DESIGN AND PROCESS OPTIMIZATION OF A FIN CAGE

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ABSTRACT

The paper deals with the manufacturing of missile component (FINCAGE used in NAG-missile) using CAM software (‘NX-CAM ‘which is exclusively CAM software use to generate part program by feeding the geometry of the component) and defining the proper tool path and thus transferring the generated part program to the required CNC machine with the help of DNC lines. The operator thus executes the program with suitable requirements. The objective of this study is to find out the optimized combination of feed and spindle speed so that the surface roughness can be minimized.

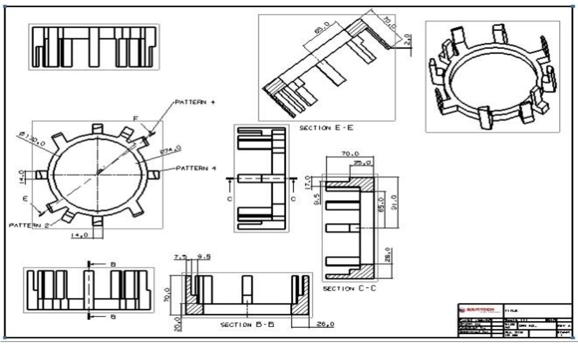
The component requires both inside and outside machining. So it needs a special type of fixture to hold the component rigidly. For this, the component is top clamped. As the component involves thin walled lugs machining and dimensional accuracy is required, it calls for CNC machining.

The latest CAM software introduced includes the new NX-CAM software, which has important features like 2D, 3D and surface modeling. The component can be either designed on this software or can be retrieved from any other CAD software. Then sequence of programmers such as modeling the component, generating the tool path, selection of tools according to the sequence of operations and sizes, at last the generated NC part program is verified and sent to the required CNC machine to manufacture the particular missile component.

Keywords: CNC, NC, NX-CAM, UG-NX7.5

I. INTRODUCTION

This paper outlines, the optimization manufacturing process and how the CAD tools are used in generation of 3D models using UG-NX7.5 package. Computer aided design and manufacturing is a technology and application driven field by utilization of which in industrial environment helps to close the gap between creating the technology and using it. The work involved in the development of modeling of components, which are going to be produced using the Part Modeling Module in the UG-NX7.5 software and development of post option files and machine configuration file for the machine tool on which the component is going to be produced.

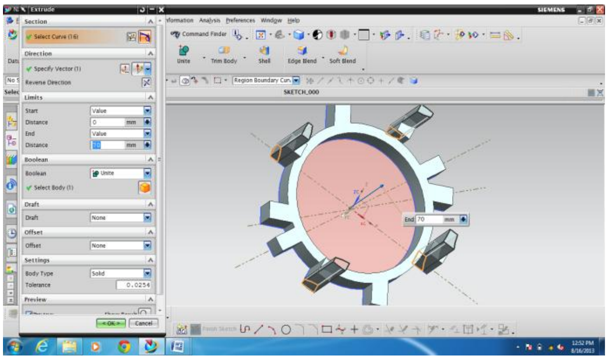


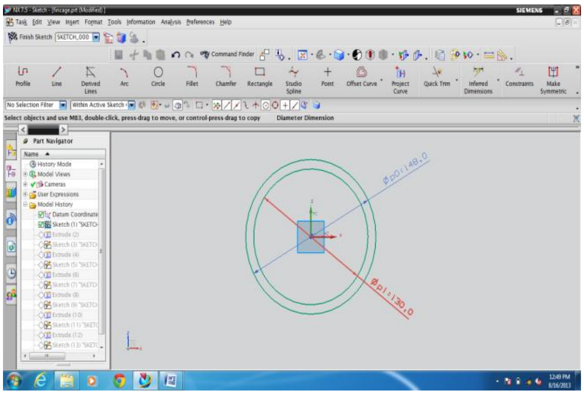
The figure shows the 2D drawings of the FIN CAGE

ISSN: 2278 – 7798

II. DESIGN OF COMPONENT

CREATING THE 3D GEOMETRY FROM 2D DRAWING





The image shows the sketch of the fin cage.

The image shows extrude of fin cage fins

III. OPTIMISATION OF CUTTING SPEED AND FEED

Cutting Speed

Cutting speed is defined as the rate at which cutting edge of a tool passes over the surface of a work piece in a unit time.

It is a very important aspect in machining since it considerably affects the tool life and efficiency machining. Selection of a proper cutting speed has to be made very judiciously.

If it is too high, the tool gets over heated and its cutting edge may fail. If it is too low, too much time is consumed in machining and full cutting capacities of the tool and machine are not utilized, which results in lower productivity and increased production cost.

Cutting Speed (v) =

D = Diameter in mm of work or cutter; N = Spindle Speed in rpm;

D = 25 mm N = 1000 rpm

V = {(25*1000)/318}

=78 m/min

Feed:

Feed of the cutting tool can be defined the distance it travels along or in to the work piece for each pass of its point through a particular position in unit time.

Choosing the right feed rates for a production machining process is like placing a hedged bet. Run a little faster, and you can make a lot more money by increasing throughput. But run too fast, and you risk losing just as much money if this lets the cutting force spike too high.

Feed (F) = f x N

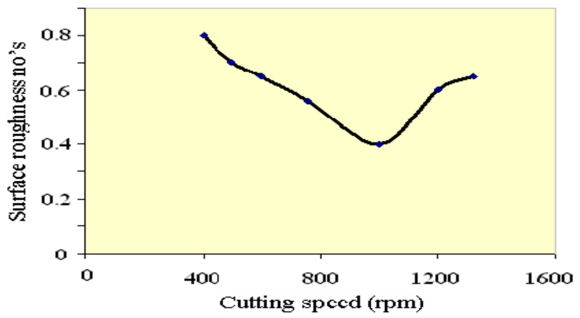
f = feed per tooth N = speed in rpm. f = 0.2mm N = 1000 rpm

ISSN: 2278 – 7798

F = 0.2*1000 = 200 mm/min

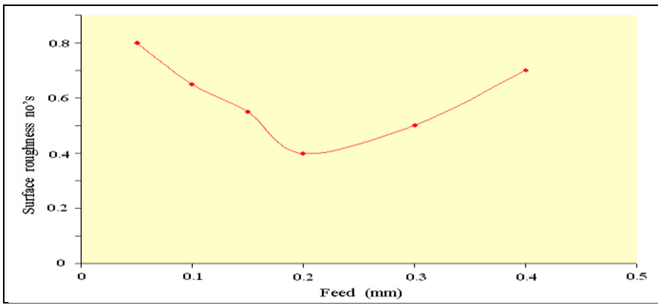
IV. RESULTS AND DISCUSIONS

SURFACE ROUGHNESS VS SPEED



- As the cutting speed is increased from 400rpm to 1500rpm, surface roughness decreased gradually from 0.8 to 0.4 and then it increased again.
- Thus the cutting speed is optimized at 1000 rpm. With lowest surface roughness number 0.4

SURFACE ROUGHNESS VS FEED



- At constant speed 1000rpm, as the feed is increased from 0.05 to 0.4mm surface roughness decreased slowly from 0.8 to 0.4(at f=0.2) and then it increased.
- Hence the feed is optimized at 0.2 with minimum surface roughness no.0.4.

The optimization, carried out in this work, gives an opportunity for the user to select the best tool geometry and cutting condition so as to get the optimum surface quality. The cutting speeds are taken as 400 rpm, 600 rpm, 800 rpm,1000 rpm,1200 rpm up to 1500rpm, surface roughness decreased gradually from 0.8 to 0.4 and then it increased again. Thus the cutting speed is optimized at 1000 rpm with lowest surface roughness number 0.4. Then spindle speed is taken as constant speed 1000rpm, as the feed is increased from 0.05mm,0.1mm,0.2mm,0.3mm to 0.4mm the surface roughness decreased slowly from 0.8 to 0.4(at f=0.2) and then it increased. Hence the optimized combination of feed and spindle speed are obtained as 0.2mm feed at spindle speed of 1000 rpm with minimum surface roughness value as 0.4.

COST ANALYSIS

Some of the uses to which cost estimates are put are the following.

- To determine most economical method, process or material for manufacturing a Product.
- To be used as basis for a cost-reduction program.
- To provide information to be used in establishing the selling price of a product.
- To determine the standards of production performance that may be used to control Costs.

As the part of cost analysis an engineer's duty is to calculate the "the direct labour cost" by finding the machining time and power consumed.

DIRECT LABOUR

For estimating the direct labor cost of a product the job is divided in to the operations needed to machine it and then estimating the operation time for each operation.

ISSN: 2278 – 7798

CALCULATION PART

1) Setup time (S_t) = N*Sc /A

N-lot size

S_c – setup cost

A - Average requirement (monthly) of jobs

S_t = 480 min

N = 60, A = 120

S_c = 480*120/60 = 960.Rs per batch

= 16.Rs

2) F= f * N mm/min

f = Feed Per Rev.

= 0.2

F = 0.2 * 1000

= 200 mm/min

3) N= 1000V/πD

D= Dia in mm of Work or Cutter

V= Cutting Speed in m/min

D = 25 mm

V = 78 m/min

N = 1000 * 78/(3.14 * 25)

= 1000 rpm

4) Machining Time (Tm) = L/F Per Cut or Pass

L= Total Tool Travel= Length of Job + Approach + Two Over Travels

F= Speed of Tool in mm/min

Time = 105 min

5) Direct Labor Cost = Tm * Man Hour Rate Rs.

Man Hour Rate = 500 Rs.

Tm = 105/60 hours

Direct Labor Cost = 875 Rs.

V. CONCLUSION AND SCOPE FOR FUTURE WORK

Finally the required surface finish has been obtained by machining the component at optimum speeds and feeds and the cost of machining is also optimized by choosing optimal machining process and machine tools.

The feed rate influences the surface roughness most significantly followed by cutting speed and nose radius. Good surface finish can be achieved when feed rate is at low level of the experimental range where as cutting speed and nose radius are set nearer to their high level of the experimental range.

The current project provides a solid foundation for predicting surface roughness from the machining process. However, there are opportunities for improving the predictive capability of the process. The following areas for future research will help to address limitations in the current process capabilities and improve the state of modeling. For the modeling used in this research, steady state conditions are assumed. The dynamic effects of the machining process such as variation in work piece hardness and thermal effects are not considered in this work. The variations in cutting output parameters due to these effects may impact the surface roughness and tool wear generation.

The results will be realized as a useful tool in improving process optimization of machining operations. In present models the effect of work piece hardness is not included. It will further make the models more reliable for all conditions. Although the the effect of cutting parameters were analysed and modeled for tool wear but in future the tool wear can also be included as independent variable as its effect can

ISSN: 2278 – 7798

also be modeled to analysis its effect on surface roughness.

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ISSN: 2278 – 7798