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## Design, Analysis and Manufacturing of Fin cage Component Used in Missile

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### Abstract

In the context of modern and fast emerging industrial world, technology and automation is considered to be a big boon for the fast and rapid industrial development. The main objective of today's industries is to maximize the production within the stipulated time using an optimum amount of man power and resources. The trends which accounts for today's technological development includes CNC machining, DNC, FMS, CAD/CAM etc.

Fin cage is used to hold the fins of the missile in folded condition while it is enclosed in launch tube. When the missile is fired, fin cage travels along with the missile, holding fins and gets strucked at the front end of the launch tube, so that the fins gets opened and guides the missile when it just crosses the launch tube.

The dynamic characteristics analysis of Fin cage is mainly involved in the calculation about vibrations on model. The objective to calculate the vibrations and resonances of Fin cage is modulating those frequencies and avoiding resonance, thus the vibrations of Fin cage may reduce.

This project also deals with development of manufacturing process plan of missile component (FINCAGE used in missile) using CAM software (NX 7.5) which is exclusively CAM software used 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 component requires both inside and outside machining. So it needs a special type of fixture to hold the component rigidly. As the component involves thin walled lugs, for machining and dimensional accuracy it calls for CNC machining. Because of such reasons it is very difficult to get high surface finish and reducing the machine utilization without doing the process optimization.

In this project, the 3d model of Fin cage is designed in UNIGRAPHICS software and it is imported to ANSYS software to perform the dynamic analysis. Then efforts are made to produce different process plans in CAM software by changing the work holding systems, tool paths, cutting tools etc. Finally, recommending an optimum process plan for manufacturing of the component.

**Keywords:** Design, Analysis, Manufacturing, Fin cage Component, Missile

### 1.0 Introduction

Process planning refers to the product design and decides how to manufacture it within the resource constraints. Process planning can be seen as an activity which integrates knowledge about products and resources.

Manufacturing process planning is the process of selecting and sequencing manufacturing processes such that they achieve one or more goals and satisfy a set of domain constraints.

Process planning is a production organization activity that transforms a product design into a set of instruction (sequence, machine tool setup etc.) to manufacture machined part economically and competitively. The information provided in design includes dimensional specification (geometric shape and its feature) and technical specification (tolerance, surface finish etc.)

My project deals with the manufacturing of "support" component using CAM software ('UGNX-7.5' which is a CAD/CAM software used to generate part program by designing and 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. Then the program is executed with suitable requirements.

A board, usually of stainless steel, fitted under part of the wire in a Fourdrinier machine for supporting the pulp stack before it is sufficiently formed to support itself on the wire.

The component can be either designed in UG or can be retrieved from any other CAD software. Then sequence of programs such as modeling the component, selection of tools according to the sequence of operations and sizes, generating the tool path, at last the generated NC part program is verified and sent to the required CNC machine to manufacture the particular component. Finally the required surface finish has been obtained by machining the component at optimum

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speeds and feeds and the cost of machining is also optimized by choosing optimal machining process and machine tools.

## 2.0 development of 3d model

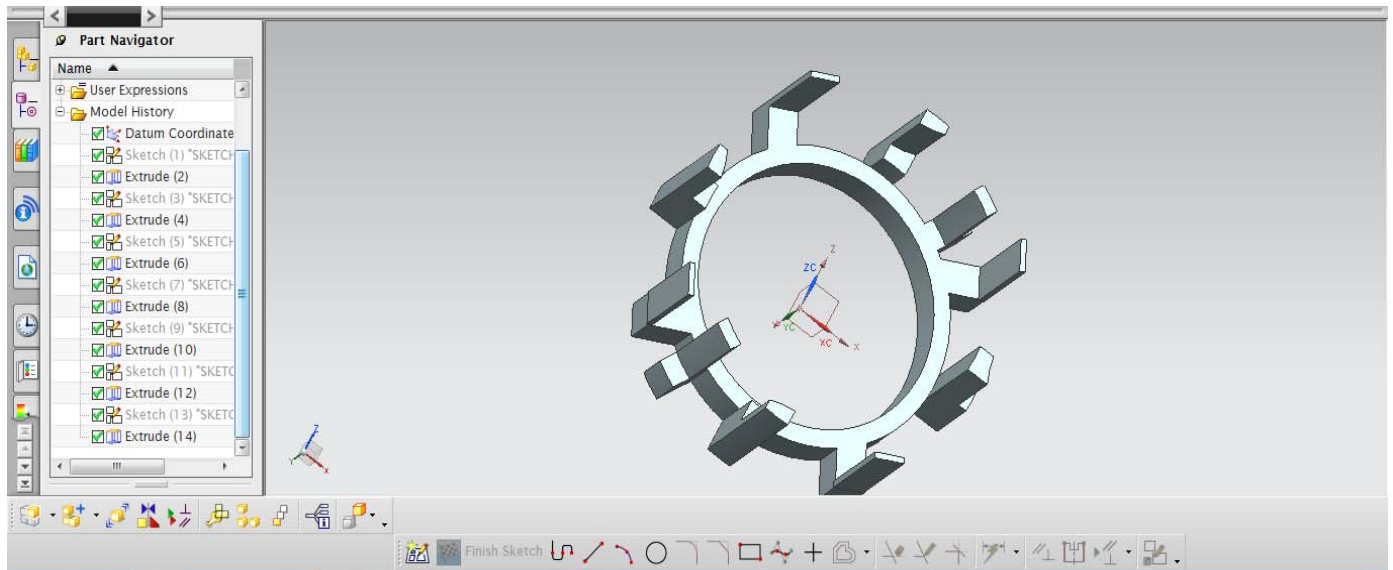


Fig 1: Final 3D model of fin cage

## 3.0 power spectrum density (PSD) analysis of fin cage

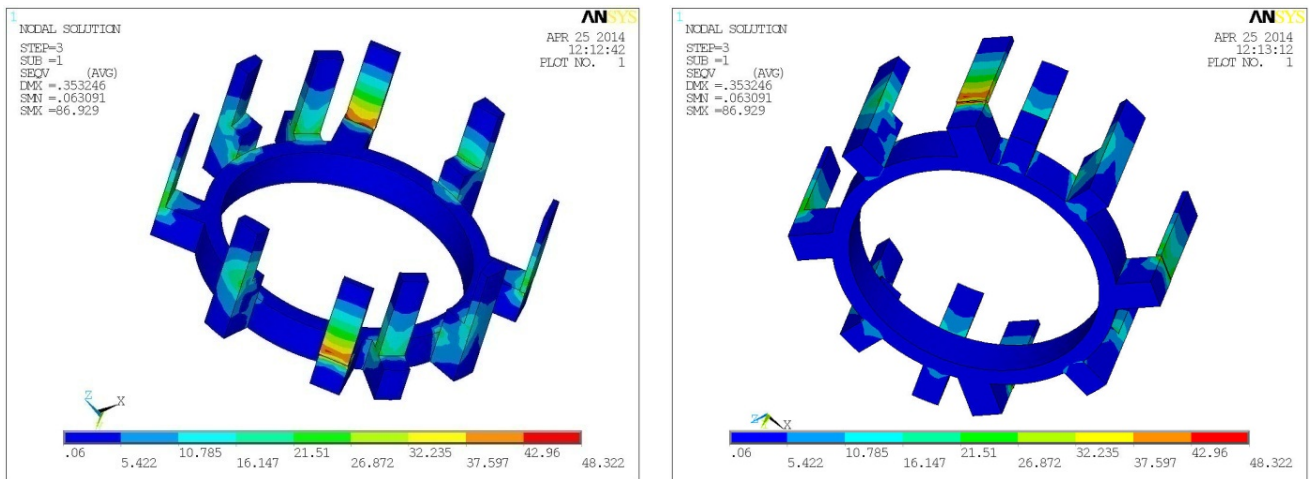


Fig 2: Von Mises stress of the Fin Cage component for PSD in X-dir

## 4.0 Shock analysis in axial direction

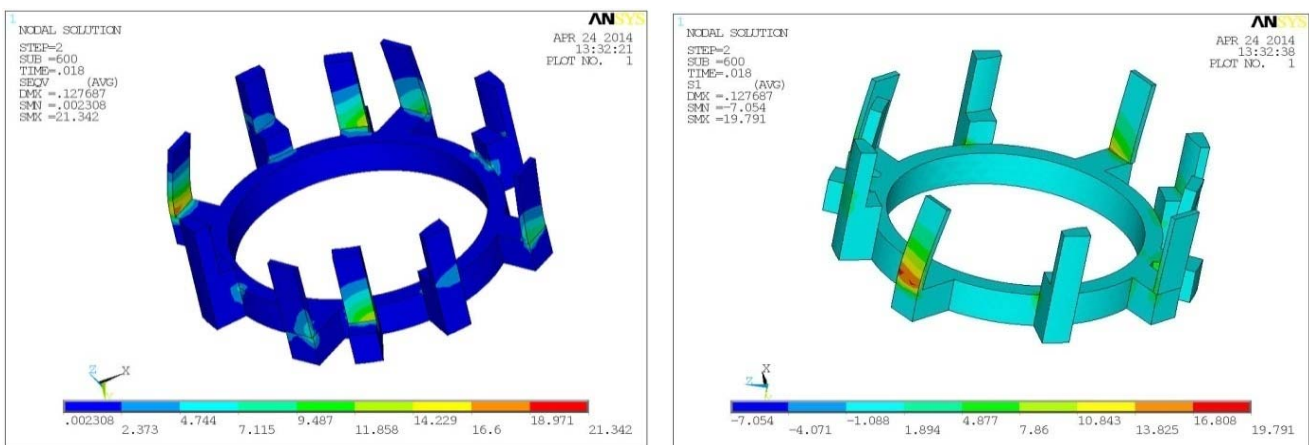
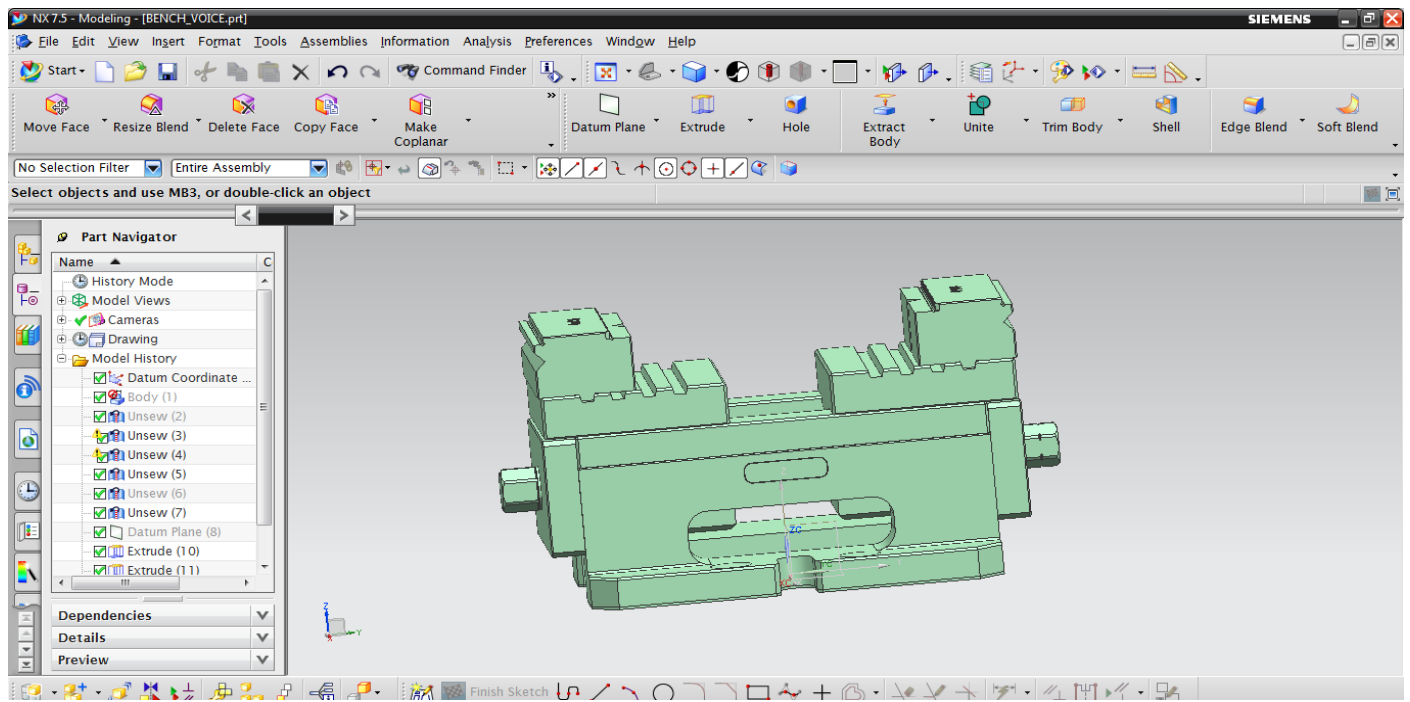


Fig 3: VonMises stress and 1<sup>st</sup> principle stress of the Fin Cage component for shock in

**5.0 computer aided manufacturing (cam)**  
**Bench vice used as a fixture for FIN CAGE.**

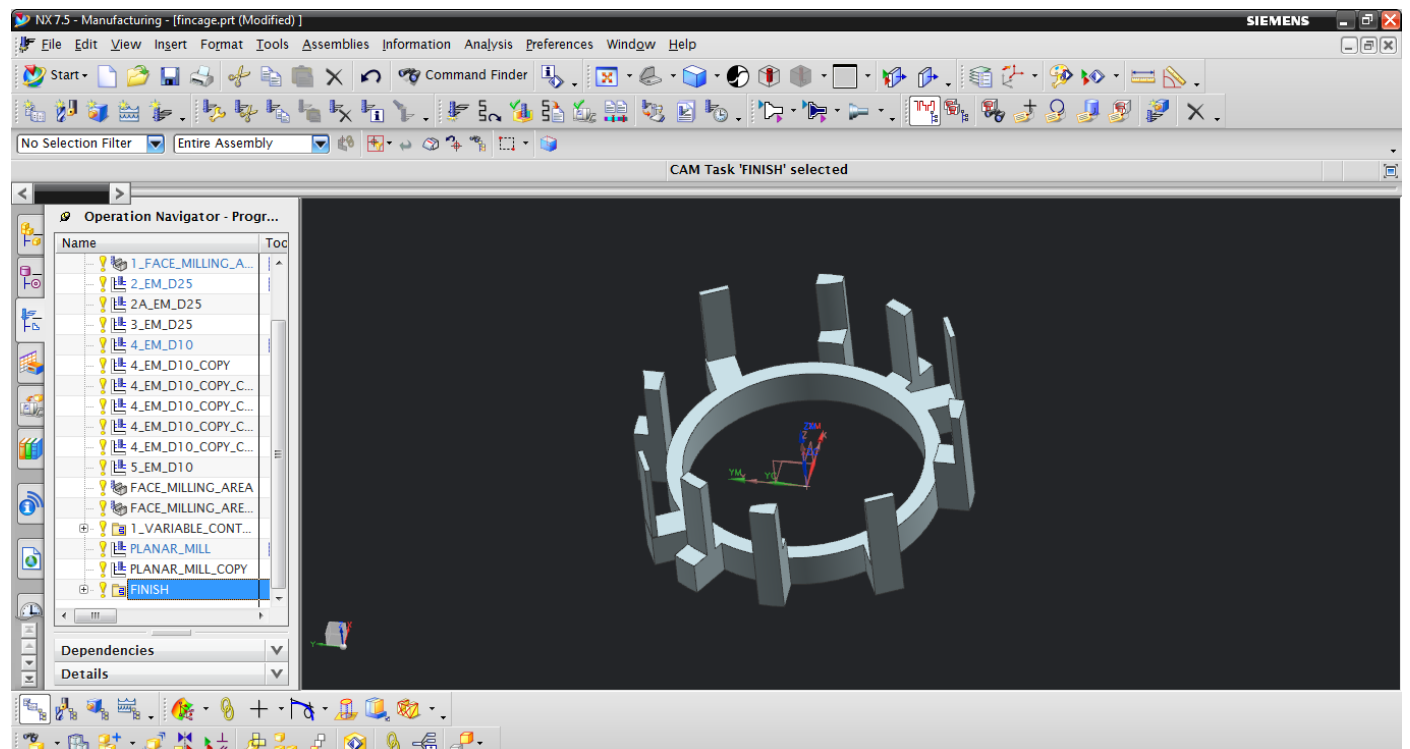


**Fig 4:** Fixture for fin cage

**6.0 sequence of operations performed on fin cage component**

Sequence of operations performed on fin cage in NX-CAM software are listed below

- Face mill area operation
- Planar mill operation with End mill dia\_25 internal
- Drilling operation
- Planar mill operation with End mill dia\_25 external
- Face milling operation
- Variable contour operation
- Planar milling operation
- Verification of tools



**Fig 5:** CAM finished model

### 7.0 Manufacturing Process Optimization

- **Process optimization** is the discipline of adjusting a process so as to optimize some specified set of parameters without violating some constraint.
- The most common goals are minimizing cost, maximizing throughput, and/or efficiency.

This is one of the major quantitative tools in industrial decision making

#### Optimization Criteria

- Commonly employed optimization criteria (objectives) are:
  - Max. Production rate or min. production time: aims to maximize number of parts produced in a unit time interval or minimize the time per unit part. Neglects cost and/or profit.
  - Min. production cost: aims to determine the least production cost. Coincides with max. Profit rate criterion for constant unit revenue. Ignores time constraints.
- Usually one of the two criteria is used. Sometimes both criteria are used simultaneously.

### 8.0 Cost analysis

Cost is the background of almost every definition the tool engineer makes in organizing manufacturing operations and selecting materials, methods, tooling and facilities. With

millions of manufacturing jobs going overseas to cheap labour countries, companies today are struggling to keep part costs competitive. The machining industries have had to look for various ways to reduce the cost of the parts being machined. Estimates of cost must be reasonably accurate if a venture is to be successful. If a job is overpriced, it is loss to a competitor, if it is underestimated, it results in financial loss.

Cost estimating may be defined as the process of forecasting the expenses that are incurred to manufacture a product. Cost estimates are the joint product of the engineer and the cost accountant and involves two factors, physical data and costing data. The engineer as part of his job of planning manufacturing determines the physical data.

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.

### 9.0 Results

Graphical representation of surface roughness Vs speed

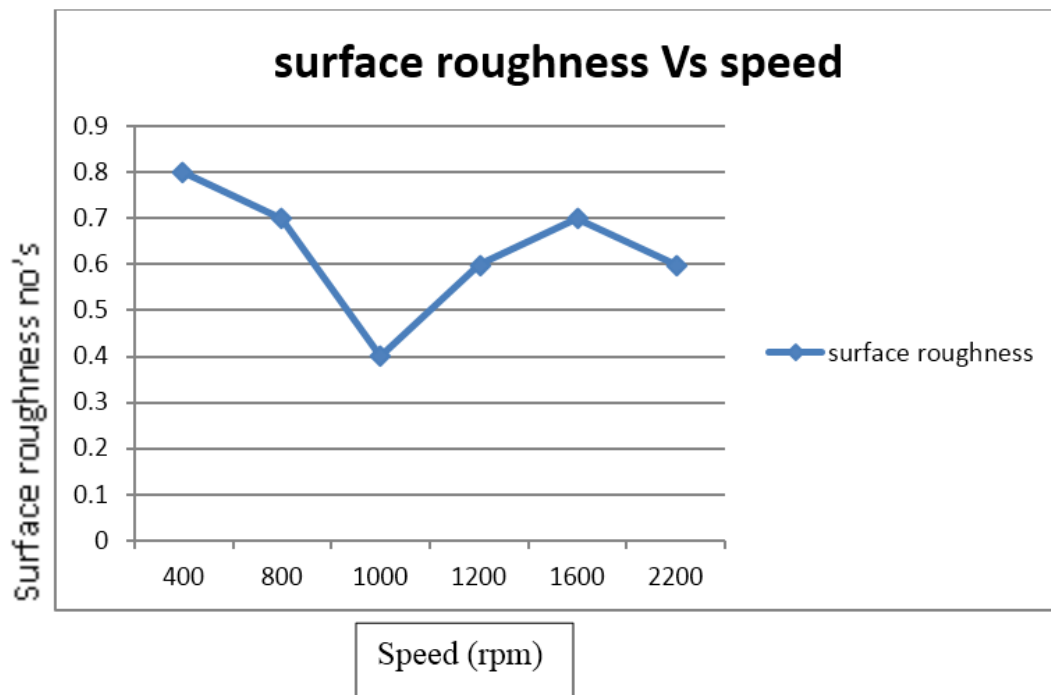


Fig: Graph of speed and surface roughness

- Under ideal conditions of machining as the speed is increased from 400rpm to 2200rpm, surface roughness decreased gradually from 0.8 to 0.4 and then it increased again.
- Thus the speed is optimized at 1000 rpm. With lowest surface roughness number 0.4

### 10.0 Conclusions

- 3D model is generated by using NX-CAD software.
- Finite element analysis of fin cage component has been done to check if the component sustains the structural operating loads.

- From the different analysis results above, it is concluded that the fin cage component is safe for the operating structural dynamic loads. Therefore the fin cage component can be sent for manufacturing.
- NC program is generated by using NX-CAM software.
- Cutting speed and feed are optimized to achieve high surface finish.
- Graphical representation of surface roughness and speed, surface roughness and feed are shown in results.
- Cost analysis is done to find out direct labour cost. Calculation part also shown in the document.

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