Thanks for submitting your entry for the Spaceport America Cup 2020, we've got it safe and sound.

Good luck!

Submission

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Connor Smith's team

Title

University of Hawaii, Honolulu

^^Enter your full formal school name in the title

Enter your university's full formal/legal name.
e.g. California State University, Long Beach (not CSULB)
e.g. Washington State University (not WSU or WAZZU)

Please also check "Submit as a team" and ensure your team name also includes your school name. If you don't see this button or you need to change the team name, go to https://www.herox.com/SpaceportAmericaCup2020 to create a team or access your existing team to change the name.

Rocket/Project Name

Apophis

Student Organization Name (if applicable)

Project Imua

Preferred Informal Name

Mission 8

City/Province and Country

Kāneʻohe, Hawaii, United States

Organization Type

Other

Project Start Date

2019-08-19

Category

10k - COTS - All Propulsion Types

Student Lead

Connor Smith

Alternate Student Lead

Lindsey Agustin

Faculty Advisor

Jacob Hudson, Jr.

Alternate Faculty Advisor

Shidong Kan

Mailing Address for Awards

Joseph Ciotti
Windward Community College
45-720 Kea'ahala Rd
Kaneohe, HI 96744

Demographic Data

Number of High School Team Members

0

Number of Undergraduate Team Members

11

Number of Masters Team Members

1

Number of PhD Team Members

3

Number of Male Team Members

9

Number of Female Team Members

4

Number of Veterans

3

Number of NAR or Tripoli Members

5

STEM Outreach

Describe any activities that your team leads or participates in that helps your local community with Science, Technology, Engineering or Math enrichment.

STEM Outreach Events

The Center for Aerospace Education is located at Windward Community College, and has an average of 20,000 visitors every year. It contains an Aerospace Exploration Lab where team members engage students in simple rocketry activities. WCC also hosts an annual fall event called Ho'olaulea. At this event CAE sponsors stomp rockets for children and informative presentations for adults. Team members may also take part in the "Bytemarks Cafe" radio program which is a one-hour radio magazine which showcases the innovation and creativity in the Hawaiian tech community.

Rocket Information

Overall rocket parameters

Airframe Length (inches)

152

Airframe Diameter (inches)

6

Fin-span (inches)

18

Vehicle weight (pounds)

24

Propellent weight (pounds)

5

Payload weight (pounds)

9

Liftoff weight (pounds)

47.36

Number of stages

1

Strap-on Booster Cluster

No

Propulsion Type

Hybrid

Propulsion Manufacturer

Commercial

Propulsion Systems: (Stage: Manufacturer, Motor, Letter Class, Total Impulse)

COTS Format - [Single stage]: [Contrail], [M1575BG], [M], [6546.79 Ns]

Total Impulse of all Motors (Ns)

6546.79

Predicted Flight Data and Analysis

The following stats should be calculated using rocket trajectory software or by hand.

Pro Tip: Reference the Barrowman Equations, know what they are, and know how to use them.

Launch Rail

ESRA Provided Rail

Rail Length (feet)

17

Liftoff Thrust-Weight Ratio

6.6

Launch Rail Departure Velocity (feet/second)

54

Minimum Static Margin During Boost

3.7

Maximum Acceleration (G)

8.3

Maximum Velocity (feet/second)

908

Target Apogee (feet AGL)

10,000 ft

Predicted Apogee (feet AGL)

9730.3 ft

Payload Information

NOTE: To compete in the SDL Payload Challenge, you MUST follow the instructions on the Spaceport America Cup Documents and Forms Page. Information provided here is for ESRA purposes only.

See http://www.soundingrocket.org/sa-cup-documents--forms.html

Payload Description

For Project Imua Mission 8, the University of Hawaii Community Colleges Team will be building a payload that consists of a two-cubesat-small-swarm. The ground station will communicate to the main (3U) cubesat which then commands and controls the child (1U) cubesat. Both the main and child cubesats will be actuated and deployed from the descending rocket at 4,000 feet AGL. The cubesats will descend using separate parachutes while performing mission controls. The child cubesat will feature a global positioning system (GPS) unit, dust sensor, temperature sensor, inertial measurement unit (IMU), battery, electronic power supply (EPS), photovoltaic cells, onboard computer system (OBCS), media for recording values, and a full duplex radio to transmit sensory data to the main cubesat. The main cubesat will feature a GPS, IMU, infrared (IR) video camera, OBCS, battery, EPS, photovoltaic cells, media for recording values, a full duplex radio to communicate with the child cubesat, and a separate, longer range full duplex radio to communicate with the ground station.
The main cubesat will send command and control signals to the child cubesat to obtain weather information. The child cubesat will then packetize the environmental temperature, dust concentration, barometric pressure, and approximate wind speed calculated from drift of GPS before sending the information via user datagram protocol (UDP) transmission to the main cubesat. The main cubesat will then verify all packet information is received and make requests to the child cubesat to obtain packets that were dropped. The main cubesat will feature an IR video feed that will be transmitted in near real-time to the ground station for viewing. After both cubesats land, the video feed will terminate and GPS coordinates will be transmitted to the ground station for recovery while an experimental retractable parachute system will recover the parachute on the main cubesat to prevent environmental relocation. If either cubesat is relocated greater than a hundred feet from the landing location prior to recovery, the new GPS coordinates will be transmitted to the ground station.

Predicted Flight Data Comments

Rocksim did not have hybrid motor selections in its internal database. We had to simulate the hybrid motor we are trying to use by using specifically located mass elements and a solid rocket motor that had similar thrust characteristics to our preferred hybrid choice.

Recovery

Describe your recovery system; dual-deploy, size and style of chute, number of chutes, length of shock cord, "Chute Release" commercial products no longer approved.

Recovery Information

The rocket will come down tethered into three parts via two installed shock cords. The three descending parts are as follows: booster section, forward section, and nosecone. A drogue, three feet in diameter, is attached to a 50 ft shock cord separating booster and forward section of the rocket. A main chute, ten feet in diameter, is attached to a 20 ft shock cord attached to the forward section just aft of the nosecone and installed in the forward section of the rocket, lying above the avionics section. Lift off speed is calculated to be 54 ft/s and the rocket has an estimated burn time of 4.4 seconds. It then has an estimated 19.6 second coast phase. Maximum speed is estimated to be 908 ft/s and maximum acceleration is calculated to be 264 ft/s^2. Target altitude for apogee is 9,730 ft. Once apogee is reached, the Telemega v.3 and Stratologger CF units of the avionics section of the rocket will trigger a 3g pyrotechnical charge that separates the booster section from the forward section and deploys the drogue chute. At a specific altitude of 4,000 feet, the Telemega v.3 will trigger a 6g pyrotechnical charge that will separate the nose cone from the forward section,

and deploy the main chute. If the Telemega fails then a redundant 6g pyrotechnical charge will detonate via the Stratologger CF at 700 feet.
The chute sizes were determined by setting the descending weight of the rocket equivalent to the drag force. Choosing a descent rate for the drogue chute of 80 ft/s, and a main chute descent rate of 25 ft/s, the area of the chute was solved for, which gave us our operational diameter.
W=D
mg=(1/2)CDAcsVT2: Where CD=0.8, =1.29 (kg/m3), Acs=(D2)/4
mg=D2((CDVT2)/8)
D=(8mg)/(CDV2T)
Once all numbers were substituted into the equation the diameter of the drogue chute was found to be three feet, and the diameter of the main chute is ten feet. For further details on calculations such as the number of sheer pins or pyrotechnic BP volumes please go to http://imua.wcc.hawaii.edu/.

Planned Tests

10/31/19 Ground static test TBD Proof of concept low power
1/18/20 Ground second static test TBD low power
2/22/20 Ground full motor static test TBD M1575 w/350cc N2O
3/7/20 Ground motor retention test TBD verify retention system
3/21/20 Ground drop test TBD testing shear pin number
3/28/20 Ground deployment test TBD testing pyro BP volume

back-up dates for all tests will be one week later

Any other pertinent information

Project Imua is funded in part through the Hawaii Space Grant Consortium (HSGC), and exists to foster collaboration between the satellite campuses of the University of Hawaii system. Imua, a Hawaiian word meaning "to move forward", is appropriate for the main mission of this collaboration; to provide undergraduate students with project-based learning opportunities in STEM related fields - with a strong emphasis on fostering interest in space related pursuits. Previous Project Imua collaborations have had teams take part in NASA's Student Launch Project (SLP), A Rocket Launch for International Student Satellites (ARLISS), and University of Colorado's RockSat-X where students designed and built payloads that were launched in sub-orbital flights to space. One of the constraints imposed on this collaborative effort is the requirement that the team of students provide educational opportunities to the nearby learning communities. As such, Project Imua has aligned itself with the Center for Aerospace Educatioin (CAE) which promotes the study of aeronautics and astronautics at all educational levels. Additionally, Project Imua is an integral part of the local NAR chapter (section #800; CAELUS - Center for Aerospace Education Launching for University Students), and hosts a rocket launch once a month. Aside from providing a safe launch opportunity for amateur rocketry enthusiasts, this activity also acts to familiarize the team members with the normal operational procedures and safety protocols required for a safe launch.

The primary campuses involved for this year's endeavor are Windward Community Campus (WCC) and Honolulu Community Campus (HCC). The team has 4 members that are level 2 certified (3 with TRA, and 1 with NAR), and the rocketry mentor is certified level 3 with both NAR and TRA (in fact, is a TAP for TRA and an L3CC for NAR). The team of students from WCC is tasked with designing the rocket that will carry the payload designed by the HCC team of students. The interesting challenge for the WCC team will be implementing a hybrid motor system into the rocket - whereas the team has many years of experience with solid rocket motors, no one on the team has experience dealing with hybrid motors. Indeed, none of our past projects allowed for a hybrid motor system which is why this team is very excited to be taking part in this competition. For our first endeavor, we have chosen to use a commercial off the shelf (COTS) system to raise our experience. This opportunity will give the team valuable learning about how to construct and use a hybrid motor system. It is hoped that in the coming years we can participate with a student designed system (SRAD).

We are very enthusiastic about this! For more information about Project Imua, its history, our current designs, and the CAE, please visit https://imua.wcc.hawaii.edu/

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○ Yes ○ No