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Casting Tool Design of a 150CC Cylinder Head

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Abstract**—** *A cylinder head is made of box type of section of considerable depth to accommodate ports of air and gas passages, inlet valve, exhaust valve and spark plug. The studs or bolts are screwed up tightly along with a metal gasket or asbestos packing to provide a leak proof joint between the cylinder and cylinder head. The cylinder head is subjected to temperatures due to combustion in cylinder and pressure on surface.*

In this paper a cylinder head is designed and modelled for the Pulser bike. Manufacturing processes for this is pressure die casting die. We designed the casting tool for the aluminium alloy because its thermal conductivity is more. Material used in casting is LM 6 blocks. This manufacturing process is done in the cold chamber Furnace. We have extracted core and cavity. Die design is prepared for the same. We are providing all manufacturing processes of all components of the die. We are also providing CNC programming for the core & cavity. Modelling, core-cavity extraction and die design is done by using Pro/Engineer software. Manufacturing process is done by using Pro/Engineer software.

Keywords**—** *Enter key words or phrases in alphabetical order, separated by colon.*

I. INTRODUCTION TO CYLINDER HEAD

The cylinder head in I.C. engine is placed above cylinders and cylinder block. The combustion chamber is formed above the cylinder. In a flat head engine all the mechanical components are with a block. The cylinder head is basically a flat plate and it is fixed above the cylinder bank with gasket. The spark plugs, poppet valves and ports have come under the design of overhead valve (OHV) and overhead crankshaft (OHC).

The manufacturing and servicing is too simple. On accounts the manufacturing of engine is a great success in automobile industry. The fuel/air is flow through the inlet valve of cylinder head is called ports and exhaust gasses flow through the exhaust valves. In some engines (water – cooled engine) the cylinder head consists integral ducts and ports. In this engines water acts as a coolant and antifreeze, which provide to outside the excess heat.

Some engines has one cylinder head fixed in each cylinder which are used for power generation and heavy equipment in industries. These engines has medium and large capacity diesel engines. By this reduce the cost of servicing.

II. DIE CALCULATIONS OF CYLINDER HEAD

A. Tonnage Calculation

Projected area of one component (a) = 50173.2 mm^2
Number of cavities (n) = 1
Projected area of Casting (A) = a x n = 50173.2 mm^2
Area of slide:
Projected Area of Slide 1 =13,599.5mm^2
Wedge Angle(α) =10 deg
Final Projected Area of slide 1 (A_1) = 13,599 x tan 10 =2398 mm^2
Projected Area of Slide 2 =5312.93mm2
Wedge Angle (α) =10 deg
Final Projected Area of slide 2 (A_2) = 5312.93 x tan 10 =936 mm^2
Projected area including overflows and feed system (A_F) =A x c/100 =50173.2 x 40/100 =20069.28 mm^2

$$\text{Total Projected area} = A + A_1 + A_2 + A_F = 50173.2+2398+936+20069.28 = 73577\ mm^2$$

Specific Injection pressure =800 kgf/cm^2
=800x 10-2 kgf/ mm^2
Total force acting on the die plate (F) =Projected area x Injection Pressure =73577 x 8 kgf =589T
Considering machine efficiency of 80%,
Locking tonnage required =F x 1.2 =576 x 1.2 =707T
Hence the locking tonnage we can select 800 T

B. Shot Weight Calculation

One component volume (v) = 9.10 x 105mm^3
Total component volume (V) = v x n mm3 = 9.828 x 105mm^3
Volume of component + Volume of overflow and feed system (V_t) = V x (1 + c/100) = 9.828x105 x(1+ 40/100)
= 1372920 mm^3

C. Plunger Diameter Calculation

Actual shot volume = V_t + Πd2h/4
Where h is biscuit thickness and d is the plunger diameter
Stroke length for 800 T machine (l) = 750 mm
Effective stroke length (L) = l – biscuit thickness
= 640 –63+15 = 592mm
Assume fill ratio = 0.50
Volume delivered by machine = πd^2 x (L/4) x f
i.e. $V_t + \pi\ d^2$ x (h/4) = πd^2 x (L/4) x f = πd^2 x (592/4) x 0.50
$V_t = \pi/4$ x d^2 (L x f - 15) = $\pi/4$ x d^2 (592 x 0.5 - 15) 1372920 = 221 d^2
D = 80 mm
Available plunger sizes in 800 T machines are 80,85,90,95,100 mm
Hence we can select 90 mm plunger tip
Shot volume = $V_t + \pi d^2 h/4$ = 1372920 +π $(90)^2$ x15/4mm^3 = 1372920 + 95425.87 = 1468345.877 mm^3
Shot weight = Shot volume x density = 1468345.877 x 2.5 x 10^{-3} = 3670.086g = 3.67kg
From machine manual, for 800T machine, shot weight capacity for 90 mmplunger is 9.2 kg. Hence according to shot capacity also 800T machine is suitable.

D. Fill Ratio Calculation

Fill ratio (f) = Metal volume/Shot sleeve volume

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$= Vt + \pi d^2h/4/\pi d^2 \times (L/4)$
$=1468345.877/\pi (90)^2 \times (592/4) = 0.39$
This value for fill ratio is acceptable for the process.

E. Fill Time Calculation

Fill Time = $k [T_i - T_f + sz] T/[T_f - T_d]$
Where k, empirically derived constant = 0.0346,
T_i, Temperature of molten metal as it enters the die = 6400c
T_f, Minimum flow temperature of metal = 5800c
T_d, Temperature of die cavity surface just before the metal enters = 2000c
S, percent solid fraction allowable in the metal at the end of filling = 30%
Z, Units conversion factor = 4.8
T, casting thickness = 2.50mm
Therefore t = 0.0346[640–580+30x4.8]x 2.5
[580 – 200]
t = 0.046 seconds= 46 milli seconds

III. PRO-E MANUFACTURING (MOLD EXTRACTION)

A die is usually made in two halves and when closed it forms a cavity similar to the casting desired. One half of the die that remains stationary is known as cover die and the other movable half is called "ejector die".

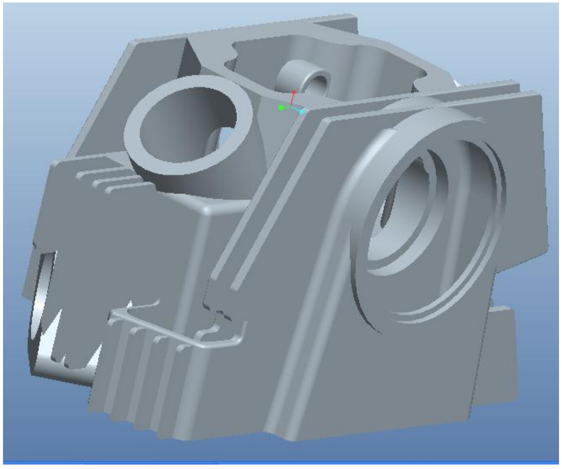
Molds separate into at least two halves (called the core and the cavity) to permit the part to be extracted. In general the shape of a part must not cause it to be locked into the mold. For example, sides of objects typically cannot be parallel with the direction of draw (the direction in which the core and cavity separate from each other). They are angled slightly (draft), and examination of most plastic household objects will reveal this. Parts that are "bucket-like" tend to shrink onto the core while cooling, and after the cavity is pulled away. Pins are the most popular method of removal from the core, but air ejection, and stripper plates can also be used depending on the application.

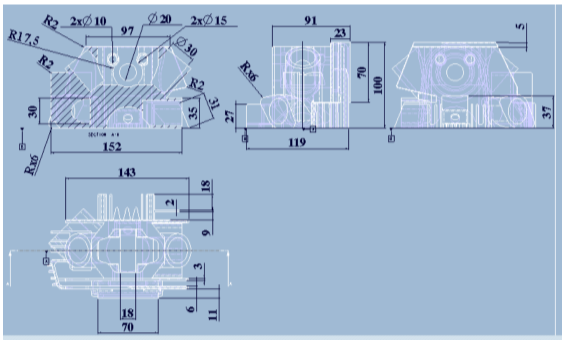
Core: The core which is the male portion of the mold forms the internal shape of the molding.

Cavity: The cavity which is the female portion of the mold, gives the molding its external form.

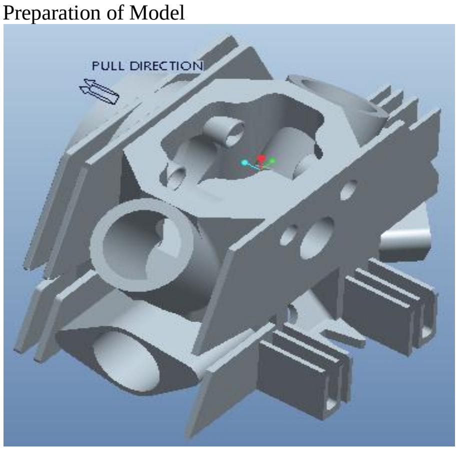
IV. 3D MODEL AND 2D DRAWINGOF DIFFERENT PARTS

Cylinder Head

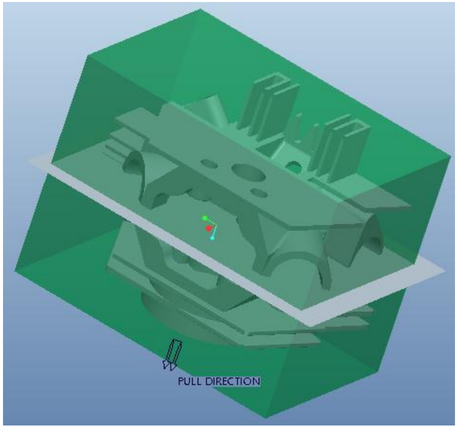




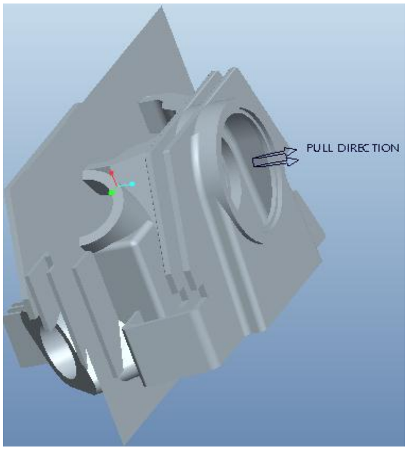
Core Cavity Preparation of Model



Workpiece



Parting Surface



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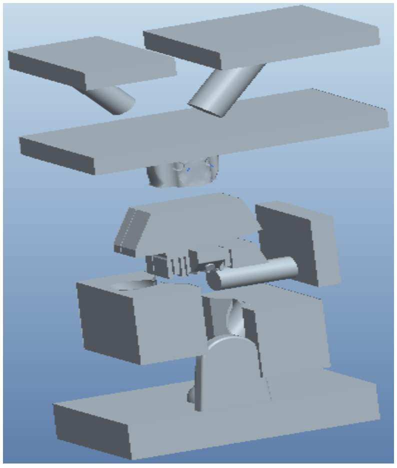
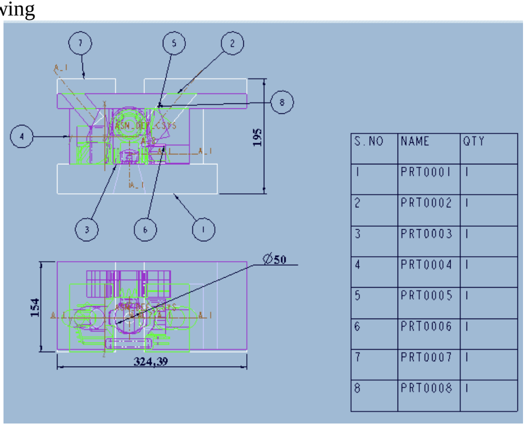
Exploded View



2D-Drawing



V. Computer Aided Manufacturing in Pro/Engineer

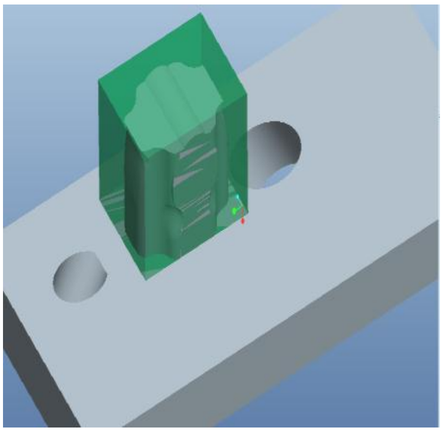
By using the fundamental abilities of the software with regards to the single data source principle, it provided a rich set of tools in the manufacturing environment in the form of tooling design and simulated CNC machining and output.

Tooling options cover specialty tools for molding, die-casting and progressive tooling design.Manufacturing lets you set up and run NC machines, create assembly process sequences, create bills of material, and generate inspection programs for Coordinate Measuring Machines (CMMs).

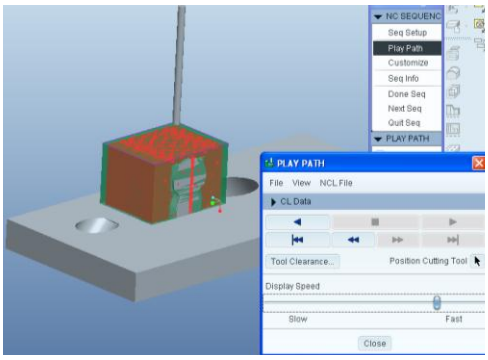
Use the Manufacturing area is about streamlining the NC programming process for production milling of prismatic parts and multisurface three-axis milling. Manufacturing shows you how to program and set up your NC machines, create process flows that cover the NC operations as well as other operations, and define CMM inspection programs that probe manufactured parts.

A. Procedure of Manufacturing Coreroughing

Workpiece



Play Path



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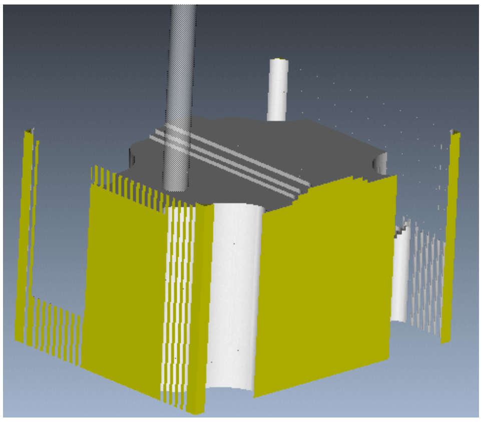

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Y-3.989
X-3.
Y-4.978
X-114.43

```
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X-3.
Y-6.956
X-114.43
Y-7.946
X-3.
Y-8.935
X-114.43
Y-9.924
X-3.
Y-10.913
X-114.43
Y-11.902
X-3.
Y-12.891
X-114.43
Y-13.88
X-3.
Y-14.869
X-114.43
Y-15.858
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Y-16.847
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Y-18.826
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X-114.43
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X-3.
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Y-23.771
X-3.
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Y-25.749
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Y-27.728
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X-114.43
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G01X-59.423
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M30
%
%
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X-33.965Y-49.374
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M30
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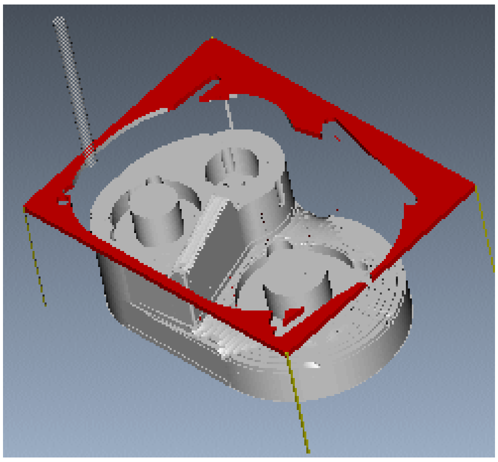
Finishing



Finishing Program

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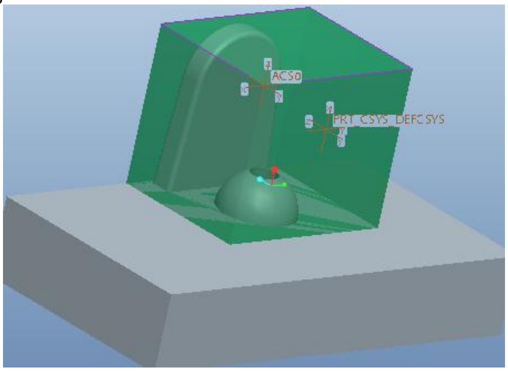
B. Procedure of Manufacturing

Cavity

Roughing



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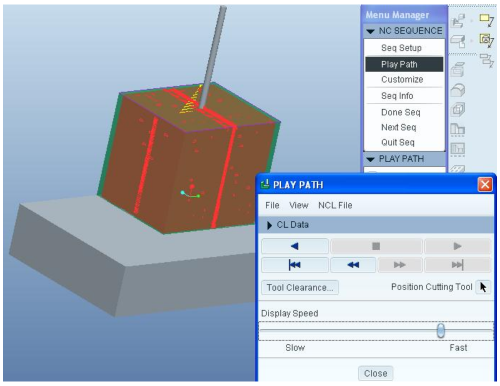

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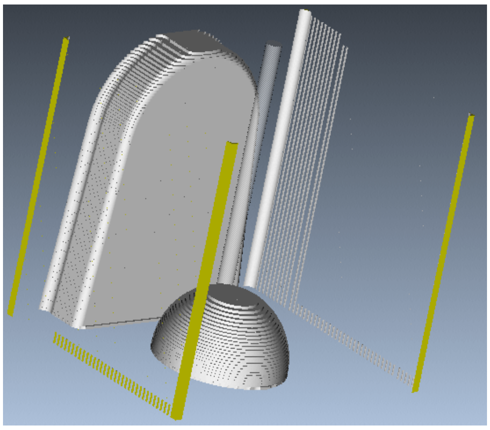

Roughing Program

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Y-17.837
X-3.
Y-18.826

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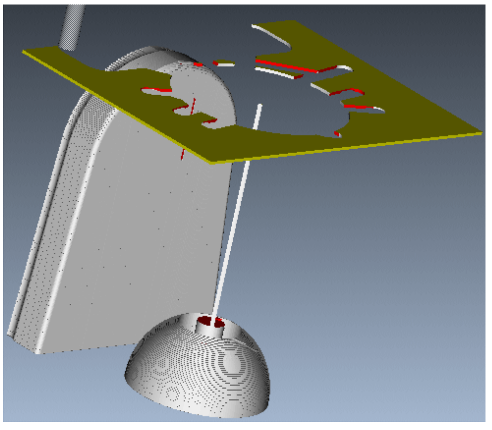

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VI. CONCLUSION

In this paper we have designed a cylinder head in 3D modelling software Pro/Engineer, die for the manufacturing of cylinder head and also die calculations of cylinder head. We have to select 800T capacity machine for the die.

We have prepared total die for the manufacturing of cylinder head and generated CNC programming for the core and cavity. We conclude that the cylinder head is ready for manufacturing.

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