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Optimal design, structural analysis and Manufacturing of pressure die casting die of Truck

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Abstract
This paper involves the design of die-casting dies requires considerable skill and expertise based on experience. The designer proposes designs of dies employed to cast parts from various alloys, and perform a variety of other operations. Every new job requires original thought in its design and the solving of individual problems in its manufacture. Each die-cast component, currently in production, presents a challenge for the improvement of its output and quality. The objective here is to design dies to be fit for the purpose, operate at optimum shot rate and is of reasonably simple construction. The main purpose of this paper is to present the systematic design procedure for pressure die-casting dies. Die-casting dies like any other type of tooling can be very simple or very complex. How difficult they are to design and build depends entirely on the parts they produce. They can be as simple as a single cavity die with no side cores or they can be complicated dies, which represent split dies along with moving cores actuated by either finger cams or hydraulic cylinders depending on the feasibility.

Keywords: Design; Analysis; Manufacturing; Pressure Die Casting

1. Introduction
Pressure die-casting is about 150 years old and one of the widely used processes for the mass production of components required in many applications like automobiles, electrical equipment, motors, telecommunications equipment, building hardware, home appliances, etc. Gear box casing is an assembly of three parts. These are:
1. Main housing
2. Side engine cover
3. Side differential cover

Objective of this paper is to model the side engine cover of gear box casing using Pro/Engineer Wild fire 5.0 software and perform structural analysis. Side engine cover of Gear box casing taken up for modeling is used in mini trucks.
Gears are used as independent units to reduce or increase the input speed. The unit is enclosed in rigid closed housing s (called casing) which supports the shafts, hold lubricant inside casing, and protect the gears from dust and moisture. Also the housing provides necessary cooling surfaces to dissipate the heat generated during operation. When the unit is used to get only one reduced output speed for a given input speed then it is called a "SPEED REDUCER", while for one input speed more than one output speeds are obtained, then the unit is called a GEAR BOX. Gear box is widely used for reduction of speed in automobiles.

1.1 Function of Side Differential Cover
The function of these Side Differential Cover (part of gear box casing) is to protect and guide the gears used in power transmission. In this casing, power transmission is done by regulating the speed of driving wheels through crank shaft to rear axle.
The material used in making the Gear box casing is Aluminum alloy Grade LM24. Using this alloy, casting for gear box casing is made which is used in most of the automobiles such as motor bikes, passenger cars and passenger auto's etc.
The engine capacity of the Mini truck is 7.5BHP/5.51KW; Speed of the engine is 3600R.P.M.

Aluminum alloy Grade LM24 is used due to its following characteristics:

1) Good thermal conductivity (Heat conducting capacity)
2) Excellent Fluidity,
3) Good resistant to corrosion,
4) Suitable for intricate castings,
5) Good weld ability,
6) Electrical conductivity.

2. Design Aspects of Die Casting

- Since the metallic mold of a die casting expands when it is filled with a molten metal and then both the casting and the mold shrinks during cooling the shrinkage allowances taken in the die mold design are smaller than those in the Sand casting.
- Parts of 0.05 lb (20 g) to 75 lb (34 kg) may be cast.
- The section thickness of permanent mold casting may vary in the range 0.02” - 0.5” (0.5-12 mm).
- The dimensional tolerances are 0.01-0.03” (0.25-0.75 mm) depending on the casting section thickness.
- Allowances of 0.004-0.01” (0.1-0.25 mm) are taken for the dimensions crossing the parting line of the mold.
- The draft angle is commonly about 1%.
- Lower (as compared to other casting methods) radii of the part corners may be achieved by die casting process.
- Changes of the section thickness should be as gradual as possible.
- The parting line should not cross critical dimensions.
- Water-cooled dies may be used for obtaining faster Solidification at a desired direction.
- The dies are fabricated from Tool and die steels. The die life is determined the ability of the material to withstand wear caused by the molten alloys and Fatigue caused by multiple heating and expansion.
- The cores are made of refractory ceramic materials. Sand based cores are not applicable due to their insufficient strength under pressure applied in die casting.

3. Design Side Differential Cover

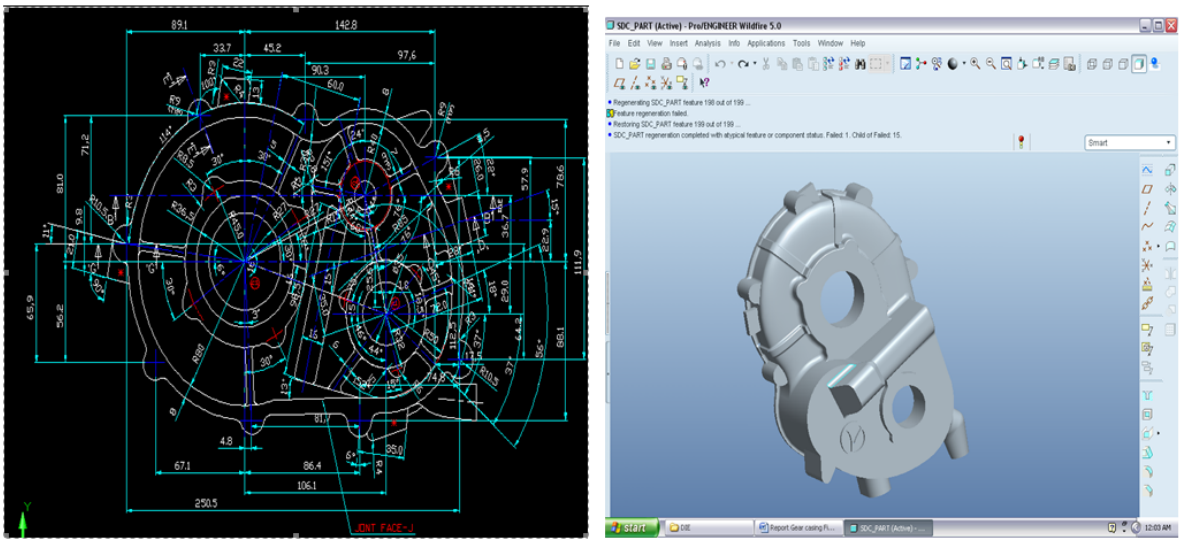
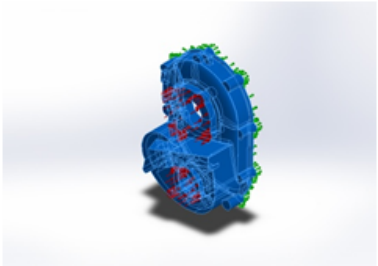


Fig1: Model of Side Differential Cover

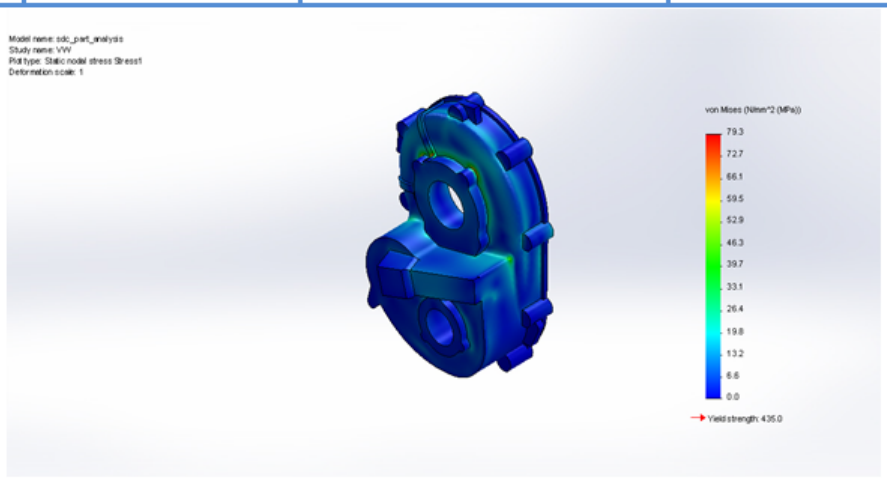
4. Analysis of Side Differential Cover Aluminum Alloy Lm24

4.1 Material properties

Model Reference	Properties	
	**Name:**	LM24
	Model type:	Linear Elastic Isotropic
	Default failure criterion:	Max von Mises Stress
	Yield strength:	4.35e+008 N/m^2
	Tensile strength:	4.35e+008 N/m^2
	Elastic modulus:	7.1e+010 N/m^2
	Poisson's ratio:	0.33
	Mass density:	2710 kg/m^3
	Shear modulus:	2.69e+010 N/m^2
	Thermal expansion coefficient:	2.16e-005 /Kelvin

4.2 Vehicle Weight

Name	Type	Min	Max
Stress1	VON: von Mises Stress	6.66052e-005 N/mm^2 (MPa) Node: 63527	79.3443 N/mm^2 (MPa) Node: 55404

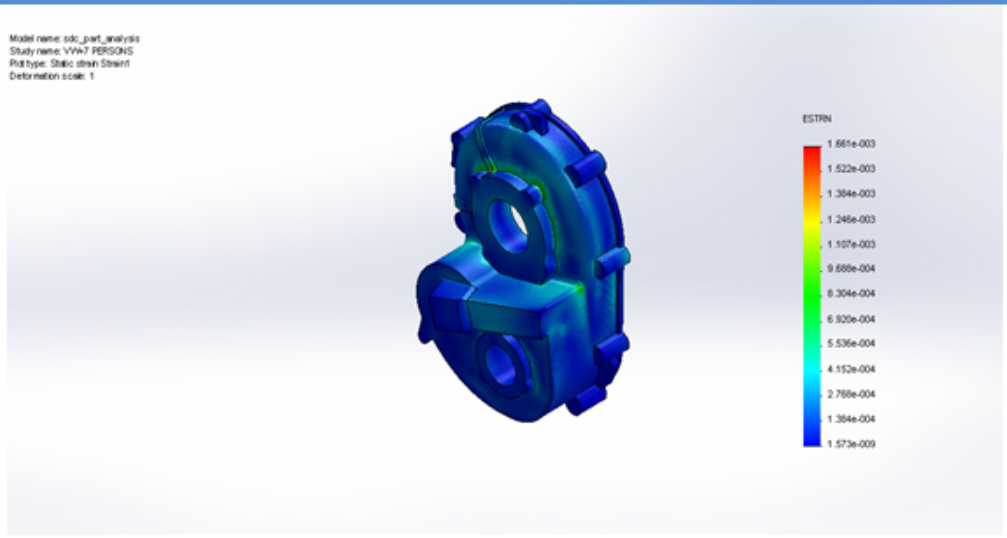


sdc_part_analysis-VW-Stress-Stress1

Fig 2:

4.3 Vehicle Weight+7 Persons

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.57314e-009 Element: 109503	0.00166084 Element: 27410



sdc_part_analysis-VW+7 PERSONS-Strain-Strain1

Fig 3:

4.4 Results Table

	Vehicle Weight	Vehicle Weight+7 Persons	Vehicle Weight+10 Persons
Stress (N/Mm^2)	79.3443	157.4	178.207
Displacement (Mm)	0.0525182	0.104157	0.117936
Strain	0.000837517	0.00166084	0.00188

5. Manufacturing

5.1 Procedure of Manufacturing Core Roughing

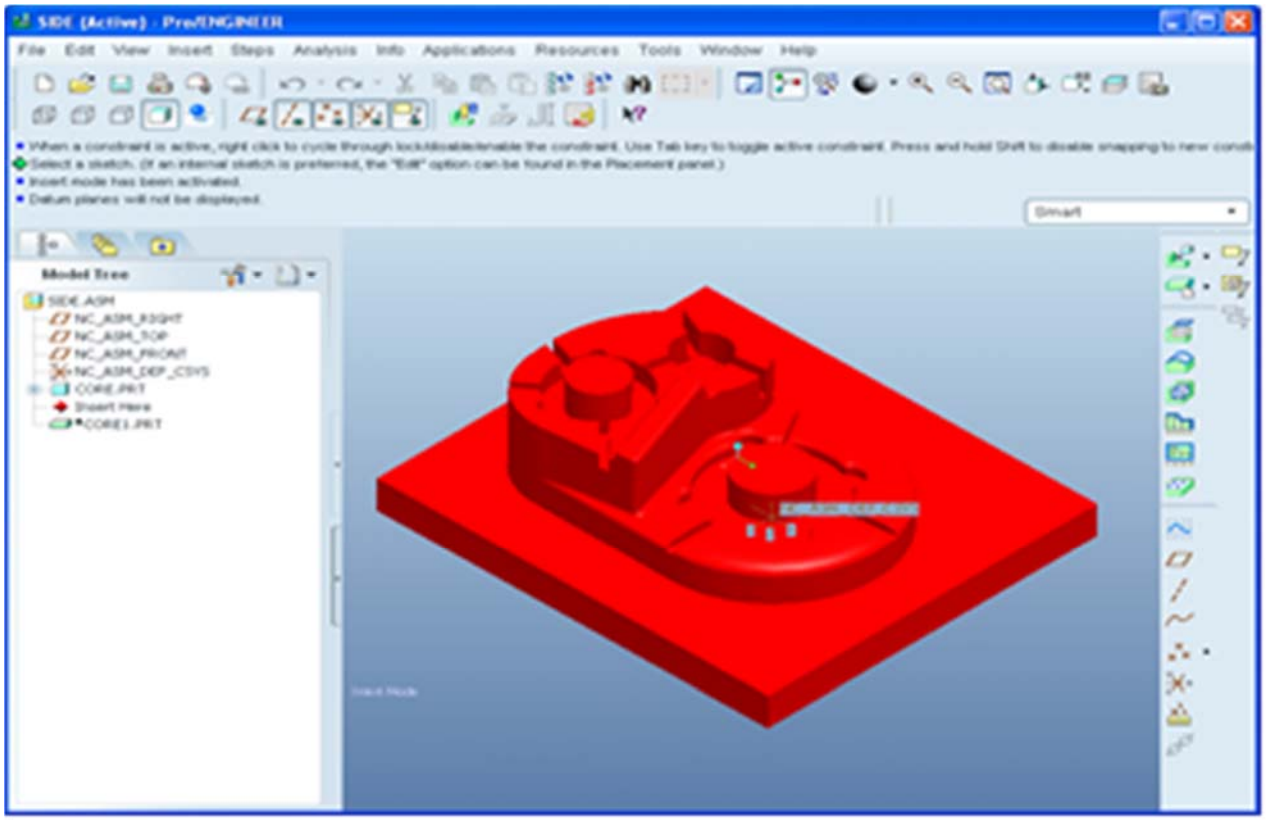


Fig 4:

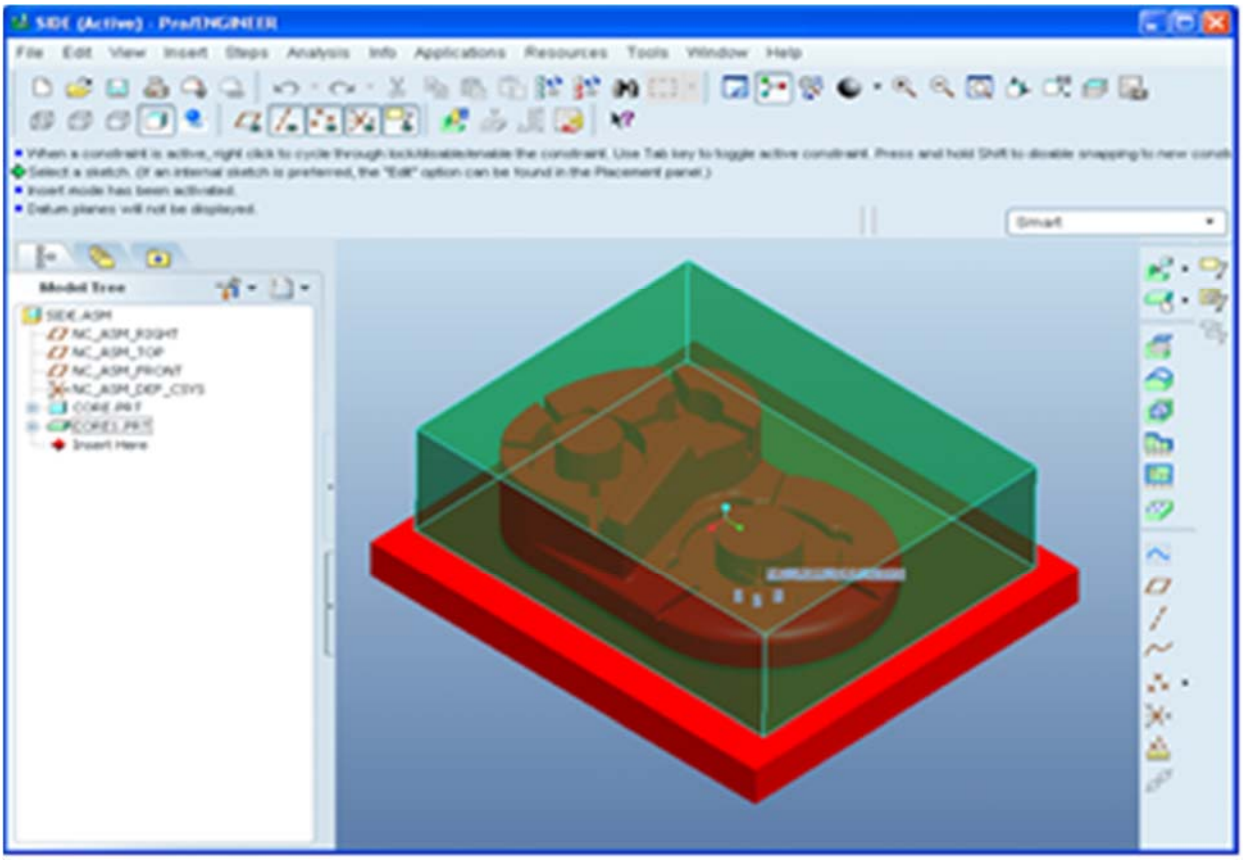


Fig 5:

5.2 Cutting Tool

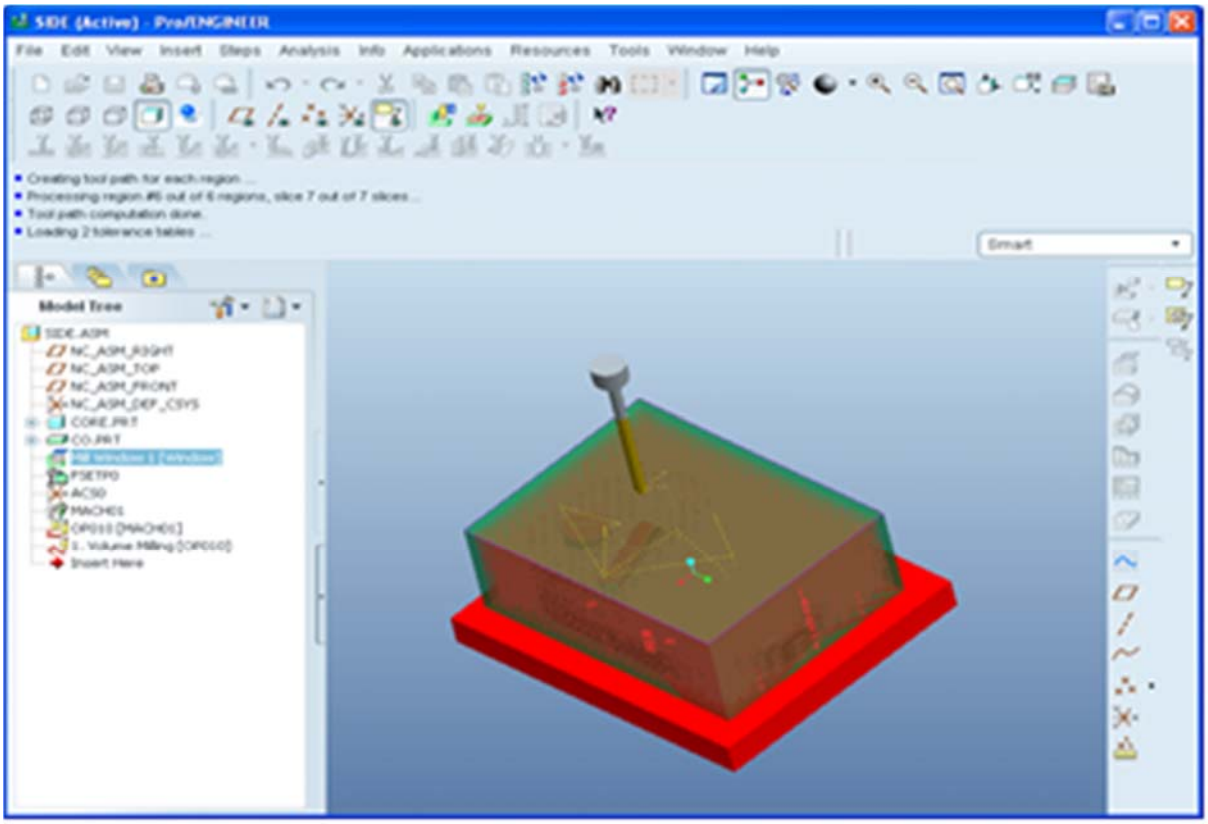


Fig 6:

Finishing

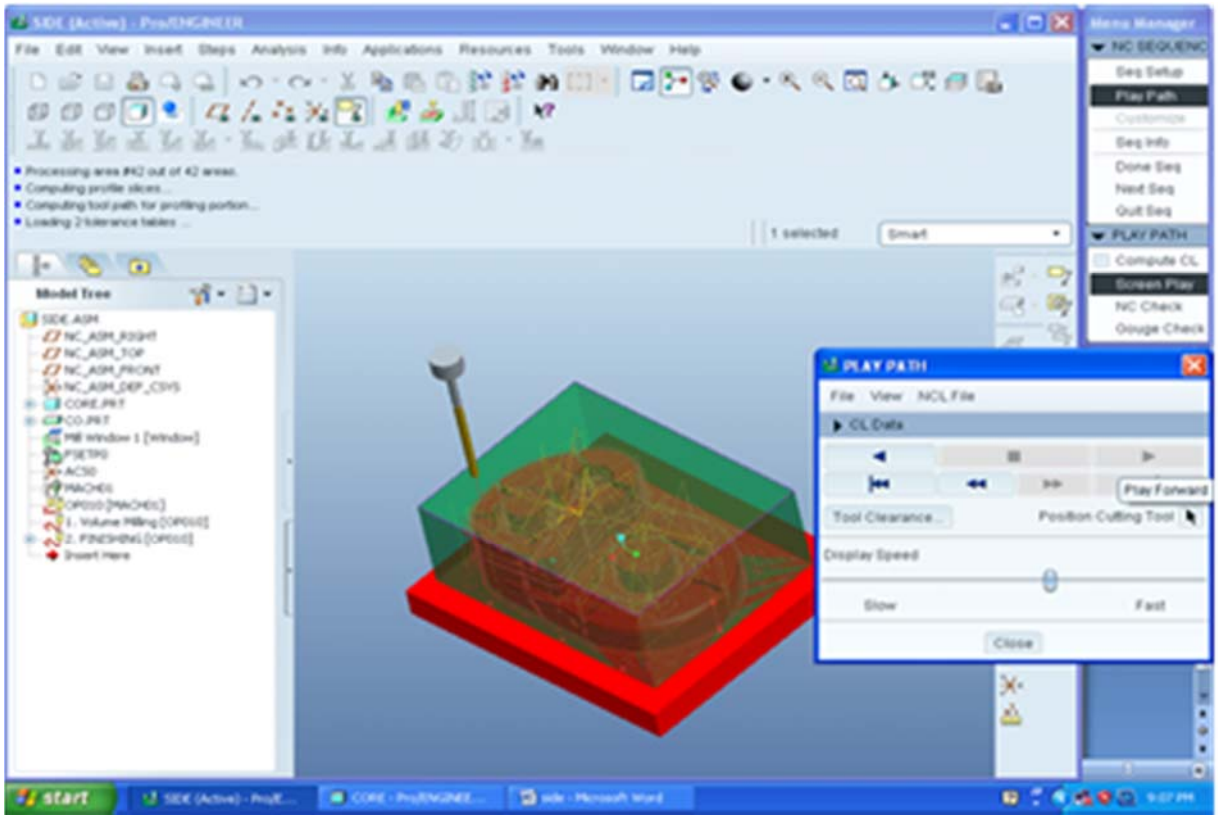


Fig 7:

5.4 Cavity Roughing

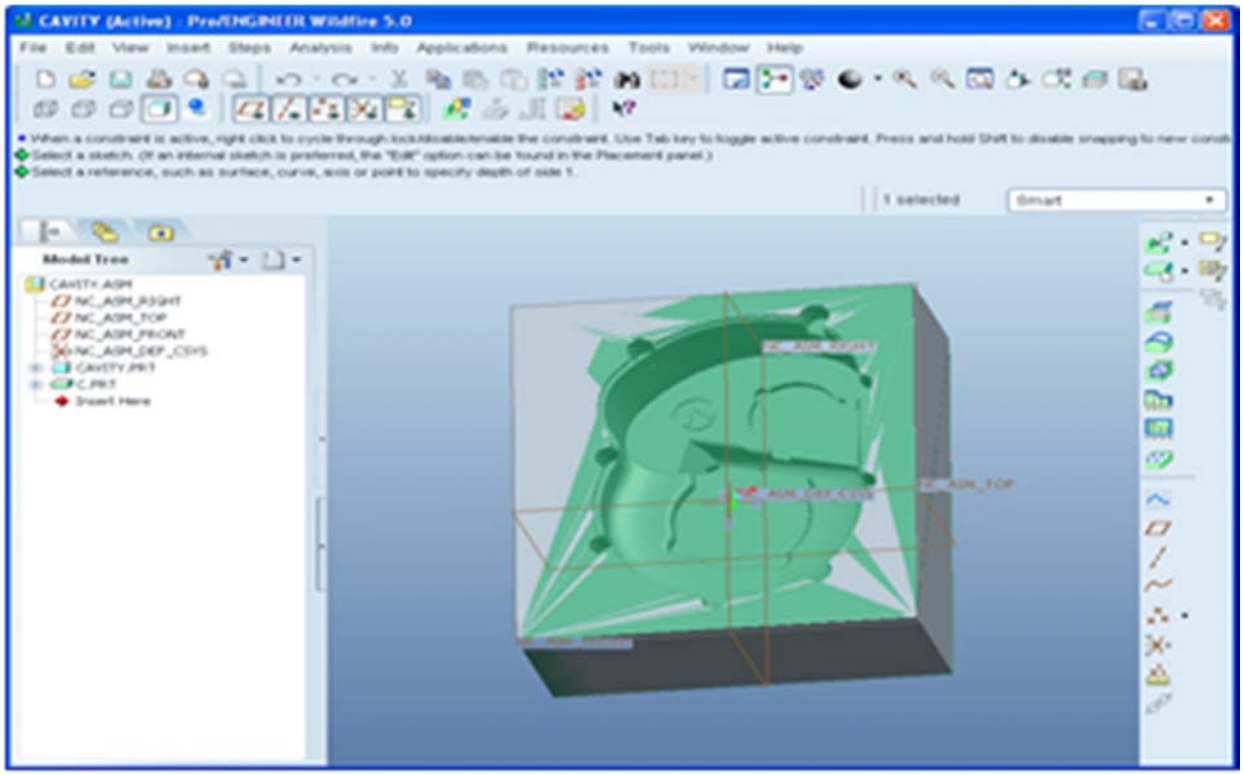


Fig 8:

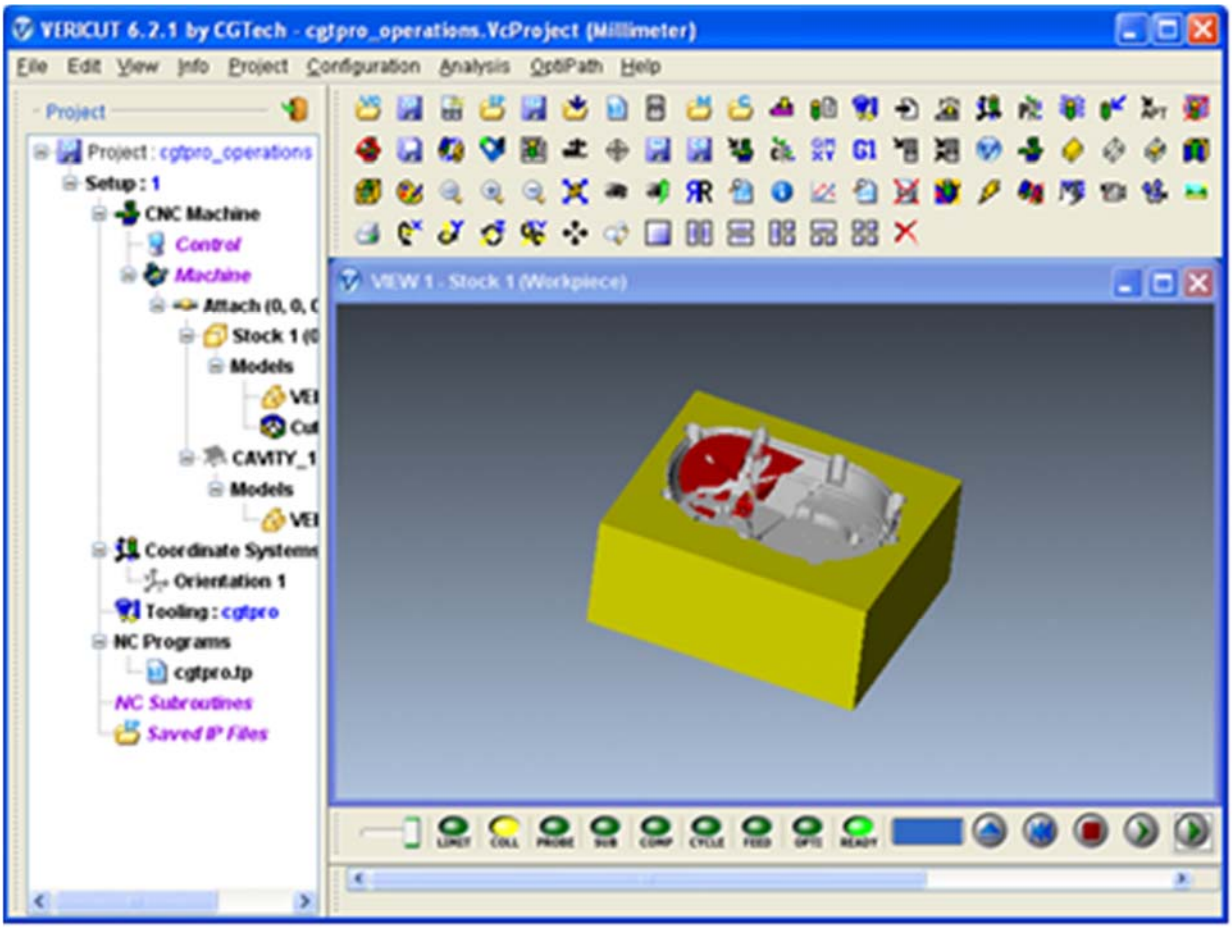


Fig 9:

6. Conclusion

The component side differential cover of a mini truck gear box casing was identified for Die design. The design for casing is completed successfully and sent for manufacturing. Manufacturing will be done at TOOL MAKE, HYDERABAD.

We have done structural analysis on the side differential cover by applying the loads of only vehicle weight, vehicle weight+ 7 persons weight and vehicle weight + 10 persons weight to validate the strength using material Aluminum alloy LM24. By observing the analysis results, the analyzed stress values are less than the respective yield stress value under all load conditions. So using LM 24 for side differential cover is safe.

Apart from the above mentioned projects, we have done the assembly, detailing and designing of feed system for other castings. This gave me a good exposure to die casting.

7. References

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