Radial Engine Outer Workings
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Aim

The Aim of this project is to complete the outer components of a radial engine with the view to assembling a total engine when combined with the project of Team P2.

Objectives

1. Review original design and update components as required.
2. Program parts for machining.
3. Manufacture and assemble the outer components.

Background

A radial engine project was initiated by mechanical and precision engineering students that was unfortunately left unfinished, it had been designed and manufacture had begun. It was not completed due to the time and Covid-19 restrictions, it was built upon and improved each year. The project is designed, it has a foundation partially completed parts and manufactured and some that remain to be machined and the assembly completed.
This group project will review all parts, drawings, components, prepare machining files, complete the manufacture of the externally mounted components, and assemble for a working engine. Reviewing each part will include the selection of material.

Design Review & Update

This project is a continuation of a previous students work. A SolidWorks assembly and parts list was provided to the team as a starting point. This assembly of parts was analyzed to determine functionality and manufacturability. During this review process several components were highlighted as needing a design update. Some parts that were originally designed to be manufactured were able to be purchased as standard parts. These parts are shown in Table 1. An example of design updates can be seen in Figure 1 Cylinder Head.

Table 1- Updated Parts

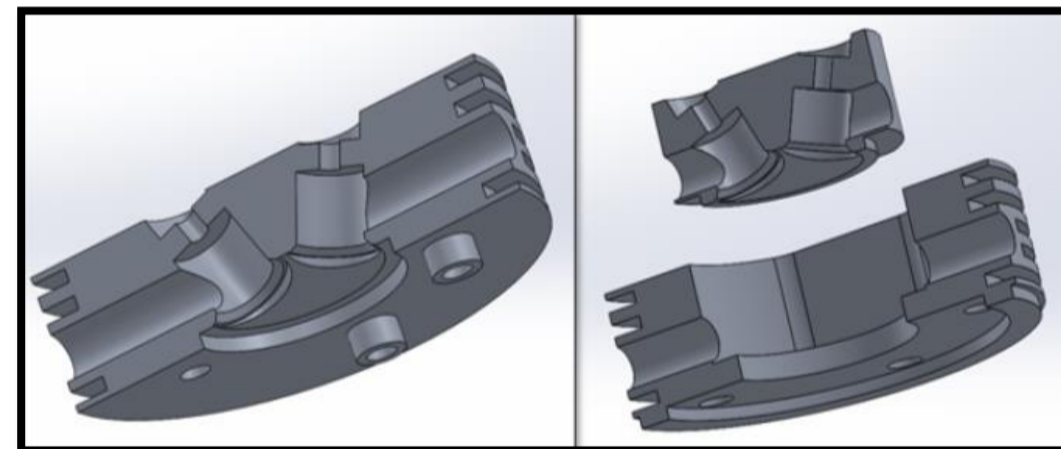| Component	Updates Made
Rocker Arm	Thickened Wall, Removed Thru Hole, Added Ball-Nose Pocket
Valve	Threaded End, Removed Clip Recess
Cylinder	Added Location Ring
Cylinder Head	Split into 2 separate parts, added shoulder and locating ring

Figure 1- Cylinder Head Updates

Final Design

Figure 2- Updated Engine Assembly

Programming & Manufacturing

The Computer Aided Manufacturing software SolidCAM was used to program the components that needed to be manufactured. The concentric nature of the Engine Cylinder lent itself to being made on the Mazak 250-II Mill Turn. The Cylinder Head was made on the Spinner U630 5 Axis Milling machine. The programming of each part was an iterative process with changes being made to various operations to suit machine tooling and work holding. Changes were also made to operations to increase the efficiency of the cutting process. This allowed for a reduction in total cycle time and better tool optimization. The Figure below shows the toolpaths generated for the Engine Cylinder.
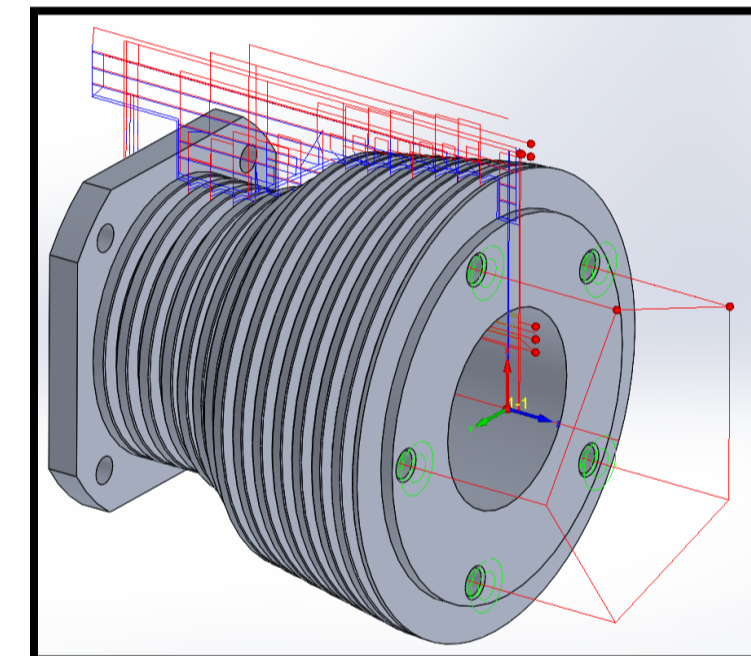

Figure 3- Cylinder Toolpaths

Valves: Due to the valve's small diameter, they prove difficult to manufacture because of the anticipated deflection. The vales complexity and large quantity the CNC late was chosen to manufacture the components. The G-code had to be manually typed out as solid cam could not add the step overs needed avoid deflection.

Figure 4- Machined Valve

Steel Insert: Two operations will be needed to manufacture the steel insert. The spinner was chosen as the part requires rotation of the vice.
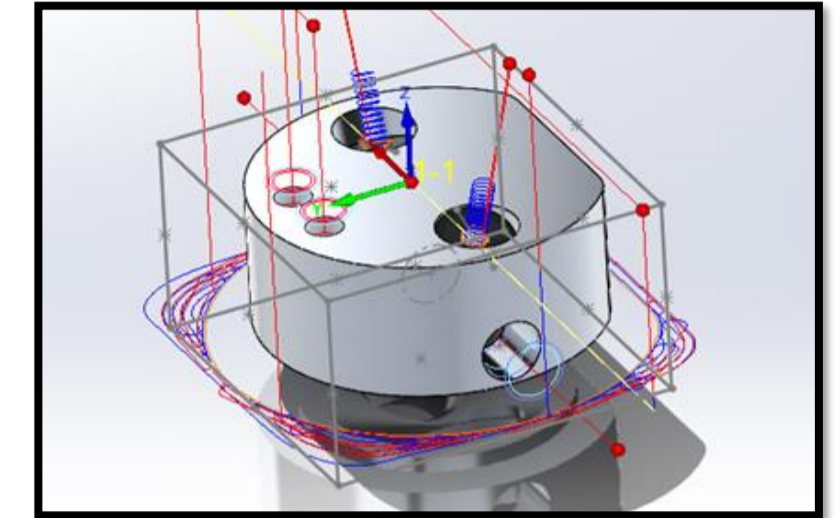

Figure 5- Steel Insert Toolpaths

Cylinder Head: Two operations are required for the manufacture of the Cylinder Head, the first operation will be machined on the CNC 5-axis Mill, while the completion of the part will be done on the manual lathe.
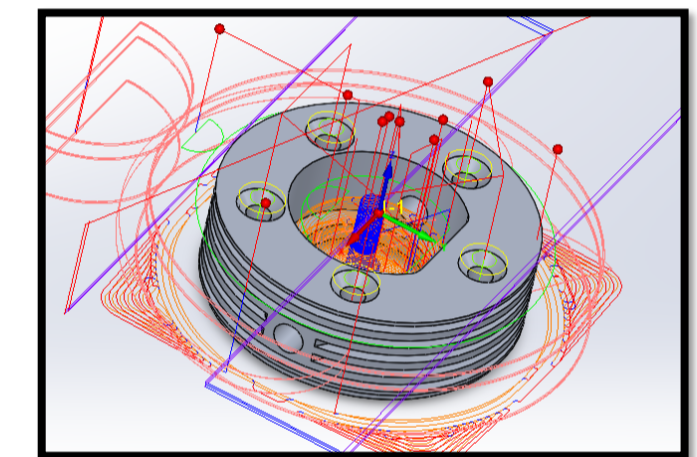

Figure 6- Cylinder Head Toolpaths

Figure 5- Machined Cylinder Head

Conclusion

The design/redesign section of this project proved to be challenging. A thorough understanding of the engine components and how they interacted was needed. A minor detail change on one component often meant an update was required for a number of related parts. Getting the CAM programs for each component to a "Ready-to-Machine" state was also an in-depth process that often took multiple revisions to get right.