A qualitative study of essential variations in the cutting tool dimensional features and end mill deflection and their effects on machining accuracy in CNC milling machine

FARHEEN MIRZA

M.tech(Production and Industrial Engineering)

Integral University Lucknow (U.P)

ABSTRACT-The main purpose of this paper is is to study the mechanism of deflection error and find the optimum condition for the cutting process to minimize deflection error. Basically, this paper is for finding the reasons of the abnormal machining accuracies and try to solve the problem in it. The two main topic to study in this are; An analysis of different types of variations in cutting tool dimensional features and their effects on machining accuracy & The effect of end mill deflection on machining accuracy. Tool deflection takes place when the cutting force overcomes the tool stiffness , causing the tool to bend. The tool might not noticeably bend throughout the operation, however the proof is within the final measurements.

1.Introduction- The challenge of modern machining industries is mainly focused on the achievement of high quality, Accuracy and precision are two important concepts in measuring of CNC machined parts, the word accuracy refers to the closeness of the measured result to a specific value.We generally encounter the fault of CNC machines tools which causes machining accuracy to differentiate, the error in the machine accuracy is generally hidden and difficult to find out.

There are specific reasons for the abnormal machining accuracy in the CNC machining like, the change of parameters, mechanical faults, positional error and optimization of electrical parameters.

Machining of steel inherently generate high cutting temperature, that not solely reduces tool life however additionally impairs the merchandise quality. Conventional cutting fluids are unsuccessful in managing the high cutting temperature and swift tool scratch. Further they additionally deteriorate the operating setting and result in general environmental pollution

2.CNC Milling- CNC milling also known as computer numerical control milling is a type of machining process which employs computerized controls and rotating multi-point cutting tools to progressively remove material from the piece of work and manufacture a custom-designed half or product.This process is suitable for machining a wide range of materials, such as metal, plastic, glass, and wood, and producing a variety of custom-designed parts and products. Following are the most common operations of CNC milling machine;

- Face milling
- Plain milling
- Angular milling
- Form milling

3.Machine Components used in the CNC Milling Machine; Despite the wide range of milling machines available, most machines largely share the same basic components. These shared machine parts include the:

- Machine interface
- Column
- Knee
- Saddle
- Worktable
- Spindle
- Arbor
- Ram
- Machine tool

Material Considerations; The CNC milling process is best suited as a secondary machining process to provide finishing features to a custom-designed part, but can also be used to produce custom designs and specialty parts from start to finish. CNC milling technology allows the process to machine parts of a wide range of materials, including:

- Metals (including alloy, exotic, heavy duty, etc.)
- Plastics (include thermosets and thermoplastics)
- Elastomers
- Ceramics
- Composites
- Glass

Main functions of the CNC Machine

- Machine Tool Control
- In-process compensation
- Improved programming and operating features
- Diagnostic

4. The technological parameters of milling include:

- rotational speed [rpm];
- diameter of the tool [mm];
- cutting speed [m / min]
- feed speed [mm / min]
- feed per revolution [mm / rev];
- feed per blade / tooth [mm / tooth]
- width & depth of cut [mm].

5. Process parameters(Adjustable):

Cutting Speed(V): It can be defined as the peripheral speed of the cutter in metre per min.

The equation for the cutting speed is: **V= DN/1000**

Where D = Diameter of the cutter (mm)

N = Speed of the cutter/rotational speed(rpm)

Basically the cutting speed in a milling machine depends on the material of the work piece, diameter of the cutter & number of cutter teeth, feed, and depth of cut, width of cutter and use of coolant.

Feed(f): Feed is the movement of work relative to the axis of the cutter and is the rate at which the work is being fed to the cutter.

In the milling operation the feed is expressed in three ways:

1. Feed per tooth (fz)

2. Feed per revolution (frev)

3. Feed per minutes (fm)

The above three feeds are related in the following way

fm = N*frev = fz*Z*N

Where, Z = no.of teeth in the cutter

N = Speed of the cutter/rotational speed (rpm)

6.The methodology to study the mechanism of maximum surface error is as follows:-

1. Develop a series of experiments for adequate and reliable measurement of the response of interest.

2. Finding the average surface error percentage through the depth of the cut and the federate.

3. Finding the value of damping coefficients of the tool at different torque values with medium variations.

4. The average of the maximum surface error should be less than 5%, this error can be decreased by adjusting the feed rate and the damping coefficients.

7.Literature Survey-

From the extensive literature survey that was carried out to identify the present knowledge on machining accuracy in CNC machining operations, it has been found that only a very limited number of published work has been reported to date. It appears that this subject has somehow been overlooked by most of the authors, as rightly pointed out by Arai et al , "The authors have made various kinds of research on the turning of NC lathe for several years, but they have not yet tried the research of working accuracy". Due to the vastness of the problem, many of the researchers have concentrated on specific factors affecting the machining accuracy of CNC machining operations.

- These authors consider the problem only from their own point of view totally ignoring the combined effect of all factors that are likely to influence the process. Basically, the problem is far more complex than it is shown.
- The study of machining accuracy necessitate wide understanding and larger information in an exceedingly range of fields. particularly with exaggerated cutting forces exploitation complex-shape tools like long finish edge tools, deflection in machining considerably affects the size and pure mathematics. this sort of error in finish edge is also expeditiously reduced by dominant the cutting parameters and properly choosing an appropriate lubrication mode.

Linyan Liu et al. (2014) presents a information-centric method management framework for the CNC machine style and development (D&D) with the mixing of method and knowledge. necessities for the framework area unit generated based mostly totally on the character of the machine style apply. The projected framework consists of method integration model, method simulation, method execution and information objects management modules. every of those modules is elaborate to support the knowledge-centric machine development method management. The epitome development is additionally conferred by the author. Results of this study facilitate the information integration in CNC machine D&D, and therefore increase machine development capability, cut back development cycle time and value, and ultimately speed up the effectiveness and make sure the glorious machine development.

Venkata Krishna pabolu et al (2010) discuss the planning and implementation of low price 3 dimensional processed numerical system (CNC) for industrial application. during this paper prototyping associate Embedded CNC machine was created. Detail description of various modules like software system development, Electronic/Electrical development, together with technical details of their implementation are given.

Druv Patel et al. (2014) studied influences of assorted parameter like tool speed, tool feed and depth of cut on CNC router and complete from ANOVA that proportion contribution of feed rate is most and it suggests that Feed rate is that the most dominating issue for modelling surface end. Kurbanoglub et al dole out edge surface roughness prediction exploitation biological process programming ways. CNC edge has become one in every of the foremost competent, productive and versatile producing ways, for classy or sculptured surfaces. so as to style, optimize, engineered up to stylish, multi-axis edge centers, their expected producing

output is a minimum of useful. during this study organic phenomenon programming technique is employed for predicting surface roughness of edge surface with associated with cutting parameters. Cutting speed, feed and depth of cut of finish edge operations area unit collected for predicting surface roughness.

Julie et al in USA has found Surface roughness optimization in associate finish edge operation exploitation the Taguchi style technique. This paper presents a study of the Taguchi style application to optimize surface quality in an exceedingly CNC face edge operation. Maintaining sensible surface quality sometimes involves extra producing price or loss of productivity. This study enclosed feed rate, spindle speed and depth of cut as management factors, and also the noise factors were the in operation chamber temperature and also the usage of various tool inserts within the same specification, that introduced tool condition and dimensional variability. associate orthogonal array of L9(34) was used; ANOVA analyses were dole out to spot the numerous factors moving surface roughness, and also the best cutting combination make up my mind by seeking the simplest surface roughness (response) and signal/noise ratio.

Material Selection- Aluminium 6061-T6 is a 6000 Series Aluminum Alloy and a non-ferrous metal

*Its general characteristics and uses are;

1. Excellent joining characteristics
2. Good acceptance of applied coatings.
3. Combines relatively high strength
4. Good workability
5. High resistance to corrosion and widely available.

Physical Properties of the Material-

Properties	Values
Yield strength	276 Mpa
Density	2.7 g/cc
Thermal Conductivity	167 W/m-K
Modulus Of Elasticity	68.9 Gpa
Ultimate Tensile Strngth	310 Mpa

Conclusion- Dynamic and static properties of edge tools area unit important for machining exactitude and chatter stability. Approximate results don't give correct data significantly for the dynamics and chatter stability. Experimental ways, on the opposite hand, area unit time intense considering the potential range of tool and power holder mixtures, tool pure mathematics associated material in an industrial setting. The analytical models conferred during this work eliminate the necessity for transfer operate measurements for each tool assembly. The models contemplate the advanced pure mathematics of flutes in development of cross sectional properties. finish mills have flutes and unfluted sections, that additional complicate their pure mathematics.

This divided characteristic has conjointly been thought of in static and dynamic modeling. The tool deflection will minimize by knowing the most distinction between the long flute and also the long reach tool. in keeping with the load stress theory, the shorter overhang length causes the lower effects of bend stress. It suggests that the deflection of the tool is weakened by decreasing the overhang length of the tool.Both static and dynamic predictions area unit incontestable to be extraordinarily correct for sort of cases. The approach conferred here is extremely helpful for implementation in an exceedingly virtual machining system wherever the shape errors and stability limits for a edge application is determined mechanically.