Modeling and Manufacturing of Input Shaft using Computer Aided Manufacturing

Syed Younus Ahmed[1], A Vidya Sagar (M.Tech)[2]
[1]P.G. Scholar, [2]Head of the Department
[1,2]BRANCH   : CAD/CAM
[1,2]Geethanjali college of engineering and technology
EMAIL.ID   : [1]syedyounusahmed1@gmail.com, [2]sagaramadala1410@gmail.com

ABSTRACT:

In modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs. The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine by a post processor, and then loaded into the CNC machines for production. Since any particular component might require the use of a number of different tools – drills, saws, etc., modern machines often combine multiple tools into a single "cell". In other installations, a number of different machines are used with an external controller and human or robotic operators that move the component from machine to machine. In either case, the series of steps needed to produce any part is highly automated and produces a part that closely matches the original CAD design.

Power enters the transmission through the input shaft. The input shaft is connected to the engine via the clutch, such that when the clutch is engaged, power goes straight from the engine to the input shaft of the transmission, and the crankshaft and input shaft rotate at the same speed. This project deals with generating NC program using CAM software for input shaft to manufacture on modern CNC machine. Using NX-CAD software 3D model of input shaft is created and program is generated using NX-CAM software.

INTRODUCTION

Introduction about input shaft:

Engines provide varying amounts of power at different efficiencies, depending on the speed at which they are turning. A transmission lets the driver select the ratio between the engine and wheels, so the engine can be run at speeds that provide more power, or at speeds that may be less powerful but allow the engine to operate more efficiently. Power enters the transmission through the input shaft. The input shaft is connected to the engine via the clutch, such that when the clutch is engaged, power goes straight from the engine to the input shaft of the transmission, and the crankshaft and input shaft rotate at the same speed. Just inside the housing of the transmission, the input shaft is connected to the countershaft (also known as the layshaft), by gears on both shafts, such that whenever the input shaft turns, so does the countershaft, and always at a fixed speed ratio.

In addition to the gear that takes power from the input shaft, the countershaft has several gears on it, one for each of the car's "gears" including reverse. The diagram above depicts a five-speed manual transmission. All of these are connected to the countershaft, so they turn as a single piece.

LITERATURE REVIEW

Hangzhou Dingshun: shaft is a mechanical component for transmitting torque and

rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them.

As torque carriers, drive shafts are subject to torsion and shear stress, equivalent to the difference between the input torque and the load. They must therefore be strong enough to bear the stress, whilst avoiding too much additional weight as that would in turn increase their inertia.

Introduction of CAD:

Computer aided design (CAD) is assistance of computer in engineering processes such as creation, optimization, analysis and modification. CAD involves creating computer models defined by geometrical parameters which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real world conditions. There are several good reasons for using a CAD system to support the engineering design function:

- ✓ To increase the productivity
- ✓ To improve the quality of the design
- ✓ To uniform design standards
- ✓ To create a manufacturing data base
- ✓ To eliminate inaccuracies caused by hand-copying of drawings and inconsistency between drawings

INTRODUCTION OF CAM:

Computer-aided manufacturing (CAM) is the use of computer software to control machine tools and related machinery in the manufacturing of work pieces. This is not the only definition for CAM, but it is the most common; CAM may also refer to the use of a computer to assist in all operations of a manufacturing plant, including planning, management, transportation and storage. Its primary purpose is to create a faster production process and components

and tooling with more precise dimensions and material consistency, which in some cases, uses only the required amount of raw material (thus minimizing waste), while simultaneously reducing energy consumption.

CAM is a subsequent computer-aided process after computer-aided design (CAD) and sometimes computer-aided engineering (CAE), as the model generated in CAD and verified in CAE can be input into CAM software, which then controls the machine tool. Integration of CAD with other components of CAD/CAM/CAE Product lifecycle management (PLM) environment requires an effective CAD data exchange. Usually it had been necessary to force the CAD operator to export the data in one of the common data formats, such as IGES or STL, that are supported by a wide variety of software. The output from the CAM software is usually a simple text file of G-code, sometimes many thousands of commands long, that is then transferred to a machine tool using a direct numerical control (DNC) program.

CAM packages could not, and still cannot, reason as a machinist can. They could not optimize tool paths to the extent required of mass production. Users would select the type of tool, machining process and paths to be used. While an engineer may have a working knowledge of G-code programming, small optimization and wear issues compound over time. Mass-produced items that require machining are often initially created through casting or some other non-machine method. This enables hand-written, short, and highly optimized G-code that could not be produced in a CAM package.

Typical areas of concern:

- High Speed Machining, including streamlining of tool paths
- Multi-function Machining
- 5 Axis Machining

- Feature recognition and machining
- Automation of Machining processes
- Ease of Use

Introduction of NC:

Numerical control (NC) refers to the automation of machine tools that are operated by abstractly programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. The first NC machines were built in the 1940s and 1950s, based on existing tools that were modified with motors that moved the controls to follow points fed into the system on punched tape. These early servomechanisms were rapidly augmented with analog and digital computers, creating the modern computer numerical control (CNC) machine tools that have revolutionized the machining processes.

In modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs. The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine via a postprocessor, and then loaded into the CNC machines for production.

Since any particular component might require the use of a number of different tools-drills, saws, etc., modern machines often combine multiple tools into a single "cell". In other cases, a number of different machines are used with an external controller and human or robotic operators that move the component from machine to machine. In either case, the complex series of steps needed to produce any part is highly automated and produces a part that closely matches the original CAD design.

Introduction of CNC:

Computer Numerical Control (CNC) is one in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric data. CNC can control the motions of the work piece or tool, the input parameters such as feed, depth of cut, speed, and the functions such as turning spindle on/off, turning coolant on/off.

The applications of CNC include both for machine tool as well as non-machine tool areas. In the machine tool category, CNC is widely used for lathe, drill press, milling machine, grinding unit, laser, sheet-metal press working machine, tube bending machine etc. Highly automated machine tools such as turning center and machining center which change the cutting tools automatically under CNC control have been developed. In the non-machine tool category, CNC applications include welding machines (arc and resistance), coordinate measuring machine, electronic assembly, tape laying and filament winding machines for composites etc.

The benefits of CNC are
(1) High accuracy in manufacturing
(2) Short production time
(3) Greater manufacturing flexibility
(4) Simpler fixturing
(5) Contour machining (2 to 5 –axis machining)
(6) Reduced human error.

Introduction of Unigraphics:

NX is one of the world's most advanced and tightly integrated CAD/CAM/CAE product development solutions. Spanning the entire range of product development, NX delivers immense value to enterprises of all sizes. It simplifies complex product designs, thus speeding up the process of introducing products to the market.

The NX software integrates knowledge-based principles, industrial design, geometric modeling, advanced analysis, graphic simulation, and concurrent

engineering. The software has powerful hybrid modeling capabilities by integrating constraint-based feature modeling and explicit geometric modeling. In addition to modeling standard geometry parts, it allows the user to design complex free-form shapes such as airfoils and manifolds. It also merges solid and surface modeling techniques into one powerful tool set. Our previous efforts to prepare the NX self-guiding tutorial were funded by the National Science Foundation's Advanced Technological Education Program and by the Partners of the Advancement of Collaborative Engineering Education (PACE) program.

NX is a premier 3D computer aided design suite. It allows you to model solid components and assemblies, to perform engineering analyses such as mechanism simulation and stress analysis, to create tool paths for computer-based manufacturing processes and to perform numerous other engineering design activities in a single software environment. Software suites like NX are referred to as product lifecycle management (PLM).
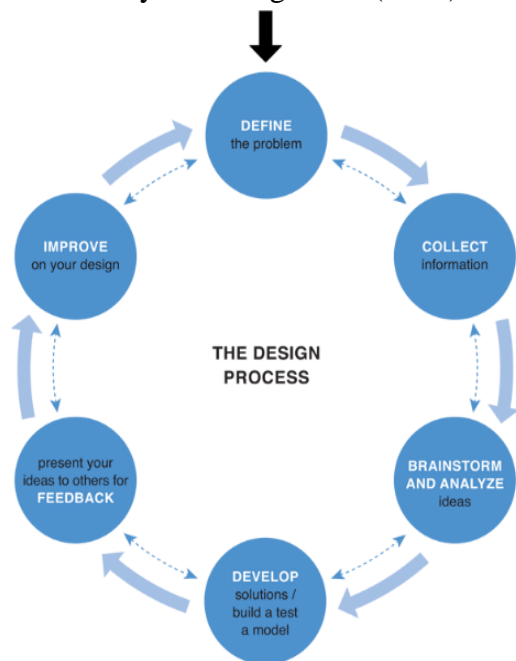
Input for the input shaft:
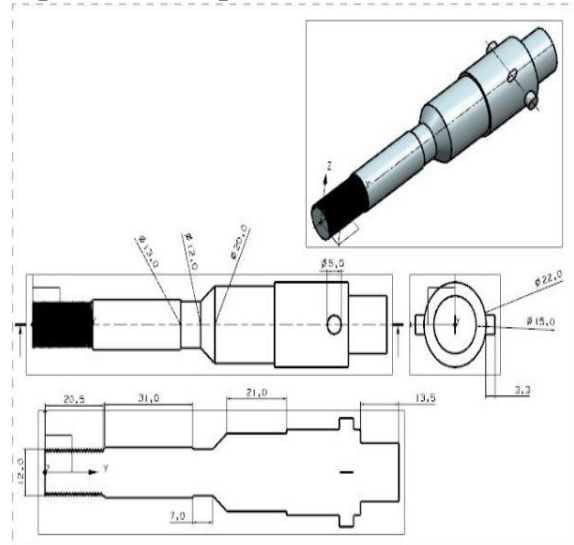
Fig: 2D drawing of input shaft

Below image shows 2D sketch of input shaft
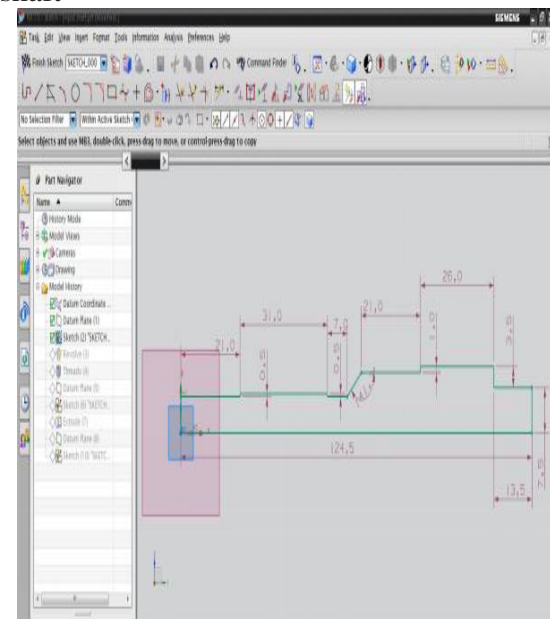
Fig: 2D sketch of input shaft

Procedure to draw the above sketch

➤ ➤ ➤ Insert

sketch in task environment   select plane and select top view   ok.

➤ ➤ insert   curve   profile.

Below image shows revolving of sketch of input shaft

MODELING OF INPUT SHAFT
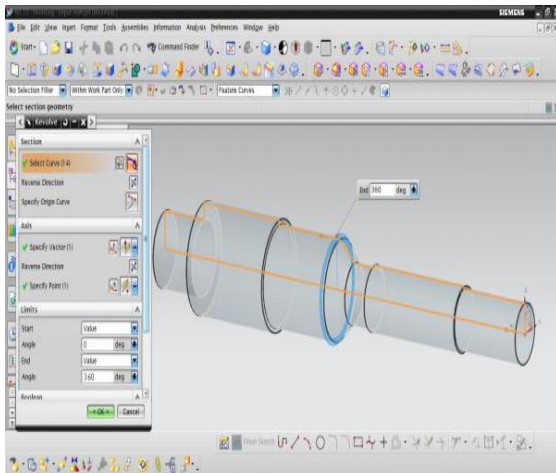
Fig: Revolving of sketch of input shaft

REVOLVE

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

Procedure to revolve the above 2D sketch.

➝➝insert

design features revolve

➝➝➝➝➝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.
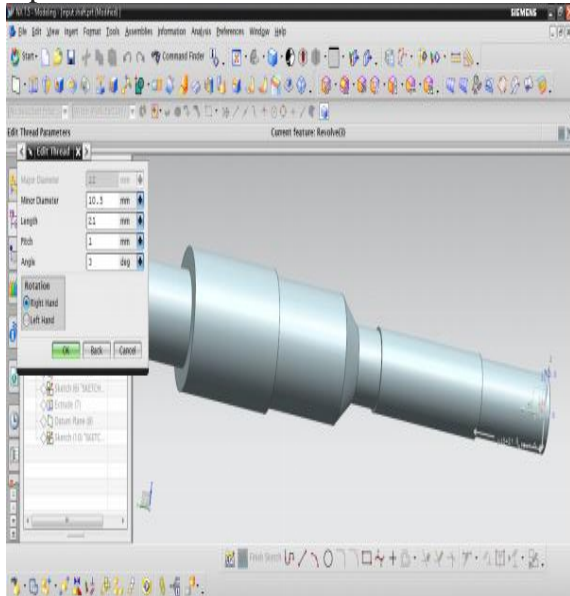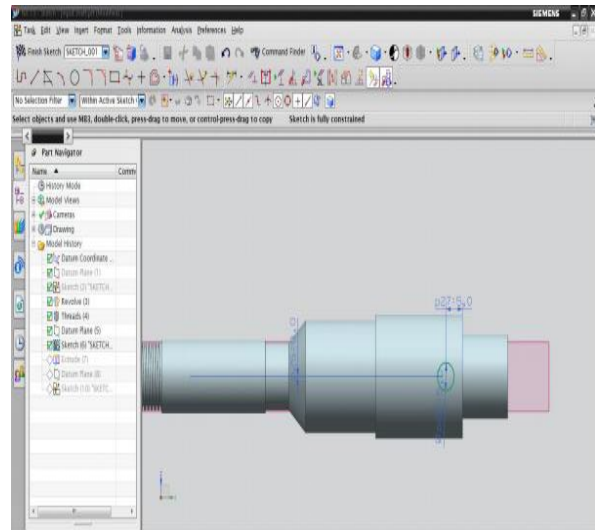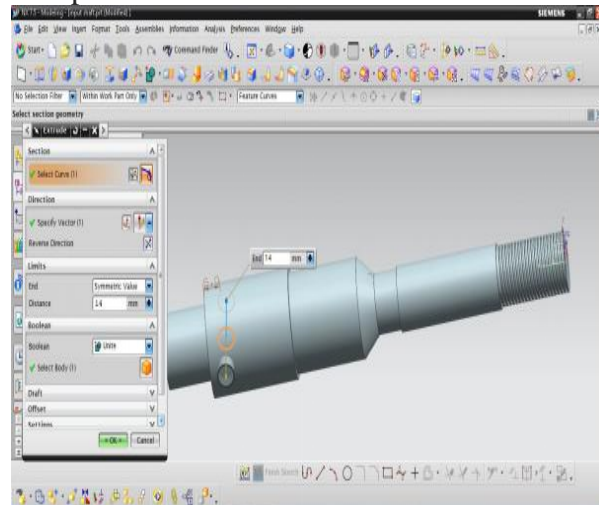
Below image shows creating of threads on input shaft

Fig: Creating of threads on input shaft

Below image shows sketch on face of input shaft

Fig: Sketch on face of input shaft

Procedure to draw the above sketch

➝➝➝Insert   sketch in task environment   select plane and select top view   ok.

➝➝insert   curve   profile.

Below image shows extrude of above sketch of input shaft

Fig: Extrude of above sketch of input shaft

EXTRUDE

➤ Extrude command is used to create a body by sweeping a 2D or 3D section of curves, Edges, sketches in a specified Direction.

➝➝Insert   design features   extrude.

➝➝➝Select curve   specify vector

Boolean operation (subtract)   ok.

Below image shows final 3D model of input shaft
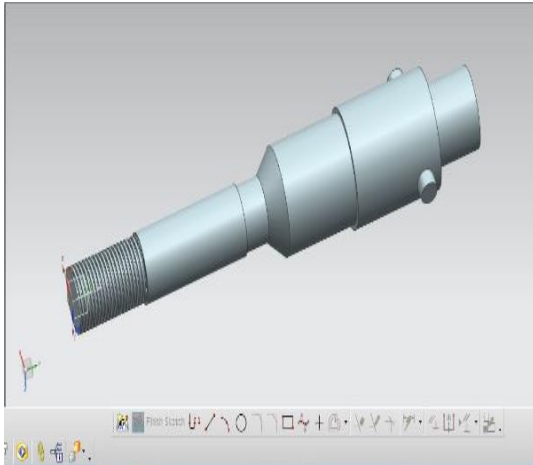
Fig: Final 3D model of input shaft

COMPUTER AIDED MANUFACTURING OF OUTPUT SHAFT

Selection of material:

V-Belt Pulleys come in a wide selection of materials with different ratings for strength, power transmission capability, thermal properties, and weight. Consult with pulley manufacturer on a specific application for optimization of pulley material selection. Stainless steel is chemical and corrosion resistant, and can have relatively high pressure ratings.

Selection of machine:

MORI SEIKI 4-AXIS CNC turning machine is used for machining missile piston. MORI SEIKI offers the industry's best lineup of high-performance lathes with better precision and rigidity, greater multi-axis compatibility and smaller footprints.

High rigidity with Integrated Turning Spindle. Spindle is directly coupled with motor. Rigid Turret with BIM (Built In Motor) Technology. Directly coupled Integrated driven tools. Is a patent technology. Y-axis machining, Up to 100mm (+/- 50). 4-axes simultaneous machining, C-axis with 360 deg and Y-axis, Machine accuracies, Positional Accuracy +/- 0.005mm, Repeatability +/- 0.003mm. In 4-axis turning machine, Axis represents as work piece rotation and spindle movement in x, y, z directions.

Fig: 4-axis CNC MORI SIEKI turning machine

4.3 SELECTION OF TOOLS

Selection of tools plays an important role in manufacturing any component. Proper tools must be selected otherwise in manufacturing process improper tools results in damage of work piece or damage to the tools, tool holders. Suitable tools for manufacturing missile piston are listed below

OD_80_L facing

Facing in the context of turning work involves moving the cutting tool at right angles to the axis of rotation of the rotating work piece. This can be performed by the operation of the cross-slide, if one is fitted, as distinct from the longitudinal feed (turning). It is frequently the first operation performed in the production of the work piece

OD_80_L rough

This process, also called **rough** or **cutoff**, is used to create deep grooves which will remove a completed or part-complete component from its parent stock.

International Journal of Research

Available at https://journals.pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
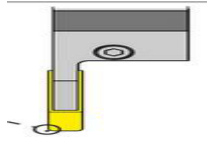p-ISSN: 2348-795X
Volume 07 Issue 02
February 2020

OD_55_L finish
Finish tool remove the left over stock after roughing process. It is the last process which gives surface finish.
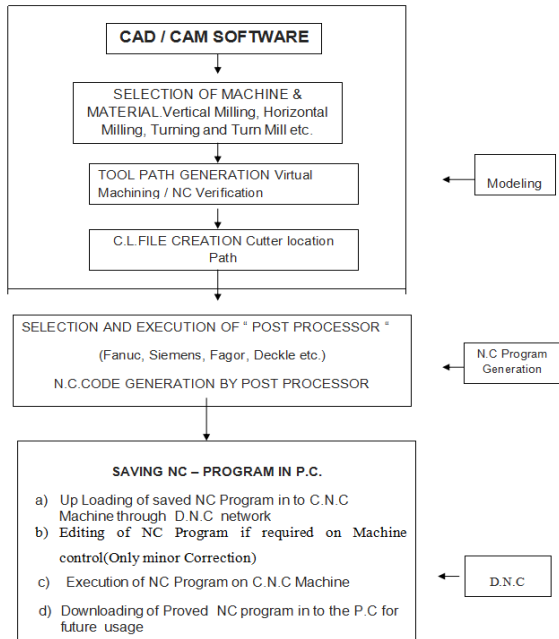
ID_80_L rough
Grooving tool remove the stock on v-shape of material.

Groove_OD

SEQUENCE OF OPERATIONS PERFORMED ON OUTPUT SHAFT COMPONENT
TURNING OPERATIONS
FACE_TURN_OD
ROUGH_TURN_OD GROOVE_OD
DRILL_ID
MILLING OPERATIONS
PLANAR_MILL
FACE_MILLING_AREA

CAM OPERATION IN NX-CAM
Basic cam setup
- In NX the NC machining environment is referred to as the setup.

- The set up for the machining jobs should be decided by looking at all the environmental information from four viewpoints: Program, Method, Geometry, and Tool.
- These four viewpoints were designed to mimic the thought process that can be used when planning the NC program.
- Each viewpoint organizes the information for the operation in a manner relevant to that particular viewpoint.

For example there are some standard setups available in NX-CAM are given below

| Setups	What Is In The Initial Setup	What Can Be Created
mill_planar	This contains an MCS, Work piece, Program, and methods for drilling, rough milling, semi-finish milling and finish milling.	Operations, tools, and groups used for drilling and planar milling.
turning	This contains an MCS, Work piece, Program, and six methods for turning.	Operations, tools, and groups used for turning
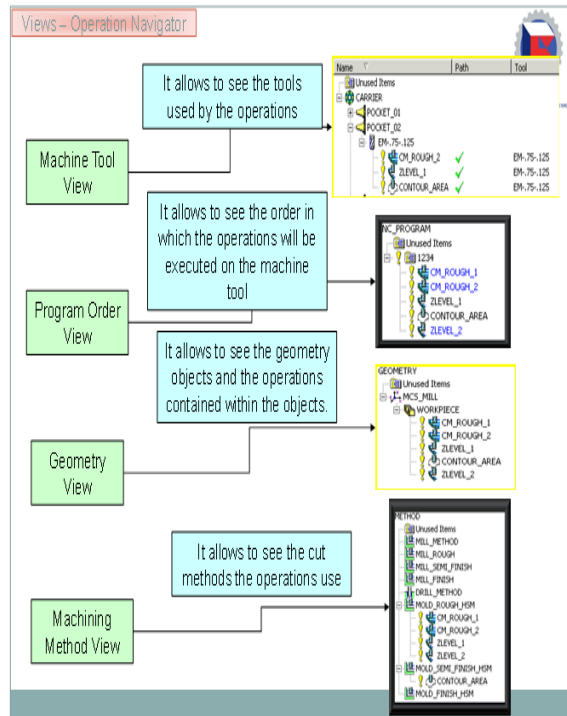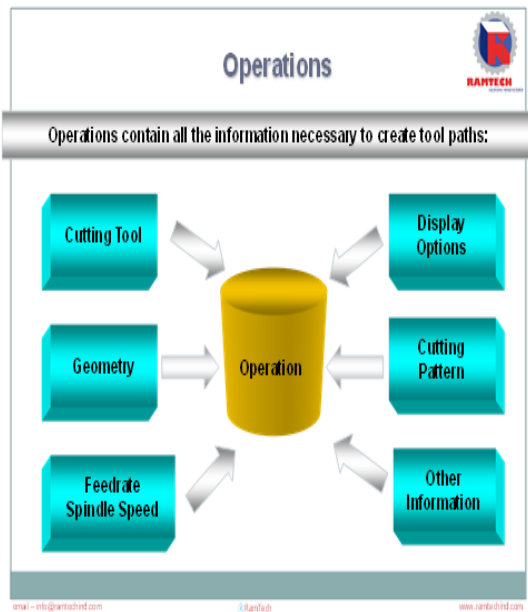
Operations come in many "types":

- ✓ Facing
- ✓ Rough
- ✓ Finish
- ✓ Groove
- ✓ Drilling
- ✓ Thread
- ✓ Reamer

Specify machine coordinate system
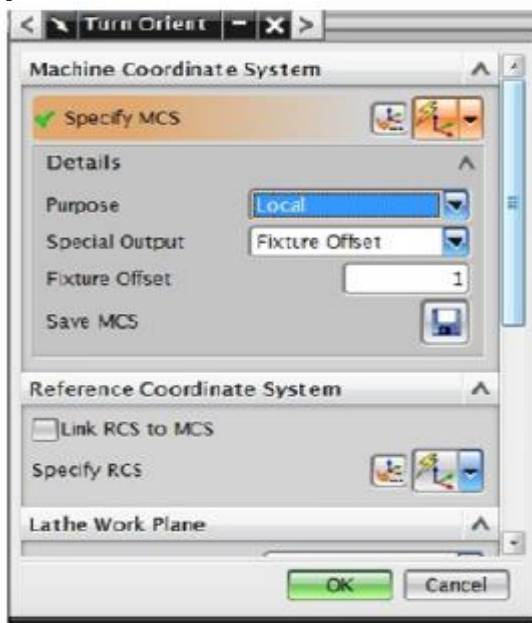
Specify part and blank
Part: The final component to be obtained

Blank: Initial raw material to be machined
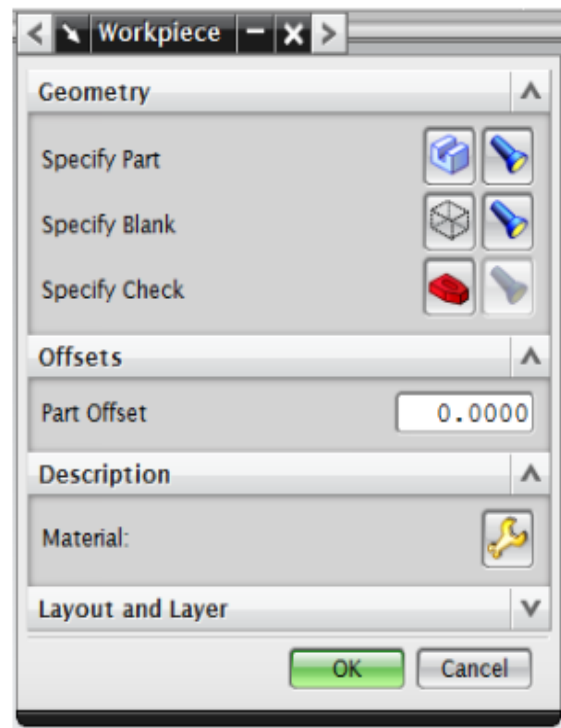
Create geometry
  ➢ Create Geometry dialog box is used to define:

1. MCS_SPINDLE
2. WORKPIECE
3. TURNING_WORKPIECE
4. TURNING_PART
5. CONTAINMENT
6. AVOIDANCE

4.7 Manufacturing process planning

Below image shows blank and part of input shaft
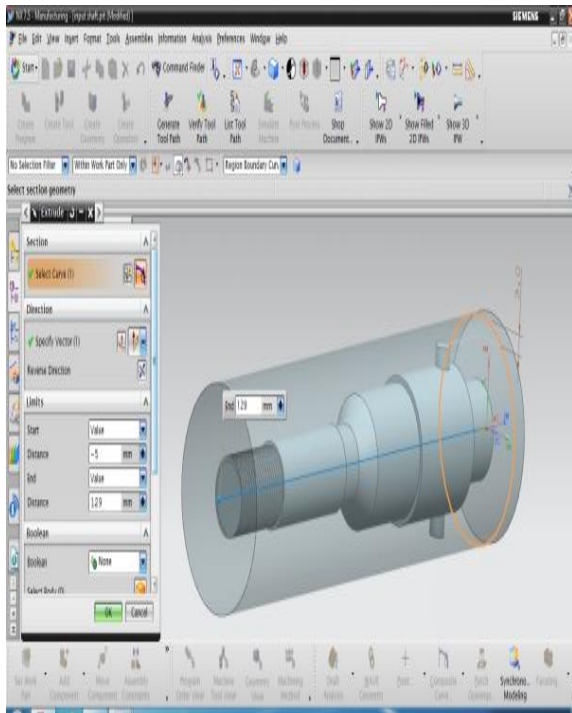
Fig: Blank and part of input shaft

Below image shows starting manufacturing process of input shaft
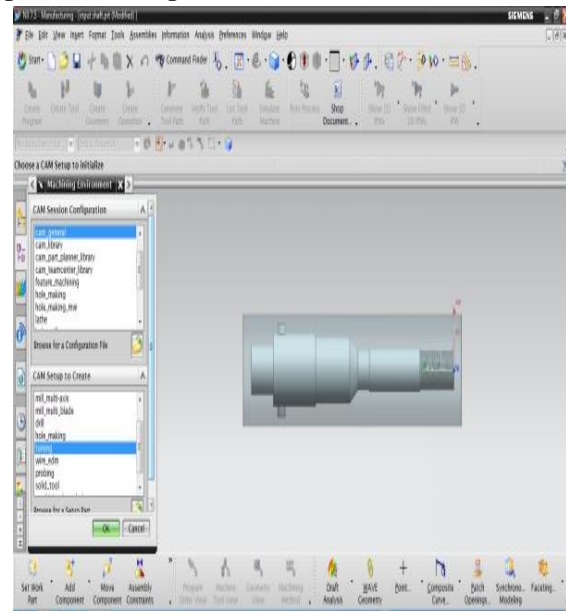
Fig: Starting manufacturing process of input shaft

Below image shows machining coordinate system given to blank
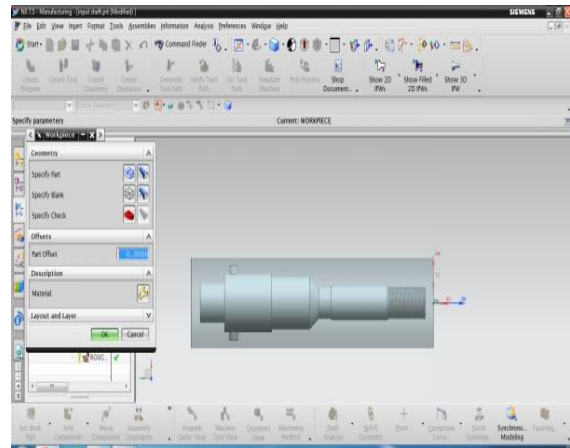
Fig: Machining coordinate system given to blank

Below image shows selection of blank and part for turning operation
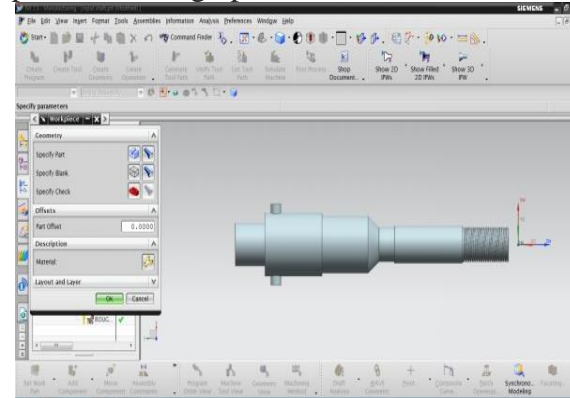
Fig: Selection of blank and part for turning operation
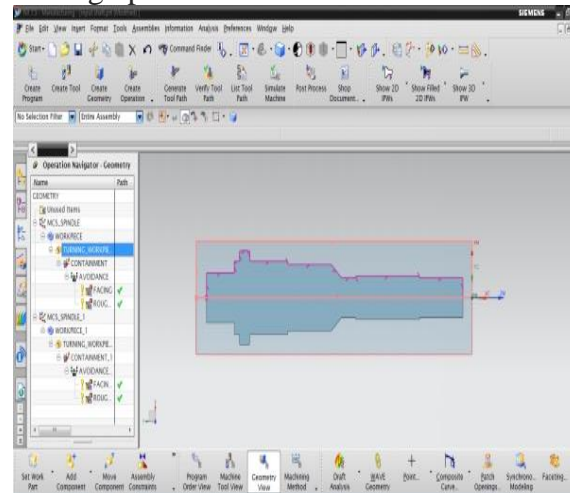
Below image shows generation of spun for turning operation

Fig: Generation of spun for turning operation

Below image shows outer avoidance given for turning operation

Fig: Outer avoidance given for turning operation

Below image shows outer containment given for turning operation

Fig: Outer containment given for turning operation

Below image shows tool path generation of facing operation
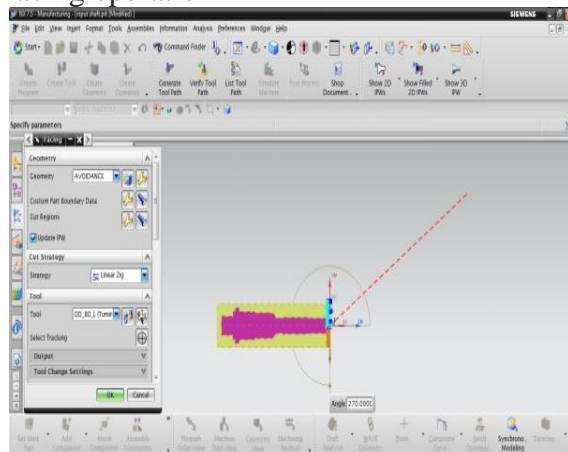

Fig: Tool path generation of facing operation

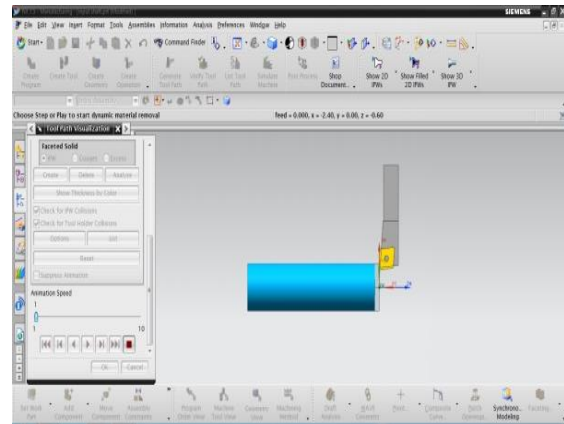Below image shows tool path visualization of facing operation

Fig: Tool path visualization of facing operation

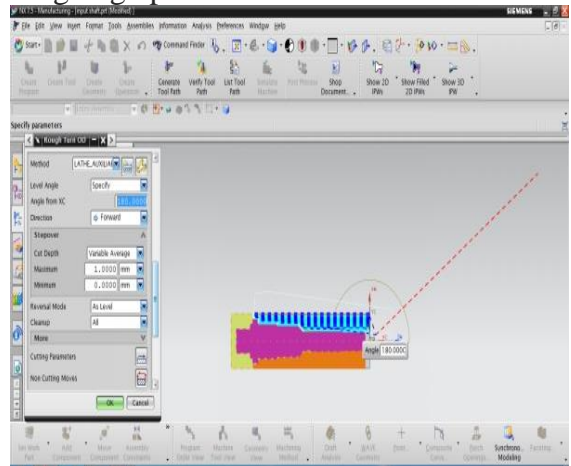Below image shows tool path generation of roughing operation

Fig: Tool path generation of roughing operation

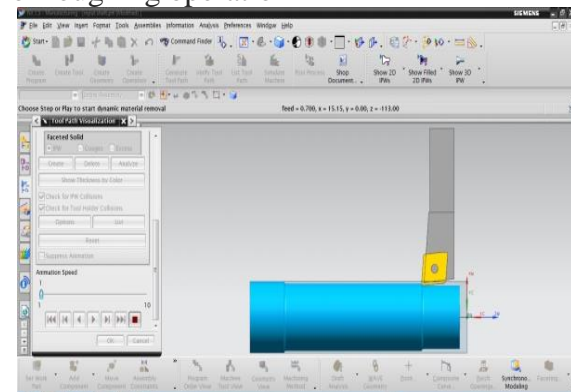Below image shows tool path verification of roughing operation

Fig: Tool path verification of roughing operation

Below image shows machining coordinate system for turning operation

International Journal of Research

Available at https://journals.pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
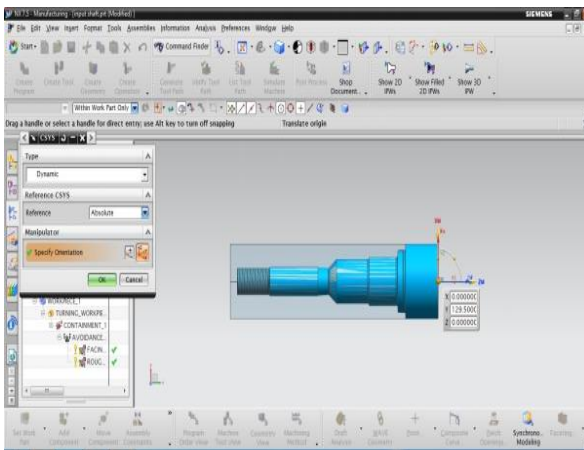Volume 07 Issue 02
February 2020

Fig: Coordinate system for turning operation

Below image shows specification of remaining blank and part for turning operation
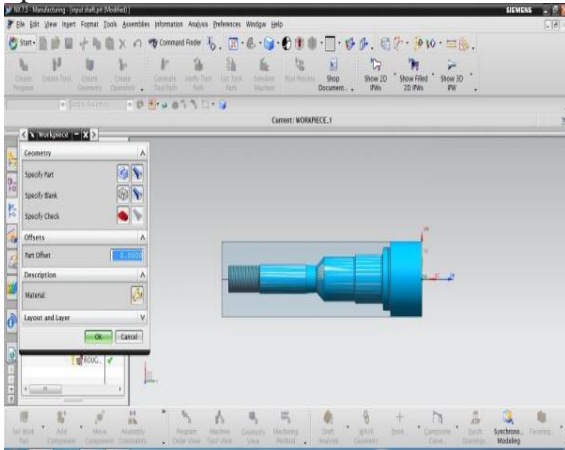

Fig: Specification of remaining blank and part for turning operation

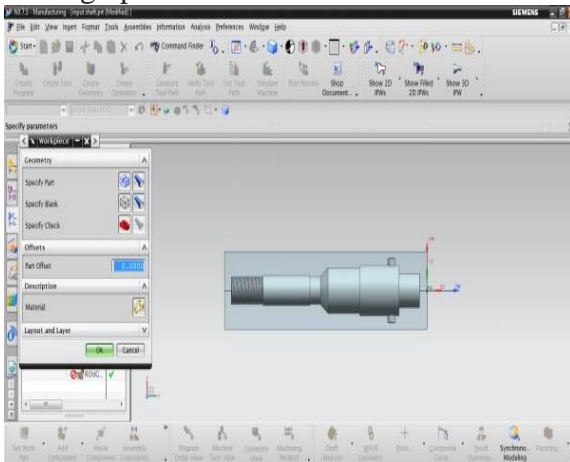Below image shows spun generation of turning operation

Fig: Spun generation of turning operation

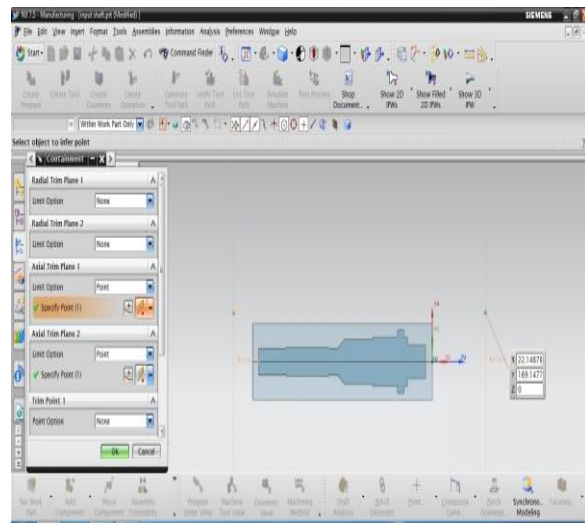Below image shows outer containment given for turning operation

Fig: Outer containment given for turning operation

Below image shows outer avoidance given for turning operation
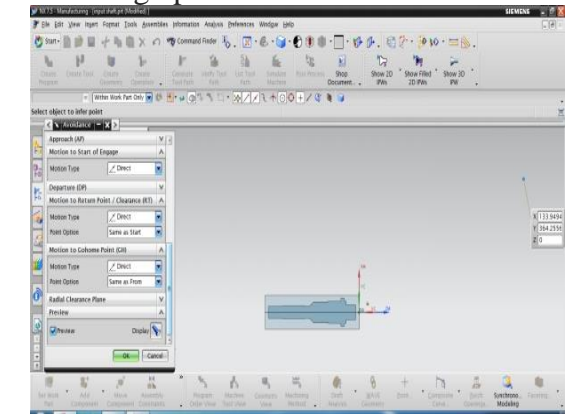

Fig: Outer avoidance given for turning operation

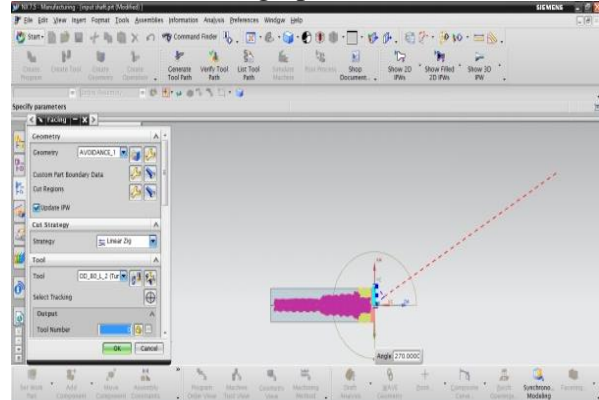Below image shows tool path generation of facing operation

Fig: Tool path generation of facing operation

Below image shows tool path visualization of facing operation

International Journal of Research

Available at https://journals.pen2print.org/index.php/ijr/

e-ISSN: 2348-6848
p-ISSN: 2348-795X
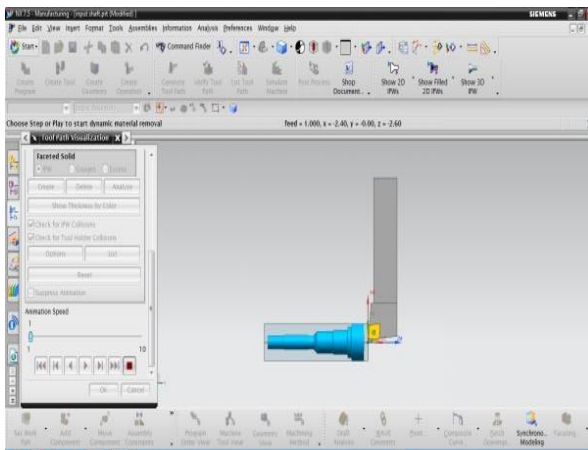Volume 07 Issue 02
February 2020

Fig: Tool path visualization of facing operation

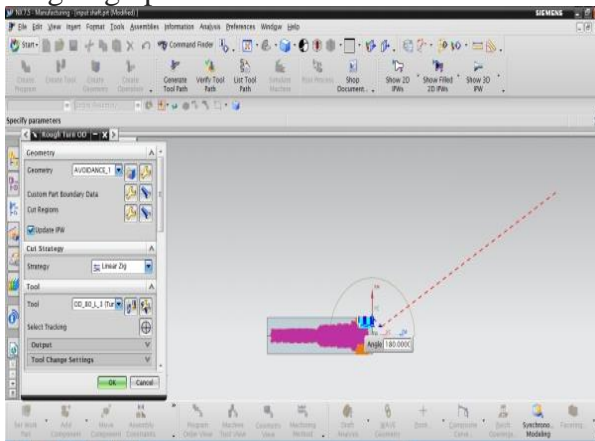Below image shows tool path generation of roughing operation

Fig: Tool path generation of roughing operation

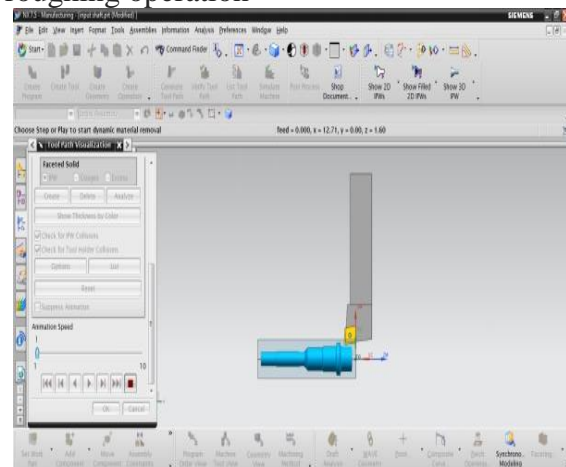Below image shows tool path verification of roughing operation

Fig: Tool path verification of roughing operation

4.8 OPERATION LIST BY PROGRAM

PROGRAM NAME: TURNING

PROGRAM NAME : SETUP1 AND OPERATIONS

OPERATION NAME	OPERATION DESCRIPTION	TOOL NAME
FACING	turning/FACING	OD_80_L
ROUGH_TURN_OD	turning/ROUGH_TURN_OD	OD_80_L

PROGRAM NAME : SETUP2_OPERATIONS

OPERATION NAME	OPERATION DESCRIPTION	TOOL NAME
FACING	turning/FACING	OD_80_L
ROUGH_BORE_ID	Turning/ROUGHING	ID_80_L

4.9 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 input shaft 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 input shaft using NX-CAM software
4. NC program is generated for input shaft component and this program is given to 4-

axis TURN-MILL CNC machine through DNC line

REFERENCES:

1. McEvily, A.J, Metal Failures: Mechanisms, Analysis, Prevention, Wiley, New York (2002), pp. 303307.

2. Heyes, AM, Automotive component failures, Eng Fail Anal, 1998, pp.129141.

3. Heisler, H, Vehicle and engine technology, 2nd ed, London, SAE International, 1999.

4. Vogwell, J, Analysis of a vehicle wheel shaft failure, Engineering Failure Analysis, 1998, Vol. 5, No. 4, pp. 271-277.

5. ASM metals handbook, Fatigue and fracture, vol. 19, Metals Park (OH), 1996.

6. Bayrakceken, H, Failure analysis of an automobile differential pinion shaft, Engineering Failure Analysis 13 (2006), pp. 14221428.

7. P.K. Mallick, S. Newman. Composite materials technology. Hanser Publishers. pp. 206-10, 1990.

8. . A. R. Abu Talib, A. Ali, M. A. Badie and et al. Developing a hybrid, carbon/glass fiber-reinforced, epoxy composite automotive drive shaft. Mater. & Des. Vol. 31, 2010, pp. 514521.

9. D.G. Lee, H.S. Kim, J.W. Kim, J.K. Kim.Design and manufacture of an automotive hybrid aluminum/composite drive shaft. Compos. Struct. Vol. 63, 2004, pp. 8799.

10. Pollard. Polymer matrix composite in drive line applications. GKN technology, Wolverhampton, 1999.

11. P Thamarai, B Karthik, Automatic Braking and Evasive Steering for Active Pedestrian Safety, Middle-East Journal of Scientific Research 20 (10), PP 1271-1276, 2014.

12. M.Bharathi, Golden Kumar,Design Approach For Pitch Axis Stabilization of 3-Dof Helicopter System an LQR Controller,International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,ISSN 2278 - 8875 , pp 351-365 ,Vol. 1, Issue 5, November 2012.

13. SRIDHAR RAJA. D ,Foliated UC-EBG UWB Bandpass filter ,International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering ,ISSN (Print) : 2320 3765,pp 3701-3708,Vol. 2, Issue 8, August 2013.