



STUDENT SUSTAINABILITY COMMITTEE

Scope Change

From time to time unforeseen challenges or opportunities can affect the planned budget, timeline, or overall goals of a project funded by the Student Sustainability Committee. Past examples of these situations include projects coming in under budget but having additional opportunities available, or inclement weather delaying the planting of agriculture projects.

Below please include a brief project summary and your requested changes. Attach additional documents as needed. If you have any questions, please contact the Student Sustainability Committee at sustainability-committee@illinois.edu.

General Information

Project Name: Student Space Systems Liquid V1 Rocket Engine

Total Amount Requested from SSC: \$12,000

Contact Information

Applicant Name: David Liljewall
Unit/Department: Student Space Systems/Director of Structures
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Project Information

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

The goal of this project is to design, build, and test a prototype liquid engine originally intended to burn natural gas and liquid oxygen fuels. This engine will produce 1000lbf of thrust on average and incorporate several first iteration technologies such as film cooling and motor control; it will serve as a testbed to practice operating high pressure fluid systems and to monitor engine health. Its operation will also inform our design of future engines and testing procedures and processes.

In November 2017, a scope change was granted that allowed the funds to be spent until June 2018. This allowed for the following hardware to be purchased and manufactured: the injector plate for the engine, piping and valves for the propellant feed system, instrumentation and other test hardware.

Please provide a brief summary of how students will be involved in the project's changes:

There are currently about 30 students who are actively involved in the project. They are responsible for designing and analyzing fluid/structural systems and combustion devices as well as selecting the remaining parts for the engine to be fully manufactured and assembled. Over the past year, these students have applied the knowledge gained from the classroom to solve real problems pertaining to their field of interest and have learned new skills which are valued in industry.

An extension on the remaining funds will allow these students to remain active in their current capacity because it assures them that their designs will be realized. It will also secure the team's future with respect to developing liquid rocket engine technology, a seminal achievement for Student Space Systems and for the university itself. The following components are concluding the design phase of the Liquid V1 Rocket Engine Program: i) the engine nozzle, and ii) valve couplers for remotely controlling the propellant system.

The testing phase will begin following the purchase of the pending components. It is anticipated this phase will cover the 2018-2019 academic year. It will give students a hands-on experience in assembling/operating fluid systems, data acquisition/processing, and technical writing. In addition, it will centralize SSS's engine-testing knowledge base in the form of a small cross-disciplinary team well-versed in crucial mechanical and electrical engineering topics.

Please provide a brief summary of your requested scope change. How is your request different from your original plan?

Our plan to have all components pertinent to engine testing completed by June 2018 has not changed. However, due to an internal purchasing error all components for the plumbing system (i.e. valves, high pressure tubing and fittings) were purchased using an account separate from

the SSC funding account. The result is that \$7218 remains in the SSC account whereas \$4600 (the total of the plumbing components) should have been spent. Had it been spent as planned, there would currently be only \$2618 remaining in the SSC account. We expect to make several purchases in the remainder of the semester that would have summed to that remaining \$2618: the metal billet to construct the nozzle, manufacturing/labor for the nozzle, and valve coupler hardware.

While the consequence of this purchasing error may not affect the feasibility of building the Liquid V1 Rocket Engine, it does however jeopardize other SSS projects which are crucial to SSS's goals and future plans. It means that \$4600 earmarked for various subsystems on SSS's future rockets and R&D projects will be lost. Given that this purchasing error does not reflect a lapse in technical preparedness or a shift in the scope of the project, we ask that SSC:

i) extends the use of the remaining funds until December 2018 and ii) permits us to spend the remaining funds on other SSS projects aside from Liquid V1 Rocket Engine. Those projects we anticipate fully funding in order of readiness are as follows:

- 1.) Rapid Reuse Testbed Rocket
 - a.) Subscale model rocket that will act as a testbed for other projects within Student Space Systems, such as avionics, parachutes, and actuating fins
 - b.) Can be recovered, reassembled, and launched every 2 weeks
- 2.) Liquid V1 Engine Controller
 - a.) Electronics hardware and embedded software system that will control the main valves that allow propellant to flow into the engine for combustion
 - b.) This will allow the engine to be tested at different operating conditions and helps to understand more about the characteristics of the engine itself and how to optimize it
- 3.) Liquid V2 Engine Augmented Spark Igniter
 - a.) Novel monopropellant reusable igniter that can be relit, allowing for multiple engine firings
 - b.) More reliable than the current spark ignition system that will be utilized on the Liquid V1 Engine

The request to change scope does not affect the goals of the development of the Liquid V1 Rocket Engine. It is worth noting that were it not for the internal purchasing error, this request would not be necessary.

Additional comments:

N/A