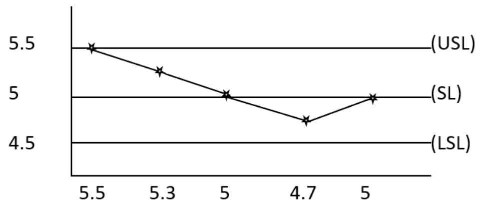
PLOTTING THE DATA IN THE SQC CHARTS











Observation from all the SQC Chart: - There is wide variation in dimension in turning operation with the help of HSS tool bit.

Measure to be taken for Improvement:-

Process improvement has been widely adapted in a variety of industries as a proven management innovation methodology to produce high product at low cost. On this 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 has been implemented for the betterment of the product according with the main key factor for the successful implementation of the program at first top management, methodology, implement the methodology in much important.

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347 - 352

Hence organization infrastructure should change, project management, skill training and linking it to the employ in much important.

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.

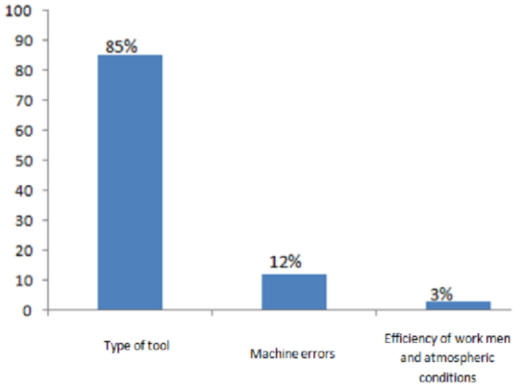


Fig.3 Pareto analysis

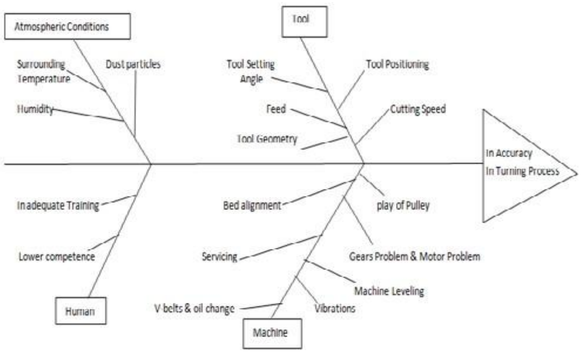


Fig .4 Cause and effect analysis (Fish bone diagram)

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
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. Aluminum material should be maintained 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.

Step turning operation in CNC machine after improvements with DCMT tool bit

Planning and operations sheet

BILLET SIZE : 30 × 60 mm			MATERIAL :aluminum				
PROGRAM NO : 101							
SI NO	OPERATION	TOOL HOLDER	TOOL TIP	TOOL STATION NO	TOOL OFFSET NO	SPINDLE SPEED RPM	FEED MM/MIN
1	MULTIPLE ROUGH FACING	SDJCR1212H11	DCMT11T304	1	1	1200	45
2	FINISHING	SDJCR1212H11	DCMT11T302	2	2	1450	25

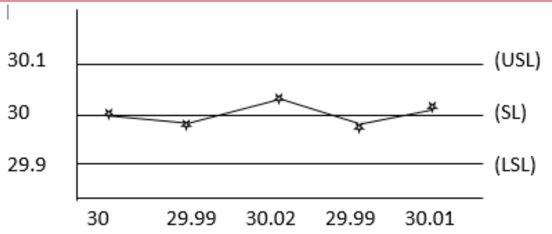
Tool offset sheet

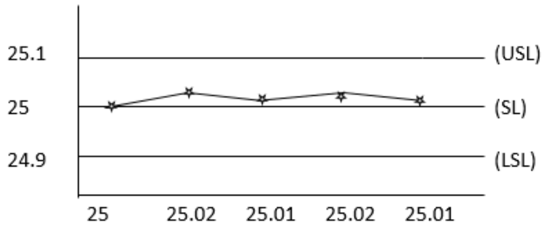
TOOL OFFSET NO	TOOL COMPENSATION, MM		TOOL NOSE RADIUS,MM	STAND TOOL NUMBER
	X	Z	R	
1			0.4	3
2			0.2	3

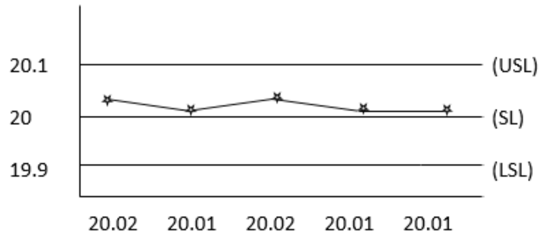
CNC Programming for Step Turning Operation

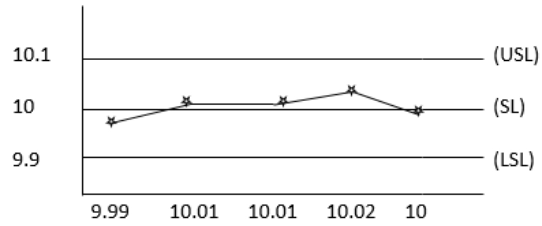
G21 G98
G28 U0 W0
M06T0303
M03 S1200
G00X31Z1
G72 DW0.5 R0.5
G72 P10 Q20 U0.1 W0.1 F35
N10 G01 Z-52
X30
Z-47
X25 Z-42
Z-37
G02 X20 Z-30 R10 F25
G01 Z-25
G03 X10 Z-15 R10
G01 Z-10 F35
N20 X5 Z0
G28 U_0 W_0
M06 T0202
M03 S1450
G00 X31 Z1
G0 P10 Q20 F25
G28 U_0 W_0
M05
M30

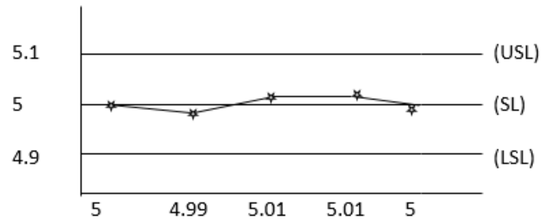
MATERIAL USED: Aluminum
DATA COLLECTION:
Dimensions with Specifications: ø30±0.1mm
Obtained Data: 30, 29.99, 30.02, 29.99, 30.01
Dimensions with Specifications: ø25±0.1mm
Obtained Data: 25, 25.02, 25.01, 25.02, 25.01
Dimensions with Specifications: ø20±0.1mm
Obtained Data: 20.02, 20.01, 20.02, 20.01, 20.01
Dimensions with Specifications: ø10±0.1mm
Obtained Data: 9.99, 10.01, 10.01, 10.02, 10
Dimensions with Specifications: ø5±0.1mm
Obtained Data: 5, 4.99, 5.01, 5.01, 5











Conclusion

In the machining process, the use of HSS tool bit does not provide accuracy and quality of the job. Hence by changing the tool bit Specification to DCMT11T304 along with carrying out Total Productive Maintenance (TPM) i.e. eliminating the defects of machine with quality maintenance of machines, before carrying the operation, and then carry out the operation, provide better quality of the product in terms of higher accuracy which have been shown in SQC chart, where it increases the productivity also.

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improvement work through turning operation in the machine by using DCMT11T304 tool bit.

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