A New Spin on Modern Rocketry

Github Link

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Why do we want to spin these rockets?

While conventional rockets achieve stability utilizing their fins, they are more susceptible to early flight perturbations that can significantly alter the trajectory of the launch. While we are not the first to test or utilize spin stabilization in rocketry, resources and information on the field are not easy to find, making it inaccessible to most rocketeers. Our goal is to complete a program that models a predicted flight path of a spin stabilized rocket and compare the predictions to data collected in the field.

Spinning and Rocketry

> Past use of spin stabilized rockets includes the Jupiter C, Delta II, Minotaur V, and Lambda 4S

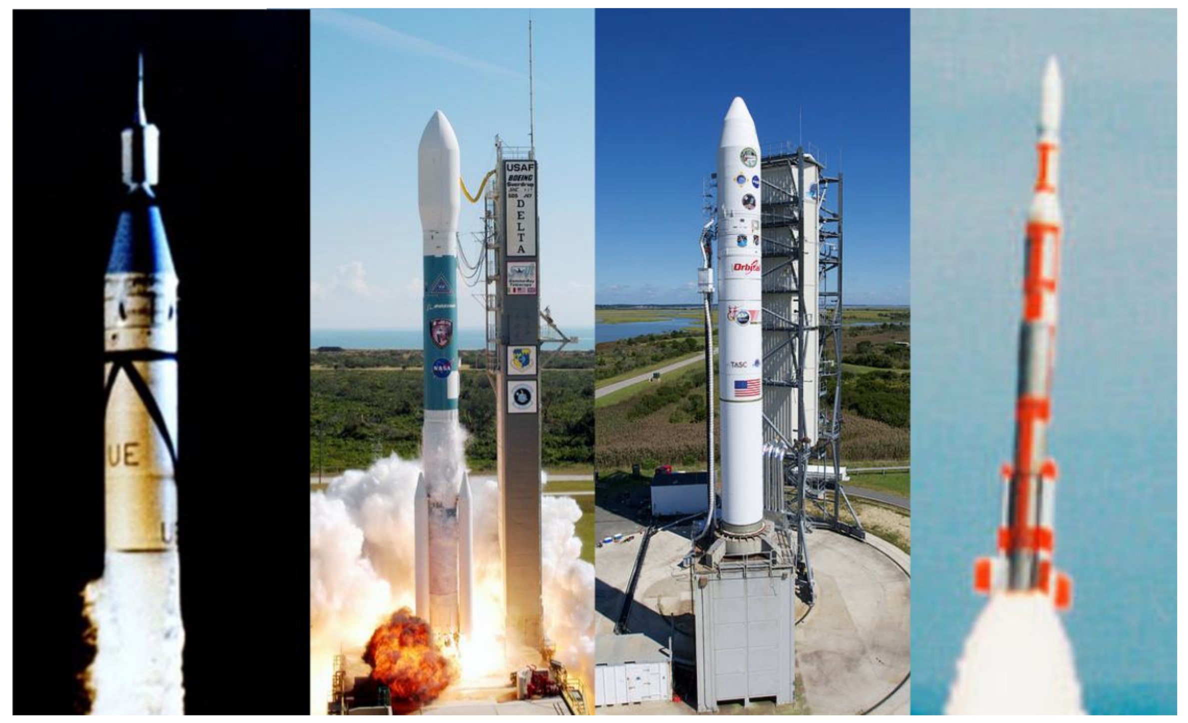
> Current use of spin stabilized rockets includes sounding rockets such as the Super Loki

> The two largest organizations in model rocketry are the National Association of Rocketry (NAR) and Tripoli Rocketry Association (TRA)

> Since 1957, over 100,000 rocket modelers have joined NAR

> TRA has members spanning 22 countries

> TRA members were the first civilians to put a rocket in space



Left to right: Jupiter C, Delta II, Minotaur V, Lambda 4S photos from nasa.gov and isas.jaxa.jp

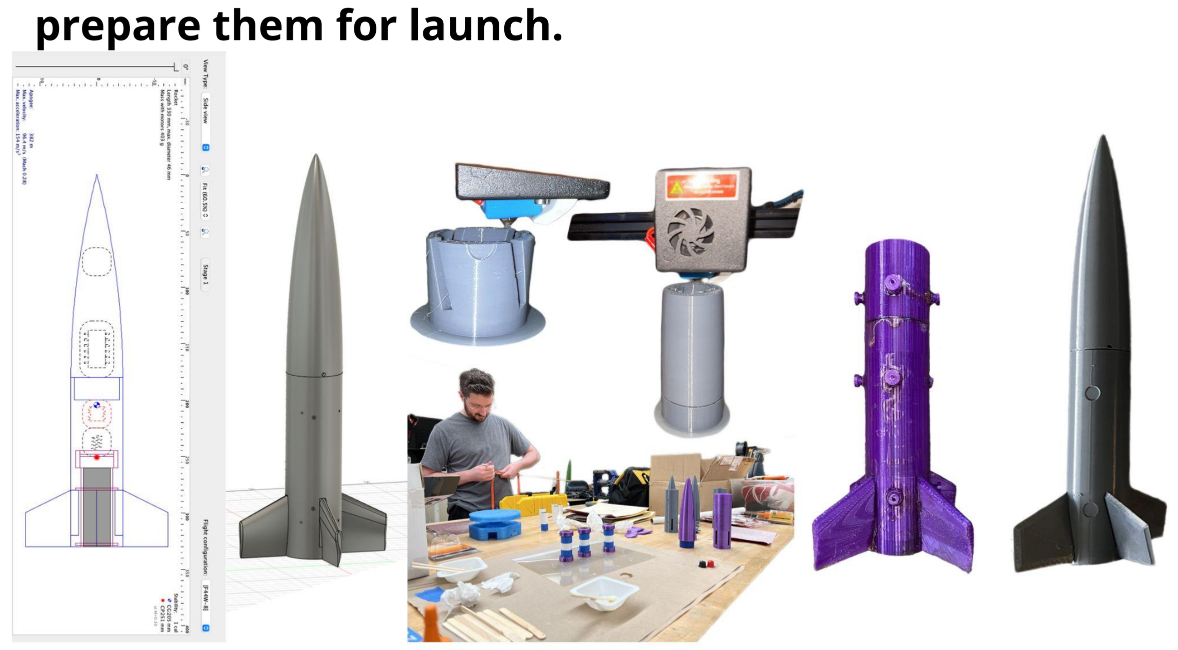
Rocket Design

In order to test the improved stability gained from spin, we needed to create rockets that were controlled for all parameters except spin.

> The rocket design phase began in OpenRocket, where we optimized the size of the rocket versus cost of materials versus rocket performance.

> We then took to AutoDesk Fusion 360 to turn our OpenRocket design into a 3D file that could be printed. These designs are then imported to Cura which turns the 3D model into instructions for the printer.

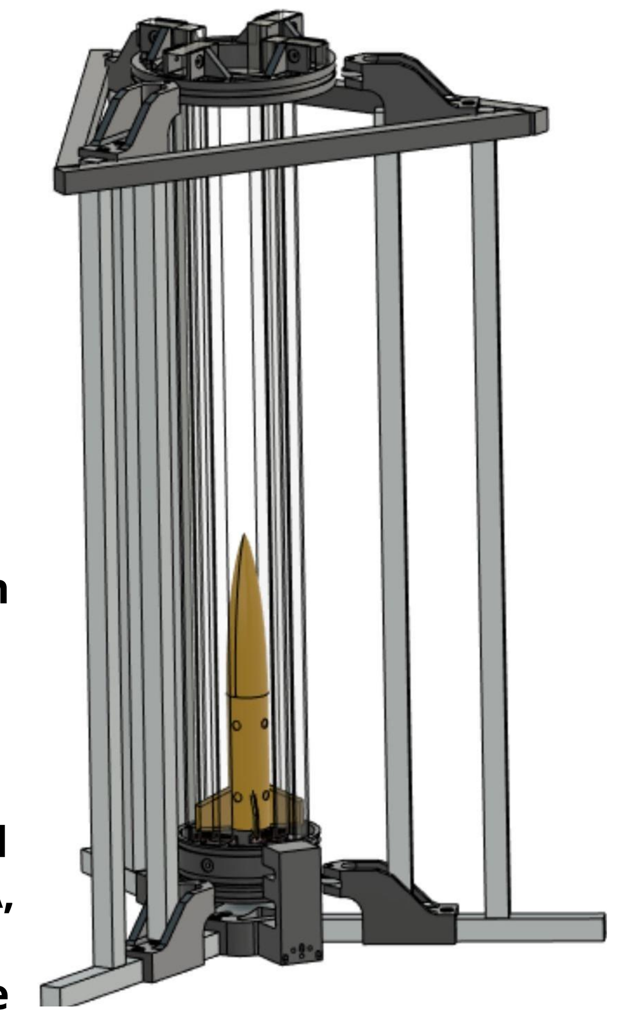
> After several iterations of printing, we end up with the PETG parts needed to assemble our rockets and prepare them for launch.



Left to right: OpenRocket file, Fusion file, 3D printing in progress, build in progress, completed rocket

Base Design

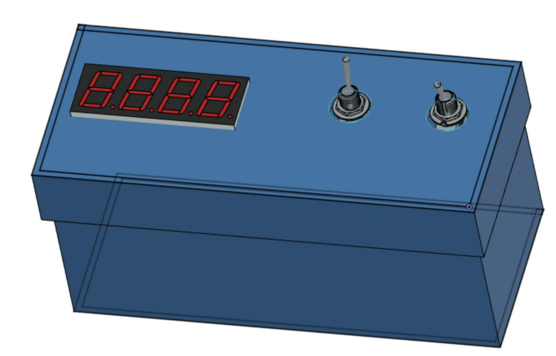
Our planned test regime necessitated the design and construction of a spinning base to pre-spin the rockets before launch.



> The design consists of four central spinning launch rods surrounded by two "bearing collars" and a carbon brush system which is used to ignite the rocket motor.

> The base was designed in Fusion 360 and constructed primarily of 3D printed PLA, 1 inch 8020 aluminum extrusion, and hobby grade remote control electronics. It is the first of its kind at the consumer scale.

> Speed control is achieved with a hall effect RPM sensor and a digital readout on the handheld launch controller.



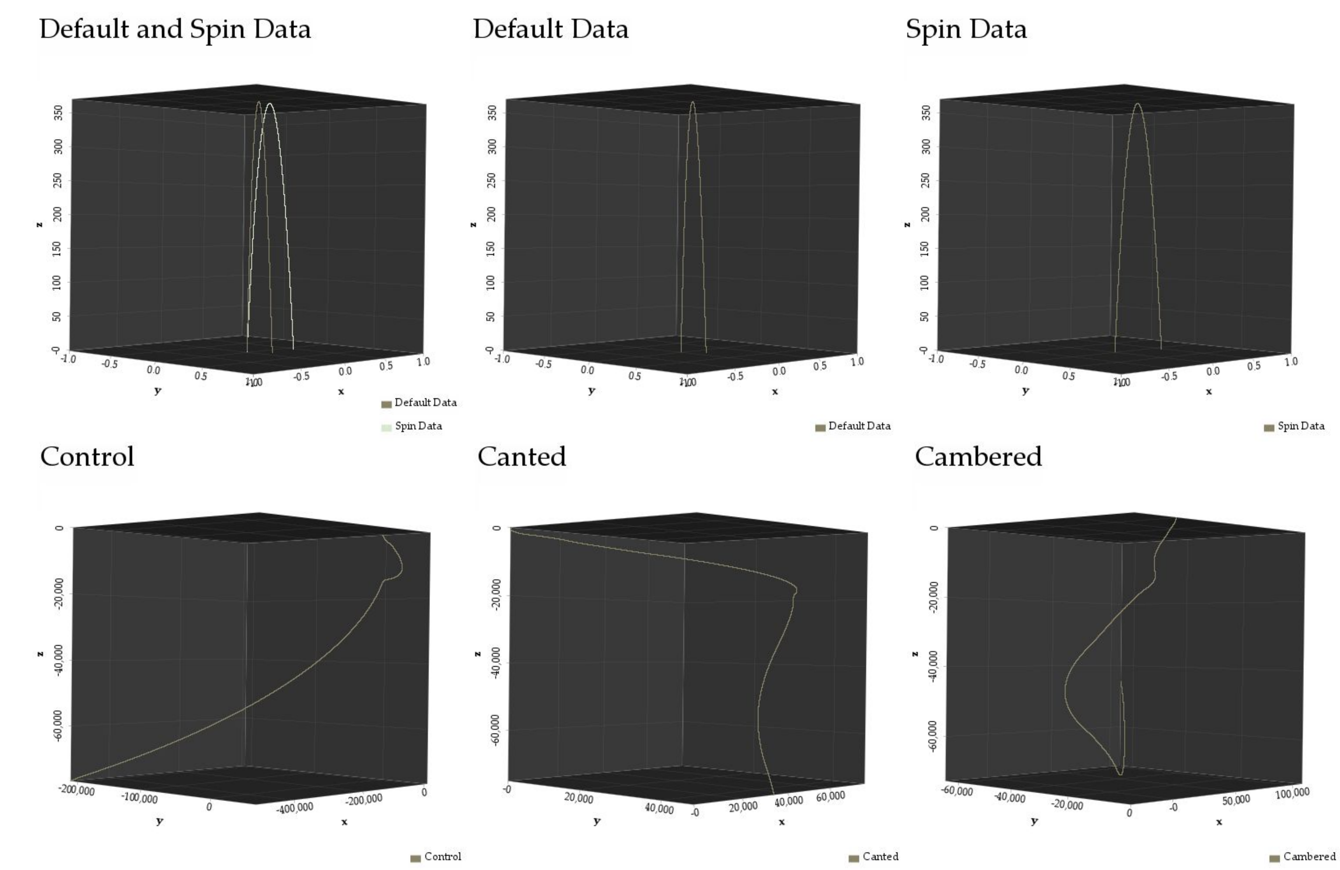
Programming

Because OpenRocket already has many of the tools necessary to predict a rocket's flight, our program works as an OpenRocket mod.

> First, we searched for all the parameters necessary as input to run our simulation. Then we create the program that computes all physics calculations to predict the rocket's motion.

> In order to visualize this, we needed a 3D graphing utility; we ultimately decided to use Orson Charts to do this.

> Finally, we integrated this into the OpenRocket GUI by adding a button in the Flight Simulation tab.



Top: Output from the (control) predictive model with 1 m/s winds
Bottom: Current interpretation of accelerometer data

Results

While we have launched and collected some data, we have yet to collect all of our data and interpret it. This is for a couple reasons:

> The spinning base needed for testing is still under construction and needs to be physically tested.

> We have yet to complete the program that graphs the rocket's flight path accurately. Above are our initial attempts.

> There may also be a limitation in our measurement tools, as it seems we have reached the maximum angular acceleration measurable by our accelerometer.

> Until we complete the fixes on our graphing utility, we won't be able to tell if our hardware has collected accurate data, and if the predicted gain in stability actually occurred.

Action shots of meeting, building, launching and recovering