

Modeling and Manufacturing of Bearing Stopper Component

S. Mohammed Hussain¹, M. Sreenivasulu²

¹P.G. Scholar, ²Guide, Head of Department

^{1,2} Branch : Machine Design

^{1,2} Geethanjali Engineering College

Email: ¹ muhammadhussain9414@gmail.com

ABSTRACT

Nowadays rejection is a serious problem arising in every manufacturing industry. Due to this reason the manufacturing industry is advancing into losses. There are many factors responsible for Rejection and reworks, such as Human errors, machine errors, process planning. Advanced why-why analyses have been developed by many researchers to model, predict and reduce errors induced by machining processes. CAD/CAM systems play a vital role in design optimization and process optimization of any component and helpful in reducing the rejections and reworks.

Bearing stopper is taken as a case study for implementation. Bearing stopper is used in metro rails. This project deals with development of manufacturing process plan of BEARING STOPPER component 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.

In this project designing done by using **NX7.5 CAD** software and manufacturing bearing stopper done using **NX7.5CAM**.

The steps involved in the project are as follows:

- (i) 3D-Design
- (ii) Material selection
- (iii) Machine and tool selection
- (iv) CAM generation

INTRODUCTION

1.1 BEARING:

Bearings are components designed to connect machine parts. Bearings transmit motion and forces. They are usually mounted on axles or shafts and inserted in housings. If a bearing transmits rotary motion, it is called a rotary bearing. Linear bearings are used for longitudinal motion. The type of friction involved distinguishes **plain bearings** from **rolling bearings**.

Plain bearings are components with a sliding layer between two parts. This sliding layer may be a solid layer that is fixed to the bearing, such as plastic or bronze layers. Otherwise, a lubricating film separates the surfaces.

Rolling bearings are bearings with two components that move in opposite directions. These parts are the inner and outer ring, and they are separated by rolling elements. The rolling elements roll between the two rings during operation. This occurs on hardened steel surfaces called raceways. The friction generated here is significantly lower compared to plain

bearings. Rolling elements are the most important parts in a bearing, because they carry most of the loads. Rolling elements come in different shapes: balls, cylindrical rollers, needle rollers, tapered rollers or spherical rollers. The names of many bearing types are based on the kind of rolling element used, such as “ball bearing” or “needle roller bearing.” In modern bearings, a cage is used to provide even spacing for the rolling elements. This prevents them from contacting each other. Cages can be made from sheet steel, plastic or brass. Additional components may be sealing shields or seals. Another important part of a bearing is the lubricant. Rolling bearings are lubricated with grease or oil to extend operating life. The seal keeps the lubricant in the bearing and prevents dirt and moisture from entering.

1.2 TYPES OF ROLLING BEARING:

Rolling bearings are classified into TWO types. 1. Ball bearings and 2. Roller bearings.

1. Ball bearing: Deep groove ball bearings, Angular contact ball bearings, Four point contact ball bearings, Self-aligning ball bearings.

2. Roller bearings: Cylindrical roller bearings Needle roller bearings Tapered roller bearings Spherical roller bearings.

1.3 BALL BEARING

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

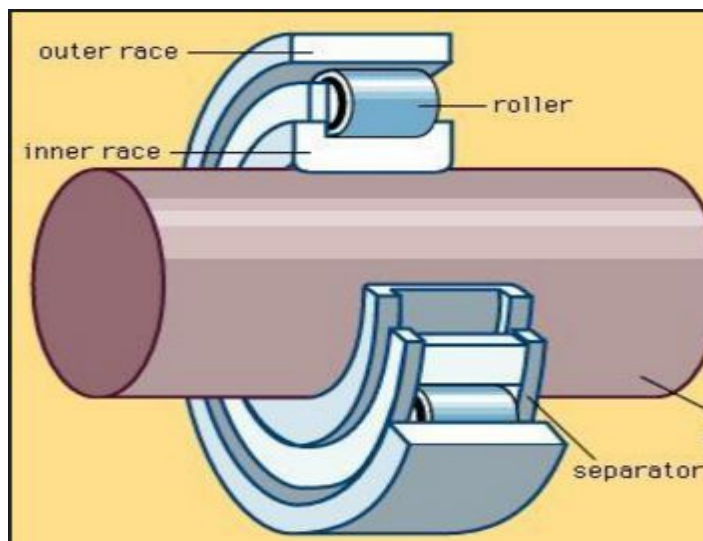


1.4 CYLINDRICAL ROLLER BEARING:

Cylindrical roller bearings are used in many industrial machines and automobiles because they have a higher load carrying capacity than ball bearings and are more suited for high speed revolution. The purpose of a bearing is to provide relative positioning and rotational freedom while transmitting a load between two structures, usually a shaft and housing. The basic form and concept of the rolling element bearing are simple. If loads are to be transmitted between surfaces which are in relative motion, the action can be facilitated in the most effective manner by rolling elements when interposed between the sliding members. The frictional resistance encountered in sliding is largely replaced by much smaller resistance associated with rolling. A commonly used bearing combination for support of a high-speed rotor is a cylindrical roller bearing. Cylindrical roller bearings have moderately high radial load capacity as well as high speed capability. Although the rolling elements are called "cylindrical", they are not true cylinders. True cylinders would produce stress concentrations at the ends of the roller-race contact, resulting in high wear and high sensitivity to misalignment. In this type of bearing, the rollers are in direct contact with each other, which causes sliding and increases friction and heat generation.

MAJOR PARTS OF CYLINDRICAL ROLLER BEARING:

1. OUTER & INNER RACES
2. CAGE(SEPARATOR)
3. CYLINDRICAL ROLLER



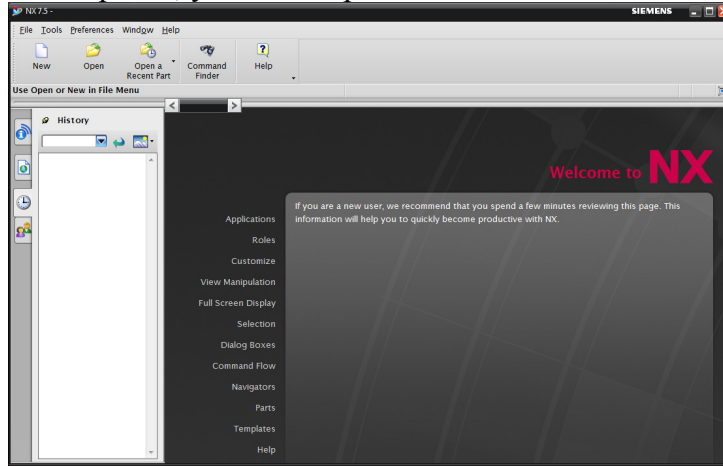
BEARING STOPPER

Bearing stopper is used for holding gear shaft in metro train engine.

GETTING STARTED

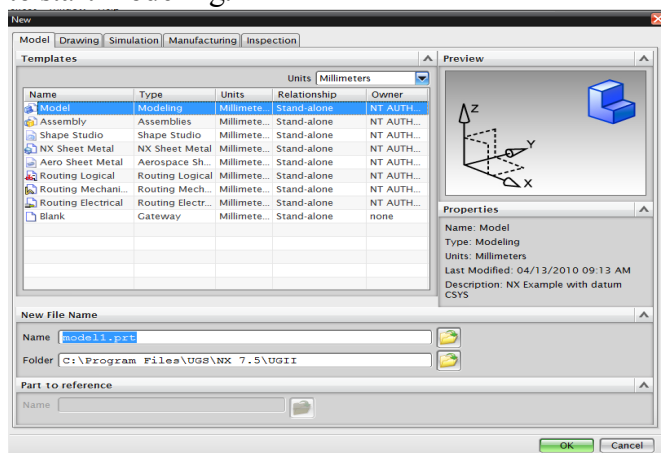
We begin with starting a NX7.5 session. This chapter will provide the basics required to use any CAD/CAM package. You will learn the preliminary steps to start, to understand and to use the package for modeling, drafting, etc.

To start NX, use the NX 7.5 shortcut under Start (or Windows button)->(All) Programs->UGS NX 7.5. It may take a minute or so for NX to start the first time. Once opened, you will be presented with the window shown in below Figure.

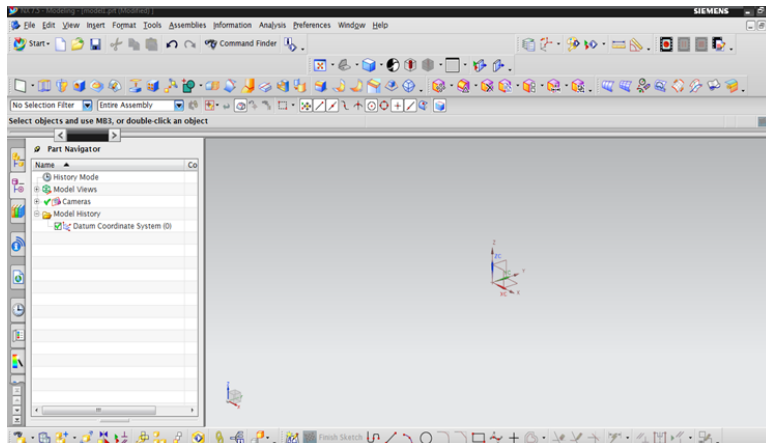


STARTING A NEW MODEL

To start modeling, you must first create a part file. NX part files use the extension .prt for both components and assemblies of components. In this tutorial, a single part file will be used with one component. To create a new part, click the New button to open the New dialog. For now, stay in the Model tab. Select Model from the Templates list (the default) and set the Folder to a location on your S: drive or desktop. The default location may be stored locally on the lab computer you are using and might not be in your roaming profile (it might not be accessible on a different computer). Once a folder has been selected, set the name of the part file. Click OK to start modeling.



Once the new file has been created, the NX modelling interface will open (Figure 3). Like most modern PLM tools, the interface for NX contains numerous icons, lists, text prompts and other features that can be incredibly overwhelming. For now, we will focus on the sketching tools, part navigator, viewer and menu.

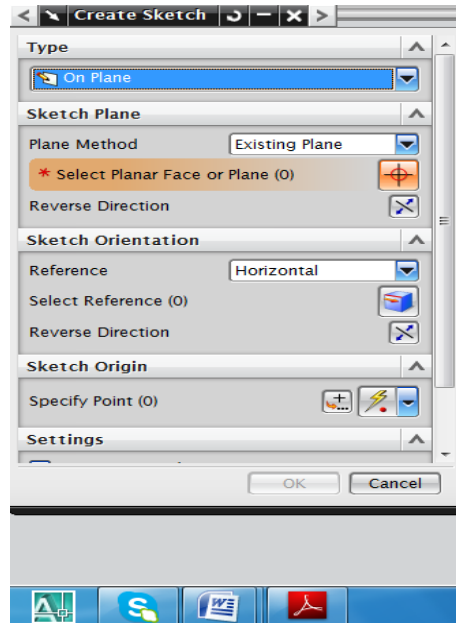


DRAWING IN NX

NX, like most modern PLM tools, is feature-based. That means you build up a component from a set of features that are added in sequence. This sequence, and the details of each feature, can be edited later if the design needs to be changed. Features can be removed, inserted or modified to create almost any solid part imaginable. This allows a precise and highly editable method for describing solid components and differs from the 3D freeform modeling approach (freeform modeling is used in computer graphics applications such as making models

for video games). The features you add to a part will appear in the Part Navigator under Model History. For a new part, the only thing appearing in the model history should be a Datum Coordinate System. This is the 3D Cartesian coordinate system used in the part and includes an origin location and coordinate axes. These are shown with the coordinate system indicator at the center of the Viewer. The general workflow for creating a part in NX is to create a sketch, extrude or revolve the sketch and then add features to the resulting solid part. Sketches are 2D (mostly) drawings that are used to define a cross section of the part. This cross section can be extruded (pushed into or pulled out of the plane of the sketch) and rotated (wrapped around a axis) to form a 3D solid part. To create a Sketch. Click the Sketch button in the sketching toolbar. This will open a new dialog for defining the sketch. The first step in defining the Sketch is to set the sketching plane. This is the 2D plane that the sketch will be drawn onto. This plane can be derived from the existing Datum Coordinate System or can be based on geometry from an existing part (you can sketch on the surface of a part). For now, start the sketch on the XY plane. To select the XY plane, move the cursor to the skewed lines connecting the x and y axis lines on the coordinate system indicator.





NX, also known as NX Unigraphics or usually just U-G, is an advanced CAD/CAM/CAE software package developed by Siemens PLM Software.

It is used, among other tasks, for:

- Design (parametric and direct solid/surface modeling)
- Engineering analysis (static, dynamic, electro-magnetic, thermal, using the Finite Element Method, and fluid using the finite volume method).
- Manufacturing finished design by using included machining modules

First release of the new "Next Generation" version of Unigraphics and Ideas, called NX. This will eventually bring the functionality and capabilities of both Unigraphics and I-DEAS together into a single consolidated product.

Increasing complexity of products, development processes and design teams is challenging companies to find new tools and methods to deliver greater innovation and higher quality at lower cost. Leading-edge technology from Siemens PLM software delivers greater power for today's design challenge. From innovative Synchronous Technology that unites parametric and history-free modeling, to NX Active Mockup for multi-CAD assembly design, NX delivers breakthrough technology that sets new standards for speed, performance, and ease of use.

NX automates and simplifies design by leveraging the product and process knowledge that companies gain from experience and from industry best practices. It includes tools that designers can use to capture knowledge to automated repetitive tasks. The result is reduced cost and cycle time and improved quality.

LITERATURE REVIEW

TIMKEN: Aerospace roller bearings are designed to meet the need for improved quality bearings used in high-speed operations. Attention to detail – including roller configuration,

separator design, guide flange finish and contour and material stability – significantly reduces end wear and improves life at high speeds.

Miltiadis A. Boboulos: CAD-CAM systems are probably the most significant development in the field of new technology related to engineering, design and drafting in all technical spheres.

PRASANNA SUBBARAO BHAMIDIPATI: has written a title on " FEA ANALYSIS OF NOVEL DESIGN OF CYLINDRICAL ROLLER BEARING " and explained that When a bearing is properly designed, manufactured, installed, and maintained, then the natural cause of bearing failure is typically the fatigue life of its rolling elements and races. The environment within which the bearing operates also determines the bearing life. The contact stresses developed in the rolling elements and races of a typical bearing is cyclic in nature. This in turn will result in a potential fatigue failure for these elements. The fatigue life a bearing is influenced by the operating speed, load conditions, bearing material, clearance of the mating parts, contact surface geometry, and the environment in which the bearing operates.

R. J. Kleckner J. Pirvics: have published a paper on " HI GH SPEED CYLINDRICAL ROLLER BEARING ANALYSIS". This paper presents that Engine shaft speeds will be increased ,to derive greater compressor efficiency. Increased speeds, however, accentuate centrifugal effects. Dominance in raceway loading is transformed from inner to outer rings. Failure to maintain loaded contact on the inner ring across thus spectrum of operating speeds results in the increased hazard of roller skidding, unnecessary heat generation and unstable performance. Combined with increased shaft diameters, required by system stiffness, increased speed raises questions beyond the limits of currently available bearing design analysis.

B. Ramu, V. V. R. Murthy: have published a project entitled " Contact Analysis of Cylindrical Roller Bearing Using Different Roller Profiles". According to this, Cylindrical roller bearings are designed to carry heavy radial loads, but due to misalignment and edge loading it is affecting the life of the bearing. So in the design of cylindrical roller bearings the profile of the roller plays important roll. Stress analysis is done based on two dimensional models of the roller and raceways. The roller profiles analyzed are flat, circular and logarithmic, which is loaded against two flat raceways.

1. **Goutam Mukhopadhyay, S. Bhattacharya:** have published a journal on " Failure Analysis of a Cylindrical Roller Bearing from a Rolling Mill". According to this project, Premature failure of a cylindrical roller bearing of a gear box input shaft from a hot strip mill has been investigated. The pins of the cylindrical rollers of the bearing broke from the welded joints at their ends on the cage ring. Investigations were carried out on the failed roller pin and the welded joint. The investigation consists of visual observation, chemical analysis, characterization of macro- and microstructures, measurement of hardness profile, fractography, and energy dispersive spectroscopy (EDS). The fracture surface of the roller pins exhibits beach marks. Scanning electron microscopy (SEM) of the fracture surfaces reveals striations suggesting fatigue failure.

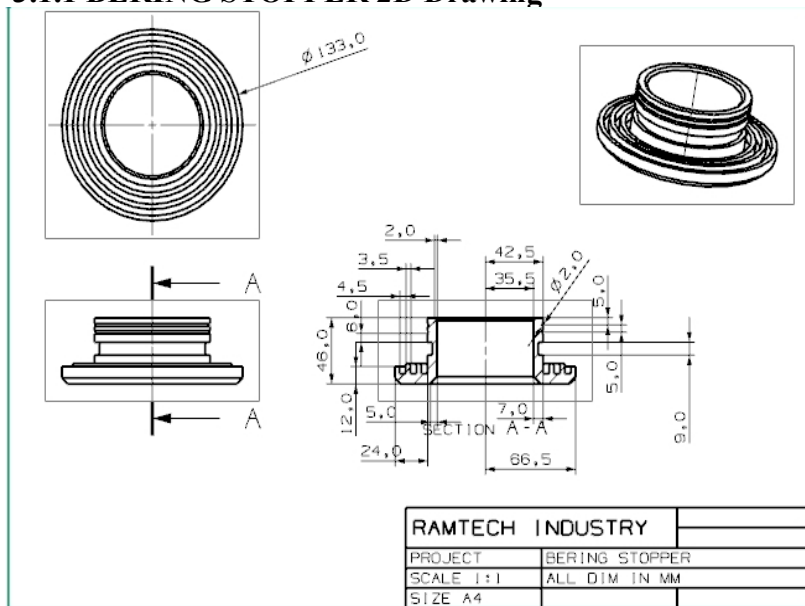
Mr.B.J.Jugale, Mr.M.V.Kharade: have written a paper on "A Review Paper on Failure Analysis of Cylindrical Roller Bearing". This paper represents that Cylindrical roller bearings are commonly used in aircraft power transmission, machine tools, steel industries and others due to their precision and high load carrying capacity. In present study, an experimental test rig

has been developed to investigate the wear in roller bearing. The changes in micro-geometry of the bearing components have been observed through scanning electron microscope. Some major cracks have been found over the inner race surface. Solid debris particles, removed from the inner race surface, further damage the other bearing surfaces. The lubricating grease has been also failed to provide elasto hydrodynamic lubrication between the inner race and rollers.

3D MODELING OF BEARING STOPPER

3.1 DEVELOPMENT OF 2D DRAWING:

3.1.1 BEARING STOPPER 2D Drawing

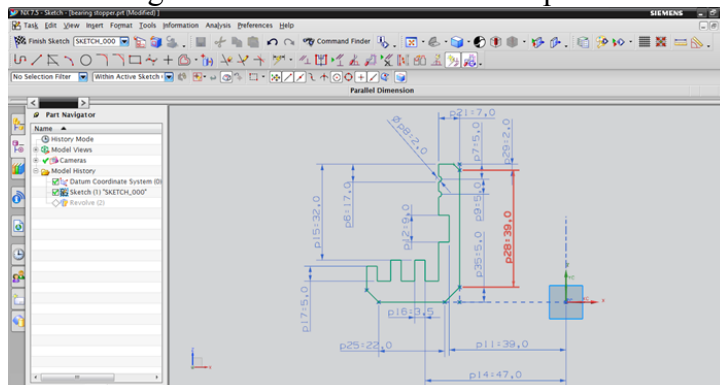


STEPS INVOLVED IN 3D MODELLING OF PISTON:

3D model is designed by using NX cad software.

Sketching:

Below is the sketch required to obtain the 3D model of the piston from the above 2D drawing. Below image shows the **SKETCH** of the piston.

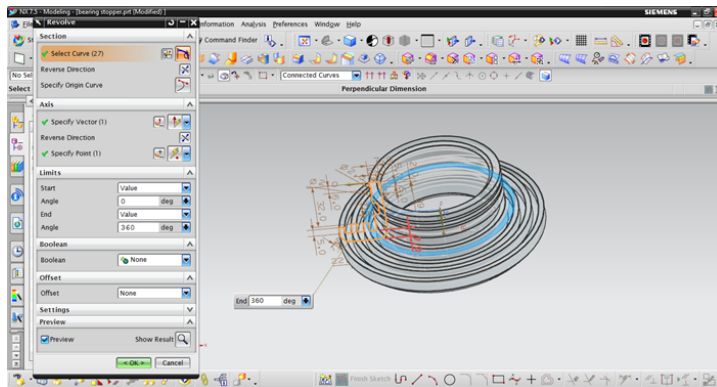


Procedure to draw the above sketch

Insert → sketch in task environment → select plane → ok.
 insert → curve → profile.

By using profile curve we will get the 2D design of piston wall cross-section.

Below image shows the **REVOLVE** option



Procedure to revolve the above 2D sketch.

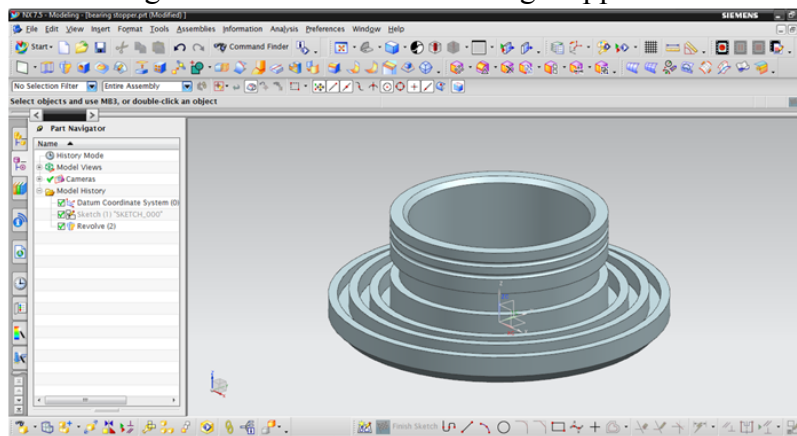
insert → design features → revolve

REVOLVE

By using revolve command we convert sketch from 2D to 3D only for axis symmetry bodies.

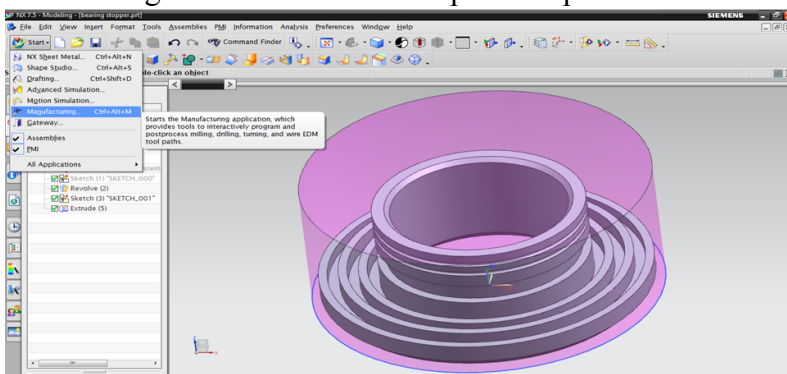
select sketch → select vector(in which direction u want to revolve) → specify point
 in limits give input as 360deg in end angle → Boolean give input as none → ok.

Below image shows 3D model of bearing stopper.

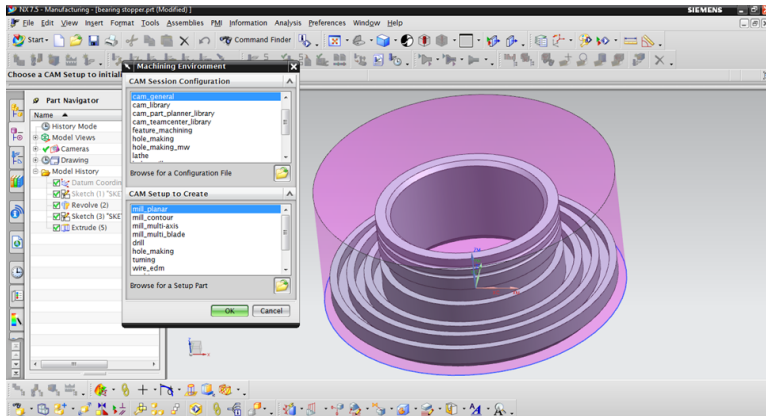


CAM GENERATION

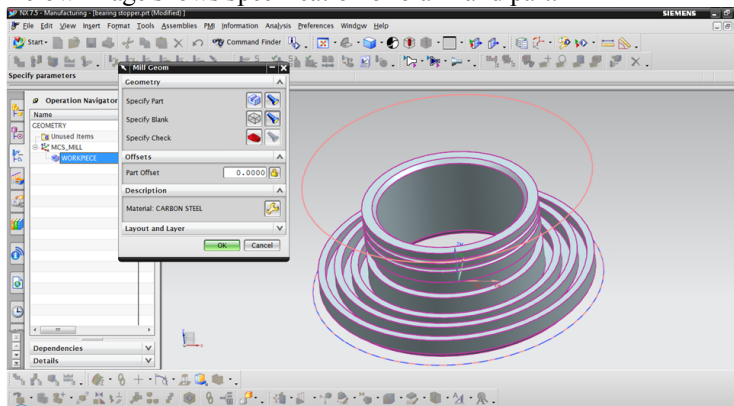
Below image shows the blank and part components for manufacturing.



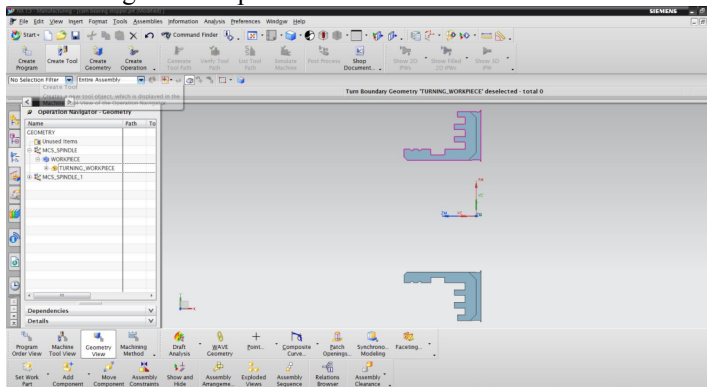
Below image shows starting of manufacturing and giving coordinate system to blank.



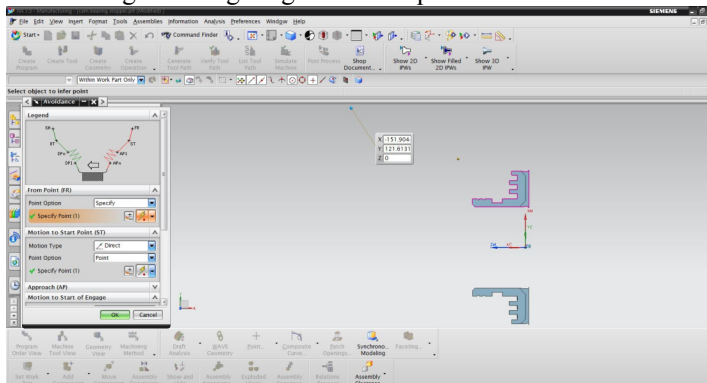
Below image shows specification of blank and part.



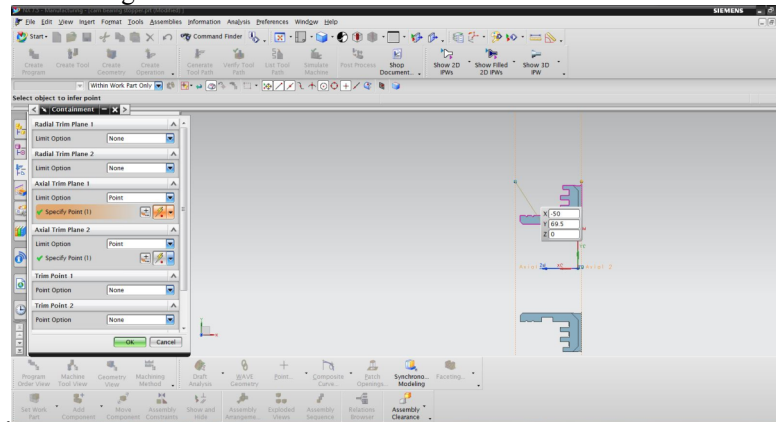
Below image shows spun creation.



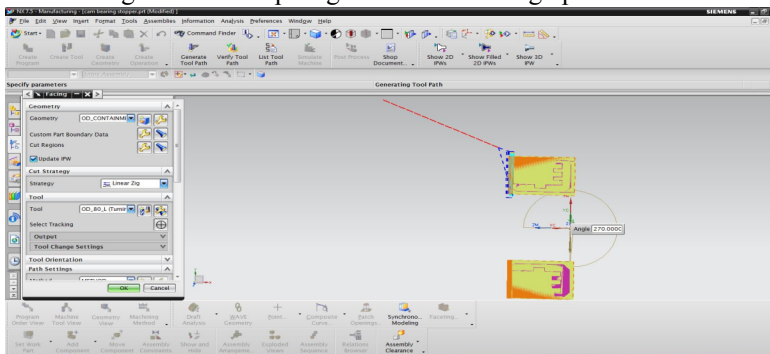
Below image shows giving avoidance points.



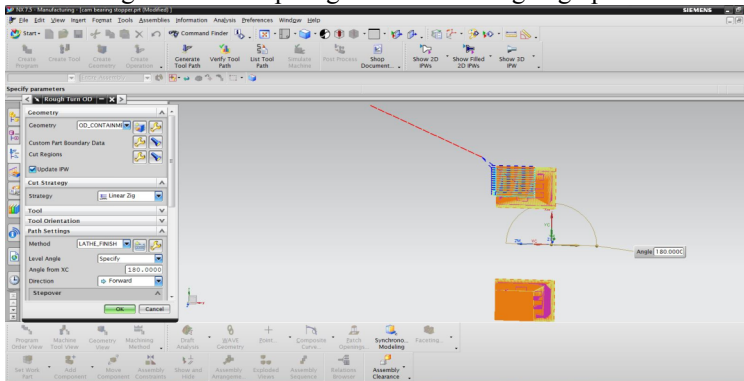
Below image shows containment limits



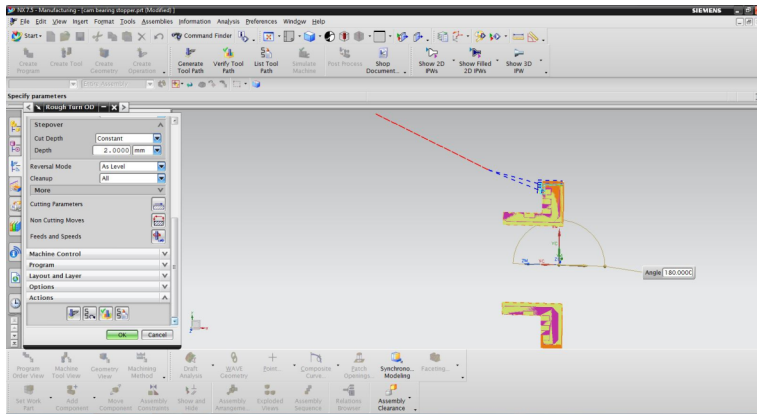
Below image shows tool path generation of facing operation.



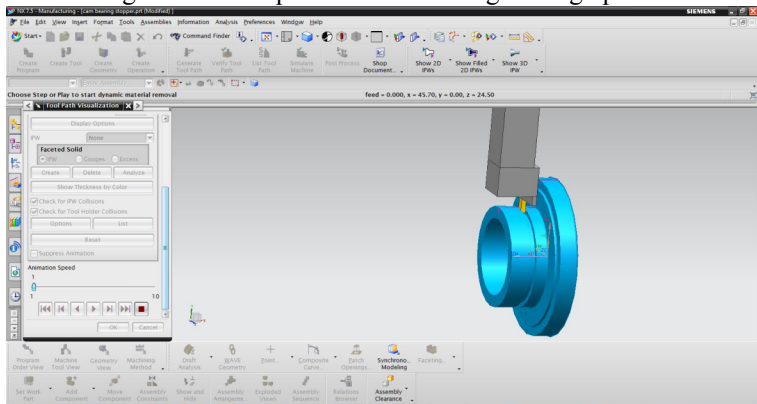
Below image shows tool path generation of roughing operation.



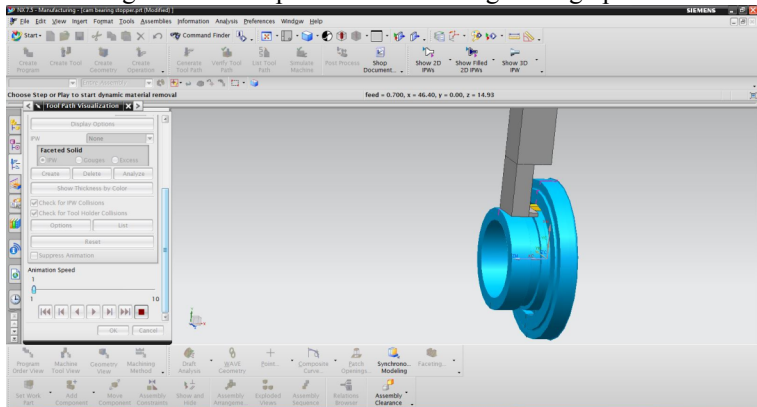
Below image shows tool path verification of roughing operation.



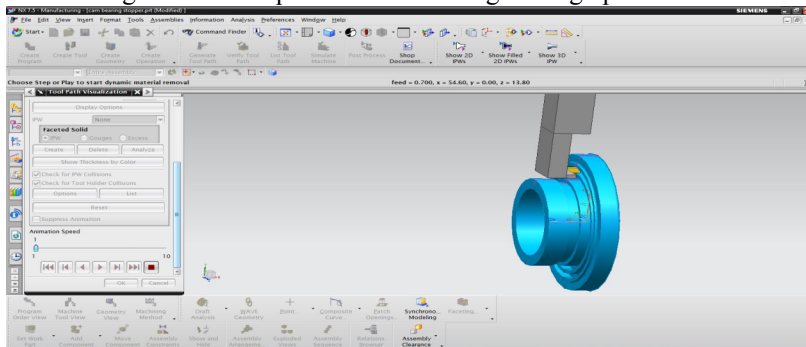
Below image shows tool path verification of grooving operation.



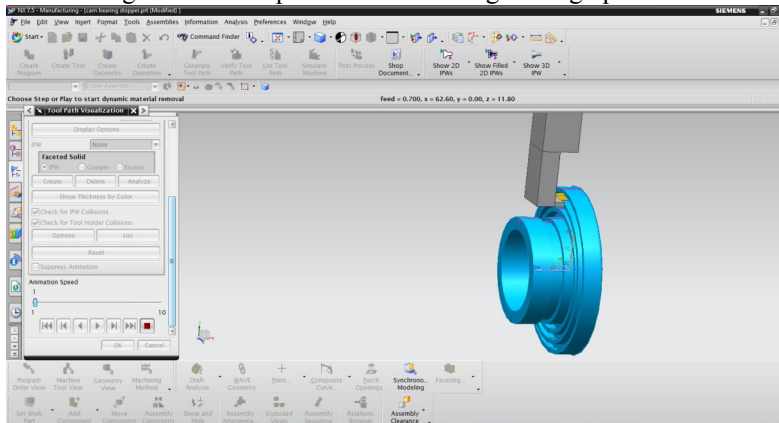
Below image shows tool path verification of grooving operation.



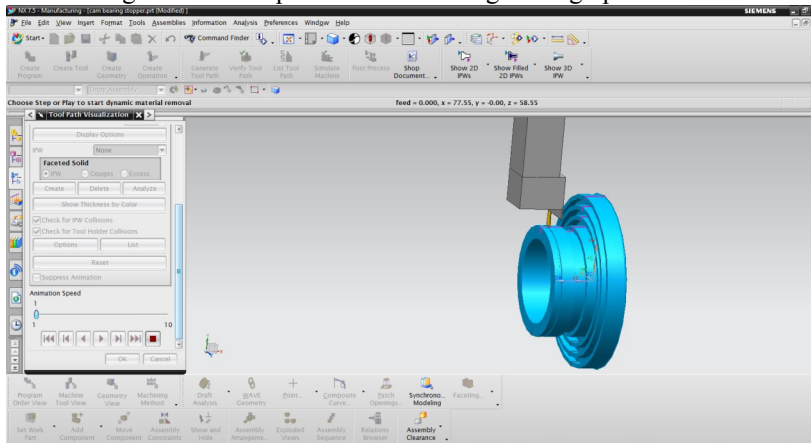
Below image shows tool path verification of grooving operation.



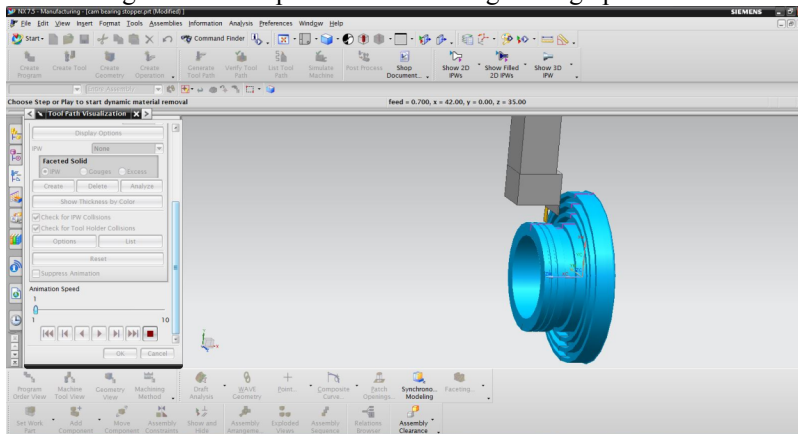
Below image shows tool path verification of grooving operation.



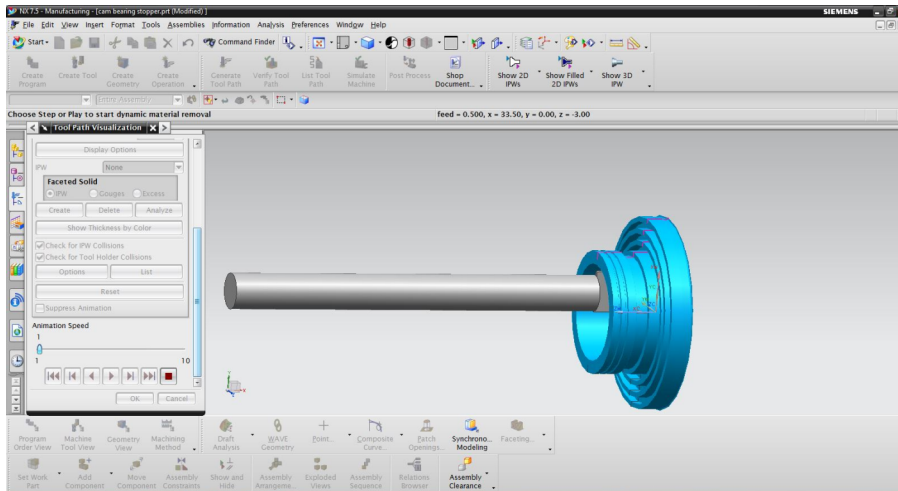
Below image shows tool path verification of grooving operation.



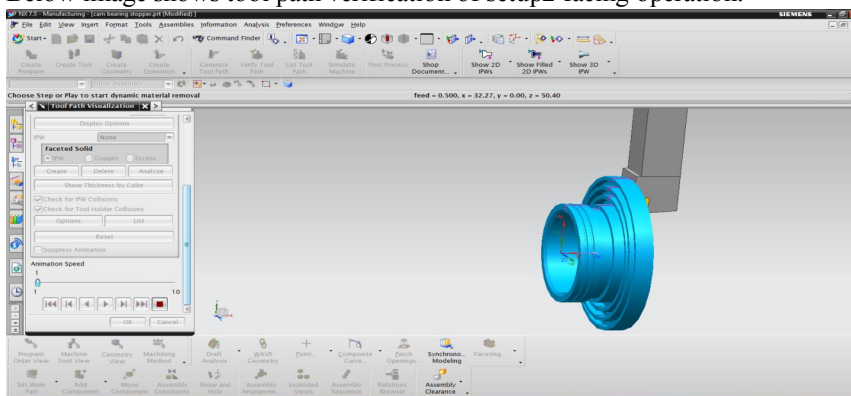
Below image shows tool path verification of grooving operation.



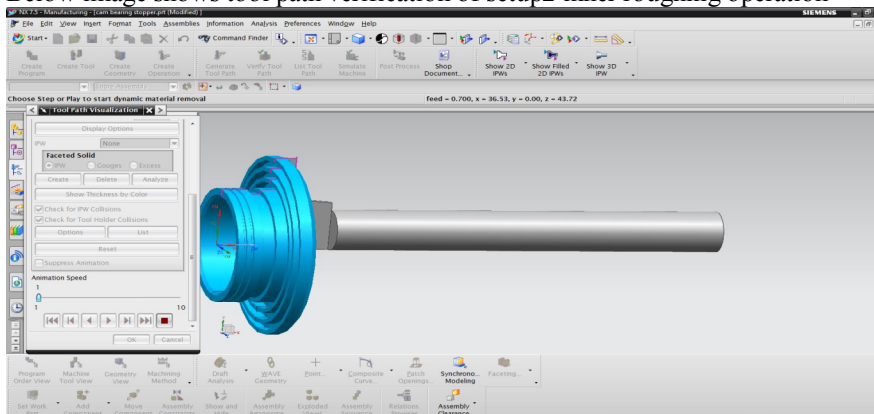
Below image shows tool path verification of inner roughing operation



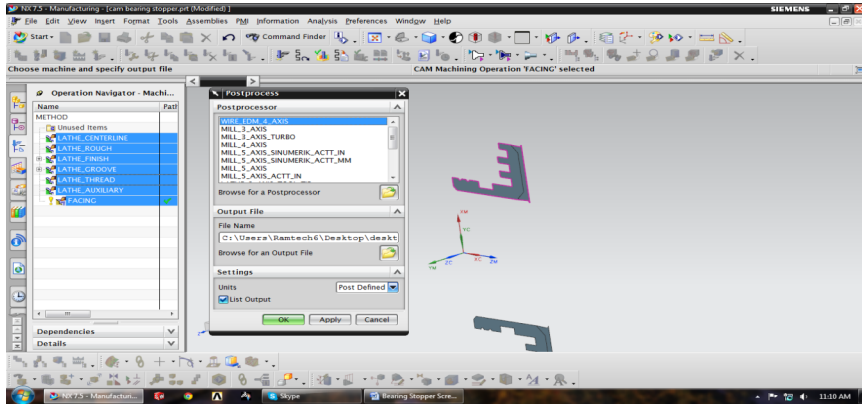
Below image shows tool path verification of setup2 facing operation.



Below image shows tool path verification of setup2 inner roughing operation



Below image shows selection of machine for generation of NC program.



NX

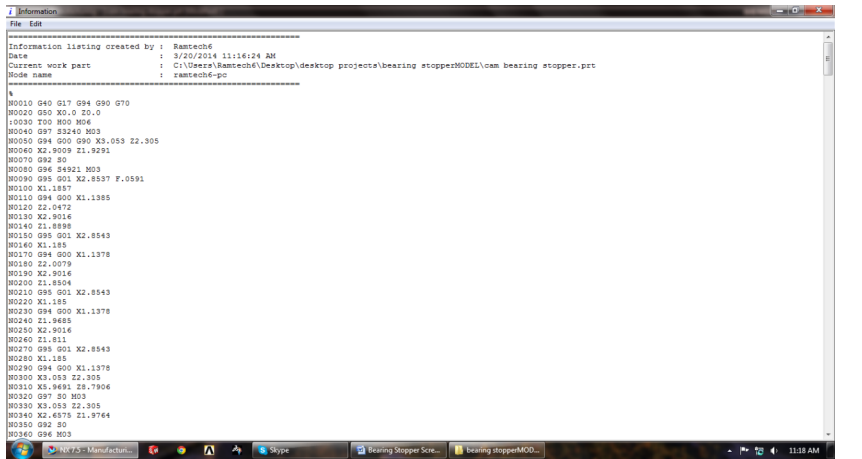
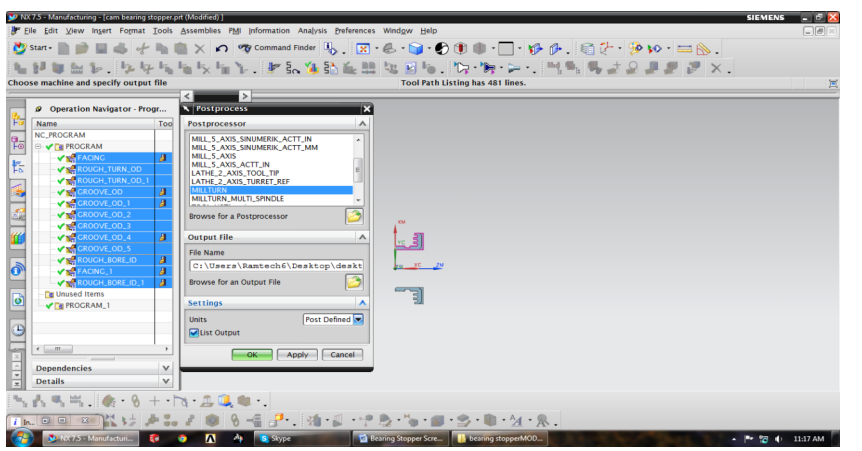
SHOP FLOOR DOCUMENTATION

CREATED BY : Ramtech6 DATE : Wed Mar 05 16:49:37 2014
PART NAME : C:\Users\Ramtech6\Desktop\MODEL\cam bearing stopper.prt

TOOLING LIST

TURNING TOOLS

TOOL NAME	DESCRIPTION	NOSE RAD	TOOL ORIENT	ADJ REG
OD_80_L	Turning Tool-Standard	1.2000	1.0023	0
OD_GROOVE_L	Grooving Tool-Standard	1.2000	90.0456	0
OD_GROOVE_I_1	Grooving Tool-Standard	0.0000	1.0005	0
OD_GROOVE_I_2	Grooving Tool-Standard	0.0000	90.0456	0
ID_80_L	Turning Tool-Standard	1.2000	275.1395	0
OD_80_L_1	Turning Tool-Standard	1.2000	95.0482	0
ID_80_I_1	Turning Tool-Standard	1.2000	183.0938	0



OPERATION LIST BY PROGRAM

PROGRAMNAME: TURNING

PROGRAM NAME : SETUP1 AND OD_OPERATIONS

OPERATION NAME	OPERATION DESCRIPTION	TOOL NAME
FACING	turning/FACING	OD_80_L
ROUGH_TURN_OD	turning/ROUGH_TURN_OD	OD_80_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
GROOVE_OD	turning/GROOVE_OD	OD_GROOVE_L
ROUGH_BORE_ID	turning/ROUGH_BORE_ID	ID_80_L

PROGRAM NAME : SETUP2_OPERATIONS

OPERATION NAME	OPERATION DESCRIPTION	TOOL NAME
FACING_2	turning/FACING	OD_80_L
ROUGH_BORE_ID	turning/ROUGH_BORE_ID	ID_80_L

TOOLING LIST

TURNING TOOLS

TOOL NAME	DESCRIPTION	NOSE RAD	TOOL ORIENT	ADJ REG
OD_80_L	Turning Tool-Standard	0.3000	5.0025	0
OD_GROOVE_L	Grooving Tool-Standard	0.3000	90.0456	0
ID_80_L	Rough bore Tool-Standard	0.3000	270.1369	0

4.8 CONVERT TO NC CODE

Using the post processor we have to convert CL file data into machine specified NC part program

1. In the Project Manager, select the first operation on the Operations page, then hold down the Shift key and select the last operation. All the cutting operations are selected.
2. Press the right mouse button and select NC Code from the menu.
3. Select a Machine Format file from the pull down list (3-Axis/5-Axis).
4. Select Apply.

RESULTS:

1. 3D model of bearing stopper is done using NX-CAD software by considering tolerances given in 2D input.
2. Generated 3D model is drafted and cross checked with 2D inputs for verification.

3. Tool path is generated on 3D model of BEARING STOPPER using NX-CAM software
4. NC program is generated for bearing stopper component and this program is given to 4-axis TURN CNC machine through DNC line

References

- [1] Taichi Oono : Toyota Production System, Diamond, Tokyo, Japan, 1978 (in Japanese)
- [2] J.F.Liker : The Toyota Way, Nikkei BP, Tokyo, Japan, 2004 (in Japanese)
- [3] K.Kajiwara : Toyota Way progressive strongest management, Business, Tokyo, Japan,2002 (in Japanese)
- [4] S.Ishii : How to work for best person in Toyota, Chukei publisher, Tokyo, Japan,2005 (in Japanese)
- [5]Cadence Management Corporation, A Master Course in the Multidisciplinary Approach of Planning and Implementing Projects Edition 10.0, Cadence Management Corporation, Portland, Oregon, USA,2008
- [6] Y.Wakamatsu & T.Kondo : Make human and goods on Toyota way, Diamond, Tokyo, Japan,2001 (in Japanese)
- [7] E.Toyota : Decision, Nikkei newspaper, Tokyo, Japan, 2003 (in Japanese)
- [8] Y.Nishi : How to make people by Toyota way and sense of crisis of Technical Master, Nikkei Strategy, issue August, pp.40-53 ,2008 (in Japanese)
- [9] T.Koroiwa : Essence of Toyota Production System (TPS) and Software development, Main speech 2, PM symposium 2006, pp27-36, Engineering Advancement Association of Japan (ENAA) & Project Management Association of Japan (PMAJ),2006 (in Japanese)
- [10] T.Miyazaki & T.Takeda & Y.Kohara: Project Management studying TPS <For IT sites to solve problem with discussion>, PM symposium 2007, IT-3, pp107-115, Engineering Advancement Association of Japan (ENAA) & Project Management Association of Japan (PMAJ) ,2007 (in Japanese)
- [11] Y.Kohara: Five Why •s by five layers for IT project – Five layers to get support for success from organizations-, PM symposium 2008, Day2 D-1, pp1-20, Engineering Advancement Association of Japan (ENAA) & Project Management Association of Japan (PMAJ),2008 (in Japanese)
- [12] Chauncey Hollingsworth , ”5 WAYS TO MAKE OR BREAK YOUR TEAM, PM NETWORK, Volume 23, No4, pp.52-57, April.2009
- [13] K.Komiya , Open the door, and outfields are wide, Tokyo, Japan (in Japanese),2003
- [14] Y.Kohara, Five layer Why-why Analysis for IT projects, PROMAC, Chiba, Japan, 2010
- [15] Y.Kohara , Why Five Times, Software & Test symposium, Tokyo, Japan (in Japanese), 2010