*Please submit this completed application, the supplemental budget spreadsheet, and any relevant supporting documentation by the deadline indicated in your Step 1 notification letter to* *Sustainability-Committee@Illinois.edu**.The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact the SSC Program Advisor, Micah Kenfield, at* *kenfield@illinois.edu*

# General Information

**Project Name:** Student Space Systems – Liquid Rocket Engine

**Total Amount Requested from SSC:** $20,000

**Project Topic Area(s):** [ ] Energy [x] Education [ ] Food & Waste

 [ ] Land [ ] Water [x] Transportation

# Contact Information

### Project Lead

Applicant Name: Alexander Faustino

Unit/Department: Aerospace Engineering

Email Address: afausti2@illinois.edu

Phone Number: 817-897-0553

### Financial Contact *(Must be Full-time University of Illinois Staff Member)*

Contact Name: Tess Hile

Unit/Department: Engineering Shared Administration Services

Email Address: tmhile2@illinois.edu

Phone Number: 217-333-0859

Organization Code: 1 633786 615000 191400

### Facilities Management Contact *(If Applicable)*

Contact Name: Name of Applicant or Project Lead

Email Address: Preferred Email Address

**Primary Project Team**

|  |  |  |
| --- | --- | --- |
| **Name** | **Department** | **Email** |
| Sean Ebihara | Chemical Engineering | sebiha2@illinois.edu |
| Florin Ghinet | Aerospace Engineering | ghinet2@illinois.edu |
| Tyler Dean | Aerospace Engineering | tsdean2@illinois.edu |
| Oguzhan Altun | Aerospace Engineering | altun2@illinois.edu |

# Project Description

**Please provide a brief background of the project, the goals, and the desired outcomes:**

We are currently developing two sustainable liquid rocket engines that will both be constructed with additive manufacturing. We plan to construct and thoroughly test our first engine in the Summer of 2016. It is designed to have a sea level thrust of 2224 N (500 lbf) and a burn time of 10 seconds. We see it as an excellent way to introduce us to the basics of liquid engines while allowing us to fine tune our design methods before advancing to more complex systems. The second engine is scaled up to 5560.277 N (1250 lbf) with the addition of regenerative cooling and thrust vectoring.

We'll be using liquid methane as our fuel and liquid oxygen as our oxidizer. A combination whose combustion yields the cleanest exhausts of any rocket fuels. The exhaust mainly consists of water and carbon dioxide as opposed to extremely hazardous exhausts e.g. diazomethane, methyl azide and hydrazine.

Currently, most rocket engines are machined with subtractive methods resulting in 70-80% waste of material; our engines will be manufactured by Direct Metal Laser Sintering which produces zero waste. This entire project is designed to greatly increase the reusability of our rockets by creating engines that can be fired multiple times and only need refueling. Additionally our laser ignition system, which will be one of the first of its kind, is completely green and reusable as opposed to pyrotechnics and other ignition methods.

**How will the project improve the sustainability of the Illinois campus and how will the project go above and beyond campus standards?**

Amateur space shot rockets currently depend on using commercially available solid motors. These motors produce hazardous exhaust chemicals and are impossible to control once ignited. Liquid engines produce significantly less hazardous exhaust due to the inherent nature of their fuels, natural gas and oxygen, as opposed to a volatile solid mixture of ammonium perchlorate, aluminum flakes and a synthetic binder. Using liquid engines is a more demanding technical goal than using solid or hybrid motors but we hope that by achieving this goal we can improve conditions for students interested in rocket propulsion while simultaneously reducing our environmental impact.

 Our long term goal is to be the main source for high altitude rocket launches for research groups on this campus. These groups currently need to outsource launches on vehicles intended to carry significantly larger payloads much farther than needed. We would like to remove the dependency on these expensive and inefficient launches by providing launch vehicles intended to carry these research payloads. Alongside that, we want to break away from other space bound student groups by using liquid engines as opposed to solid and hybrid engines. We believe this goal will help push the envelope for what is achievable by a student group not only on this campus but in the nation.

**Where will the project be located? Will special permissions be required to enact the project on this site? If so, please explain and submit any relevant letters of support with the application.**

The completed engine will be assembled and stored in our office in the Atkins building at Research Park. The fuel and oxidizer will be kept at Talbot laboratory with the rest of the Aerospace department’s compressed gases.

**Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments affiliated directly or indirectly by the project. This includes any entity providing funding (immediate, future, ongoing, matching, in-kind, etc.) and any entities that will be benefitting from this project. Please attach letters of commitment or support at the end of the application.**

Our project group is a part of the registered student organization Student Space Systems, an RSO dedicated to the goal of sending a rocket designed and built by students on this campus to space. Our long term goals impact both the Aerospace Engineering department and the CubeSat research group. Since the Aerospace Engineering department directly provides funding to us they are directly affiliated and the CubeSat group isn’t affiliated but we hope to be affiliated with them in the future once we reach applicable altitudes.

**Please indicate how this project will involve or impact students. What role will students play in the project?**

This project, like all our projects, is entirely lead and completed by undergraduates. It gives students the opportunity to improve upon and implement technical skills taught in lectures as well as provide leadership and organizational experience unavailable in the classroom. Not only will our student members be impacted but students and research groups across the campus will have on-campus accessibility to space once are rockets are launching on our fully developed liquid engine.

# Financial Information

*In addition to the below questions, please submit the supplemental budget spreadsheet available on the Student Sustainability Committee website. Submission of both documents by the submission deadline is required for consideration of your project.*

**Have you applied for funding from SSC before? If so, for what project?**

No.

**If this project is implemented, will there be any ongoing funding required? What is the strategy for supporting the project in order to cover replacement, operation, or renewal costs?

Please note that SSC provides funding on a case by case basis annually and should not be considered as an ongoing source of funding.**

The bulk of the project’s cost is in the manufacturing and is therefore a one-time expense. The fuel and oxidizer are the only main components that require repurchasing but are relatively cheap and fall within the scope of our RSO’s annual budget.

**Please include any other sources of funding that have been obtained or applied for. Please attach any relevant letters of support as needed in a separate document.**

 We are currently in informal negotiations with GPI Prototype, the manufacture in Chicago that will be DMLS printing the engine’s components, about receiving a discount for services.

# Environmental, Economic, and Awareness Impacts

*In addition to the below questions, please indicate specific measurable impacts as applicable on the supplemental budget spreadsheet.*

**Which aspects of sustainability does your project address, and how? Does the project fit within any of the iCAP goals? If so, how does the project go beyond the university status quo standards and policies.**

Our project will aid in the University’s goals of reducing total waste diversion by producing no machine shop waste during its manufacturing and reducing transportation emissions by using fuels that have a less detrimental impact on the environment compared to other fuel options.

**How will the environmental impacts of your project be measured in the near and long term? What specific monitoring and evaluation processes will you be using to track outcomes and progress?**

 With a combination of flow meters and combustion analysis we can accurately predict our exhaust mass balance to determine the amount of CO2 and CO we put out with every firing of the engine.

**What is the plan for publicizing the project on campus? In addition to SSC, where will information about this project be reported?**

 Publicity for this project will be primarily through our website, social media, the Aerospace department newsletters and the College of Engineering newsletter. Once the fully developed engine passes our flight readiness review we will also seek to publish a technical paper.

**What are your specific, measurable outreach goals? How will these be measured?**

 Our outreach goals as an organization deal with the education of University students as well as local K-12 students. SSS aims to educate members on all rocketry topics, including liquid engines and sustainable design. From day one our members attend director run lectures on topics and as a result they gain valuable knowledge into senior and graduate level topics as freshmen and sophomores. They are able to contribute to advanced rocketry projects because they have the capabilities to do so. Along with gaining valuable knowledge in the classroom, our members gain valuable hands-on experience with research, design, and testing.

We are able to measure the success of our outreach efforts with the large amounts of internships and research positions our members attain with various aerospace companies and universities due to their extensive knowledge of aerospace topics and hands-on experience. Along with university students being able to apply the skills they learn during our projects and lectures, many children that attend our outreach events have a newfound hunger for science and engineering. By interacting with the communities around Champaign and Urbana we are able to invigorate the next generation of engineers.

**Do you have any additional comments or relevant information to aid in evaluation of this application?**

 Feel free to visit our website, [studentspacesystems.org](http://www.studentspacesystems.org), for more information or watch our [new promo video](https://www.youtube.com/watch?v=pmv3VnxUJQY) about our recent launch.