TUS

# Design, test and manufacture a Stirling Engine


## Team P1; Stephen Mooney, Dylan Orth, Ben O'Neill


## Aim of the Project

The aim of the Project was to design, manufacture and test a Stirling Engine.
There were three configuration options to choose from; Alpha, Beta and Gamma. These configurations only really differ in layout.

## Background

The Stirling engine is quite a simple engine that efficiently converts thermal energy to mechanical work. It is able to do this through utilizing the expansion or the contraction of the molecules that make up a gas (or a liquid), that occurs when the temperature of the substance changes. Quite uniquely, the thermal energy Is applied externally to the engine, rather than internally. This engine is characterized by its high reliability and safety, but lower potential for power. It certainly is less cost effective to try producing a higher power output version of the Stirling engine when comparing to other options such as internal combustion.

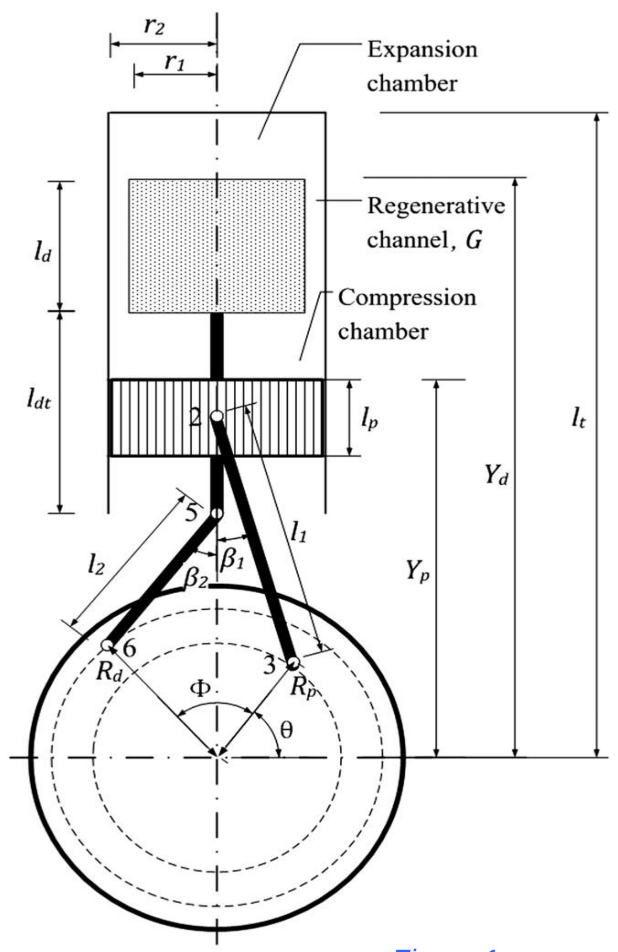



Figure 1: **"Stirling Engine Diagram"**
ResearchGate.com

## Design

When beginning to design our Stirling engine we each split and designed a different potential configuration to speed up the process.

We determined the Beta configuration to be the most visually appealing and easiest to design

We went through many different iterations of our SOLIDWORKS assemblies and parts, this was our main mode of developing our engine design.

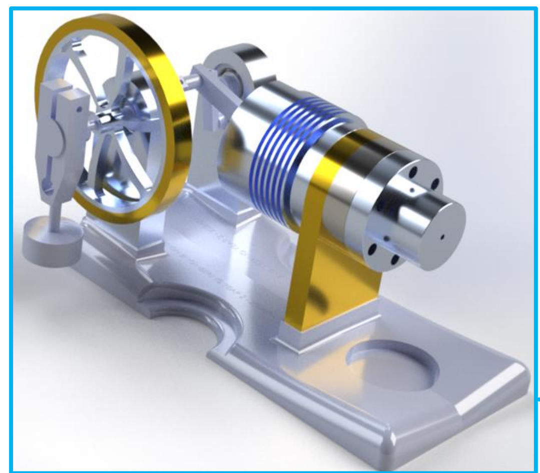


Figure 2: **Our Final CAD Assembly**

SolidCAM
SOLIDWORKS

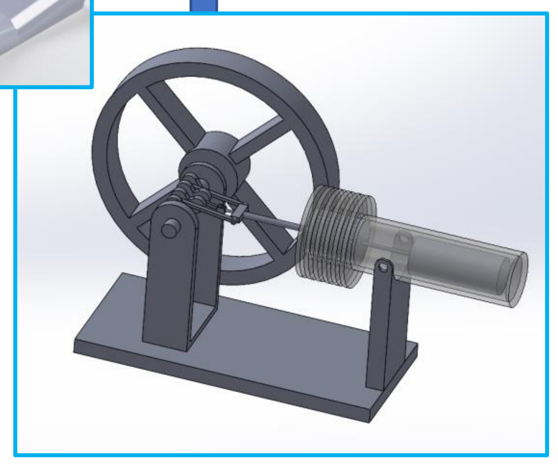
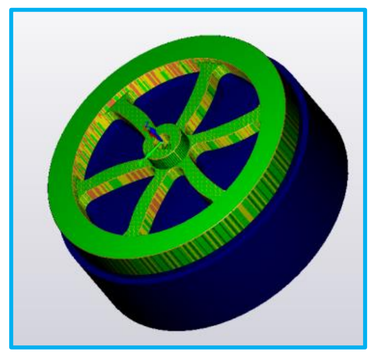


Figure 3: **Our First CAD Assembly**

We also machined some of our more complex components on CNC machines we programmed these parts through SolidCAM.
Through the use of these softwares we could troubleshoot very easily and ensure all parts in the assembly could mate properly. Examples of some issues that arose; linkages being far too thin, impossible geometries to manufacture and components clipping within the assembly.

Figures 4+5: **Our CNC Flywheel after initial operations shown in person and on SolidCAM simulation**



## Manufacturing

Various manufacturing techniques were used to machine all the parts of the engine.

The Engine base, Flywheel and burner were machined using CNC machines while the other parts were machined on manual lathes and mills.

We were allowed one class per week for 6 weeks, 4 hours per class.

Overall we had 72 workshop hours to manufacture all parts. This was a relatively tight schedule as we were also learning some more complex machining techniques as we were going.

Figure 6: **Manual Machining Displacer**

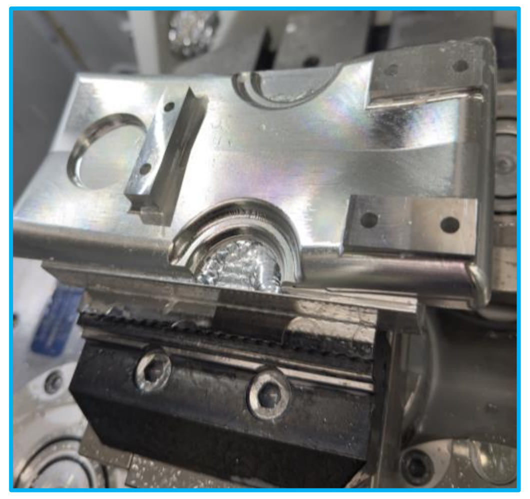


Figure 7: **Engine Base Made on Siemens Spinner U-620**

One of our biggest issues while in this stage of production was hitting tolerances on manual machines particularly the bearing fits when boring on the mill. We missed These tolerances and made the necessary adjustments. One of the bores was oversized and a grub screw had to be implemented into the design to catch onto the mated surfaces.

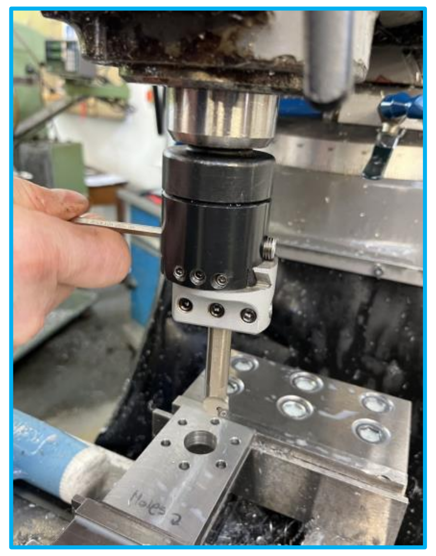


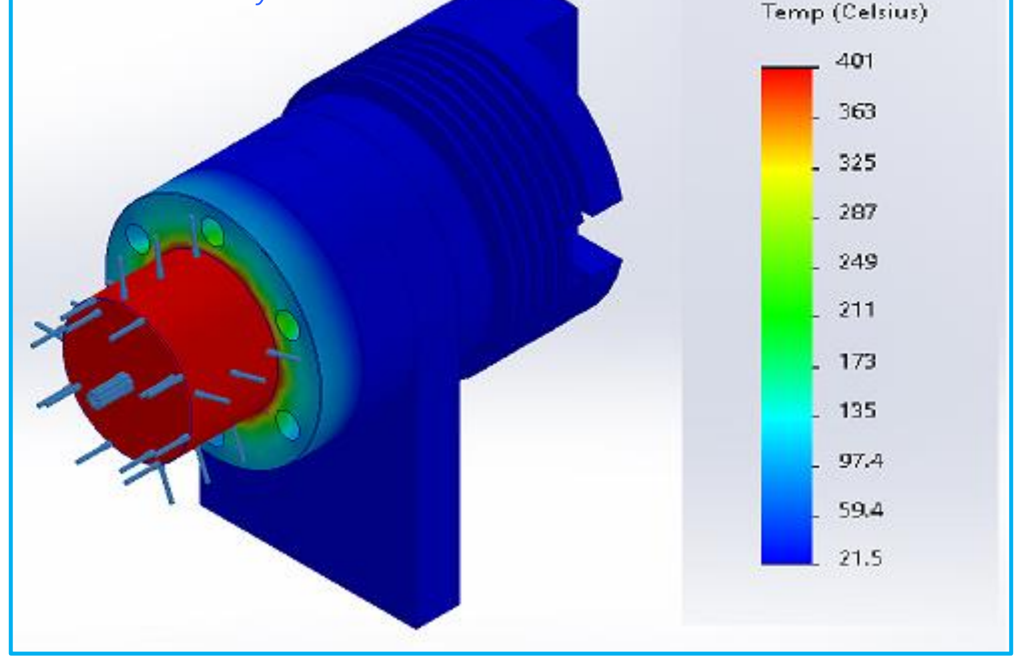
Figure 8: **Using a boring head on a manual mill**

Overall the manufacturing stage was a success without major issues occurring.

## Analysis

We conducted a thermal finite element analysis (FEA), within SOLIDWORKS to determine if the thermal break was a suitable thickness and material . As seen in the image below the designed thermal break was deemed sufficient, as it prevented the 400 degree Celsius heat applied from passing through to the cold end.

Figure 9: Heat transfer Simulation Study




## Conclusion

Throughout the duration of the project we encountered multiple issues and learned a substantial amount from them such as.

- Time Management skills
- Communication
- Problem Solving
- Working around design constraints

## References


Schematic diagram of the beta-type Stirling engine with cam-drive... | Download Scientific Diagram
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