International Journal of Mechanical and Industrial Technology ISSN 2348-7593 (Online)
Vol. 2, Issue 1, pp: (83-92), Month: April 2014 - September 2014, Available at: www.researchpublish.com

Design of Index Drill & Tap Gang Head used in Manufacturing of 4 Line Engine Block

[1]Kumar S P, [2]Dr. H R Vitala

PG student, Dept. of Mechanical Engineering
East Point College of Engineering & Technology Bangalore, India

Abstract: **Shortening design and manufacturing lead times while maintaining product quality requires careful planning of the design process. This paper describes a new design used at a major automobile manufacturer to create a simple, flexible process to do just that for their engine design group and investigated the company's existing design and manufacturing process, identified areas for improvement, and synthesized mechanisms and machines to achieve those improvements. While this car manufacturer currently designs world class engines, they felt a need to reduce their time to market. As part of this overall effort, they identified their engine manufacturing process as one for examination and improvement. Manufacturing has been influenced by trade liberalization, global competition, market fragmentation, technological innovation and the demands of more sophisticated consumers. In response to these pressures, manufacturers are incorporating more flexibility and technology in their production practices. These features have become a trademark of world-class corporations. An issue of importance in this strategic decision is whether the process should be transferred without modification or adopted in some way for transfer . Implementing this design of manufacturing process is one of the lengthiest, expensive and complex tasks a firm is undertaking.**

Keywords: **Design, Engine Block, Index Drill, Index Tap, Gang head.**

I. INTRODUCTION

The market place of the twenty-first century is evolving into one of merging national markets, fragmented consumer markets, and rapidly changing product technologies. These changes are driving firms to compete, simultaneously, along several different dimensions: design, manufacturing, distribution, communication, sales and others. Although manufacturing has not been utilized as a competitive weapon historically, the market place of the twenty first century will demand that manufacturing assume a crucial role in the new competitive arena. Progress in human society has been accomplished by the creation of new technologies. The last few years have witnessed unparalleled changes throughout the world. Rapid changes in the markets demand drastically shortened product life cycles and high-quality products at competitive prices. Customers now prefer a large variety of products. This phenomenon has inspired manufacturing firms to look for progressive computerized automation in various processes. Thus mass production is being replaced by low-volume, high-variety production. Manufacturing firms have recognized the importance of flexibility in the manufacturing system to meet the challenges posed by the pluralistic market. The concept of flexibility in manufacturing systems has attained significant importance in meeting the challenges for a variety of products of shorter lead times together with higher productivity and quality. The flexibility is the underlying concept behind the transition from traditional methods of production to the more automated and integrated methods. They stress that firms implementing automation projects should prioritize their needs for different flexibilities for long-range strategic perspectives .Intensifying global competition and rapid advancement of manufacturing technology are two realties in today's business environment. These have combined to shift the business strategic priorities toward quality, cost effectiveness and responsiveness to market place changes.

International business strategies frequently demand the transfer of manufacturing processes. Manufacturing process is defined as any repetitive system for producing a product, including the people, equipment, material inputs, procedures and software in that system. An issue of importance in this strategic decision is whether the process should be transferred without modification or adopted in some way for transfer.

II. LITERATURE SURVEY

The first stage of this project was a study of the existing process for the design of major engine components. There are five such components: the engine block, the crankshaft, the cylinder head, the combustion chamber, and the camshaft. These components, more than any others, define the engine's performance, cost, and manufacturability. A recently completed engine design program was identified by the car company as a case study. The DEs who worked on the major components of the engine in the case study were interviewed by the authors, both individually and in small groups. Each DE was thus interviewed at least twice. The first interview established what the DEs perceived as their individual roles in the design process, and provided an understanding of that role independent of interactions with other DEs. The second interview probed the relationships the DEs perceived between their roles. On the basis of the interviews, a picture of the existing design process began to emerge. The process begins with an overall engine design concept developed jointly by systems Engineers (SEs) and members of the marketing group. This concept is then examined by the DE in charge of designing the engine's crank. The substantial history and expertise of the car manufacturer had led them to consider that the viability of an engine is largely determined by whether a suitable crank could be designed to fit in the volume allocated to it. If this is possible, the engine is deemed feasible and the full, detailed engine design process could be initiated. If the crank could not be designed to fit, the design concept required modification.

The detailed design is initiated with a meeting that includes all the relevant parties: the DEs for the five primary components, the SE, manufacturing and casting engineers, and finance officers. During this meeting the assembled personnel would attempt to iron out basic design parameters, such as the number of cylinders, cylinder angle, the location of the cylinder centres points, the style and number of cams, and the location of the crank bushings. After this meeting, the design team members each begin working on their components. The inevitable discrepancies that arise between the components' designs are resolved through informal communication between the DEs. Formal communications during weekly design meetings are used to verify progress and resolve any remaining design discrepancies. The results of this process are released designs of the components which, when taken together, comprised an approved engine design.
Cost of product depends on

1. Design and engineering technologies
   Computer-aided design (CAD)
   Computer-aided process planning (CAPP)
2. Fabricating/machine and assembly technologies
   NC/CNC or DNC machines
   Materials working laser (MWL)
   Pick-and –place robots
   Other robots
   Intermediate systems
3. Automated material handling technologies
   Automatic storage and retrieval systems Automated material handling systems
4. Automated inspection and testing systems
   Automated Inspection and testing equipment
   Integrated systems
5. Flexible manufacturing technologies
   Flexible manufacturing cells/systems
6. Computer-integrated manufacturing systems
   Computer-integrated manufacturing
7. Logistic related systems
   Just-in-time (JIT)
   Material requirements planning
   Manufacturing resources planning (MRPII)

III. DESIGN OF INDEX DRILL & TAP GANG HEAD USED IN MANUFACTURING OF 4 LINE ENGINE BLOCK

3.1 Engine Block

The Engine Block is a single unit that contains all the pieces for the engine. The block serves as the structural framework of the engine and carries the mounting pad by which the engine is supported in the chassis. The block is made of cast iron and sometimes aluminium for higher performance vehicles. The engine block is manufactured to withstand large amounts of stress and high temperatures .The internal design of the engine block must be extremely precise, because all parts must fit and be able to function properly once the entire engine is assembled. The outside design of the engine only has to fit fewer requirements like attaching to the car properly. Engines are made in all different shapes and sizes to fit inside the frame of the car, therefore a company must be able to manufacture many different engine block designs yet keep up with product demand chassis. The block is made of cast iron and sometimes aluminium for higher performance vehicles. The engine block is manufactured to withstand large amounts of stress and high temperatures.

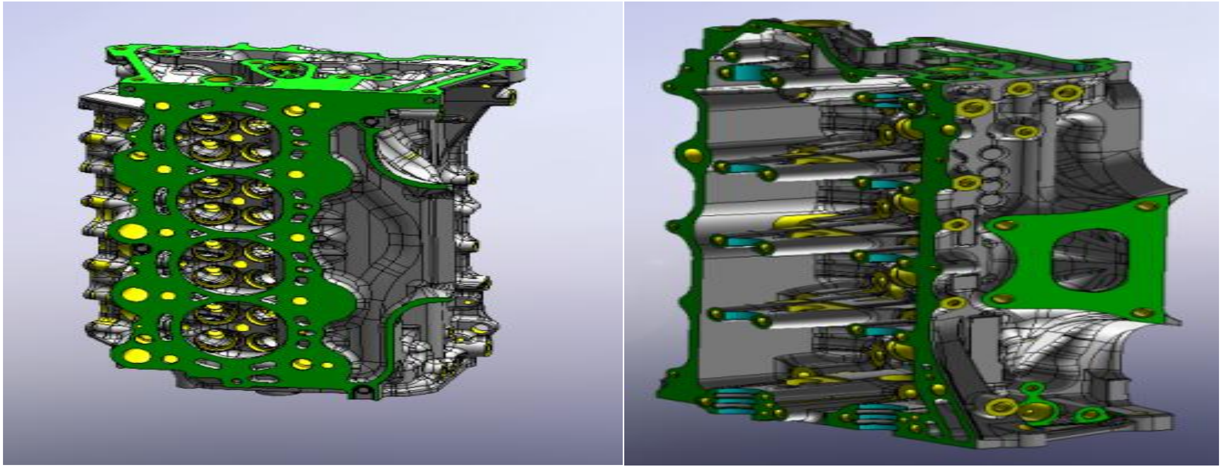


Figure 1: Typical Cylinder Block used for project

There are two major cycles used in internal combustion engines: Otto and Diesel. The Otto cycle is named after Nikolaus Otto (1832 –1891) who developed a four stroke engine in 1876. It is also called a spark ignition (SI) engine, since a spark is needed to ignite the fuel-air mixture. The Diesel cycle engine is also called a compression ignition (CI) engine, since the fuel will auto-ignite when injected into the combustion chamber. The Otto and Diesel cycles operate on either a four- or two stroke cycle. Since the invention of the internal combustion engine many pistons-cylinder geometries have been designed. The choice of given arrangement depends on a number of factors and constraints, such as engine balancing and available volume.

3.2 Concept Selection Process

Concept selection is the process of evaluating concept with respect to customer needs and other criteria, comparing the relative strengths and weakness of the concepts, and selecting one or more concepts for further investigation or development.

- We use some method, implicit or explicit, for selecting concepts, Decision techniques employed for selecting concepts range from intuitive approaches to structured methods.
- Successful design is facilitated by structured concept selection. We recommend a process called Concept Screening Matrix.
- Concept screening uses a reference concept to evaluate concept variant against selection criteria and it uses a coarse comparison system to narrow the range of concepts under consideration.
- Concept selection is applied not only during concept development but throughout the subsequent design and development process.

Concept selection uses matrix as the basis of selection process. The steps are:

1. Prepare the concepts.
2. Rate the concepts.
3. Select one or more concepts.
4. Hand sketch of the selected concept

3.3 Power Transmission and Design Of Gang Head

Gears: Gears are also used for power transmission. This is accomplished by the successive engagement of teeth. The two gears transmit motion by the direct contact like chain drive. The drive between the two gears can be represented by using plain cylinders or discs 1 and 2 having diameters equal to their pitch circles. We have seen that the idle gears, in a simple train of gears do not affect the speed ratio of the system. But these gears are useful in bridging over the space between the driver and the driven. But whenever the distance between the driver and the driven or follower has to be bridged over by intermediate gears and at the same time a great (or much less) speed ratio is required, then the advantage of intermediate gears is intensified by providing compound gears on intermediate shafts. In this case, each intermediate shaft has two gears rigidly fixed to it so that they may have the same speed. One of these two gears meshes with the driver and the other with the driven or follower attached to the next shaft.

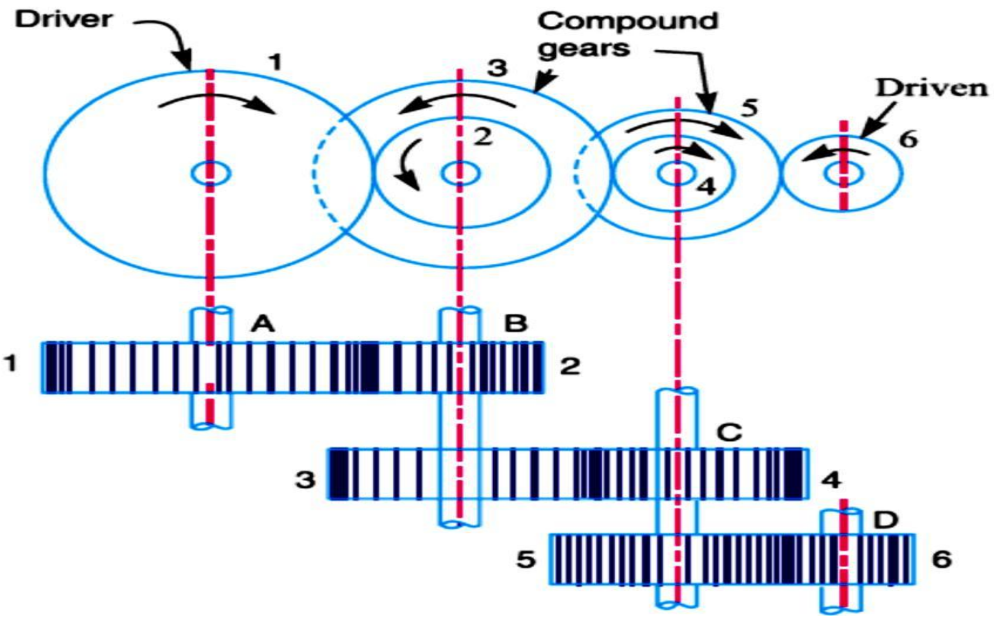


Figure 2: Compound Gear Train

In a compound train of gears, the gear 1 is the driving gear mounted on shaft A, gears 2 and 3 are compound gears which are mounted on shaft B. The gears 4 and 5 are also compound gears which are mounted on shaft C and the gear 6 is the driven gear mounted on shaft D.
Let N1 = Speed of driving gear 1,
T1 = Number of teeth on driving gear 1,
N2, N3 ..., N6 = Speed of respective gears in r.p.m., and
T2, T3..., T6 = Number of teeth on respective gears.
Since gear 1 is in mesh with gear 2, therefore its speed ratio is

$$\frac{N_1}{N_2} \times \frac{N_3}{N_4} \times \frac{N_5}{N_6} = \frac{T_2}{T_1} \times \frac{T_4}{T_3} \times \frac{T_6}{T_5}$$

Since gears 2 and 3 are mounted on one shaft B, therefore N2 = N3. Similarly gears 4 and 5 are mounted on shaft C, therefore N4 = N5.

The advantage of a compound train over a simple gear train is that a much larger speed reduction from the first shaft to the last shaft can be obtained with small gears. If a simple gear train is used to give a large speed reduction, the last gear has to be very large. Usually for a speed reduction in excess of 7 to 1, a simple train is not used and a compound train or worm gearing is employed. Conventional Automobile Gear Box.

A conventional gear box of an automobile uses compound gear train. For different gear engagement, it may use sliding mesh arrangement, constant mesh arrangement or synchromesh arrangement. Discussion of these arrangements is beyond the scope of this course.

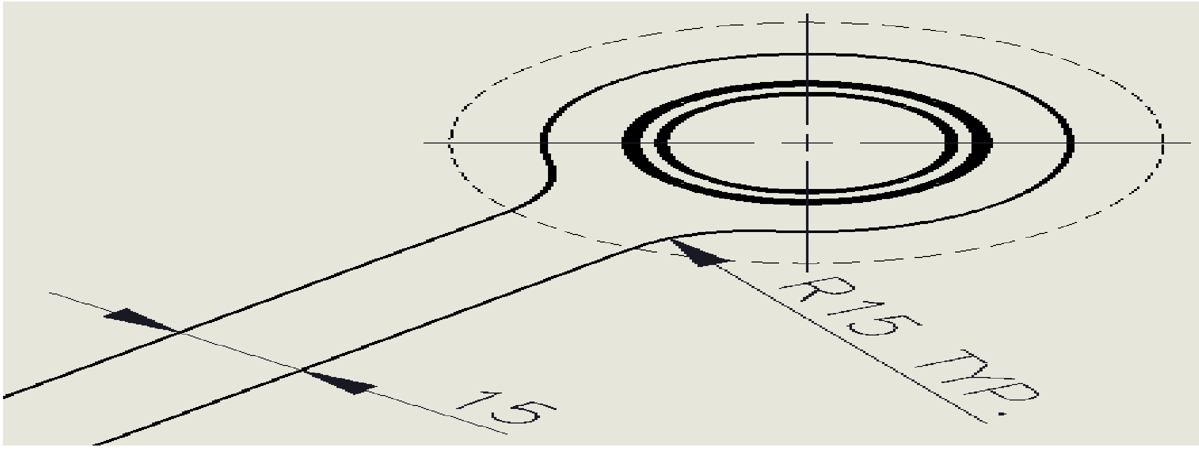


Figure 3: Rib and Fillet Dimensions For Bosses

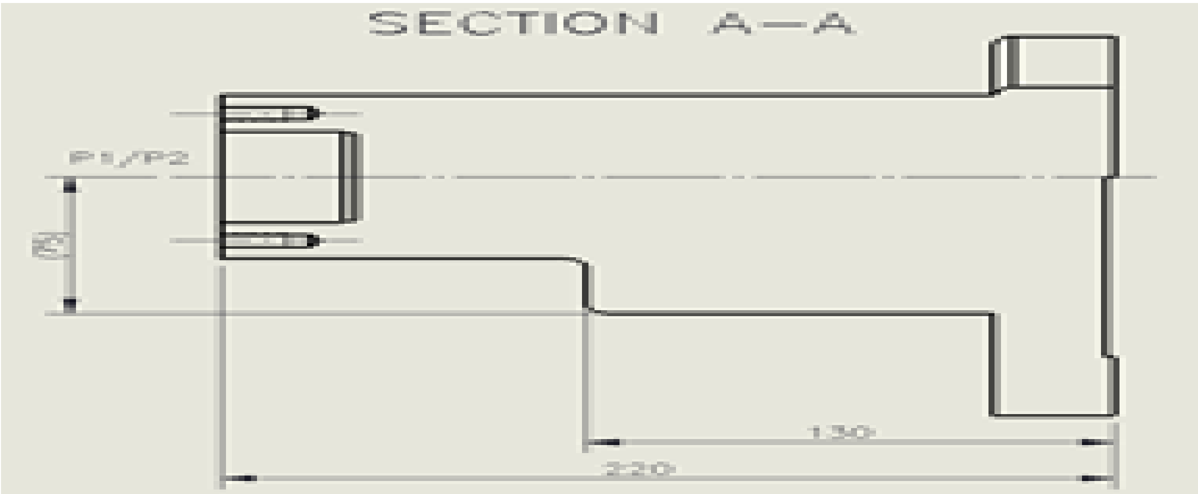


Figure 4: Pillar Dimensions For Bosses

The speed of a drill is usually measured in terms of the rate at which the outside or periphery of the tool moves in relation to the work being drilled. The common term for this velocity is "surface feet per minute", abbreviated as sfm. Every tool manufacturer has a recommended table of sfm values for their tools. General sfm guidelines are commonly found in resources such as the Machinery Handbook.

The peripheral and rotational velocities of the tool are related as shown in the following equation:

$V = \pi * D * N$

Where

V is the recommended peripheral velocity for the tool being used
D is the diameter of the tool
N is the rotational velocity of the tool
Since the peripheral velocity is commonly expressed in units of feet/min and tool diameter is typically measured in units of inches, Equation 1 can be solved for the spindle or tool velocity, N in the following manner:
$N [rpm] = 12 [in/ft] * V [sfm] / (\pi * D [in/rev])$

Provide a guideline as to the maximum speed when drilling standard materials. The optimum speed for a particular setup is affected by many factors, including the following:

- Composition, hardness & thermal conductivity (k) of material
- Depth of hole
- Efficiency of cutting fluid
- Type, condition and stiffness of drilling machine
- Stiffness of work piece, fixture and tooling (shorter is better)
- Quality of holes desired
- Life of tool before regrind or replacement

Use the smaller values for stiffer/harder/stronger materials and the larger values for softer materials. To calculate the feedrate, use the following formula: f = N * fr

Where

f = feed rate [in/min]
N = spindle speed [rpm]
fr= feed per revolution [in/rev]

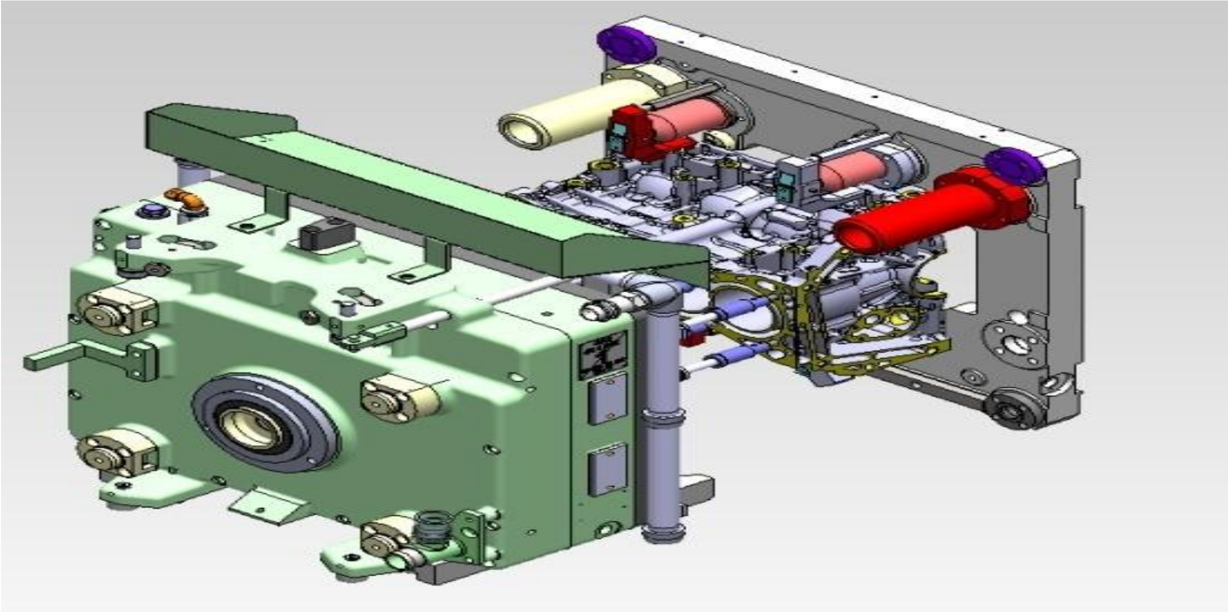


Figure 5: Indexed Head

Selecting And Inserting Gears In order to select the right gears you need the following information:

- Main drive rpm and tooth number
- Spindle gear rpm and tooth number
- Hand spindle rpm and tooth number

Tooth number for main drive side gears needs to be decided one way to do that is as follows: For the bottom drive gear the required tooth number is equal to one of the spindle gear's tooth number.
The tooth number on the upper drive gear should be such that when connected to center main drive its rpm should equal to spindle gear's rpm (same spindle gear as one used in last point).

Make sure to change the upper and lower drive gear's tooth number to the one's selected/calculated. Only use the following tooth numbers as specified by the customer: 17t, 23t 28t, 35t, and 50t.

Select the main 'datum' located at the very bottom of the tree and then under the gear assembly find the gear datum plane Now apply a tangent mate between the inserted gear and the existing main drive.
The design requires us to use at least two main drive side gears. Repeat steps to insert and position another side gear. The main driveand the two side gears should now look something.

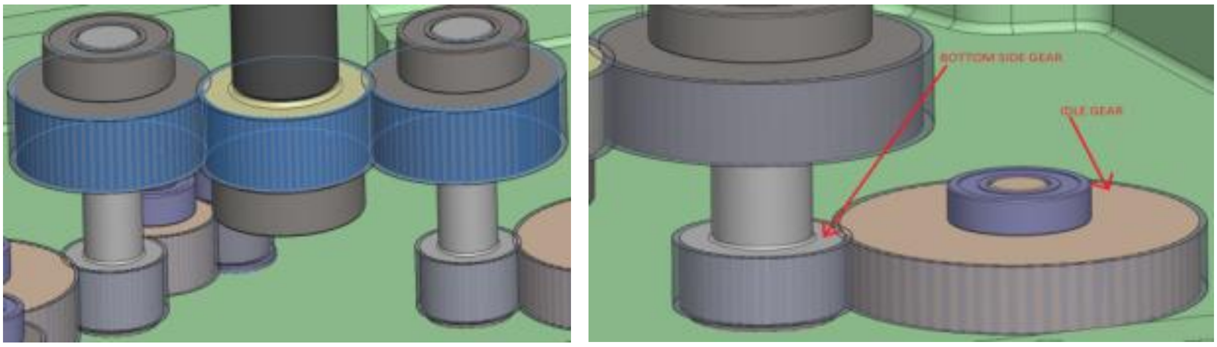


Figure 6: Main and secondary Spindle drives

Below shows an example of an efficient gear train. All spindles should rotate in (+) direction. The orange gears are idle gears. They can have any of the allowed tooth number build an efficient gear train by inserting required number of gears and positioning them using appropriate mates to change tooth number on each idle gear individually make sure the gear assemblies have been dissolved in the tree.

An efficient gear train should make sure that the least possible number of gears is used to drive the spindles in a positive direction.main drive rotation is (+) for 6 index ghs and (-) for 4 index.

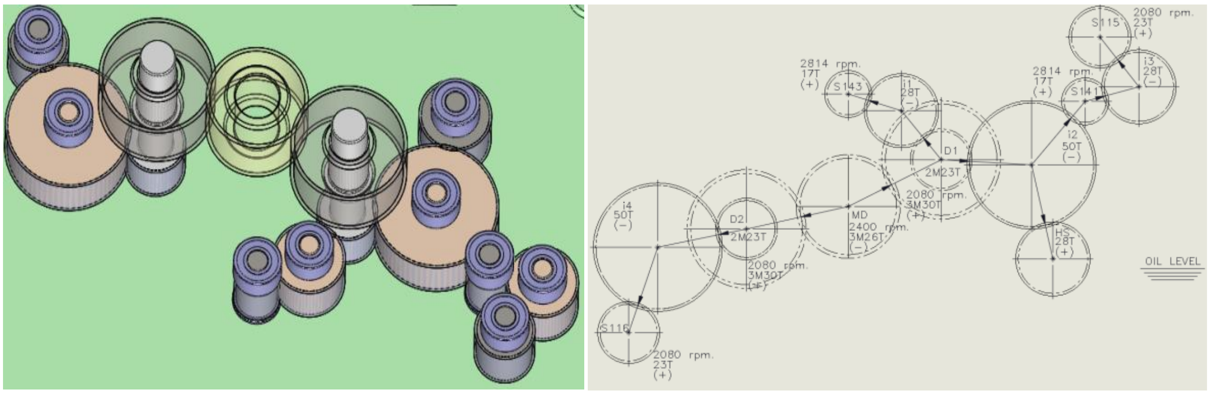


Figure 7: Gear train used in Index head.

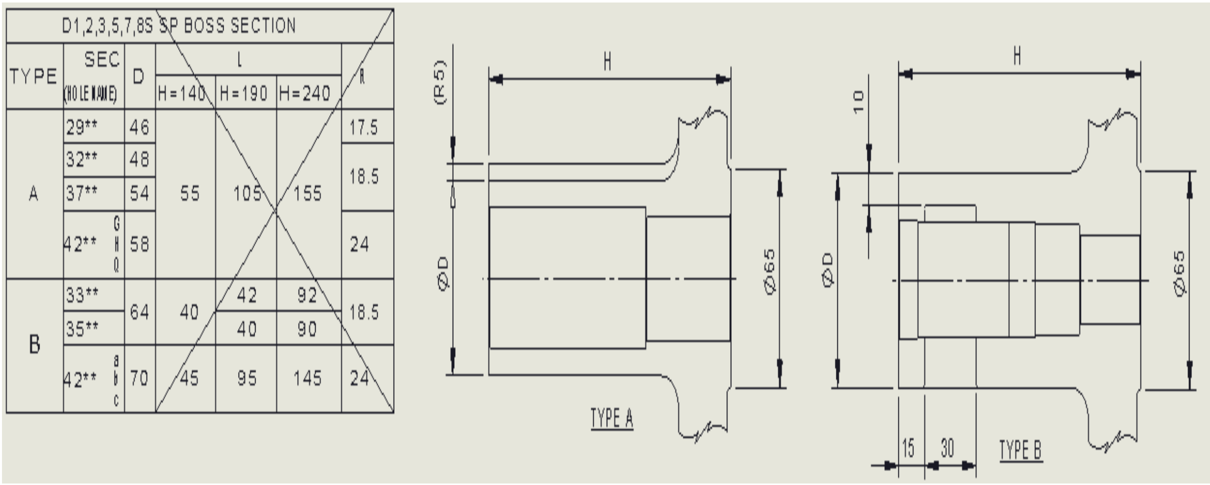


Figure 8: Sp Boss Size Details.

The smart features have now been inserted. Repeat this step to insert smart features for all gears present including drive gears, spindle gears, and hand spindle. Make sure all plates/cases have appropriate holes created after inserting smart features. When inserting smart features a display appears as can be seen in the figure 10 which highlights the reference that needs to be selected next. These references can be selected directly from the model or from the assembly tree.

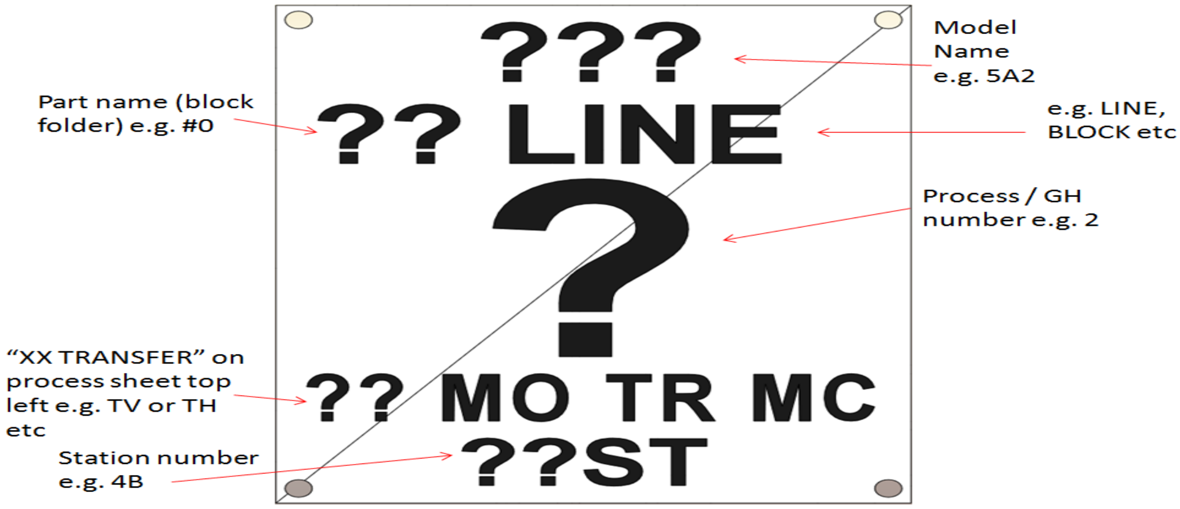


Figure 9: Name Plate Format

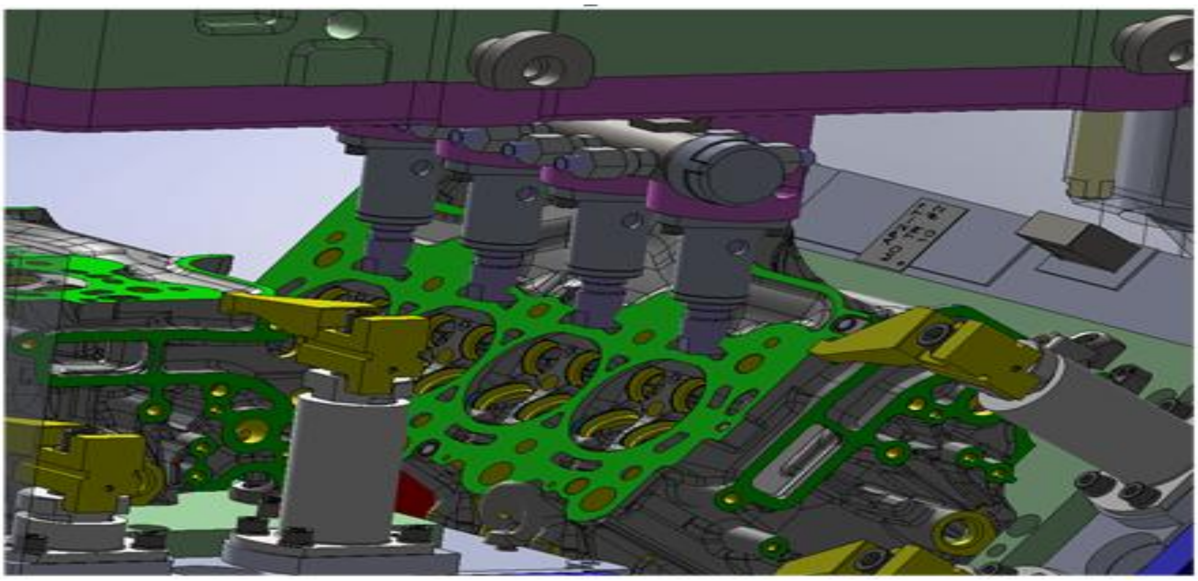
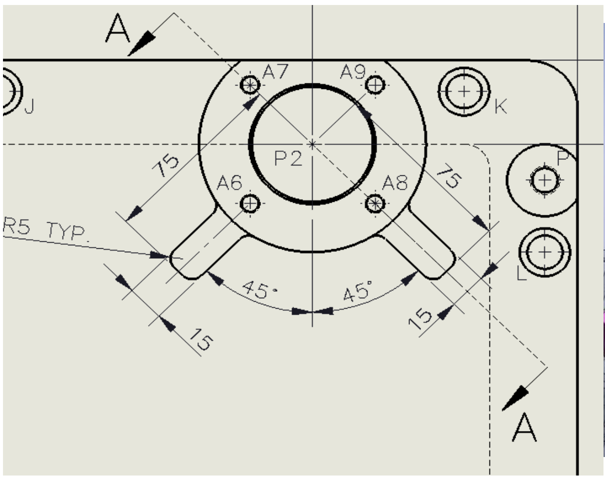
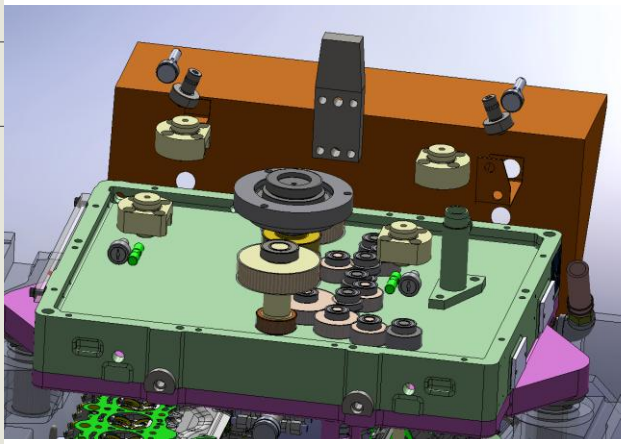


Figure 10: Gang head drilling on engine block





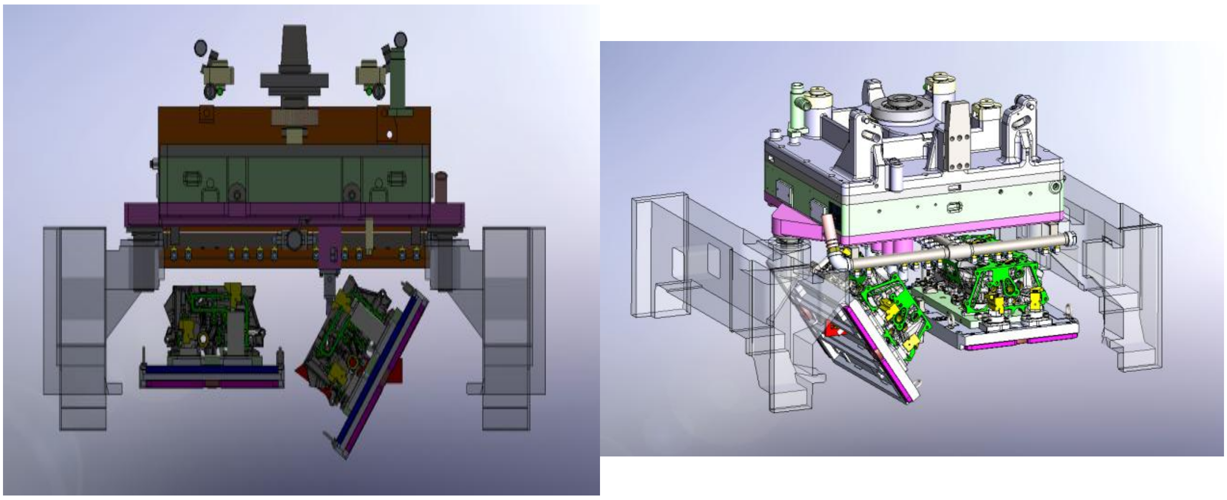


Figure 11: Detailed design of Index head

IV. CONCLUSION

Manufacturing is a process of converting raw material into produce that is useful many process are used to produce parts and shapes. There is usually more than one method of manufacturing a part from a given material. The manufacturing process to produce a particular part involves many considerations. Some of these considerations include cost, appearance, volume of production, application of the material, and many other issues. In this project, we try have try our best to find out the best method to produce the parts in a engine. However, we need to know that the method of producing these parts may differ for different manufacturer. Also, we need to know that manufacturing process of parts keep changing because new technology showing up. And a good method to produce one part today may not be a good method tomorrow since technology keeps improving. A key task for manufacturing engineering is to select an optimal manufacturing method among multiple alternatives, given product design goals, process capabilities, and cost considerations. Beside this, the selection of materials for different parts is also important in determining a best manufacturing processing doing this project; we have learned the various possible processes to produce apart. It all depends on the manufacturer and also the material used. This project give us a opportunity to experience the decision making on which process is more suitable to use for manufacturing each part that have different quality requirements and usage. Hence by using the new design discussed through this entire paper adds some value by reducing the manufacturing time for specific operation.

V. FUTURE SCOPE

Magnomatics has developed a range of magnetic gear technologies for achieving low and high ratios and a linear gear variant. The magnetic gear concept has been extended to provide both an ultra high torque density pseudo direct drive electrical machine and a variable ratio gear topology for continuously variable transmission systems. Contactless, high-efficiency, high-torque transmission with inherent overload protection The high-torque magnetic gear was invented and demonstrated by Magnomatics

- Reduced maintenance and improved reliability
- Lubrication free
- Higher efficiency than conventional gears
- Precise peak torque transmission and inherent overload protection
- Physical isolation between input and output shafts
- Inherent anti-jamming transmission
- Significantly reduces harmful drive train pulsations
- Allows for misalignment/vibration of shafts.
- Very low acoustic noise and vibration.

Design of Automatic tool palette changer and indexed conveyor for movement of engine block with respect to machining time.

VI. ACKNOWLEDGMENT

I express my sincere gratitude to **Dr.H R Vitala** the management of **EASi Engineering,** for giving me an opportunity to do my internship, here by acknowledge my sincere and heartfelt gratitude to my mentors **Mr. Kiran Narayana rao Mr Suhas Narashima, Mr Shynesh Mr Harish Manohar** and all **members of Design Dept, Assembly Dept, and Quality Inspection Dept.** for all their assistance during my internship.

REFERENCES

[1] Karl. T .Ulrich & Steven Eppinger "Product design and Development".

[2] "ASME Landmark: Additional Information on Marcus car," [Online], 20 March2005-lastupdate, available: http://www.asme.org/history/attachments/marcus1.

[3] "Anatomy of an Engine – the New North star V8," [Online], 7 April 2012-last visited, Available: http://www.autospeed.com/cms/A_1569/article.html.

[4] "BMWWorld – BMW S54 Engine," [Online], 7 April 2012-last update, available: http://www.bmwworld.com/engines/s54.html.

[5] "Corvette V8 Comparison," [Online], 2002-2004 copyright, Available:http://www.funco-motorsports.com/v8_comparison.html.

[6] Luther, Norris: "Metalcasting and Molding Processes," [Online], 22 March 2005-last, Available: http://www.castingsoruce.com/tech_art_metalcasting.asp