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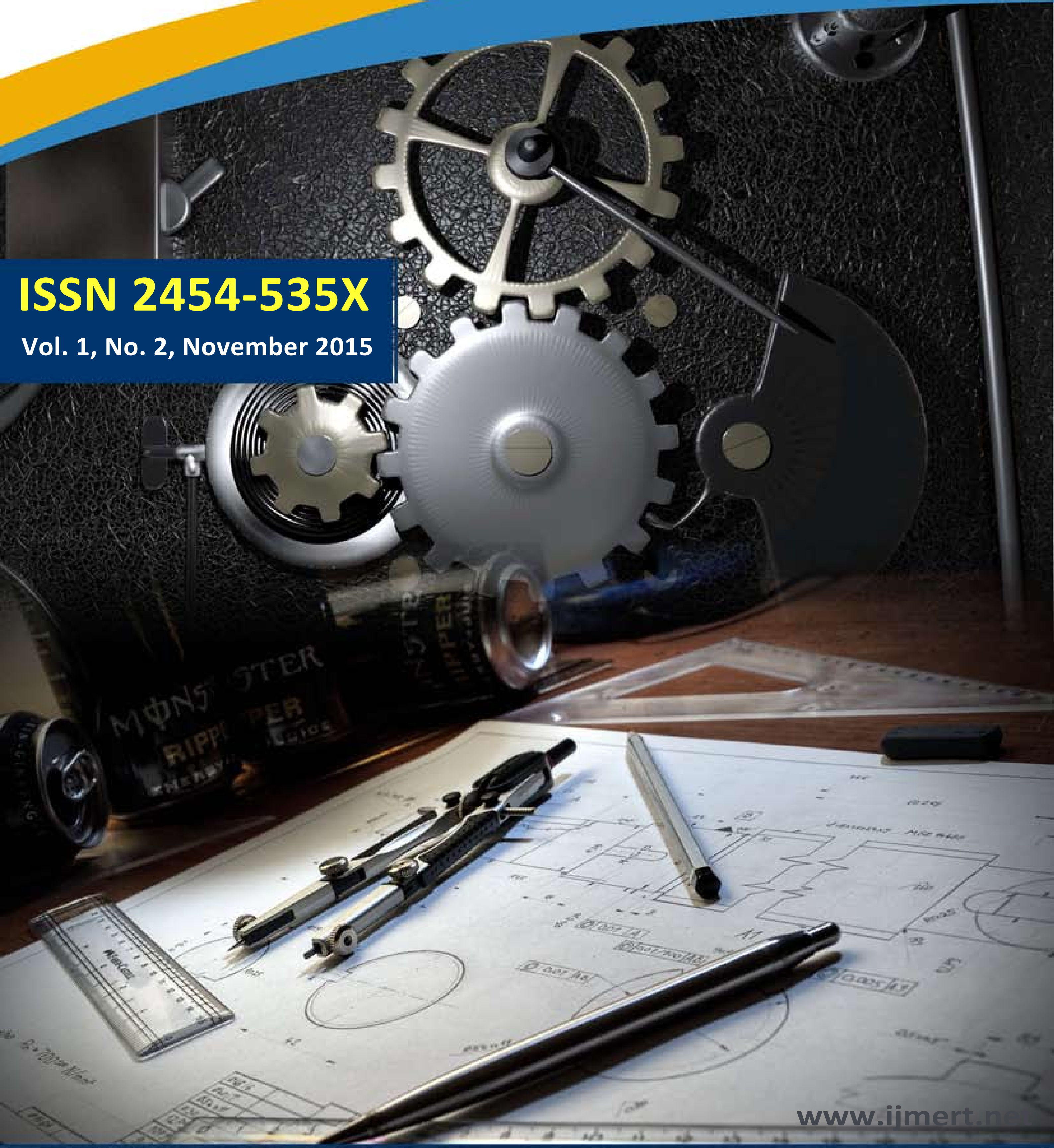

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Research Paper

DESIGNING CASTING TOOL FOR PISTON HOUSING

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An Oil filter is a filter to remove contaminants from engine oil, transmission oil, lubricating oil, or hydraulic oil. Oil filters are used in many different types of hydraulic machinery. A chief use of the oil filter is in internal-combustion engines in on- and off-road motor vehicles, light aircraft, and various naval vessels. Other vehicle hydraulic systems, such as those in automatic transmissions and power steering, are often equipped with an oil filter. Gas turbine engines, such as those on jet aircraft, require the use of oil filters. And oil production, transport, and recycling facilities employ filters. Parts of the hydraulic oil filter in our project are piston housing, shaft housing, top plate, crankshaft, and piston. The aim of the project is to model and design casting tool for piston housing which is used in a hydraulic oil filter pump having pressure 50 kg/cm^2, and temperature rating 300 deg C. In casting tool, we are designing core cavity, mould base plates. Calculations are to be done for cavity fill time, cavity fill rate, gate area, runner area, shot weight, die cooling calculations. CNC programming for core and cavity is to be done and for remaining manufacturing processes are to be done.

Keywords: Oil filter pump, Casting tool, Piston housing, 3D parametric software Pro/Engineer, CNC program

INTRODUCTION

Hydraulic machines are machinery and tools that use liquid fluid power to do simple work. Heavy equipment is a common example. In this type of machine, hydraulic fluid is transmitted throughout the machine to various hydraulic motors and hydraulic cylinders and which becomes pressurised according to the resistance present. The fluid is controlled directly or automatically by control valves and distributed through hoses and tubes. The popularity of hydraulic machinery is due to the very large amount of power that can be transferred through small tubes and flexible hoses, and the high power density and wide array of actuators that can make use of this power. Hydraulic machinery is operated by the use of hydraulics, where a liquid is the powering medium.

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An oil filter is a filter designed to remove contaminants from engine oil, transmission oil, lubricating oil, or hydraulic oil. Oil filters are used in many different types of hydraulic machinery. A chief use of the oil filter is in internal-combustion engines in on- and off-road motor vehicles, light aircraft, and various naval vessels.

Hydraulic Pump

Hydraulic pumps supply fluid to the components in the system. Pressure in the system develops in reaction to the load. Hence, a pump rated for 5,000 psi is capable of maintaining flow against a load of 5,000 psi. Pumps have a power density about ten times greater than an electric motor (by volume). They are powered by an electric motor or an engine, connected through gears, belts, or a flexible elastomeric coupling to reduce vibration.

Casting

Casting is one of the oldest procedures done on metals. Many products are formed using this method. Here is an attempt to share the knowledge of casting.

Cast Metals

The main die casting alloys are: zinc, aluminium, magnesium, copper, lead, and tin; although uncommon, ferrous die casting is possible. Specific dies casting alloys include: ZAMAK; zinc aluminium; aluminium to, e.g. The Aluminum Association (AA) standards: AA 380, AA 384, AA 386, AA 390; and AZ91D magnesium.

The minimum section thickness and minimum draft required for a casting as outlined in the table below.

Table 1

S. No.	Metal	Minimum Section	Minimum Draft
1	Aluminium alloys	0.89 mm (0.035 in)	1:100 (0.6°)
2	Brass and bronze	1.27 mm (0.050 in)	1:80 (0.7°)
3	Magnesium alloys	1.27 mm (0.050 in)	1:100 (0.6°)
4	Zinc alloys	0.63 mm (0.025 in)	1:200 (0.3°)

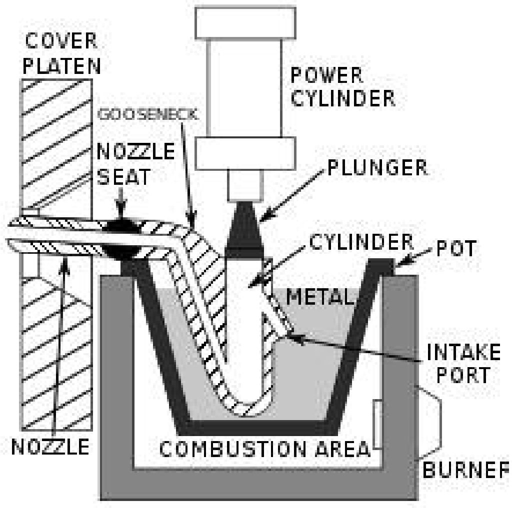
Equipment

There are two basic types of die casting machines: hot-chamber machines and cold-chamber machines. These are rated by how much clamping force they can apply. Typical ratings are between 400 and 4,000st (2,500 and 25,000 kg).

Hot-Chamber Machines

Hot-chamber machines, also known as gooseneck machines, rely upon a pool of molten metal to feed the die. At the beginning of the cycle the piston of the machine is

Figure 1: A Schematic of a Hot-Chamber Machine

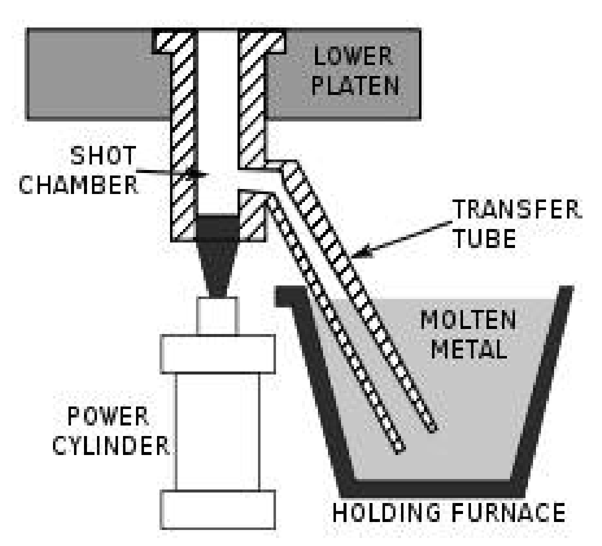


retracted, which allows the molten metal to fill the "gooseneck". The pneumatic or hydraulic powered piston then forces this metal out of the gooseneck into the die. The advantages of this system include fast cycle times (approximately 15 cycles a minute) and the convenience of melting the metal in the casting machine. The disadvantages of this system are that high-melting point metals cannot be utilized and aluminium cannot be used because it picks up some of the iron while in the molten pool. Due to this, hot-chamber machines are primarily used with zinc, tin, and lead based alloys.

Cold-Chamber Machines

Cold-chamber machines are used when the casting alloy cannot be used in hot-chamber machines; these include aluminium, zinc alloys with a large composition of aluminium, magnesium and copper. The process for these machines start with melting the metal in a separate furnace. Then a precise amount of molten metal is transported to the cold-chamber machine where it is fed into an unheated shot chamber (or injection cylinder). This shot is then driven into the die by a hydraulic or mechanical piston. This biggest disadvantage of this system is the slower cycle time due to the need to transfer the molten metal from the furnace to the cold-chamber machine.

Figure 2: A Schematic of a Cold-Chamber Die Casting Machine



Dies

Two dies are used in die casting; one is called the "cover die half" and the other the "ejector die half". Where they meet is called the parting line. The cover die contains the sprue (for hot-chamber machines) or shot hole (for cold-chamber machines), which allows the molten metal to flow into the dies; this feature matches up with the injector nozzle on the hot-chamber machines or the shot chamber in the cold-chamber machines. The ejector die contains the ejector pins and usually the runner, which is the path from the sprue or shot hole to the mold cavity. The cover die is secured to the stationary, or front, platen of the casting machine, while the ejector die is attached to the movable platen. The mold cavity is cut into two cavity inserts, which are separate pieces

Figure 3: The Cover Die Half

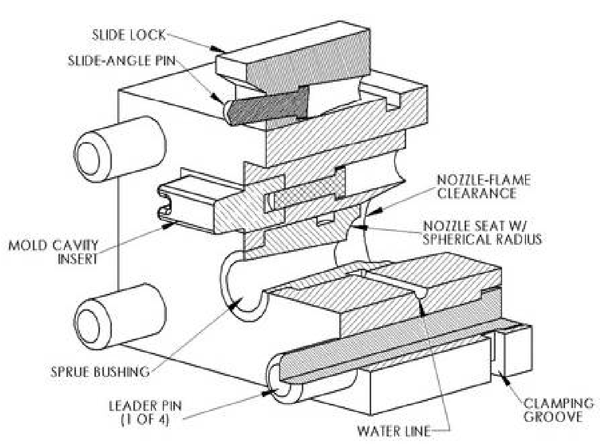
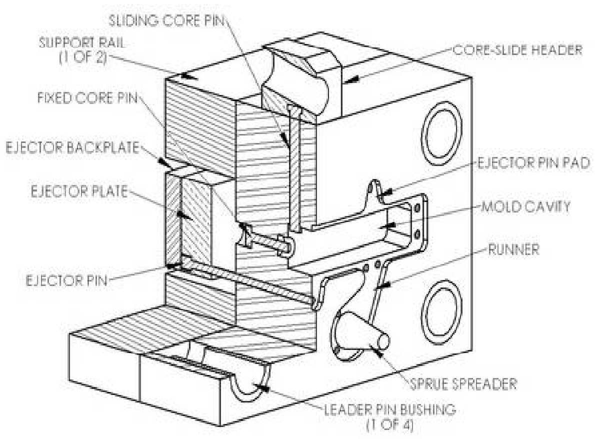


Figure 4: The Ejector Die Half



that can be replaced relatively easily and bolt into the die halves.

The dies are designed so that the finished casting will slide off the cover half of the die and stay in the ejector half as the dies are opened. This assures that the casting will be ejected every cycle because the ejector half contains the ejector pins to push the casting out of that die half. The ejector pins are driven by an ejector pin plate, which accurately drives all of the pins at the same time and with the same force, so that the casting is not damaged. The ejector pin plate also retracts the pins after ejecting the casting to prepare for the next shot. There must be enough ejector pins to keep the overall force on each pin low, because the casting is still hot and can be damaged by excessive force. The pins still leave a mark, so they must be located in places where these marks will not hamper the castings purpose.

The most important material properties for the dies are thermal shock resistance and softening at elevated temperature; other important properties include hardenability, machinability, heat checking resistance, weldability, availability (especially for larger dies), and cost. The longevity of a die is directly dependent on the temperature of the molten metal and the cycle time. The dies used in die casting are usually made out of hardened tool steels, because cast iron cannot withstand the high pressures involved, therefore the dies are very expensive, resulting in high start-up costs. Metals that are cast at higher temperatures require dies made from higher alloy steels.

The main failure mode for die casting dies is wear or erosion. Other failure modes are heat checking and thermal fatigue. Heat checking is when surface cracks occur on the die due to a large temperature change on every cycle. Thermal fatigue is when surface cracks occur on the die due to a large number of cycles.

MODELING AND CORE, CAVITY EXTRACTION IN PRO/ENGINEER

Modeling

2-D Model with dimensions

3-D Modeling of the model

Core and Cavity Extraction

Select New - Manufacturing - Mold Cavity enter name - Change units - ok.

Assemble the piston housing in to the manufacturing.

Splitting the Volume in to Core and Cavity

Cavity 1

Cavity 2

Side Cavity

Die Components

Back Plate for Cavity

<table>
<tr><th colspan="8">Table 2: Die and Component Material and Hardness for Various Cast Metals</th></tr>
<tr><th rowspan="3">S. No</th><th rowspan="3">Die Component</th><th colspan="6">Cast Metal</th></tr>
<tr><th colspan="2">Tin, Lead & Zinc</th><th colspan="2">Aluminium & Magnesium</th><th colspan="2">Copper & Brass</th></tr>
<tr><th>Material</th><th>Hardness</th><th>Material</th><th>Hardness</th><th>Material</th><th>Hardness</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">Cavity inserts</td><td>P20</td><td>290–330 HB</td><td>H13</td><td>42–48 HRC</td><td>DIN 1.2367</td><td>38–44 HRC</td></tr>
<tr><td>H11</td><td>46-50 HRC</td><td>H11</td><td>42–48 HRC</td><td>H20,H21, H22</td><td>44-48 HRC</td></tr>
<tr><td>H13</td><td>46-50 HRC</td><td rowspan="2">H13</td><td rowspan="2">44–48 HRC</td><td rowspan="2">DIN 1.2367</td><td rowspan="2">40-46 HRC</td></tr>
<tr><td>H13</td><td>46-52 HRC</td></tr>
<tr><td>2</td><td>Cores</td><td colspan="2"></td><td>DIN 1.2367</td><td>42-48 HRC</td><td></td><td></td></tr>
<tr><td>3</td><td>Core Pins</td><td>H13</td><td>48-52 HRC</td><td>DIN 1.2367 Prehard</td><td>37-40 HRC</td><td>DIN 1.2367 Prehard</td><td>37-40 HRC</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Sprue Parts</td><td rowspan="2">H13</td><td rowspan="2">48-52 HRC</td><td>H13</td><td>46-48 HRC</td><td rowspan="2">DIN 1.2367</td><td rowspan="2">42-46 HRC</td></tr>
<tr><td>DIN 1.2367</td><td>44-46 HRC</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Nozzle</td><td rowspan="2">420</td><td rowspan="2">48-52 HRC</td><td rowspan="2">H13</td><td rowspan="2">42-48 HRC</td><td>DIN 1.2367</td><td>40-44 HRC</td></tr>
<tr><td>H13</td><td>42-48 HRC</td></tr>
<tr><td>6</td><td>Ejector Pins</td><td>H13</td><td>48-52 HRC</td><td>H13</td><td>46-50 HRC</td><td>H13</td><td>46-50 HRC</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Plunger Shot Sleeve</td><td rowspan="2">H13</td><td rowspan="2">48-52 HRC</td><td>H13</td><td>42-48 HRC</td><td>DIN 1.2367</td><td>42-46 HRC</td></tr>
<tr><td>DIN 1.2367</td><td>42-48 HRC</td><td>H13</td><td>42-46 HRC</td></tr>
<tr><td>8</td><td>Holder Block</td><td>4140 Prehard</td><td>~300 HB</td><td>4140 Prehard</td><td>~300 HB</td><td>4140 Prehard</td><td>~300 HB</td></tr>
</table>

Table 3: Typical Die Temperatures and Life for Various Cast Materials

	Zinc	Aluminium	Magnesium	Brass (Leaded Yellow)
Maximum die life [number of cycles]	1,000,000	100,000	100,000	10,000
Die temperature [C° (F°)]	218 (425)	288 (550)	260 (500)	500 (950)
Casting temperature [C° (F°)]	400 (760)	660 (1220)	760 (1400)	1090 (2000)

Figure 5: 2-D Drawing of the Model

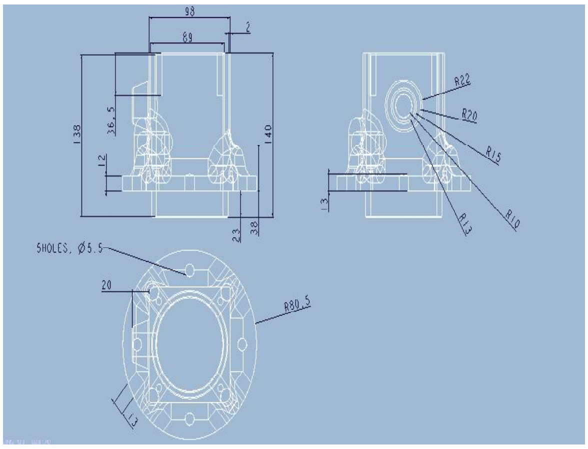


Figure 6: 3-D Model

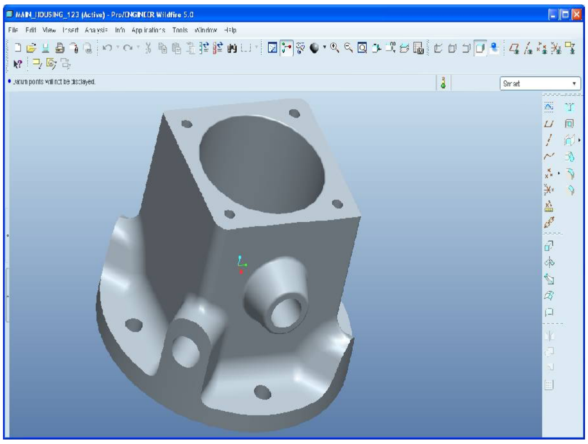


Figure 7: 3-D Model

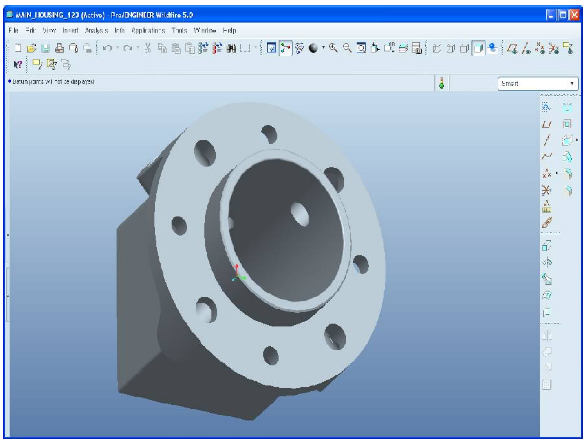


Figure 8: Assembling the Model into Manufacturing (Mold Cavity) Module Create a Work Piece and Parting Surface

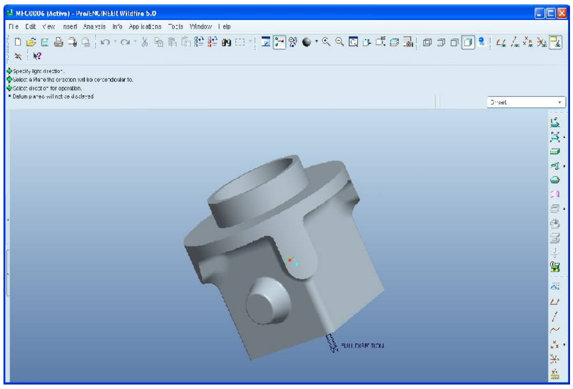


Figure 9: Work Piece and Parting Surface

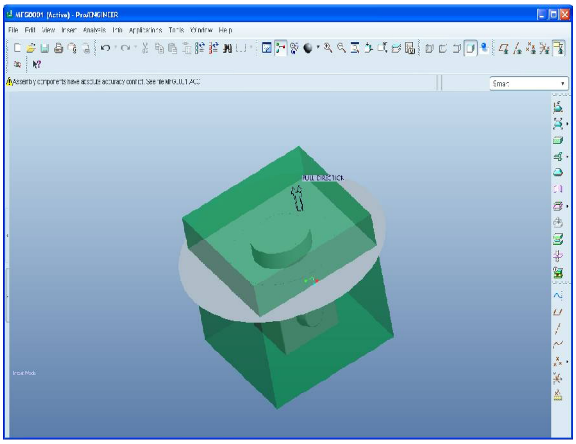


Figure 10: Cavity 1

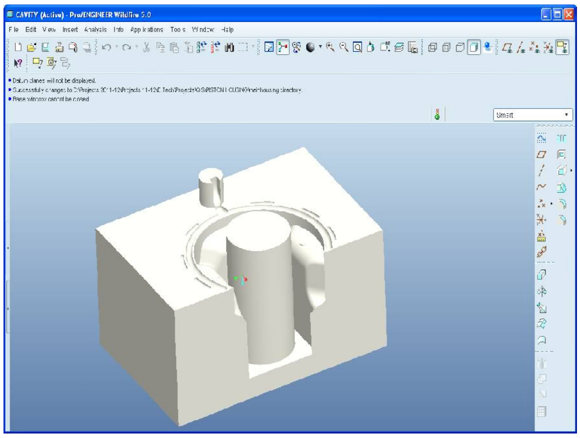


Figure 11: Cavity 2

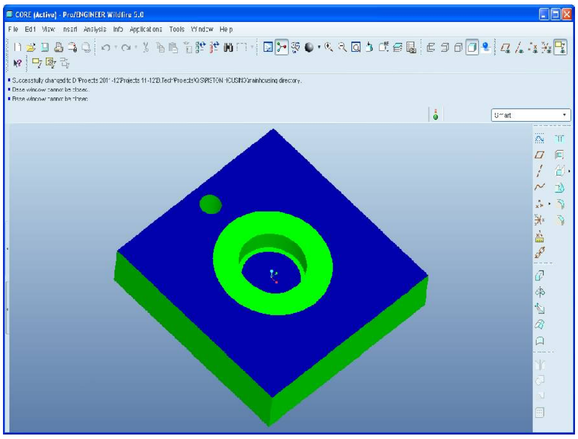


Figure 12: Side Cavity

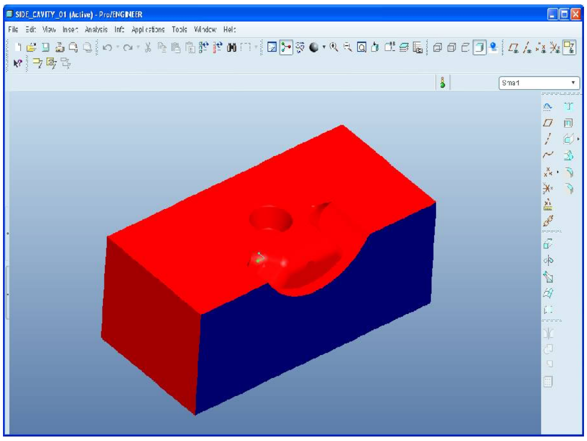


Figure 13: Back Plate

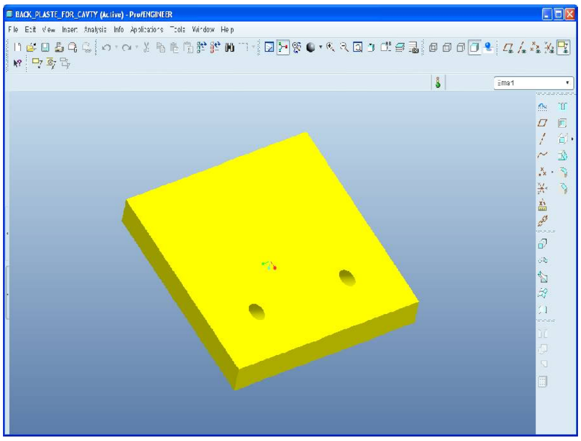


Figure 14: Angular Pins

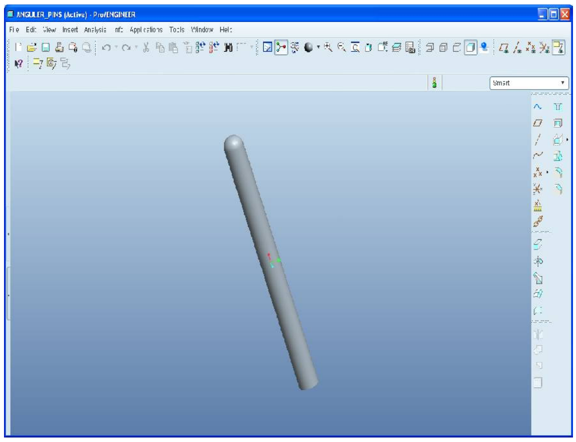


Figure 15: Spacer Housing

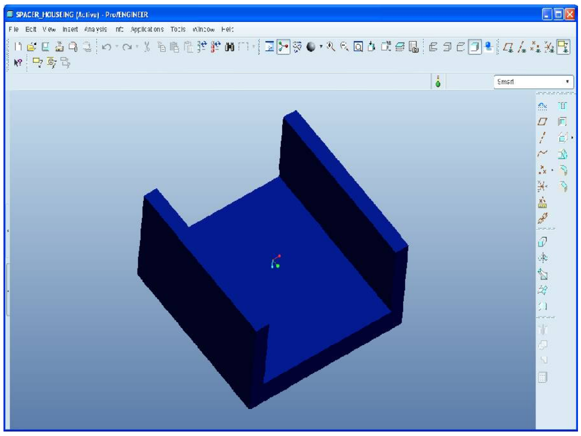


Figure 16: Plate

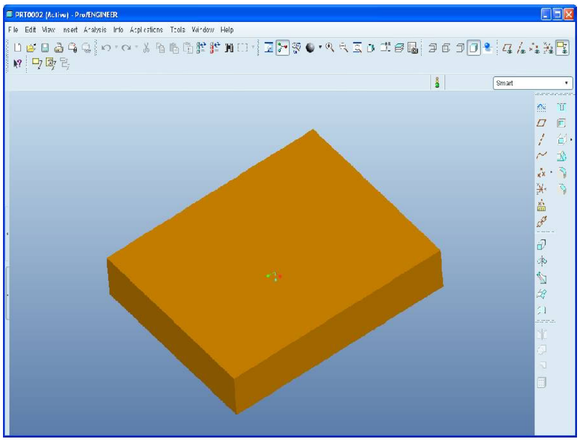


Figure 17: Total Assembly of Die

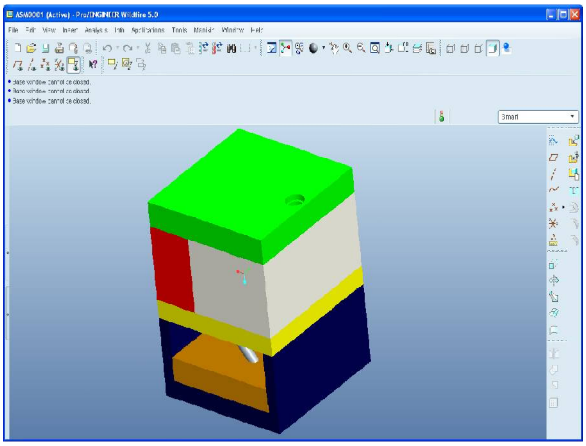


Figure 20: Work Piece for Core

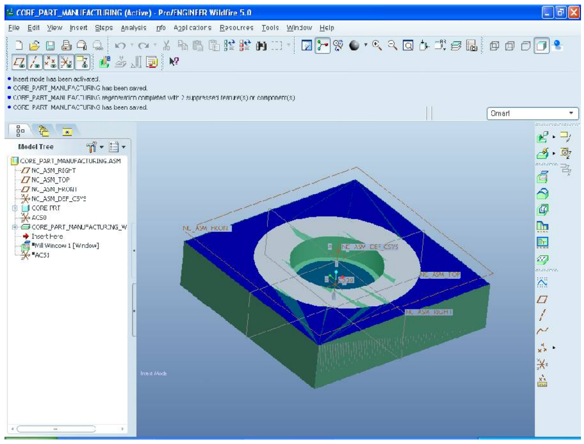


Figure 18: Exploded View

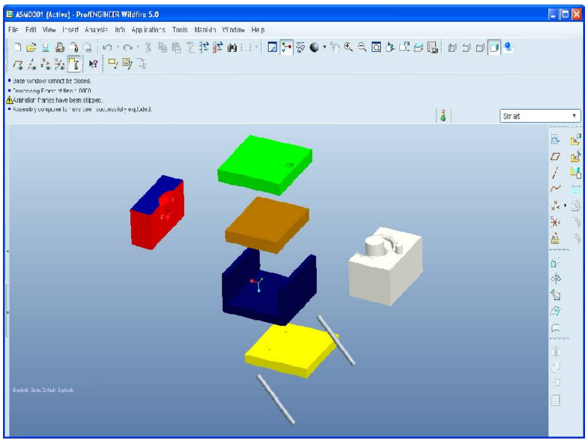


Figure 21: Cutting Tool

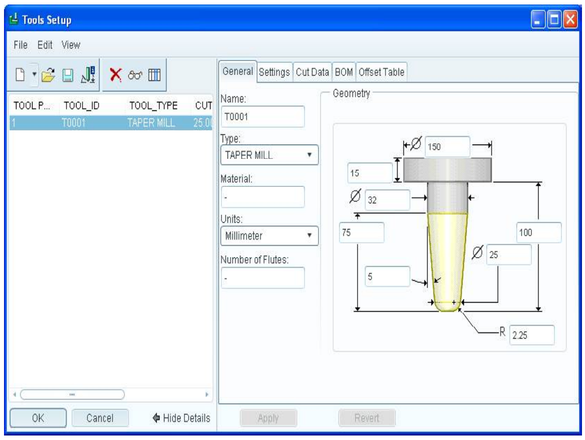


Figure 19: Core in Manufacturing (NC Assembly) Module Creating Workpiece

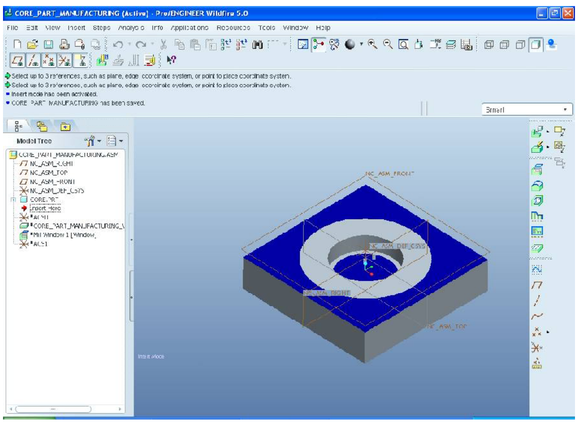


Figure 22: Parameters for Roughing

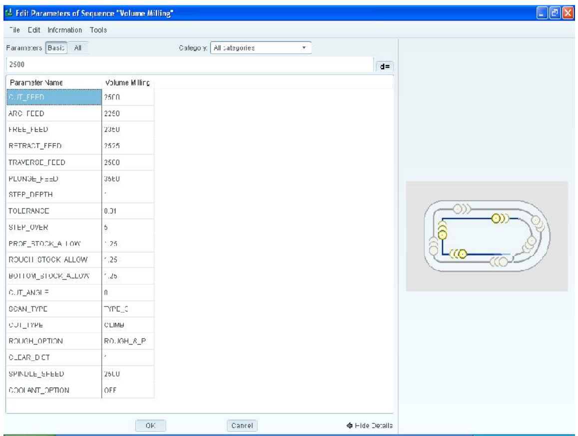


Figure 23: Play Path for Roughing

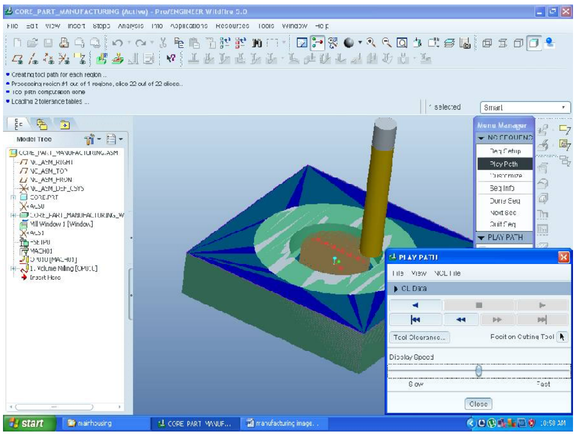
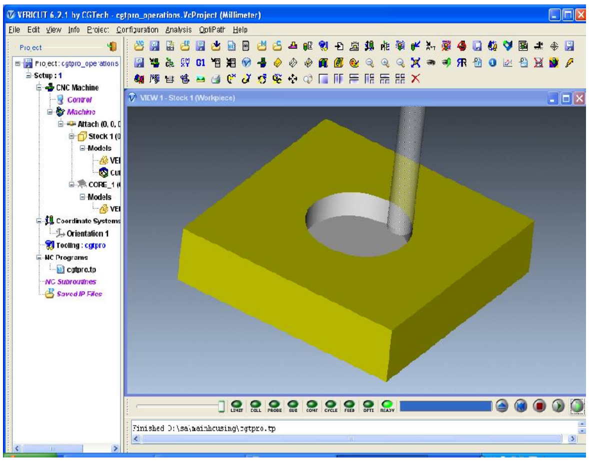


Figure 24: NC Check for Roughing



Angular Pins

Spacer Housing

Plate

Total Assembly

Total assembly of die

Exploded View

Manufacturing Process

Core

Select New - Manufacturing - NC Assembly - Enter name - Select units - ok

Retrieving the core in to manufacturing

Set up the machine tool by selecting type of machine, cutting tool, Machine zero and retract.

For Roughing

Select NC sequence - Machining - Volume - Done - Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, rough stock allow, scan type and spindle speed.

Create volume.

Select Playpath

After completing Playpath, Select NC check

Machining → CL data → NC sequence → sequence → file → MCD file.

Done . Enter name . ok . Done.

NC PROGRAM FOR ROUGHING PROCESS

%

G71

O0001

(D:\sa\pistonhousing\seq0001.ncl.1)

N0010T1M06

S2500M03

G01G43X-88.099Y-76.462Z2.5F2350.H01

Z1.

Z-1.F3560.

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G01X-81.838F2500.

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G01X-133.255F2500.

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G01X-74.937F2500.

G02X-73.078Y-95.787I-30.563J-14.532F2250.

G01X-137.922F2500.

G03X-138.99Y-100.618I32.422J-9.701F2250.

G01X-72.01F2500.

G02X-71.658Y-105.449I-33.49J-4.87F2250.

G01X-139.342F2500.

Y-105.488

G03X-139.001Y-110.28I33.842J0.F2250.

G01X-71.999F2500.

G02X-73.055Y-115.111I-33.501J4.792F2250.

G01X-137.945F2500.

G03X-136.1Y-119.942I32.445J9.623F2250.

G01X-74.9F2500.

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G02X-74.937Y-90.956I-27.755J-19.363F2250.

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G03X-137.945Y-115.111I33.501J4.792F2250.

G01X-73.055F2500.

G02X-74.9Y-119.942I-32.445J9.623F2250.

G01X-136.1F2500.

G03X-133.309Y-124.773I30.6J14.454F2250.

G01X-77.691F2500.

G02X-81.758Y-129.604I-27.809J19.285F2250.

G01X-129.242F2500.

G03X-123.03Y-134.435I23.742J24.116F2250.

G01X-87.97F2500.

G02X-103.43Y-139.266I-17.53J28.947F2250.

G01X-107.57F2500.

G03X-107.57Y-139.266I2.07J33.778F2250.

G01Z-4.F3560.

X-103.43F2500.

G03X-87.97Y-134.435I-2.07J33.778F2250.

G01X-123.03F2500.

G02X-129.242Y-129.604I17.53J28.947F2250.

G01X-81.758F2500.

G03X-77.691Y-124.773I-23.742J24.116F2250.

G01X-133.309F2500.

G02X-136.1Y-119.942I27.809J19.285F2250.

G01X-74.9F2500.

G03X-73.055Y-115.111I-30.6J14.454F2250.

G01X-137.945F2500.

G02X-139.001Y-110.28I32.445J9.623F2250.

G01X-71.999F2500.

G03X-71.658Y-105.488I-33.501J4.792F2250.

G01Y-105.449F2500.

X-139.342

G02X-138.99Y-100.618I33.842J-.039F2250.

G01X-72.01F2500.

G03X-73.078Y-95.787I-33.49J-4.87F2250.

G01X-137.922F2500.

G02X-136.063Y-90.956I32.422J-9.701F2250.

G01X-74.937F2500.

G03X-77.745Y-86.125I-30.563J-14.532F2250.

G01X-133.255F2500.

G02X-129.162Y-81.294I27.755J-19.363F2250.

G01X-81.838F2500.

G03X-88.099Y-76.462I-23.662J-24.194F2250.

G01X-122.901F2500.

G03X-122.901Y-76.462I17.401J-29.026F2250.

G01Z-5.F3560.

X-88.099F2500.

G02X-81.838Y-81.294I-17.401J-29.026F2250.

G01X-129.162F2500.

G03X-133.255Y-86.125I23.662J-24.194F2250.

G01X-77.745F2500.

G02X-74.937Y-90.956I-27.755J-19.363F2250.

G01X-136.063F2500.

G03X-137.922Y-95.787I30.563J-14.532F2250.

G01X-73.078F2500.

G02X-72.01Y-100.618I-32.422J-9.701F2250.

G01X-138.99F2500.

G03X-139.342Y-105.449I33.49J-4.87F2250.

G01X-71.658F2500.

Y-105.488

G02X-71.999Y-110.28I-33.842J0.F2250.

G01X-139.001F2500.

G03X-137.945Y-115.111I33.501J4.792F2250.

G01X-73.055F2500.

G02X-74.9Y-119.942I-32.445J9.623F2250.

G01X-136.1F2500.

G03X-133.309Y-124.773I30.6J14.454F2250.

G01X-77.691F2500.

G02X-81.758Y-129.604I-27.809J19.285F2250.

G01X-129.242F2500.

G03X-123.03Y-134.435I23.742J24.116F2250.

G01X-87.97F2500.

G02X-103.43Y-139.266I-17.53J28.947F2250.

G01X-107.57F2500.

```
G01X-136.063F2500.
G03X-137.922Y-95.787I30.563J-14.532F2250.
G01X-73.078F2500.
G02X-72.01Y-100.618I-32.422J-9.701F2250.
G01X-138.99F2500.
G03X-139.342Y-105.449I33.49J-4.87F2250.
G01X-71.658F2500.
Y-105.488
G02X-71.999Y-110.28I-33.842J0.F2250.
G01X-139.001F2500.
G03X-137.945Y-115.111I33.501J4.792F2250.
G01X-73.055F2500.
G02X-74.9Y-119.942I-32.445J9.623F2250.
G01X-136.1F2500.
G03X-133.309Y-124.773I30.6J14.454F2250.
G01X-77.691F2500.
G02X-81.758Y-129.604I-27.809J19.285F2250.
G01X-129.242F2500.
G03X-123.03Y-134.435I23.742J24.116F2250.
G01X-87.97F2500.
G02X-103.43Y-139.266I-17.53J28.947F2250.
G01X-107.57F2500.
G03X-107.57Y-139.266I2.07J33.778F2250.
G01Z-21.796F3560.
X-103.43F2500.
G03X-87.97Y-134.435I-2.07J33.778F2250.
G01X-123.03F2500.
G02X-129.242Y-129.604I17.53J28.947F2250.
G01X-81.758F2500.
G03X-77.691Y-124.773I-23.742J24.116F2250.
G01X-133.309F2500.
G02X-136.1Y-119.942I27.809J19.285F2250.
G01X-74.9F2500.
G03X-73.055Y-115.111I-30.6J14.454F2250.
G01X-137.945F2500.
G02X-139.001Y-110.28I32.445J9.623F2250.
G01X-71.999F2500.
G03X-71.658Y-105.488I-33.501J4.792F2250.
G01Y-105.449F2500.
X-139.342
G02X-138.99Y-100.618I33.842J-.039F2250.
G01X-72.01F2500.
G03X-73.078Y-95.787I-33.49J-4.87F2250.
G01X-137.922F2500.
G02X-136.063Y-90.956I32.422J-9.701F2250.
G01X-74.937F2500.
G03X-77.745Y-86.125I-30.563J-14.532F2250.
G01X-133.255F2500.
G02X-129.162Y-81.294I27.755J-19.363F2250.
G01X-81.838F2500.
```

G03X-88.099Y-76.462I-23.662J-24.194F2250.

G01X-122.901F2500.

G03X-122.901Y-76.462I17.401J-29.026F2250.

G01Z2.5F2525.

M30

%

For Finishing

Select NC sequence - Machining - Finishing - Done - Select tool and enter parameters like

Figure 25: Parameters for Finishing

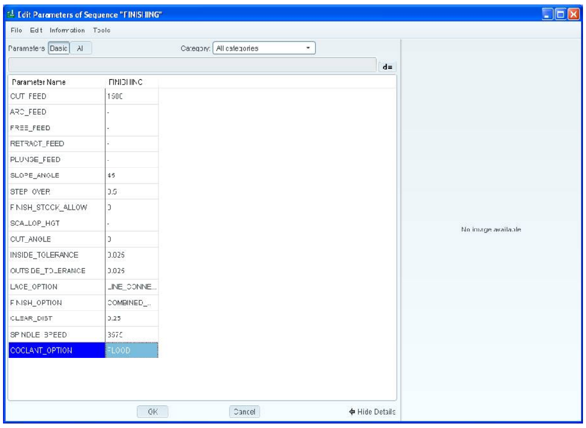
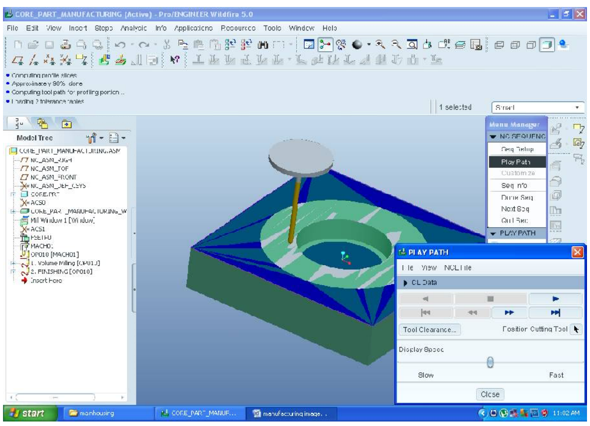


Figure 26: Play Path for Finishing



Cut feed, Step depth, Step over, Profile stock allow, scan type and spindle speed.

Type of Cutter - 8 R0.5 Bull nose cutter

Create volume and Select Playpath

After completing Playpath, Select NC check

Machining → CL data → NC sequence → sequence → file → MCD file.

Done . Enter name . ok . Done.

NC PROGRAM FOR FINISHING PROCESS

%

G71

O0002

(D:\sa\pistonhousing\seq0002.ncl.1)

N0010T1M06

S3575M03

G00X-68.866Y-142.971

G43Z2.5H01M08

Z.75

G01Z0.F1500.

X-68.01

X-68.011Y-141.263

X-68.856Y-142.127

X-69.722Y-142.971

X-68.866

X-68.709Y-143.008

X-68.567Y-143.101

X-68.298Y-143.342

X-68.157Y-143.434

X-68.Y-143.471

X-67.51
X-67.511Y-139.994
X-68.635Y-141.19
X-69.796Y-142.349
X-70.993Y-143.47
X-68.Y-143.471
X-67.843Y-143.508
X-67.701Y-143.601
X-67.432Y-143.842
X-67.29Y-143.934
X-67.133Y-143.972
X-67.01
X-67.012Y-138.678
X-68.263Y-140.073
X-69.565Y-141.421
X-70.916Y-142.721
X-72.313Y-143.97
X-67.133Y-143.972
X-67.03Y-144.009
X-66.949Y-144.101
X-66.809Y-144.342
X-66.728Y-144.435
X-66.625Y-144.472
X-66.51
X-66.512Y-137.307
X-67.783Y-138.8
X-69.112Y-140.243
X-70.495Y-141.634
X-71.931Y-142.969
X-73.418Y-144.248
X-73.693Y-144.469
X-66.625Y-144.472
X-66.522Y-144.509
X-66.442Y-144.601
X-66.306Y-144.842
X-66.226Y-144.935
X-66.123Y-144.972
X-66.01
X-66.013Y-135.875
X-67.412Y-137.606
X-68.886Y-139.274
X-70.434Y-140.874
X-72.051Y-142.404
X-73.734Y-143.861
X-74.429Y-144.421
X-75.133Y-144.969
X-66.123Y-144.972
X-66.02Y-145.009
X-65.941Y-145.102
X-65.805Y-145.342
X-65.725Y-145.435
X-65.623Y-145.472
X-65.51
X-65.513Y-134.372
X-66.772Y-136.035
X-68.1Y-137.643
X-69.495Y-139.194
X-70.953Y-140.684

X-72.473Y-142.112
X-74.052Y-143.475
X-75.332Y-144.492
X-76.643Y-145.469
X-65.623Y-145.472
X-65.52Y-145.509
X-65.44Y-145.602
X-65.304Y-145.843
X-65.225Y-145.935
X-65.122Y-145.972
X-65.009
X-65.014Y-132.787
X-66.165Y-134.416
X-67.381Y-135.997
X-68.661Y-137.527
X-70.002Y-139.003
X-71.402Y-140.424
X-72.859Y-141.787
X-74.37Y-143.089
X-75.627Y-144.088
X-76.915Y-145.048
X-78.231Y-145.968
X-65.122Y-145.972
X-65.02Y-146.009
X-64.94Y-146.102
X-64.804Y-146.343
X-64.725Y-146.435
X-64.622Y-146.472
X-64.509
X-64.514Y-131.105
X-65.576Y-132.725
X-66.701Y-134.3
X-67.889Y-135.83
X-69.137Y-137.311
X-70.443Y-138.741
X-71.805Y-140.118
X-73.22Y-141.439
X-74.688Y-142.703
X-76.376Y-144.029
X-78.118Y-145.285
X-148.94Y-101.898
X-149.044Y-103.46
X-149.092Y-105.313
X-149.089Y-105.488
X-149.092Y-105.491
X-149.072Y-106.811
X-149.014Y-108.069
X-148.988Y-108.444
X-148.919Y-109.332
X-148.896Y-109.606
X-148.757Y-110.878
X-148.684Y-111.401
X-148.55Y-112.34
X-148.297Y-113.774
X-148.036Y-115.008
X-147.97Y-115.307
X-147.647Y-116.612
X-147.208Y-118.166

X-146.727Y-119.651

X-146.219Y-121.045

X-146.153Y-121.22

X-145.585Y-122.619

X-145.549Y-122.698

X-144.948Y-124.035

X-144.896Y-124.147

X-144.166Y-125.617

X-143.36Y-127.095

X-142.493Y-128.548

X-142.384Y-128.716

X-141.595Y-129.926

X-141.409Y-130.195

X-140.528Y-131.435

X-139.447Y-132.835

X-138.364Y-134.124

X-137.598Y-134.97

X-137.151Y-135.459

X-136.964Y-135.654

X-135.798Y-136.829

X-134.452Y-138.077

X-133.083Y-139.242

X-132.53Y-139.677

X-131.624Y-140.383

X-131.406Y-140.542

X-130.056Y-141.505

X-128.482Y-142.53

X-127.034Y-143.385

X-126.756Y-143.543

X-125.327Y-144.306

X-123.485Y-145.197

X-121.743Y-145.94

X-120.047Y-146.579

X-119.149Y-146.877

X-118.223Y-147.181

X-117.325Y-147.435

X-116.356Y-147.706

X-115.482Y-147.911

Z2.5

M30

%

Cavity

Select New - Manufacturing - NC Assembly - Enter name - Select units - ok

Retrieving the cavity in to manufacturing

Creating Workpiece

Set up the machine tool by selecting type of machine, cutting tool, Machine zero and retract.

Figure 27: Cavity in Manufacturing (NC Assembly) Module

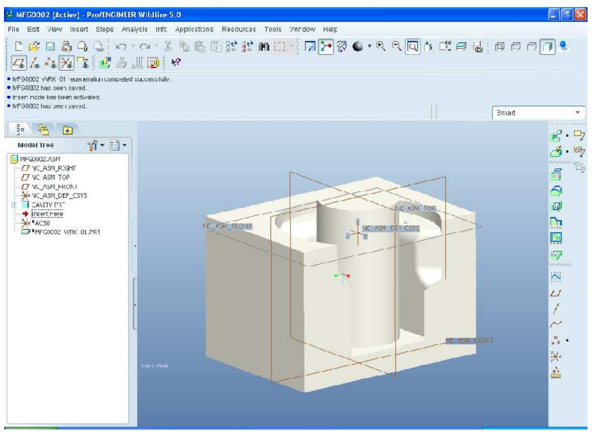
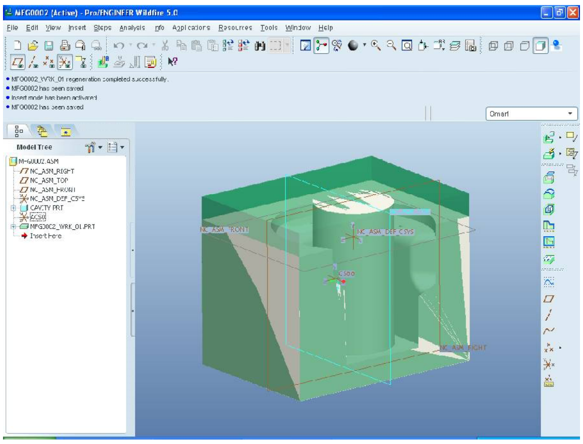


Figure 28: Work Piece for Cavity



For Roughing

Select NC sequence - Machining - Volume - Done - Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, rough stock allow, scan type and spindle speed.

Create volume.

Select Playpath

After completing Playpath, Select NC check

Machining → CL data → NC sequence → sequence → file → MCD file.

Done . Enter name . ok . Done.

Figure 29: Playpath for Roughing

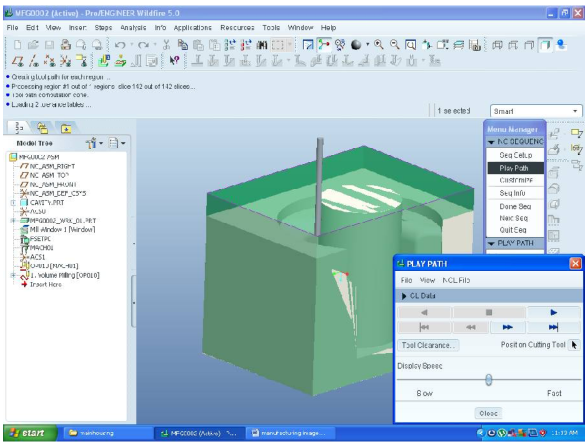
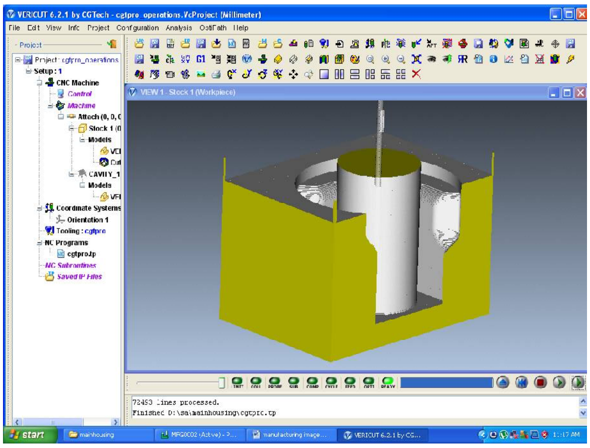


Figure 30: NC Check for Roughing



NC PROGRAM

%

G71

O0003

(D:\sa\pistonhousing\seq2001.ncl.1)

N0010T1M06

S2500M03

G00X-2.893Y-2.866

G43Z0.H01

G01Z-1.F2500.

X-208.107

Y-3.865

X-2.893

Y-4.864

X-208.107

Y-5.863

X-2.893

Y-6.863

X-97.011

G02X-93.032Y-7.862I-8.489J-42.235

G01X-2.893

Y-8.861

X-90.11

G02X-87.717Y-9.86I-15.39J-40.237

G01X-2.893

Y-10.859

X-85.659

G02X-83.842Y-11.858I-19.841J-38.239

G01X-2.893

Y-12.857

X-82.209

X-80.723Y-13.856

X-2.893

Y-14.855

X-79.36

X-78.1Y-15.854

X-2.893

Y-16.854

X-76.931

/X-75.842Y-17.853

X-2.893

Y-18.852X-147.142Y-34.636

X-151.598

Y-35.628

X-147.474

X-147.779Y-36.621

X-151.598

Y-37.614

X-148.06

X-148.315Y-38.607

X-151.598

Y-39.6

X-148.546

X-148.754Y-40.592

X-151.598

Y-41.585

X-148.937

X-149.097Y-42.578

X-151.598

Y-43.571

X-149.234

X-149.348Y-44.564

X-151.598

Y-45.556

X-149.439

X-149.508Y-46.549

X-151.598

Y-47.542

X-149.554

X-149.578Y-48.535

X-151.598

Y-49.527

X-149.58

X-149.559Y-50.52

X-151.598

Y-51.513

X-149.516

X-149.45Y-52.506

X-151.598
Y-53.499
X-149.362
X-149.251Y-54.491
X-151.598
Y-55.484
X-149.117
X-148.96Y-56.477
X-151.598
Y-57.47
X-148.78
X-148.576Y-58.463
X-151.598
Y-59.455
X-148.348
X-148.096Y-60.448
X-151.598
Y-61.441
X-147.819
X-147.516Y-62.434
X-151.598
Y-63.427
X-147.188
X-146.834Y-64.419
X-151.598
Y-65.412
X-146.452
X-146.042Y-66.405
X-151.598
Y-67.398
X-145.604
X-145.136Y-68.391
X-151.598
Y-69.383
X-144.637
X-144.106Y-70.376
X-151.598
Y-71.369
X-143.542
X-142.943Y-72.362
X-151.598
Y-73.355
X-142.308
X-141.634Y-74.347
X-151.598
Y-75.34
X-140.92
X-140.162Y-76.333
X-151.598
Y-77.326
X-139.359
X-138.506Y-78.319
X-151.598
Y-79.311
X-137.599
X-136.635Y-80.304
X-151.598
Y-81.297

X-135.607

X-134.509Y-82.29

X-151.598

Y-83.282

X-133.332

X-132.066Y-84.275

X-151.598

Y-85.268

X-130.698

X-129.21Y-86.261

X-151.598

Y-87.254

X-127.576

G03X-125.764Y-88.246I22.076J38.156

G01X-151.598

Y-89.239

X-123.718

G03X-121.35Y-90.232I18.218J40.141

G01X-151.598

Y-91.225

X-118.483

G03X-114.661Y-92.218I12.983J42.127

G01X-151.598

Y-93.21

X-59.952

X-151.598

Y-94.203

X-60.773

G02X-63.416Y-95.196I-2.643J3.021

G01X-151.598

X-149.582Y-49.098

G02X-149.582Y-49.098I44.082J0.

G01Z0.

G00X-147.584Y-2.996

Z-139.07

G01Z-140.28

G03X-151.598Y-7.014I.005J-4.019

G01Y-95.196

X-63.416

G03X-59.402Y-91.182I0.J4.014

G01Y-2.866

Z0.

M30

%

For Finishing

Select NC sequence - Machining - Finishing - Done - Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, scan type and spindle speed.

Create volume and Select Playpath

Figure 31: Playpath for Finishing

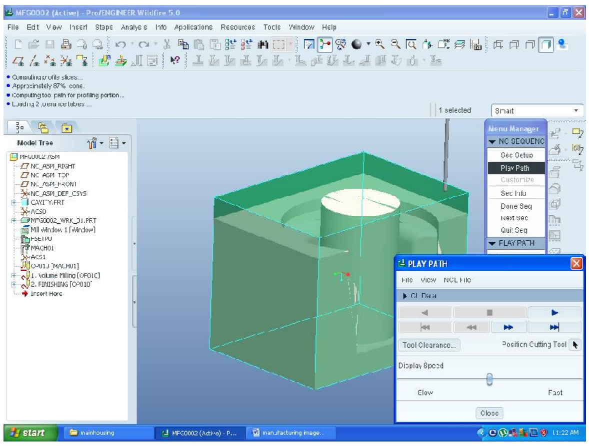
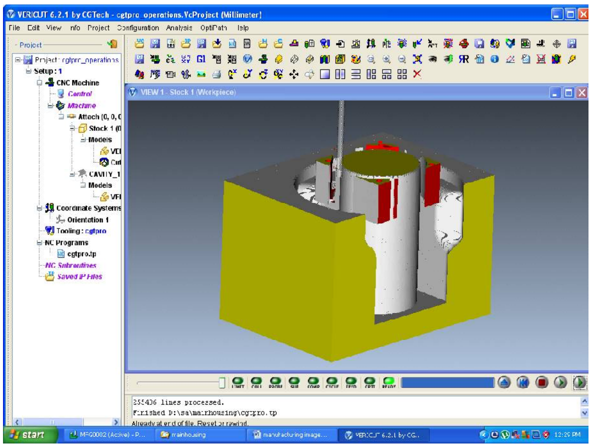


Figure 32: NC Check for Finishing



After completing Playpath, Select NC check

Machining $\rightarrow$ CL data $\rightarrow$ NC sequence $\rightarrow$ sequence $\rightarrow$ file $\rightarrow$ MCD file.

Done . Enter name . ok . Done.

NC PROGRAM

%

G71

O0004

(D:\sa\pistonhousing\seq2002.ncl.1)

N0010T1M06

S3500M03

G00X-194.399Y-17.749

G43Z0.H01

Z-21.546

G01Z-23.046F2500.

Y-18.923

X-193.99Y-17.746

X-193.566Y-16.574

X-194.399

Y-17.749

X-194.436Y-17.906

X-194.528Y-18.047

X-194.769Y-18.316

X-194.862Y-18.458

X-194.899Y-18.615

Y-22.12

X-194.26Y-20.09

X-193.576Y-18.074

X-192.845Y-16.074

X-194.899

Y-18.615

X-194.936Y-18.772

X-195.028Y-18.914

X-195.269Y-19.183

X-195.362Y-19.325

X-195.399Y-19.482

Y-25.751

X-194.689Y-23.172

X-193.905Y-20.615

X-193.048Y-18.082

X-192.119Y-15.574

X-195.399

Y-19.482

X-195.436Y-19.639

X-195.528Y-19.78

X-195.769Y-20.049

X-195.862Y-20.191

X-195.899Y-20.348

X-104.617Y-105.093

X-104.265Y-105.138
X-103.918Y-105.205
X-103.236Y-105.392
X-102.901Y-105.503
X-102.572Y-105.637
X-101.934Y-105.949
X-101.628Y-106.121
X-101.324Y-106.32
Z-35.545
G00X-107.095Y-105.137
Z-36.045
G01Z-37.045
X-106.748Y-105.07
X-106.395Y-105.024
X-105.676Y-104.967
X-105.325
X-104.605Y-105.024
X-104.252Y-105.07
X-103.905Y-105.137
X-103.407Y-105.271
Z-35.045
G00X-45.506Y-54.994
G01Z-35.545
X-45.806Y-54.811
X-46.096Y-54.609
X-46.564Y-54.244
X-46.825Y-54.007
X-47.069Y-53.755
X-47.458Y-53.31
X-47.671Y-53.025
X-47.864Y-52.73
X-48.161Y-52.222
X-48.314Y-51.903
X-48.533Y-51.352
X-48.645Y-51.017
X-48.734Y-50.678
X-48.845Y-50.097
X-48.89Y-49.745
X-48.913Y-49.392
Y-48.804
X-48.89Y-48.451
X-48.845Y-48.099
X-48.734Y-47.518
X-48.645Y-47.179
X-48.533Y-46.844
X-48.314Y-46.293
X-48.161Y-45.974
X-47.989Y-45.668
X-47.671Y-45.171
X-47.458Y-44.886
X-47.229Y-44.616
X-46.825Y-44.188
X-46.564Y-43.952
X-46.286Y-43.731
X-45.806Y-43.384
X-45.506Y-43.202
X-45.357Y-43.125
Z-35.045

```
G00X-47.119Y-54.331
G01Z-36.045
X-47.364Y-54.078
X-47.807Y-53.573
X-48.02Y-53.289
X-48.38Y-52.723
X-48.552Y-52.417
X-48.705Y-52.098
X-48.954Y-51.472
X-49.065Y-51.137
X-49.154Y-50.797
X-49.28Y-50.138
X-49.325Y-49.785
X-49.348Y-49.433
Y-48.763
X-49.325Y-48.411
X-49.28Y-48.059
X-49.154Y-47.399
X-49.065Y-47.059
X-48.954Y-46.724
X-48.705Y-46.098
X-48.552Y-45.779
X-48.38Y-45.473
X-48.02Y-44.907
X-47.807Y-44.623
X-47.578Y-44.353
X-47.119Y-43.865
X-47.016Y-43.772
Z-35.045
G00X-48.564Y-52.814
Z-35.545
G01Z-36.545
X-48.736Y-52.508
X-48.889Y-52.189
X-49.151Y-51.528
X-49.263Y-51.193
X-49.352Y-50.853
X-49.484Y-50.156
X-49.53Y-49.804
X-49.553Y-49.452
Y-48.744
X-49.53Y-48.392
X-49.484Y-48.04
X-49.352Y-47.342
X-49.263Y-47.003
X-49.151Y-46.668
X-48.889Y-46.007
X-48.736Y-45.688
X-48.564Y-45.382
X-48.278Y-44.928
Z-35.545
G00X-49.419Y-50.872
Z-36.045
G01Z-37.045
X-49.554Y-50.163
X-49.599Y-49.811
X-49.622Y-49.458
Y-48.738
```

X-49.599Y-48.385

X-49.554Y-48.033

X-49.419Y-47.323

X-49.33Y-46.984

Z0.

M30

%

Side Cavity

Select New - Manufacturing - NC Assembly - Enter name - Select units - ok

Retrieving the side cavity in to manufacturing

Creating Workpiece

Set up the machine tool by selecting type of machine, cutting tool, Machine zero and retract.

For Roughing

Select NC sequence - Machining - Volume - Done - Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, rough stock allow, scan type and spindle speed.

Figure 33: Side Cavity in Manufacturing (NC Assembly) Module

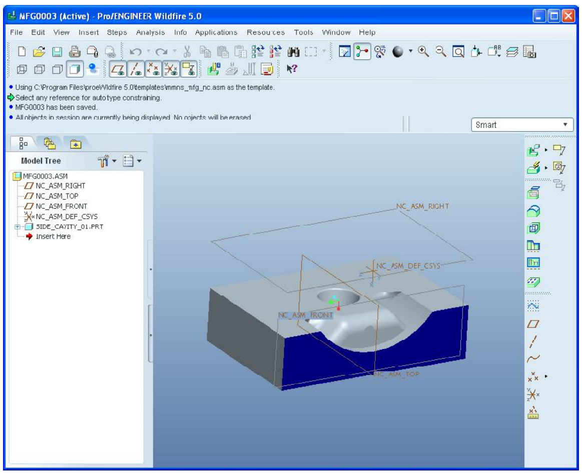


Figure 34: Work Piece for Side Cavity

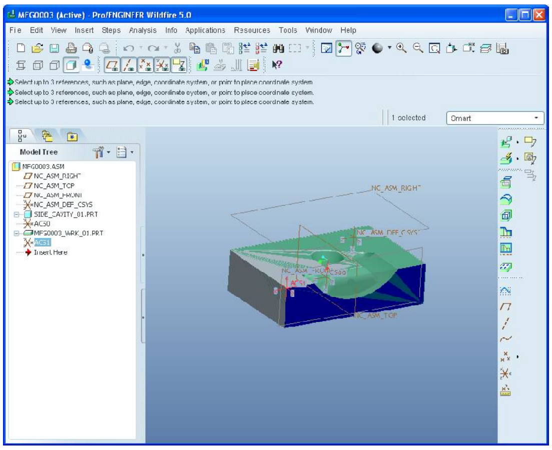


Figure 35: Playpath for Roughing

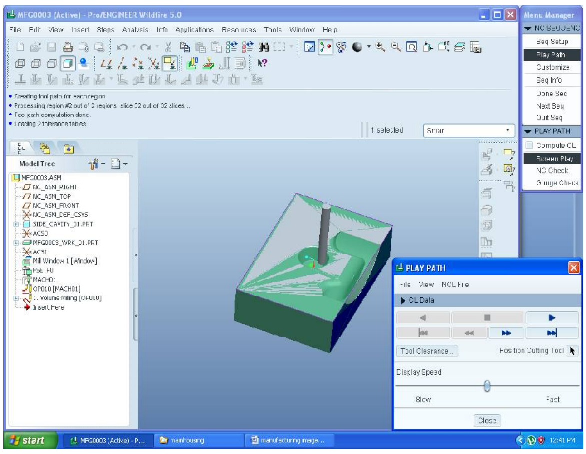
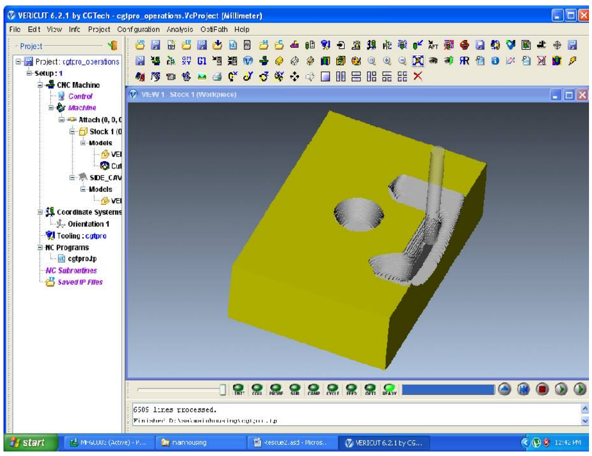


Figure 36: NC Check for Roughing



Create volume and Select Play path

After completing Playpath, Select NC check

Machining → CL data → NC sequence → sequence → file → MCD file.

Done . Enter name . ok . Done.

NC PROGRAM

```
%
G71
O0003
(D:\sa\pistonhousing\seq2003.ncl.1)
N0010T1M06
S5000M03
G00X111.616Y-139.396
G43Z0.H01
G01X111.854Y-140.92Z-1.753F200.
X112.545Y-142.3Z-2.34
X113.625Y-143.402Z-2.684
X114.989Y-144.124Z-2.874
X116.508Y-144.395Z-2.94
X116.616Y-144.396
G03X116.616Y-144.396I0.J5.
G02X120.025Y-146.076I0.J-4.3
G01X120.153Y-146.242
G03X123.68Y-146.474I1.865J1.433
X116.616Y-149.396I-7.064J7.078
G02X120.228Y-151.363I0.J-4.3
G01X120.353Y-151.557
G03X123.997Y-152.454I2.298J1.484
X116.616Y-154.396I-7.381J13.058
G02X120.313Y-156.501I0.J-4.3
G01X120.342Y-156.549
G03X124.298Y-157.861I2.734J1.624
X116.616Y-159.396I-7.682J18.465
G02X120.34Y-161.546I0.J-4.3
G01X120.474Y-161.779
G03X124.192Y-163.22I2.755J1.59
X116.616Y-164.396I-7.576J23.824
G02X120.34Y-166.546I0.J-4.3
G01X120.376Y-166.608
55.984Y-107.449
G03X249.995Y-98.248I-78.935J-44.833
G01X248.896Y-97.165Z-10.886
X247.519Y-96.468Z-10.702
X245.996Y-96.224Z-10.363
X244.47Y-96.457Z-9.788
X243.088Y-97.143Z-8.442
X243.001Y-97.206Z-7.945
Z-1.945
G00X237.162Y-205.787
Z-4.945
G01Z-7.945
X238.092Y-207.018Z-9.734
X239.353Y-207.907Z-10.332
X240.825Y-208.37Z-10.684
X242.368Y-208.361Z-10.877
X243.835Y-207.883Z-10.945
X243.931Y-207.833
G03X249.297Y-204.421I-20.16J37.632
G01X251.861Y-202.359
```

```
X252.422Y-201.866
G03X266.136Y-139.266I-135.326J62.448
G01X266.108Y-136.141
X265.993Y-133.019
X265.698Y-131.775
X264.848Y-128.564
X263.904Y-125.38
X262.586Y-121.544
X260.806Y-117.109
X260.008Y-115.301
X258.674Y-112.57
X257.792Y-111.305Z-10.886
X256.565Y-110.369Z-10.702
X255.111Y-109.851Z-10.363
X253.569Y-109.801Z-9.788
X252.085Y-110.224Z-8.442
X251.988Y-110.271Z-7.945
Z-1.945
G00X245.482Y-201.346
Z-4.945
G01Z-7.945
X246.681Y-202.316Z-9.734
X248.119Y-202.875Z-10.332
X249.659Y-202.969Z-10.684
X251.155Y-202.589Z-10.877
X252.463Y-201.771Z-10.945
X252.544Y-201.699
X254.009Y-200.373
X256.309Y-197.915
X258.546Y-195.2
G02X261.59Y-192.804I8.912J-8.187
G03X266.814Y-175.565I-138.893J51.501
G01X267.464Y-170.904
X267.677Y-169.138
X268.148Y-164.223
X268.408Y-158.971
X268.437Y-157.969
X268.434Y-153.158
X268.398Y-151.88
X268.152Y-147.299
X267.845Y-144.275
X267.496Y-141.256
X266.701Y-136.339
X266.053Y-133.487
X265.483Y-132.054Z-10.886
X264.502Y-130.862Z-10.702
X263.206Y-130.026Z-10.363
X261.716Y-129.625Z-9.788
X260.174Y-129.698Z-8.442
X260.069Y-129.72Z-7.945
Z-1.945
G00X254.792Y-190.855
Z-4.945
G01Z-7.945
X255.74Y-192.073Z-9.734
X257.014Y-192.944Z-10.332
X258.492Y-193.385Z-10.684
X260.035Y-193.354Z-10.877
```

X261.495Y-192.855Z-10.945
X261.59Y-192.804
G02X266.363Y-191.335I5.868J-10.583
X265.523Y-181.146I10.654J6.008
G01X266.28Y-178.252
X266.525Y-176.911
X266.565Y-175.369Z-10.886
X266.133Y-173.888Z-10.702
X265.269Y-172.609Z-10.363
X264.057Y-171.654Z-9.788
X262.612Y-171.115Z-8.442
X262.505Y-171.094Z-7.945
Z-1.945
G00X124.95Y-211.859
Z-4.945
G01Z-7.945
X123.903Y-212.993Z-9.734
X123.251Y-214.392Z-10.332
X123.057Y-215.922Z-10.684
X123.339Y-217.439Z-10.877
X124.071Y-218.798Z-10.945
X124.137Y-218.884
G02X125.715Y-221.504I-9.378J-7.432
X127.571Y-218.463I11.06J-4.667
G01X128.368Y-217.142Z-10.886
X128.723Y-215.64Z-10.702
X128.604Y-214.102Z-10.363
X128.021Y-212.673Z-9.788
X127.03Y-211.49Z-8.442
X126.948Y-211.42Z-7.945
Z-1.945
G00X60.026Y-186.089
Z-4.945
Z-97.231
G00X182.212Y-118.939
Z-100.231
G01Z-103.231
X183.738Y-119.166Z-105.02
X185.261Y-118.916Z-105.619
X186.635Y-118.214Z-105.97
X187.73Y-117.127Z-106.164
X188.441Y-115.758Z-106.231
X188.475Y-115.655
X188.595Y-115.269
X188.293Y-115.188
X186.759Y-115.024Z-106.172
X185.247Y-115.335Z-105.988
X183.903Y-116.092Z-105.65
X182.853Y-117.223Z-105.075
X182.198Y-118.62Z-103.728
X182.169Y-118.724Z-103.231
Z-97.231
G00X182.354Y-123.787
Z-100.231
G01Z-103.231
X180.837Y-124.064Z-105.02
X179.475Y-124.791Z-105.619
X178.4Y-125.898Z-105.97

X177.714Y-127.28Z-106.164
X177.482Y-128.805Z-106.231
X177.484Y-128.913
X177.517Y-130.222
X183.091Y-131.716
X184.628Y-127.347
X184.909Y-125.83Z-106.172
X184.715Y-124.299Z-105.988
X184.063Y-122.901Z-105.65
X183.016Y-121.768Z-105.075
X181.673Y-121.008Z-103.728
X181.571Y-120.971Z-103.231
Z-97.231
G00X183.232Y-115.216
Z-103.231
G01Z-106.231
X181.883Y-115.965Z-108.36
X180.827Y-117.089Z-108.969
X180.163Y-118.482Z-109.212
X180.028Y-119.06Z-109.231
X179.329Y-123.56
G03X185.133Y-119.504I.88J4.922
X184.101Y-115.466I-5.045J.861
G01X180.878Y-114.585
X180.028Y-119.06
X180.004Y-120.602Z-109.167
X180.451Y-122.079Z-108.965
X181.327Y-123.349Z-108.591
X182.548Y-124.292Z-107.934
X183.784Y-124.771Z-106.231
Z-100.231
G00X184.931Y-119.245
Z-103.231
G01Z-106.231
X183.388Y-119.285Z-108.02
X181.931Y-119.793Z-108.619
X180.699Y-120.722Z-108.97
X179.808Y-121.982Z-109.164
X179.344Y-123.453Z-109.231
X179.329Y-123.56
X179.039Y-125.8
X178.786Y-128.044
X180.786Y-128.6
X181.549Y-128.548
X182.275Y-128.421
G03X186.999Y-116.225I-187.862J79.783
G01X184.099Y-115.47
X182.564Y-115.316Z-108.933
X181.055Y-115.638Z-107.717
X180.627Y-115.824Z-106.231
Z-100.231
G00X178.862Y-127.332
Z-103.231
G01Z-106.231
X180.102Y-128.25Z-108.989
X181.032Y-128.624Z-109.231
X182.062Y-128.922
X182.274Y-128.424

X182.653Y-126.928Z-109.172

X182.557Y-125.388Z-108.988

X181.997Y-123.951Z-108.65

X181.025Y-122.752Z-108.075

X179.734Y-121.907Z-106.728

X179.635Y-121.864Z-106.231

Z0.

M30

%

For Finishing

Select NC sequence - Machining - Finishing - Done - Select tool and enter parameters like Cut feed, Step depth, Step over, Profile stock allow, scan type and spindle speed.

Create volume.

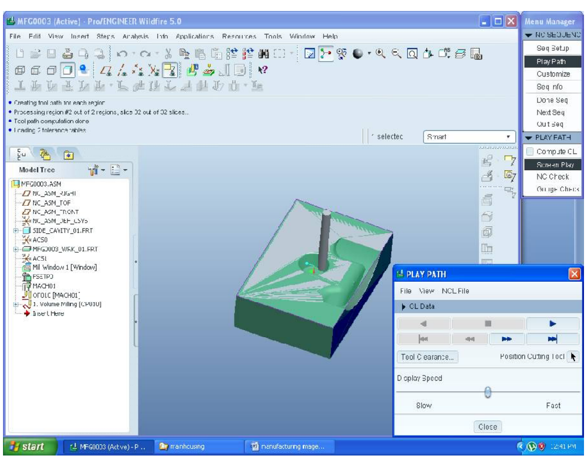
Select Playpath

After completing Playpath, Select NC check

Machining → CL data → NC sequence → sequence → file → MCD file.

Done . Enter name . ok . Done.

Figure 37: Play Path for Finishing



RESULTS

Die Design Calculations

Tonnage Calculation

Projected area of one component (a) = 36252.7 mm^2

Number of cavities(n) = 1

Projected area of Casting(A) = axn

= 1494.77 x 1

= 36252.7 mm^2

Area of Slide

Projected Area of Slide 1 = 55987 mm^2

Projected Area of Slide 2 = 84078 mm^2

Projected area including overflows and feed system

(AF) = A x c/100

= 36252.7 x 40/100

= 14501 mm^2

Total Projected area = A + A1+ A2 + AF

= 36252.7 + 55987 + 84078 + 14501

= 190818.7 mm^2

Specific Injection pressure = 800 kgf/cm^2

= 800 x 10^{-2} kgf/mm^2

Total force acting on the die plate (F) = Projected area x Injection Pressure

= 190818.7 x 8 kgf

= 1526549.6 kg

= 1526.5496 tons

Considering machine efficiency of 80%,

Locking tonnage required = F x 1.2

= 1526.5496 x 1.2

= 1831.85T

Hence according to locking tonnage we can select 2500T

Shot Weight Calculation

One component volume (v) = 31675.68 mm^3

Total component volume (V) = v x n

= 31675.68 x 1

= 31675.68 mm^3

Volume of component + Volume of overflow and feed system

(Vt) = V x (1 + c/100)

= 31675.68 x (1 + 40/100)

= 79000 mm^3

= 79000 x $2.6e^{-6}$

= 205 gms

= 0.205 kgs

Plunger Diameter Calculation

Actual shot volume = Vt + $\pi d^2h/4$

Where h is biscuit thickness and

d is the plunger diameter

h = biscuit thickness = 4 mm

No. of biscuits = 6

Total thickness = 24 mm

Stroke length for 2500T machine (l) = 220 mm

Effective stroke length (L) = l-h

= 220-4

= 216 mm

Assume fill ratio = f = 0.5

Volume delivered by machine = πd^2 x (L/4) x f

(i.e.) Vt + $\pi d^2h/4$ = πd^2 x (L/4) x f

Vt = πd^2 x (L/4) x f – $\pi d^2h/4$

Vt = ($\pi d^2/4$) (Lf-h)

79000 = ($\pi d^2/4$) (216 x 0.5-4)

5346.5778 = d^2

d = 31.67 mm

Fill Ratio Calculation

Fill ratio = Metal volume/shot sleeve volume

= Vt + πd^2 x (h/4)/πd^2x(L/4)

= 79000 + 3038.5/3038.5*26

Fill ratio = 1.038

We have to reduce 3% of plunger dia = 31.67-0.95 = 30.72 mm

= 30 mm

Fill Time Calculation

Fill Time = k $[T_i – T_f + S_Z]T/[T_f – T_d]$

where

k, empirical derived constant = 0.0346

T_i, Temperature as it enters in to the die = 640 °C

T_f, Minimum flow temperature of metal = 580 °C

T_d, Tempearture of die cavity surface just before the metal enters = 200 °C

S, percent solid fraction allowable in the metal at the end of filling = 30%

Z, Units conversion factor = 4.8

T, Casting thickness = 8.701 mm

Fill Time = k $[T_i – T_f + S_Z]T/[T_f – T_d]$

Fill Time = 0.0346 [640 – 580 + 30*4.8] 8.7/[580 – 200]

= 74.736/320

= 161 millisecs

CONCLUSION

In our project we have modeled a piston housing used in a hydraulic oil filter pump in 3D modeling software Pro/Engineer. We have designed total cavity die for the piston housing. We have done die design calculations for piston housing. From the calculations, we have to select 2500T machine.

We have extracted core, cavity, prepared total die for the piston housing. We have done CNC programming for core, cavity and side cavity. We have prepared the total casting tool die of piston housing which is ready for manufacturing.

BIBLIOGRAPHY

1. Groover (2006), CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, India
2. Ibrahim Zeid (2010), CAD/CAM Theory & Practice 2E, Tata McGraw-Hill Education
3. Mikell P Groover (1986), Industrial Robotics, McGraw-Hill
4. Gupta A K and S K Arora (2013), Industrial Automation and Robotics, Third Edition, Laxmi Publications
5. Miltiadis A Boboulos (2010), Automation and Robotics, Book Boon
6. Nand K Jha (1991), Handbook of Flexible Manufacturing Systems, Academic Press Inc
7. Nageswara Rao P (2004), CAD/CAM Principles and Applications (2nd Edition), McGrawHill.

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