Stirling Engine Project

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Aim of the Project

The aim of the project is to design, assemble and manufacture an efficient sterling engine.

Objectives

- ✓ **Design Optimization**: Create an efficient engine design with minimal energy loss.
- ✓ **Component Selection**: Choose durable, cost-effective materials.
- ✓ **Thermal Efficiency**: Maximize heat exchange and minimize energy losses.
- ✓ **Prototype Development**: Build and test a working prototype.
- ✓ **Testing and Analysis**: Evaluate performance under various conditions.
- ✓ **Manufacturing Process**: Develop a cost-effective, precise production process.
- ✓ **Sustainability**: Ensure environmentally friendly design and materials.

Background

A Stirling engine is a heat engine that works by cyclically expanding and compressing gas to create mechanical work. It operates smoothly and efficiently, making it ideal for quiet and reliable power generation.
When it came to the design and background research it was important to keep the list of project constraints in mind as these had to be followed throughout the project.

Specification	Details
Cylinder configuration	• Single cylinder with vertical or horizontal displaced piston
Output shaft configuration	• Must be horizontal axis and contain a flywheel
Flywheel	• Manufactured using CNC technology as part of CAD CAM • Maximum diameter of available material 100mm
Power piston	• Stroke not to exceed 40mm • Diameter not to exceed 25mm
Engine design	• External combustion, air cooled
Heat source	• Burner/lamp designed by each team and manufactured on CNC lathe. • Teams supplied with a wick.
Engine base	• To be manufactured using CNC technology as part of CAD CAM. • Engraved to include names of each of the team members, the course, year and TUS logo. • Design must allow for 3d milling of surfaces (get creative!) • Material available – Aluminium 150 x 100 x 20mm or 150mm diameter
Testing parameters	• **Torque** – must be designed so that it can be connected to a Torque meter • **Gas Temperature** – must include a thermocouple in the gas stream • **RPM** – rotational speed measured using Tachometer

Design

As stated in the brief, we had to design and manufacture a sterling engine. This simply began by researching ideas online and making simple sketches. As the project began to advance and the group had reached a final design idea, we then began drawing up the components on SolidWorks. From here, we used the solid works assembly mode to assemble the parts.

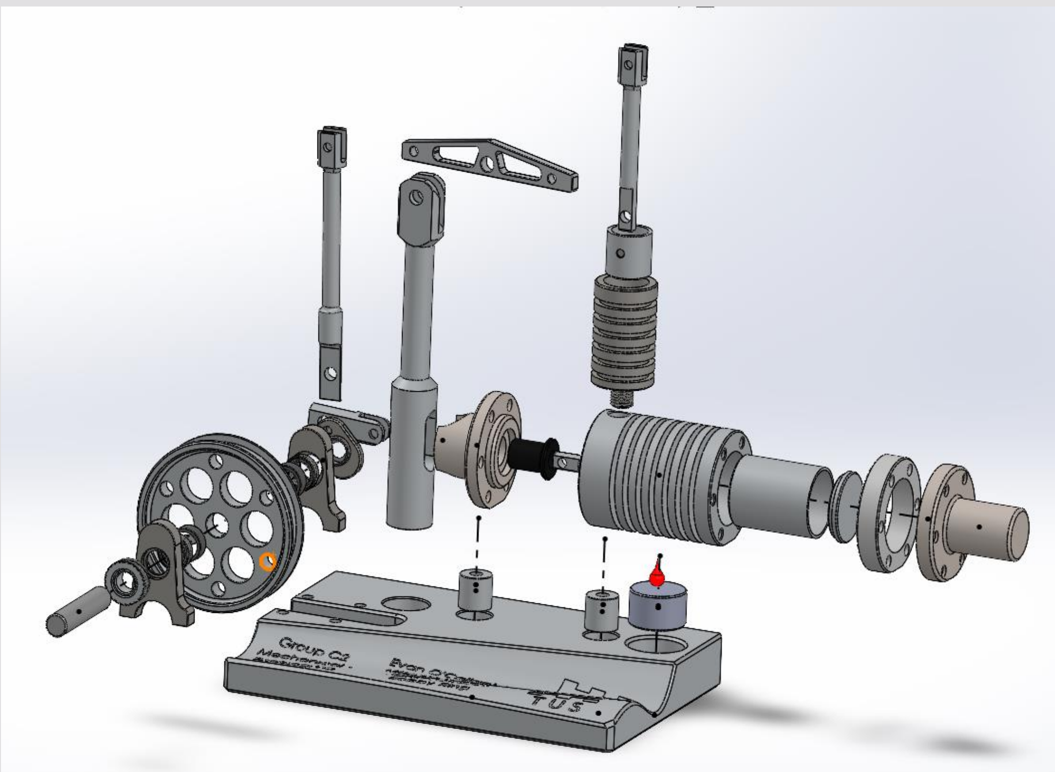

Figure 1: Solid works exploded view.

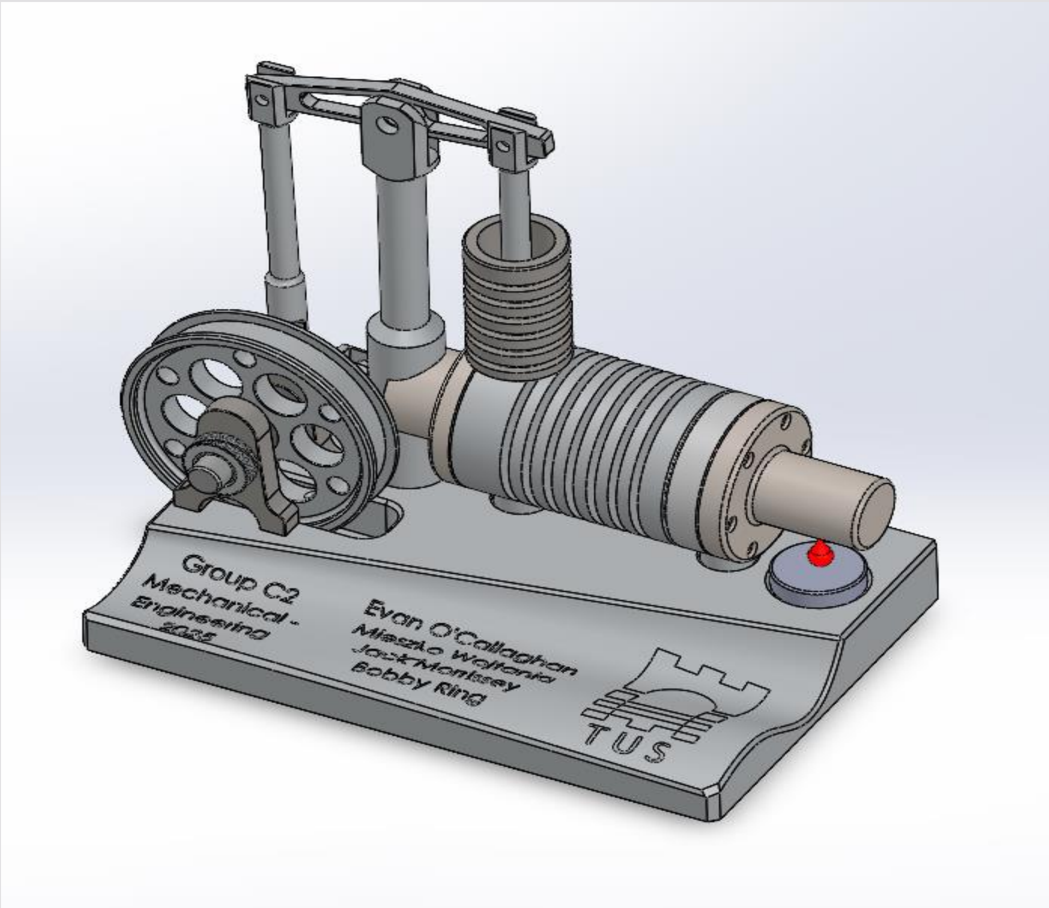

Figure 2: solid works final assembly.

This was the final design idea that we reached. This idea involved A huge range of various machining methods and also had many complex Parts so it also set a challenge for the team. We used process planning Sheets to ensure that all deadlines would be met.

Simulation & analysis

When it came to material selection and analysis, a key tool to this was the use of solid works FEA. This tool helped us choose a suitable material for the part shown below as the original idea was to 3D print it but through FEA we realized 3D printed material would not withstand the force applied.

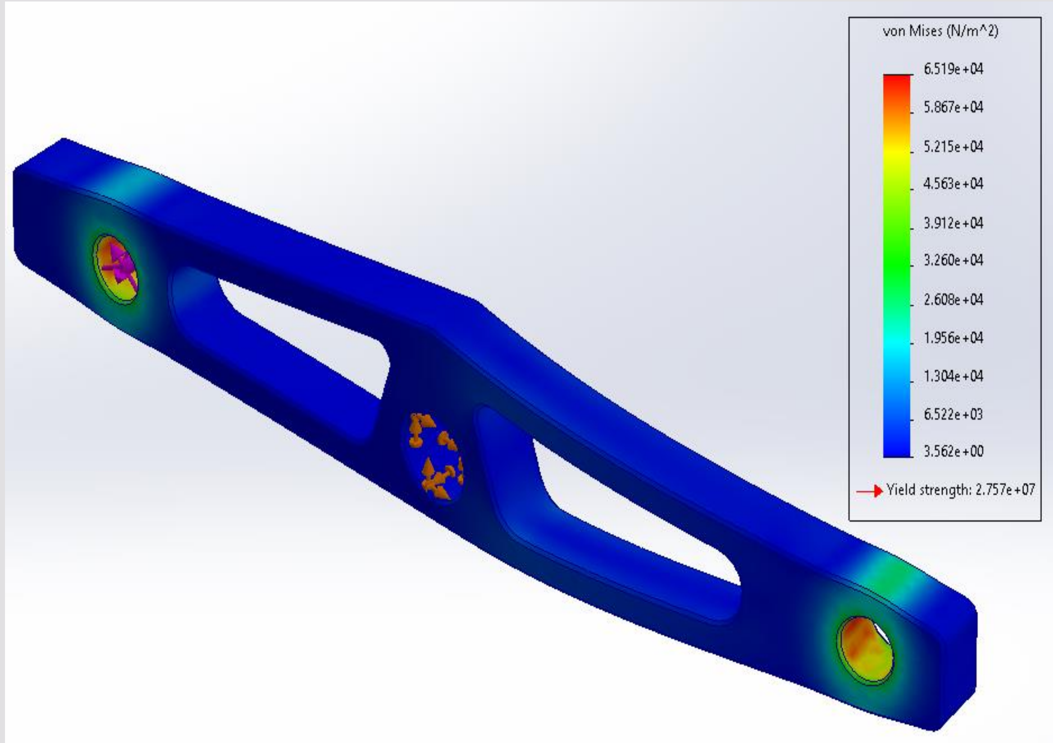

Figure 3: FEA of project component

Manufacture

The manufacturing processes used in the project included:

- ➢ **CNC work:** the project base was manufactured on the CNC machine as it could cut a complex shape.
- ➢ **Milling machine:** the milling machine was used to drill holes. Also boring and profiling operations were used too.
- ➢ **Lathe:** A lot of the cylindrical pieces were manufactured on the lathe using operations such as turning facing and reaming.
- ➢ **Bench work:** this included tapping, filing polishing as some pieces were small and complex shaped.
- ➢ **3D printing:** was used to print the stands for the flywheel due to their complex curves and hole concentricity.

References

- https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://auto.howstuffworks.com/stirling-engine.htm&ved=2ahUKEwjJiseqpbCMAxW6T0EAHVW5ITsQFnoECCgQAQ&usg=AOvVaw08l_muWLbgq9nplXfC9DT9
- https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://medienportal.siemens-stiftung.org/en/physics-of-the-stirling-engine-101604&ved

Shown on the left is an image of the CNC machine which was used to cut the complex shapes on the base of the model.

Pictured on the right is an example of a lathe turning operation during manufacture. A 2mm parting off tool was used to cut the cooling fins. We chose this over the standard 4mm tool as it allowed for more fins which resulted in better cooling efficiency.

Conclusion

In conclusion, we were able to design, manufacture and test a working sterling engine. This was a great chance for all of the team members to come together and display their different skills in various design and manufacture techniques.

Throughout the project, there were many challenges faced by each member of the team ranging from materials to measurements. These challenges were overcome through different ideas and techniques displayed by the team members. We are happy with our design and overall happy with how the engine turned out.

Acknowledgments

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