Stirling Engine

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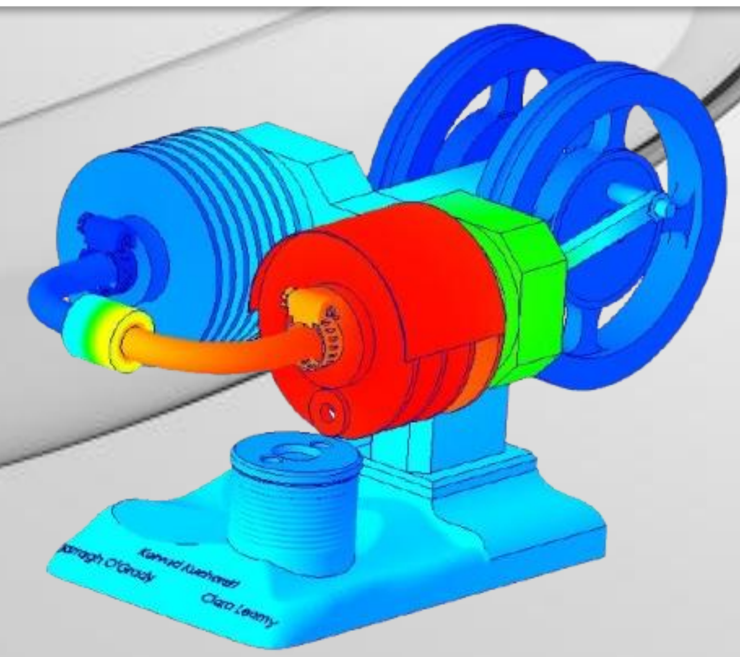
Aim of the Project

Our project aimed to design and develop a fully operational Stirling engine within the given constraints. As a team of three, we focused on researching, prototyping, and testing various mechanical configurations, materials, and fitments. Given the limited timeframe, we strategically assigned roles and managed resources efficiently to ensure the successful completion of a functional final product.

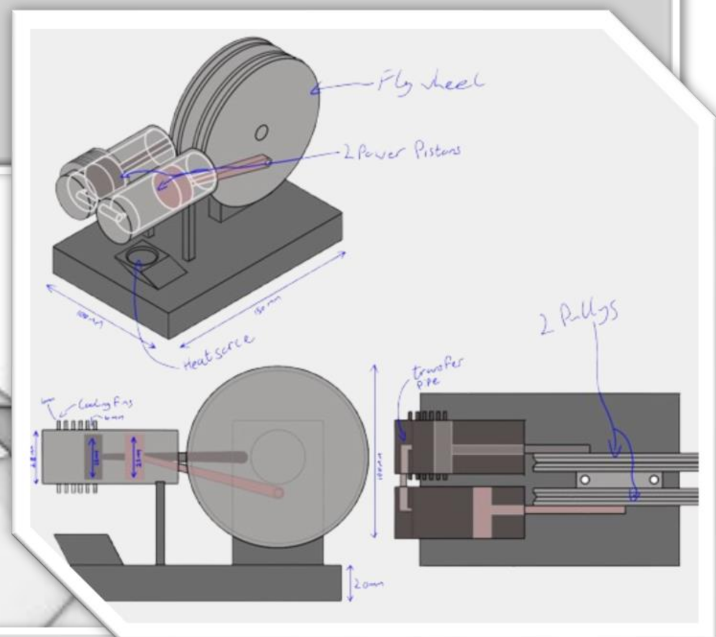
Background

A Stirling Engine is a closed system that converts heat into mechanical work, which contains a fixed amount of gas sealed in the system. The gases are in two different cylinders connected by pistons, one hot and one cold. A wick is used to heat the hot cylinder which heats up the gas, expanding, pushing the piston forward. The gas then flows into the cold cylinder when it cools and compresses it moves the piston. There are three types: the Alpha, the Beta and the Gamma. The Gamma and the Alpha have two cylinders, and the Beta has one cylinder.



Design

When designing, factors such as operation, aesthetics, cost and production clash between each other which can create downtime.



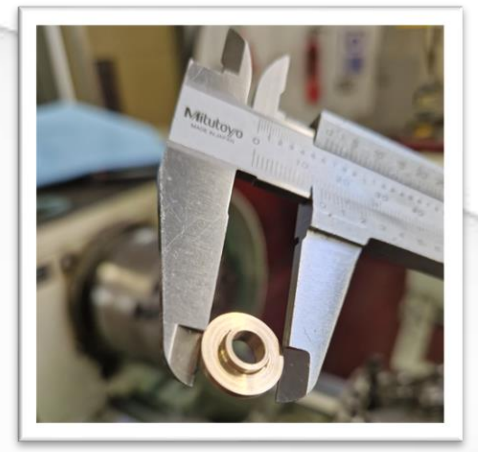
These were analyzed using a point system which concluded the alpha type having a good efficiency to power ratio while maintaining manufacturability to a minimum.

	Beta Style	Alpha Type	Gamma Type
Efficiency	1	4	2
Power	2	5	2
Manufacturing	4	3	4
Total	7	12	8

However, to keep industry standards, components required tolerances and standardized fitments. Most our parts are within a 0.025mm tolerance and a common m6 tap, this ensured functionality and reduced the variety of parts to order.
Similarly, the choice of materials was crucial as for an engines cylinder and piston the friction and thermal heat expansion needs to be factored. Reducing stresses and applying self-lubricating properties improves efficiency.

Manufacturing

The production facilities included a fully equipped workshop featuring a Centre Lathe, Milling Machine, and various sub-tools. Additionally, up to three parts could be manufactured using CNC machining, utilizing either a Spinner 4-Axis for milling or a Mazak for turning.

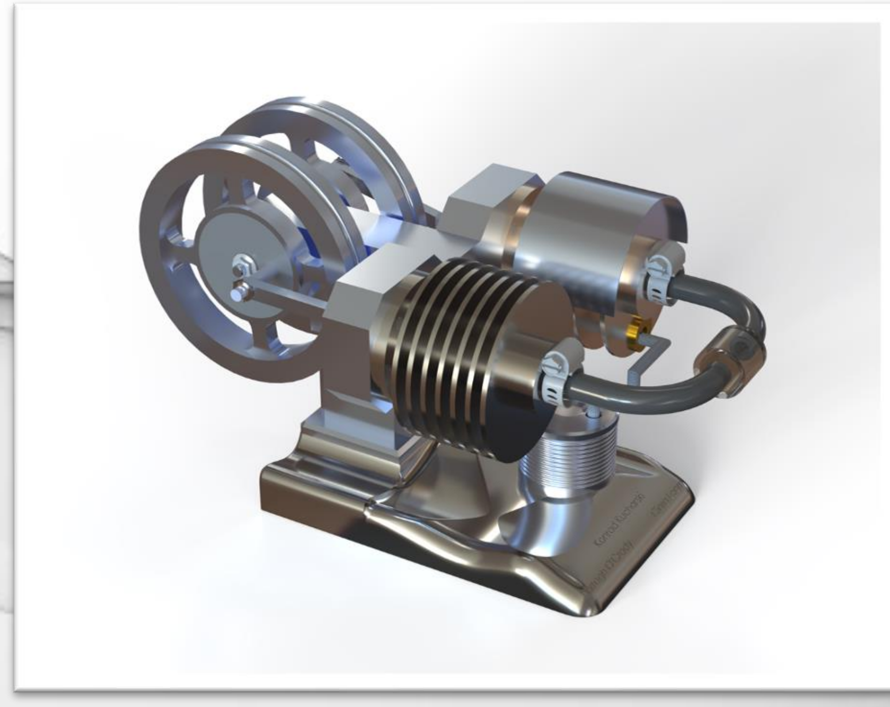


Geometric tolerance drawings were created using SolidWorks to ensure precise tolerances and accurate feature positioning. A Vernier caliper and micrometer were used for precise measurement of part diameters, lengths, and widths, while a bore micrometer ensured a perfect seal between the cylinder bore and piston.

Full Build

The final assembly of the Stirling engine required precise tolerances to ensure proper functionality. Critical components, such as the pistons and cylinders, needed to be perfectly aligned and airtight. Each part was meticulously inspected using a micrometre, Vernier callipers, and a depth micrometre to verify dimensions and identify any defects.

While the build was ultimately successful, challenges arose due to time constraints and the complexity of the design. Some aesthetic features had to be simplified or omitted to meet project deadlines. Despite these setbacks, the completed engine demonstrated the principles of thermodynamics effectively and achieved its intended functionality.



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