Project Icarus Technical Summary

Project Icarus Team

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The primary objectives of Project Icarus are twofold - one, design, construct, and launch a rocket to reach 100 km ASL altitude, commonly referred to as the Karman Line or the edge of space, and two, safely recover the launch vehicle in such condition that it can be flown again. Due to limited project resources, an emphasis is placed on achieving these goals with the smallest reasonable budget. Due to the associated higher cost and increased regulatory requirements, the project is also designed to remain under the limits for a Class 2 rocket per FAA regulations.

The current design of the launch vehicle is an approximately 3.65 m tall, two stage rocket, constructed primarily of carbon fiber, with small amounts of stainless steel, aluminum, and fiberglass strategically placed to aid with thermal shielding, ease of manufacture of intricate, precise components, and RF transparency, respectively. The total mass of the launch vehicle is approximately 29 kg on the pad, with a total installed impulse of 32,202 Newton seconds between the first stage Aerotech O5280 and second stage Cesaroni M2245. The first stage is a nominal 98mm minimum diameter airframe designed to hold the booster motor, recovery hardware, and recovery/tracking electronics. The second stage is a nominal 75mm minimum diameter airframe similarly designed to hold only the bare minimum materials.

Recovery of the launch vehicle is achieved with redundant dual-deploy systems on both the booster and sustainer. Both stages use Tinder Rocketry's Tender Descender units to accomplish dual-event recovery from a single avionics bay. The booster utilizes two Eggtimer TRS altimeter/GPS transmitter units for both tracking and deployment. The sustainer uses dissimilar redundancy, due to the much higher performance expectations for the upper stage, since the team anticipates potential additional problems for altimeters operating in this much more strenuous environment. The two systems to be utilized are the MARSA Recovery Systems MARSA33HD altimeter with Gyro unit, and the Featherweight Recovery Raven4 altimeter. These altimeters will also be used to initiate the upper stage motor burn using head-end ignition. Tracking of the upper stage will utilize both a custom-designed telemetry unit, which will incorporate a GPS, accelerometer, and gyro, as well as a backup commercial Featherweight GPS system.

The launch vehicle will be launched using a standard wireless launch system, from a custom-designed 12' tall launch tower. The first stage will reach a maximum velocity of approximately 780 m/s, and stage separation will occur directly after motor burnout. The first stage will reach a maximum altitude of 6 kilometers. Second stage ignition is designed to occur approximately 15 seconds later, to reduce drag losses both by increasing altitude (and decreasing atmospheric density) as well as decreasing the maximum velocity of the launch vehicle. The second stage will reach a maximum velocity of approximately 1,550 m/s, before coasting for approximately 2 minutes and 20 seconds to an apogee of approximately 108 km.

The team has elected to use off the shelf components, procedures, and analysis software where practical to minimize costs, hence the use of commercial motors, altimeters, and a commercial backup tracking system. Siemens NX, RASAero II, and OpenRocket are all being utilized for performance and structural analysis where possible, with in-house programs augmenting those capabilities where needed. Using largely off-the-shelf components allows for greatly reduced project cost. The total budget for the project estimated at under $23,000 in these early stages. This estimate accounts for significant cost overruns on in-house work, and larger than typically expected price increases on commercial components, allowing for sufficient margin in the event that project needs change as the design evolves.