High-Power Rocketry for Freshmen – Both Educational and Exciting

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Launch of one freshman high-power rocket

https://www.youtube.com/watch?v=Hxd-pOwUZMQ

What is NASA's "Space Grant" and what does it do?

- A NASA Higher Education program <u>in every state</u>
- "Linking NASA to Higher Education in Minnesota."
- Designed to engage college students & faculty in <u>extra</u> NASA / aerospace / STEM activities

EMPHASIS AREAS

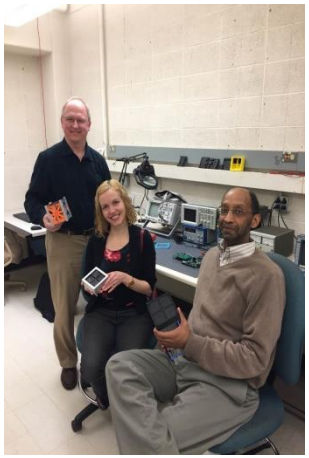
- Higher education course development
- Scholarship/Fellowship/Internship support for college students
- Fund NASA-related research on college campuses
- Offer NASA-themed teacher professional development
- NASA-themed outreach to schools & the general public

MN Space Grant Consortium (MnSGC)

Linking NASA to Higher Education in Minnesota

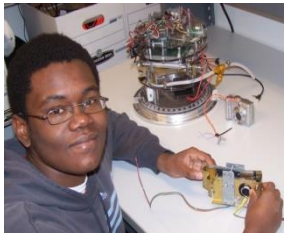
ACADEMIC AFFILIATES OF THE MNSGC

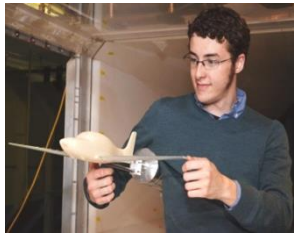
U OF MN – TWIN CITIES (LEAD INSTITUTION)
AUGSBURG COLLEGE, MINNEAPOLIS
BEMIDJI STATE UNIVERSITY, BEMIDJI
BETHEL UNIVERSITY, ST. PAUL
CARLETON COLLEGE, NORTHFIELD
CONCORDIA COLLEGE, MOORHEAD
FOND DU LAC TRIBAL AND COMM. COLL., CLOQUET
LEECH LAKE TRIBAL COLLEGE, CASS LAKE
MACALESTER COLLEGE, ST. PAUL
ST. CATHERINE UNIVERSITY, ST. PAUL
SOUTHWEST MN STATE UNIV., MARSHALL
U OF MN – DULUTH
UNIVERSITY OF ST. THOMAS, ST. PAUL



NON-HIGHER-ED AFFILIATES & PARTNERS

MNDOT – OFFICE OF AERONAUTICS, ST. PAUL
SCIENCE MUSEUM OF MN, ST. PAUL
BELL MUSEUM OF NATURAL HISTORY, ST. PAUL
HEADWATERS SCIENCE CENTER, BEMIDJI
TRIPOLI MN (HIGH POWER ROCKETRY CLUB)
MN SCIENCE TEACHERS ASSOCIATION (MNSTA)
MN EARTH SCIENCE TEACHERS ASSOCIATION (MESTA)
SCIMATHMN
MN ASTRONOMICAL SOCIETY
MINNESOTA 4-H
MINNEAPOLIS PUBLIC SCHOOL DISTRICT
ST. PAUL PUBLIC SCHOOL DISTRICT
OTHER SCHOOLS AND SCHOOL DISTRICTS





Fellowships/Scholarships

Support full-time college students at MnSGC institutions majoring in NASA-related STEM fields with undergraduate scholarships and graduate fellowships.

NASA-Related Research

Support both faculty and students at MnSGC institutions by helping fund STEM research projects in areas of interest to NASA Research Centers.

Higher Ed Course Development

Support new-course development and the revision of existing courses on topics of particular interest to NASA, such as rocketry, wearable technology, and climate change.

Pre-College Teacher Support

Support pre-college teachers (and their students) by offering teacher workshops on aerospace topics and by consulting regarding teaching aerospace lessons.

Fund Internships at NASA

Support full-time college students from all across Minnesota (not just at MnSGC schools) who are selected for research internships at NASA Research Centers.

Matching Requirement

All recipients of MnSGC programmatic (i.e. non-Fellowship/Scholarship) funds are required to provide at least a 1-to-1 match of new-money or in-kind value.

Learn More / Contact Us

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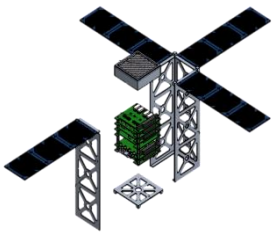


Higher Ed Hardware Teams

Support college-student teams working on aerospace-hardware projects such as stratospheric ballooning, quadcopters (drones), CubeSats (pico-satellites), and high-power rocketry.

Informal Ed Programming

Offer presentations on aerospace topics for specific groups (like school groups and the general public) to educate about NASA and about aerospace opportunities.

Some specific MnSGC hands-on build projects.

Stratospheric ballooning

High-Power Rocketry

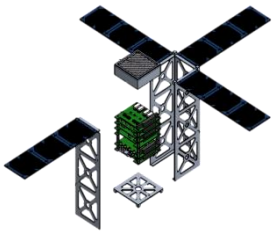
Senior Design

Freshman Seminar

Competitions

Research

Extracurricular or just for fun



CubeSats

In my rocketry freshman seminars, students

- use simulation software to predict the performance of various rocket shapes,
- use CAD software to draw components then fabricate them with machine shop tools, 3D printers, laser cutters, and/or water-jet cutters,
- do airframe construction using epoxy, hand tools, and basic power tools,
- learn avionics bay (av-bay) assembly, which includes basic wiring, soldering, and altimeter programming,
- engage in collection and spreadsheet analysis of flight sensor data, plus on-board video footage,
- practice working on a team, doing oral presentations, and generating written reports (i.e. technical documentation),
- Gain a deeper appreciation of NASA/aerospace/engineering, regardless of what they ultimately decide to major in,

and more!

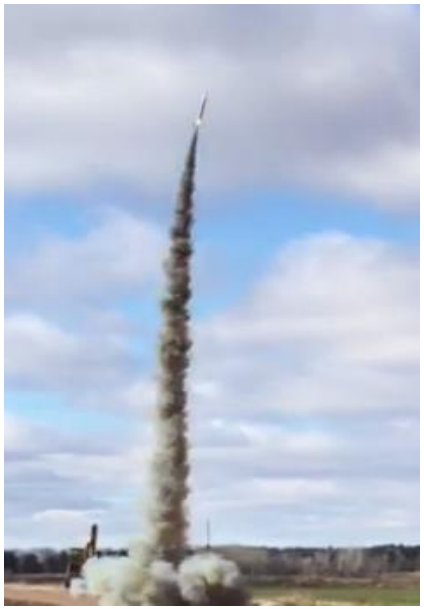
Such a class will directly benefit students in

- aerospace engineering
- physics
- mechanical engineering
- computer science
- electrical engineering
- mathematics
- material science
- chemistry

and more!

Best of all (I think)

- High-power rocketry can be taught without any prerequisites and
- Students' enthusiasm for rocketry appears to be boundless!



To get started / Learning curve

- High-Power rocketry is a regulated activity so first learn about who does it in your community – there are National Association of Rocketry (NAR) clubs and Tripoli High-Power Rocketry clubs all around the country. I work with Tripoli MN www.tripolimn.org that hold launches near North Branch, MN – about a 1-hour drive north from Minneapolis.

- Attend a public launch (monthly, in the summer) – go to a club meeting – find a mentor – attend a workshop – build and fly a basic rocket for "Level 1 certification" – build and fly an intermediate rocket for "Level 2 certification"

- Link up with people who do rocketry in educational contexts, like me and/or students here at the U of MN – Twin Cities. Our extracurricular "Rocket Team" has a display table here today, for example, with even bigger rockets to talk about.

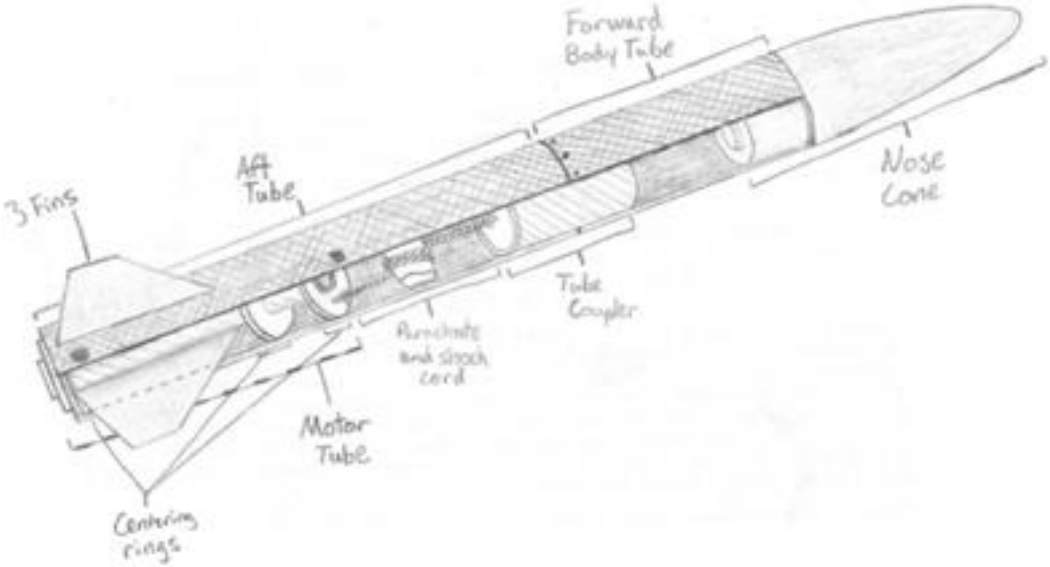
Some content of my freshman seminars

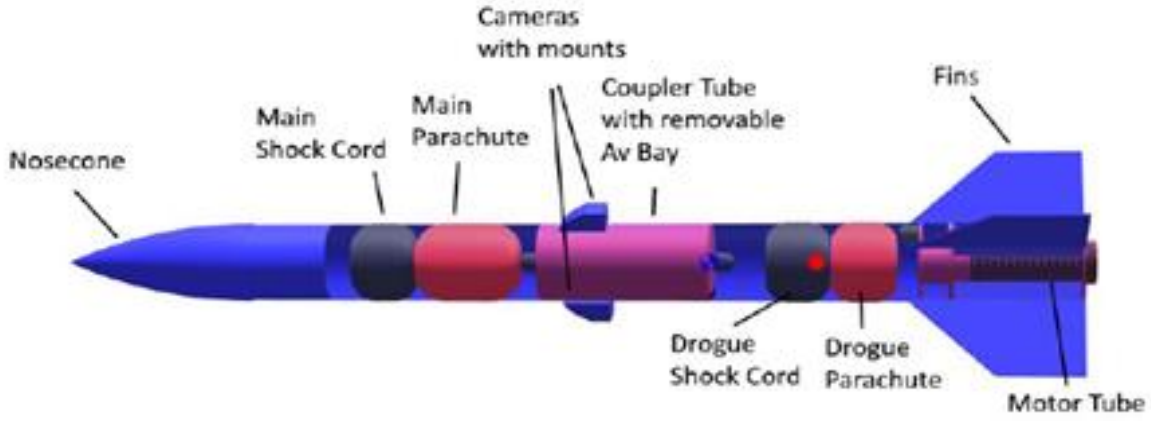
- Learn some basic rocketry concepts and vocabulary, possibly starting with model rockets
- Practice build techniques and using computer simulations when assembling then flying a high-power rocket kit (AKA "Round 1")
- Use lessons from "Round 1" to design a "Round 2" rocket from scratch, build it, fly it, and analyze its performance – this involves learning skills such as (basic) CAD for fabrication of custom parts, soldering, wiring, (altimeter) programming, working with hand tools and power tools, data analysis with Excel, etc.
- Practice communication skills by giving oral presentations and generating written documentation about both rockets as a team and also doing a public exhibit of their rockets
- Do some modest calculations of performance, in parallel with the simulation software.
- Hear mini-lectures about other aerospace (esp. outer space) rocket topics. Trajectories to planets, people in space, etc.

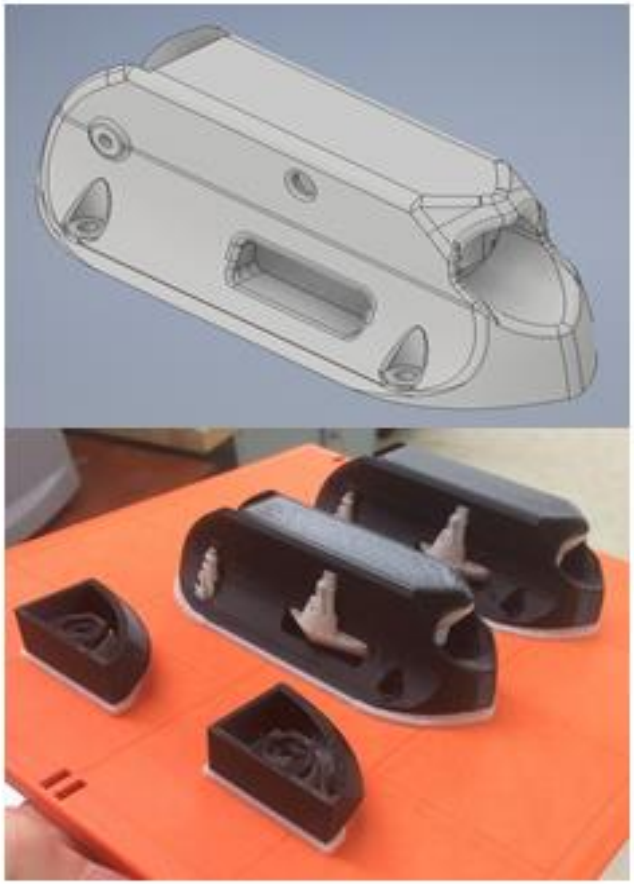
Some class specs and logistics

- 2-credit, freshmen-only seminar, no prerequisites nor expectation of a rocketry background
- Meets for 2 hours straight, once a week
- Class capped at 20 students – divide them into teams of about 4 students and each team makes one Round 1 "kit" rocket and one Round 2 "scratch" rocket
- Has a dedicated "lab" space with benches on which rockets can be built and left to dry as need be (plus a lecture room)
- CAD is done with SolidWorks. Simulations are done with RockSim 9.0 (pricey) or OpenRocket (free, but less fancy)
- Attending the Round 1 launch is required – on a Saturday. Attending the Round 2 launch is strongly encouraged. (Each rocket must have at least some team members in attendance.) Transportation is provided. Trips last from ~8:30 till ~3:30.

Images from oral and written reports







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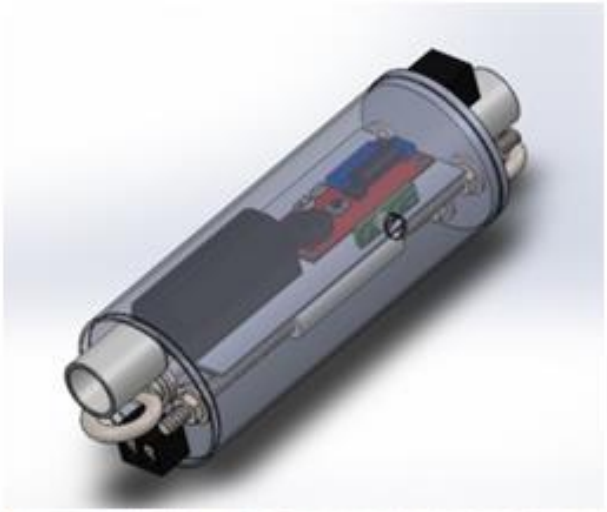
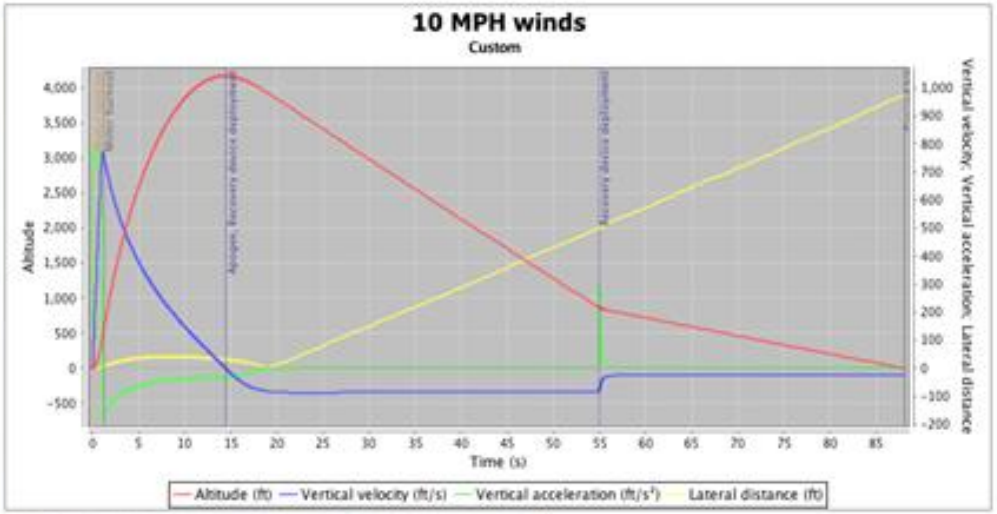




Challenges / Other Options

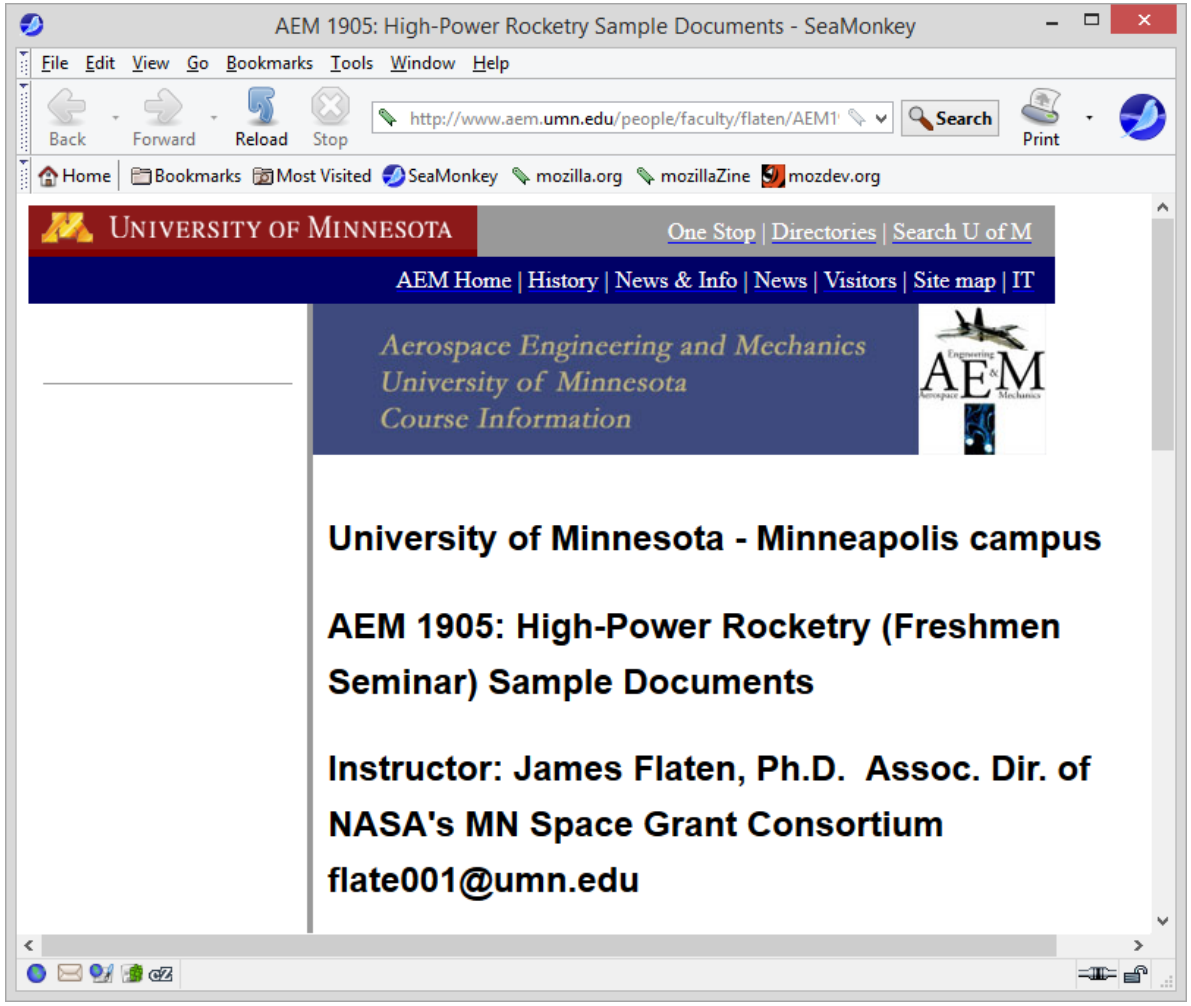
- There is a learning curve for the instructor to get past before trying to teach high-power rocketry – get certified!
- Expense – even "small" high-power rocket kits cost about $100, plus another $100 to build and fly them, this does require a budget – my freshman seminars are supported by the CSE Dean's office here at the U of MN (thanks!)
- Some travel will be required – to high-power launch sites (these exist all around the country, but never in metro areas)
- High-power rocketry is probably too much to superimpose on another class (like a module in a physics class with lab)
- You can reap essentially all the educational benefits with model rocketry, which is less expensive and less restrictive (e.g. can launch from a ball field without FAA permission)
- High-power people nearly always started with, and know lots about, model rocketry (so networking still works)
- Perhaps models with classes and high-power as extra-curr.

What I brought with me today

- A "scratch" high-power rocket, built by freshmen and flown last fall
- A "split rocket" (made from a kit) showing the innards of a "dual-deploy" (i.e. two-parachute) configuration
- The two books I use, one about high-power rocketry and the other (more technical) about design of (model) rockets
- A sample model rocket motor and sample high-power rocket motor, for size comparison
- An "Altimeter Two" data logger which is small enough to fit even in a model rocket. It can record max altitude (apogee), max velocity, max acceleration, ejection time (compared to apogee time), descent speed, flight duration, and more!

I will leave these items on the rocketry table in the back.

To learn more, check out posted docs



http://www.aem.umn.edu/people/faculty/flaten/AEM1905RocketrySampleDocuments/

Fin

Questions?

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