# Engineering Portfolio

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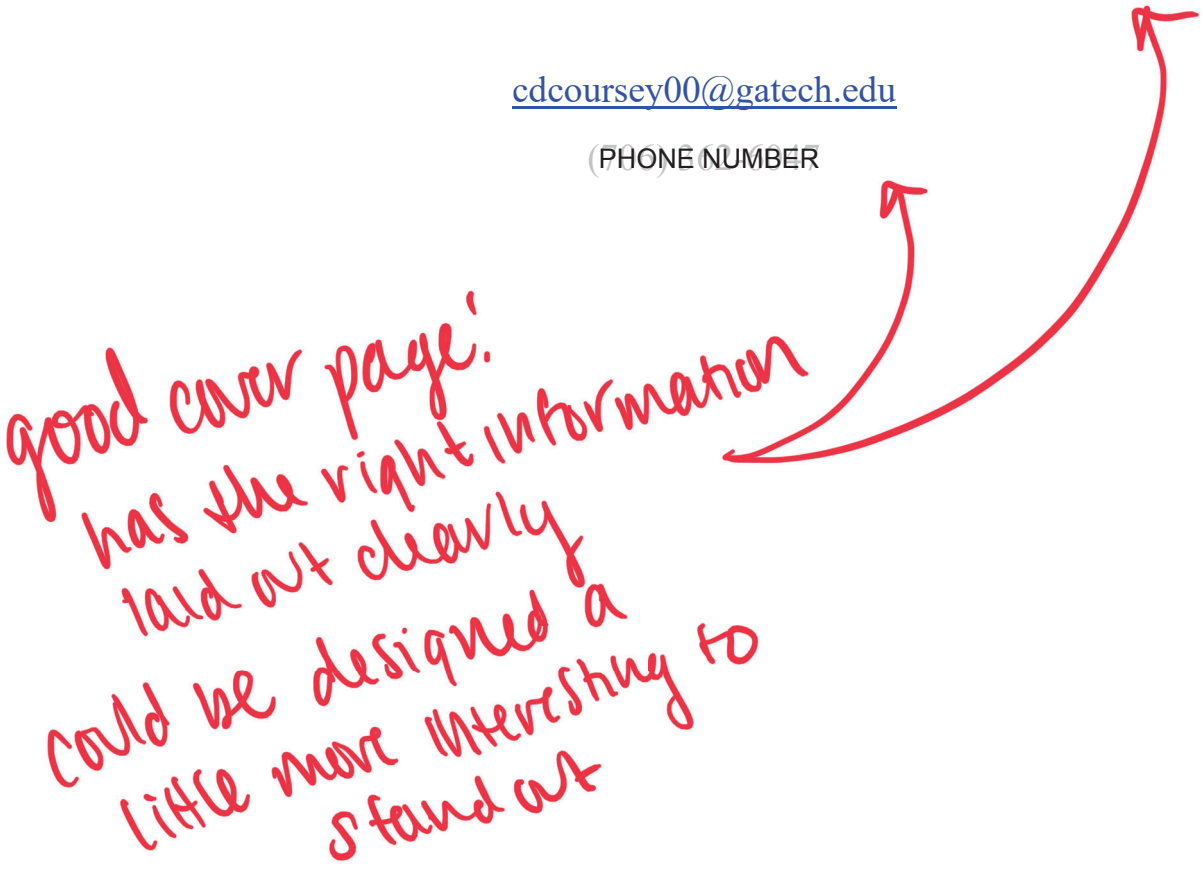
PHONE NUMBER



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could be good to add your title & skills under each experience so people reading know what projects they want to read about

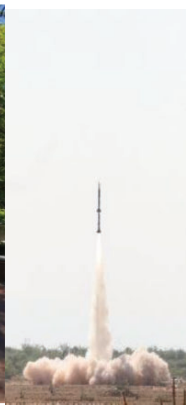
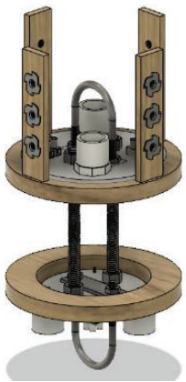
**GT Experimental Rocketry (Fall 2018 – Spring 2019)**

*Team Member*

Overview: The GT Experimental Rocketry Team was formed in Fall 2018 to compete in the annual Spaceport America Cup. In our first year we entered "Sustain Alive", a two stage (the only successful two stage rocket at the competition), supersonic sounding rocket, into the 30,000ft altitude target with commercial motors category, winning first place in this category and second place overall out of 100 international teams, as well as winning the Charles Hoult Award for Modelling and Simulation. Our rocket had an almost completely nominal flight, flew to an apogee of 28,140ft, and was recovered in completely re-flyable conditions. Our top speed was just over Mach 1.2, and our total impulse from our two commercial solid rocket motors summed to about 24,000 Ns. The airframe consisted of G12 fiberglass, while most of the interior components were machined from aluminum 6061-T6.

Individual Responsibilities:

- Designed and manufactured sustainer avionics bay
  - Designed system to house and protect essential flight electronics from ejection charges and stress of flight, allowing for successful flight events
  - Manufactured bulkheads on waterjet and lathe
- Designed and manufactured payload-vehicle interface
  - Designed mount for 8.8lb 3U cubesat
  - Machined precision payload-vehicle interface on manual mill to within +- 0.001in
- Communicated my work in various mediums to various audiences, including technical reports and poster presentations to judges and presentations to school children



*(L to R): Me with Sustain Alive, Sustain Alive at launch, my payload bay design, and the team at the competition*

Links:

- https://ae.gatech.edu/news/2019/03/getting-ready-launch-georgia-techs-first-ever-submission-spaceport-america-cup
- https://ae.gatech.edu/news/2019/06/rocket-designed-georgia-tech-student-engineers-soars-above-rest-spaceport-america-cup
- https://www.youtube.com/watch?v=RNNrmxY-qSY

**GT Experimental Rocketry Team (Fall 2019 – Fall 2020)**

*President*

Overview: After overwhelming success in the 2019 Spaceport America Cup, the GT Experimental Rocketry (GTXR) team has shifted its focus to the student researched and developed category and started the first solid rocket motor program at Georgia Tech. As of December 2019, the GTXR team has become the first organization on campus to complete successful hot fire tests, as we've completed four 54mm characterization tests and three 98mm flight motor tests. In addition to pursuing new propulsion technologies, the team is also improving on the previous year's rocket design in several ways. Bulkheads and avionics bays are being further optimized to reduce weight, and a new staging mechanism is being designed to reduce shock from ejection charges traditionally used for stage separation. The airframe is being made in-house out of carbon fiber, while internal components will be a mix of aluminum 6061-T6 and G10 fiberglass.

Individual Responsibilities:

- Managed entire team
  - Managed sub teams and their integration into system as a whole
  - Provided feedback on designs and made final decisions on implementation and integration into vehicle
  - Included representing team at professional events, securing funding, and working with school administration
  - Oversaw testing and solid rocket motor mixing operations
- Oversaw machining and assembly
  - Worked with most students who machine parts for the team, taught them how to use machine shop equipment from the ground up
  - Ensured that all parts made by team members are within required tolerance
- Designing booster thrust bearing bulkhead
  - Utilized ANSYS Workbench FEA to determine structural margins on thrust bearing bulkhead, allowing for reduced vehicle weight
  - Improved on previous design to produce an even more efficient rocket

*(L to R): Our first 98mm solid rocket motor test in progress, the team on test day, me with our motor*

# GT Experimental Rocketry Team: Sample Write Up

emphasize individual contributions as such

Sample taken from *The Sustain Alive Sounding Rocket, Design, Analysis, and Testing, Team 24 Project Technical Report for the 2019 Spaceport America Cup*

**Project Test Reports**

*Staging Event*

Because the vehicle has a second stage, a staging event is necessary to separate the booster from the sustainer once the booster has burnt out. This is accomplished with black powder charges that ignite inside the airframe and push the upper and lower stage apart through the increased pressure in the interstage compartment. To the best of our knowledge there was no better way of charge sizing available than experience value and rules of thumb. Therefore, we developed a model to predict under which conditions separation would occur, and devised related experimental tests of the ejection charges utilizing a rocket surrogate (to avoid potential damage on the actual vehicle).

Our model is a MATLAB program that solves a set of ordinary differential equations associated with the relative motion of the independent sections, heat release due to the black powder burning, mass conservation as well as an equation of state and a burning model for the black powder charges. The user has to supply drag coefficients, ambient conditions (e.g. separation height), state of motion of the rocket at the initiation of the separation as well as masses and some geometric details. The main outputs of the model are changes in velocity of the two stages, temperature and pressure inside of the separation chamber, mass of black powder burned, change in altitude and time from ignition to separation. From that, the forces acting on the rocket bulkheads and accelerations can be calculated as well, while accounting for uncertainty in factors such as the black powder packing through a stochastic sampling approach.

To verify the results of the model and ensure successful separation, we conducted two static test firings of the ejection charge. A mass simulator was placed on the ejection charge bulkhead assembly, and the whole assembly was placed on horizontal rails or launched vertically. A motion tracking target was placed on it and a high-speed camera was set up to record the motion of the mass simulator. Thus, allowing us to derive velocity and acceleration profiles which could also be compared to results from the model. The acceleration data is shown in Figure 10., showing that horizontal and vertical test firings result in significantly different forces acting on the rocket. Both iterations of the tests resulted in the upper stage being ejected successfully, giving us sufficient confidence in our staging setup. In the figure, the first recorded image frame showing successful separation is marked by a black square around the data point, putting times from charge ignition till separation at about 20-40 ms (ignition occurs in both cases at the datapoint just before acceleration deviates from zero). In addition, the motion tracking results highlighted some shortcomings of the model, provided guidelines for future improvements, and made clear that the model provided very conservative estimates. We are therefore confident in the staging system's ability to separate the sustainer. Both the model and related experimental results are discussed in detail in our extended abstract and technical presentation, *Reliable Modelling and Experimental Validation of Staging Events for Model Rockets*.

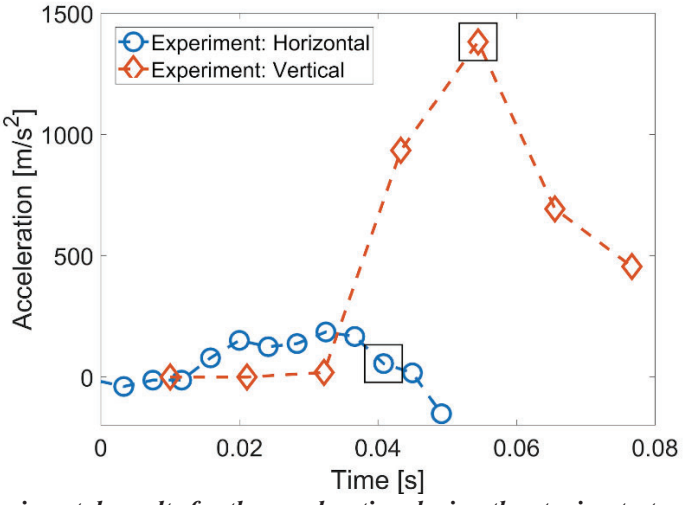



**Figure 10.** ***Experimental results for the acceleration during the staging tests of a surrogate setup***

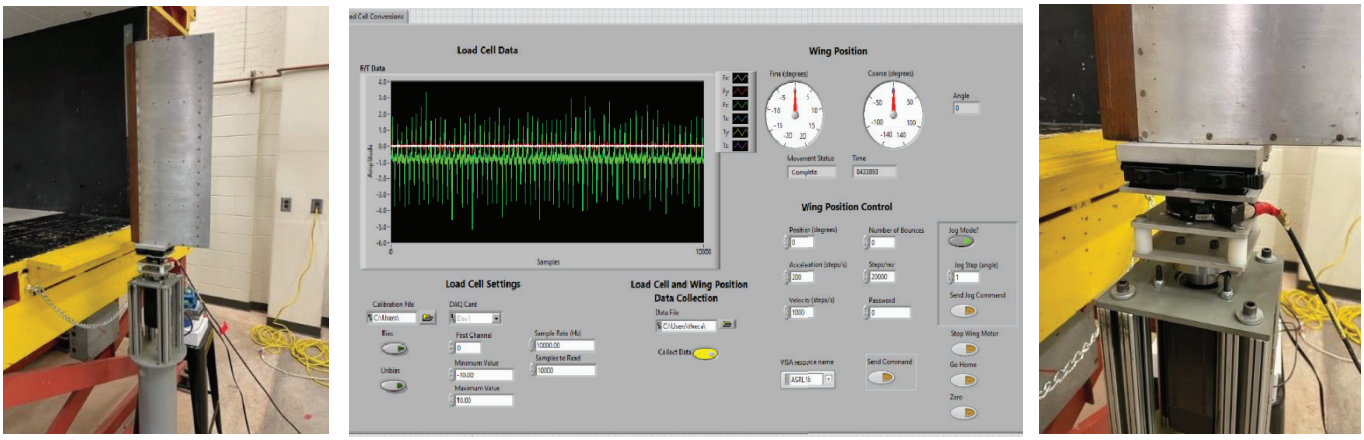
## GT Aerospace Engineering Department, (Summer 2021 - Present)

*Assistant to Lab Manager*

Overview: As Georgia Tech aerospace engineering labs conduct both research and educational activities, there is a staff member in the Georgia Tech aerospace engineering department who serves as a Lab Manager, and I assist them in several ways. I design and implement experimental setups for use in undergraduate educational labs, graduate research, and commercial entities. This includes designing and machining structural components, writing software to operate the experimental setups, and installing them in test facilities. In addition to designing test stands, I also aid in setting up existing undergraduate lab facilities and assist graduate students with their research.

Individual Responsibilities:

- Currently implementing new low turbulence wind tunnel test stand for educational undergraduate labs, graduate research, and commercial entities
    - Designing physical wing test stand using SolidWorks CAD
    - Fabricating components using machine shop tools (lathes, mill, waterjet)
    - Designing software to operate the wing and collect data
        - Using NI LabVIEW to send commands to the test stand over UART, display collected data, and log collected data
        - Coding in C++ on an Arduino microcontroller to communicate between UART commands and wing motor controller
        - Collecting force and moment data using ATI Gamma load cell and NI DAQ system




*Various images of the wind tunnel test stand and the software associated with it*

**GT Ben T. Zinn Combustion Laboratory, (Fall 2020)**
*Undergraduate Research Assistant*

Overview: The Zinn Combustion Lab, one of Georgia Tech's state of the art facilities, is home to many experiments that involve combustion. Many of these include testing of novel natural gas combustors that either improve performance or lower emissions of certain natural gas configurations. In my time at the Zinn Combustion Lab, I worked under a research engineer and graduate student on a novel Siemen's combustor with the goal of acquiring empirical data on its performance (termed 'shakedown testing'). The novel concept in question dealt with lowering the concentration of NOx particles in the exhaust products of the natural gas combustion by running with a leaner fuel mixture.

Individual Responsibilities:

- Installed sensors to capture operational data
    - Bronkhorst mass flow rate sensor
    - Horiba emissions probe
    - Ashcroft digital pressure gauge
    - Dwyer digital manometer
- Wrote script in MATLAB to calculate and plot adiabatic flame temperature and other values at experimental equivalence ratios
    - Developed deep stoichiometric understanding of methane and air combustion reaction
- Test rig maintenance and fabrication as needed

*No images are included due to the commercial nature of testing novel natural gas combustor designs.

good to note this!

but there are creative ways to create visuals of the work that has been done

**GT Space Systems Design Laboratory, (Summer 2021 - Present)**
*Undergraduate Research Assistant*

Overview: Georgia Tech's Space Systems Design Laboratory creates space technologies and advanced mission concepts that enable new missions and capabilities in robotic and human space exploration. In my time at SSDL, I've worked on several projects under the direction of Dr. Brian Gunter relating to space solar power concepts, megaconstellation management, and imaging of satellites in Earth orbit.

Individual Responsibilities:

- Space solar power concept (satellites in space that beam power to Earth)
    - On a small team competing in SPACE Canada's 2021 International Space Solar Power Student Competition (we're currently preparing for the final round at the 72 International Astronautical Congress (IAC))
    - Responsible for analyzing launch vehicle's $CO_2$ impact and financial cost in the context of deploying large solar power satellite constellations
    - Developing novel spaceflight operation concepts to enable effective deployment of solar power satellite constellations
    - Publication *Modular Development of an SPS with Electromagnetic Small Satellites* to be released at IAC
- Megaconstellation management with new proposed large megaconstellations
    - Researched orbital parameters of the 5 largest proposed megaconstellations: Starlink, Telesat, Kuiper, OneWeb, Guowang
    - Used orbital parameters to generate unique two-line element files for each satellite to be used in modelling what near-Earth orbital space could look like if proposed megaconstellations come to fruition
- Satellite imaging and orbital determination
    - This is the newest project I am involved with, but it involves imaging satellites in Earth orbit and developing techniques to determine their orbits with image processing techniques. The goal is to improve which objects can be detected in the hope of identifying smaller space debris.

shorten some of these bullets

* Add pictures | diagrams ☆