Oscillating Air Engine Project

Jack Sides, 2022

Project overview

The air engine project is the main project that freshman engineering students at George Fox do in their first term. The basic idea is that you create an oscillating air engine (wobbler engine) from scratch with the tools and materials provided by GFU. In the project, students are expected to come up with an initial concept that is focused on one goal (speed, cost, torque, etc.), derive and compute engine variables, create hand drawings with specific measurements, make a bill of materials that does not exceed $33, create a 3d model of the engine, make new drawings using the 3d model of the engine, machine and assemble the engine using the machine shop and resources provided, and finally, showcase your engine at the "Wobble Off" and compete in the category that you selected. Needless to say, it is a massive project for first year engineering students.

My engine

At the beginning of the term when this project was first announced, I had big ambitions to make something that nobody had ever seen before, but I quickly realized that some of my ideas were not going to pan out well. So, I ended up going for a basic inline 3 engine. Here are some of the other key design features that I settled on:

- Inline 3-cylinder layout
- Upright piston layout (bottom mounted flywheel)
- A solid crankshaft with 3 crankpins (one for each cylinder)
- 120 degree offset for each cylinder to prevent any dead spots in torque
- Top mounted air inlets

On the right is a render of the SolidWorks model of the engine:

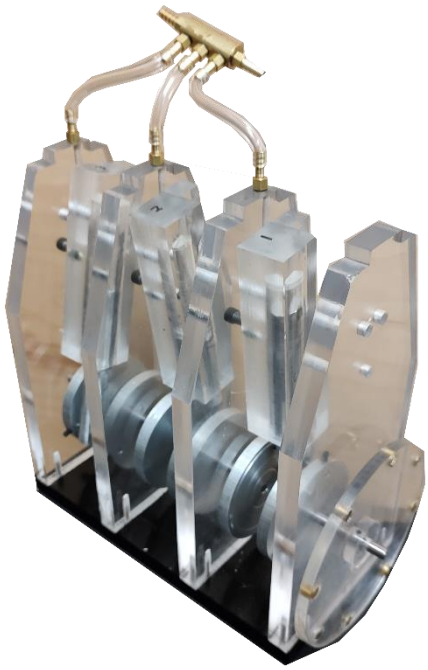
Challenges

The idea was to basically make 3 normal wobbler engines and put them in series driving one crankshaft. When I first came up with this idea, I didn't realize exactly how precise I was going to need to be in order to make this work. The height of the valve plates that support the crankshaft were going to need to be within about 5 thousandths of an inch of each other in order to not make the crankshaft seize when trying to rotate. There was also a lot of precision needed in the crank disks, because if a set of 2 didn't have to exact same radius, then it would be slightly skewed and seize. It was going to be a challenge to pull off.

Design changes

Because this was such a tough engine to build, there were a lot of things that needed to be changed along the way in order for it to work and stay inside the budget. Here's a list of the major changes that I made during the build process:

- Switching from threaded inserts to tapped threads in the cylinders to prevent the acrylic from cracking.
- Changing the base plate from wood to acrylic so that it would be more even and allow the crankshaft to rotate more freely.
- Changing the cylinders from black acrylic to clear acrylic because the shop ran out of 1" black acrylic. This ended up benefiting me a lot more than I was expecting because I was able to see the holes that I was drilling while I was drilling them. It also helped me fine tune my pistons because I could see how far they were reaching into the bore.
- Building a 2 – 3 valve air splitter to take the 2 hoses of air provided and split them into 3 to supply all cylinders with air.
- Adding wings to the sides of the cylinders to seal the air loop when the cylinders are at max oscillation. This was needed because of the addition of the 2 – 3 valve air splitter, when the cylinders were at max oscillation, the intake valve was releasing all of the pressure into the atmosphere, so the wings were added to cover up the intake holes at max oscillation.



On the right is a picture of the complete engine with all these design changes applied

Skills learned

This whole project was a massive undertaking for someone like me, who has never had access to this type of machinery or software before. Some of the skills I learned include

- Hand drawing designs (3d and 2d)
- Deriving formulas for projects
- SolidWorks modeling
- Machining
- Rapid prototyping
- Creating applicable excel sheets
- And presenting all my work in a was that is easy for the viewer to understand

It was a steep learning curve, and there were times that I was extremely lost, but now that it's over, I honestly feel like I know the project well enough to teach a class on it myself.

Future design changes

This was a fun project, and I don't regret anything in my design. All of the things that I got wrong are things that I learned from and fixed along the way. I am glad that I was able to make mistakes and change the design on the fly to compensate for them. But with all that being said, if I was to do this project again there are a few things from my design that I would do differently. Here are some of the major changes that I would make

- I would create the engine so that the crankshaft top mounted instead of bottom mounted. This would have allowed for a bigger flywheel, but it also would have made it harder for me to vertically align the crankshaft holes in the valve plates. Therefore, I would do it on my second design, so that I already know how to use the machines and make things precise.
- I would make my pistons wider to eliminate the need for wings on the cylinders.
- I would make the cylinders out of aluminum, and the pistons out of brass. I originally did the acrylic cylinders and aluminum pistons because of cost restrictions, but after seeing how much friction that created, it definitely would have been better to take that money from a different part of the engine.