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2023 Argonia Cup Rocket

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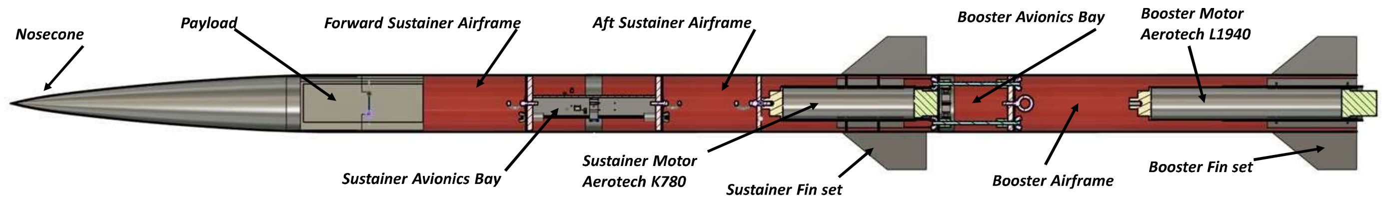


Summary

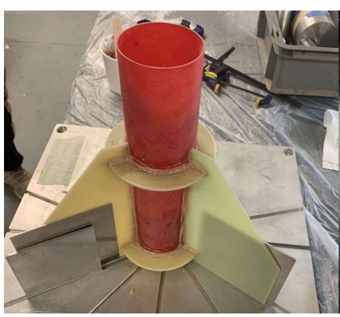
- **Project name:** Double Bogey
- **Specifications**
  - **Length:** 113 in
  - **Dry Mass:** 29.4 lbs.
  - **Mass with Motors:** 44.37 lbs.
  - **Airframe Diameter:** 5 in
  - **Expected Apogee:** 11020 ft
  - **Expected Maximum Velocity:** 993 ft/s
- **Booster Motor:** Aerotech L1940
- **Sustainer Motor:** Aerotech K780
- **Booster Flight Computer:** MissileWorks RRC3
- **Sustainer Flight Computer:** Featherweight Raven4
- **GPS System:** Featherweight GPS System

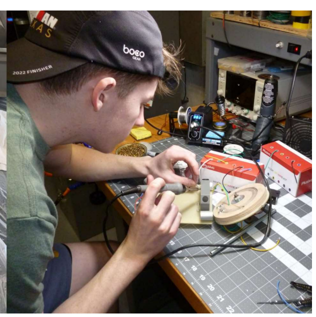
Abstract

The Mizzou Space Program designed, manufactured, tested, and launched a 44-pound, 113-inch, two-stage competition rocket containing a drone carrying a golf ball payload at the Argonia Cup competition on March 25th - March 26th, 2023. This project provided members with experience in mechanical, electrical, computer, and aerospace engineering through involvement in areas such as, but not limited to, drone construction and software development, two-stage rocket design and manufacturing, and the development and analysis of various tests done on both rocket and drone systems.

Construction

- Bulkheads were manufactured from G10 fiberglass.
- Centering rings and fins were cut on a waterjet.
- Fin slots were cut in the airframe and interstage coupler allowing the two stages to interlock.
- Two fin sets were epoxied onto their motor tubes and installed into the vehicle itself.
- The fins underwent a process we call tip-to-tipping, in which a sheet of fiberglass cloth is draped over each fin set and epoxied on using wet lay up epoxy methods.
- The fin sets were given a clear coat of epoxy, sanded, and patched with Bondo.
- The rocket underwent deployment charge testing, was painted, and was given a layer of clearcoat to improve its surface finish.





Avionics

- The sustainer avionics bay housed a Featherweight GPS and a Featherweight Raven4 flight computer to control sustainer motor ignition and ejection charges to deploy parachutes for the sustainer.
- The booster avionics bay housed a MissileWorks RRC3 flight computer that controlled the ejection charge for the booster parachute deployment as well as a redundant separation charge.
- Two radio transmitters were attached to the drone and booster electronics bay to aid in recovery.

Payload

- Research was done to find a drone that would have enough range and battery power and be compact enough to be housed inside the rocket.
- The drone chosen was a GEPRC Crocodile Baby 4.
- MSP designed new arms around springs that would be placed in between the two arms on either side to hold them in place while also allowing them to pivot and take up less space in the vehicle.
- MSP water-jetted these new arms out of carbon fiber.
- The 3D-printed drone bay consisted of two separate pieces that connected to the main line of the shock cord.
- The sustainer drogue parachute deployed at apogee; it was designed to pull the bay out.
- The drone was designed to separate the pieces, and the controller would fly the drone towards the designated target.

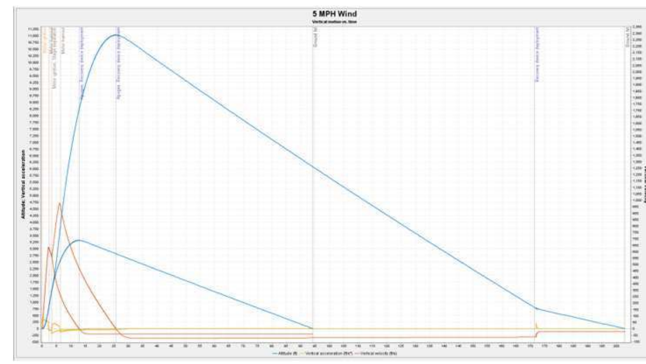
Recovery

- A 24 in. Fruity Chute elliptical parachute was used as a drogue parachute in the forward sustainer body tube.
- A 60 in. Fruity Chute elliptical parachute was used as the main parachute, which was housed in the rear sustainer body tube.
- A 30 in. Fruity Chute elliptical parachute was housed in the booster to be deployed at the apogee of the booster's flight.

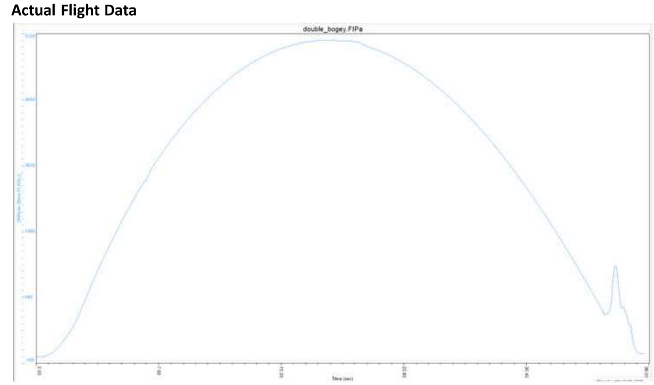
Flight

- The booster stage functioned as expected; it carried the rocket to the required altitude and velocity needed for sustainer ignition.
- The ejection charge in the booster was not properly deployed, resulting in no parachute deployment.
- The Raven in the sustainer checked for sustainer ignition and sent current to the igniter of the sustainer motor; however, the motor did not ignite.
- The Raven sent current to deploy the ejection charge that was meant to ignite at apogee; however, it did not ignite.
- Due to these electronic issues, both the booster and the sustainer suffered significant damage.
- Due to the damage, the drone was unable to be deployed properly and was destroyed upon impact with the ground.

Simulated Flight with 5 MPH windspeeds



Actual Flight Data



Conclusions and Future Work

In the future, MSP will use redundant flight computers on both stages to ensure the sustainer will ignite at the proper altitude and velocity. MSP will also ensure that a thorough analysis of the competition rules is done by the team to verify that all team members understand the rules and procedures for the design and construction of the vehicle.