High-Power Rocketry by Videocon Lessons

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NASA
MINNESOTA SPACE GRANT CONSORTIUM
L'etoile du Nord

2012-2013 Advanced Rocketry Workshop – offered in partnership with the Alabama Space Grant

https://www.nasa.gov/directorates/heo/education/advanced-rocketry-workshop.html

2012-2013 Advanced Rocketry Workshop

The 2012-2013 NASA Advanced Rocketry Workshop (ARW) was held from July 18-21, 2012 in Huntsville, Ala. This workshop provides interested teams with project requirements for the NASA Student Launch Projects, details on developing high-powered rockets and payloads, and information on NASA Education's goals and objectives. At the workshop, participants attempted a National Association of Rocketry (NAR) Level 1 certification. More than 50 participants attended the workshop, representing 16 middle and high schools, one 4-H organization, and 15 colleges and universities from 19 states and Puerto Rico.

Developed in partnership with the Alabama Space Grant Consortium, these workshops are open to participants from any college or university in the U.S. and middle and high school teams who have placed in the top of the Team America Rocketry Challenge (TARC) or the Rockets For Schools (R4S) competitions.

Upon completion of the optional ARW, new and returning teams will be sent a Request For Proposal (RFP) in August. Selection of the 2012-2013 NASA Student Launch Initiative (SLI) and NASA University Student Launch Initiative (USLI) teams will be made in late September, 2012. After a series of reports, presentations and requirements, teams will travel to Huntsville, Ala. for launch week activities April 17-21, 2013.

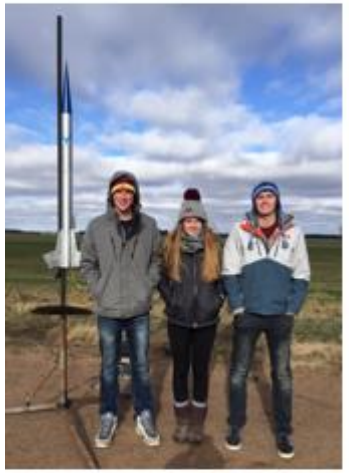
NASA Student Launch Projects are sponsored by ATK Aerospace Systems. The annual launch event is hosted at Bragg Farms in Toney, Ala., and launch services are provided by the National Association of Rocketry.

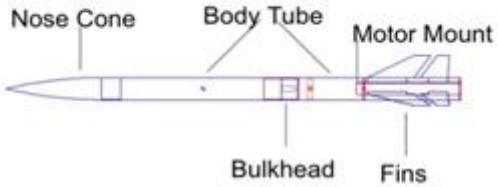
› Read more about the Student Launch Projects

https://www.nasa.gov/directorates/heo/education/advanced-rocketry-workshop.html

AEM 1905 Freshman Seminar
High-Power Rocket Exhibit

Balas Atrium in Akerman Hall
4:15 to 5:00 p.m., Tuesday, 12/15/15





All are welcome to join us for Hot Cocoa and Conversation.

Questions? Contact Prof. James Flaten
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NASA's MN Space Grant Consortium (MnSGC)

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The Space Grant Midwest High-Power "Efficient Supersonic" Rocket Competition coming May 2019

Posted on February 21, 2019 by Ethan Och

The MnSGC and Tripoli MN, a local high-power rocket club, are pleased to announce the 2018-2019 Space Grant Midwest High-Power Rocket Competition which will be held on May 18 & 19, 2019. In this competition college student teams are challenged to design, build, and fly a high-power rocket which can go supersonic, but do so as "efficiently" as possible. Team presentations about rocket designs will be held (probably at Split Rocks Entertainment Center in Wyoming, MN) on Saturday, May 18, 2019, starting in the late afternoon and going into the evening. The competition launches will take place all day (weather permitting) at the Tripoli MN high-power rocket launch site outside North Branch, MN, on Sunday, May 19, 2019. Spectators are welcome to attend all events. For more information, go to http://www.aem.umn.edu/msgc/Space_Grant_Midwest_Rocketry_Competition_2018_2019/.

Related Links

Space Grant 2018-2019 Midwest High-Power Rocket Competition Website

Posted in News/Events

The "Problem" (as I saw it)

Despite my offering freshman seminars, plus independent growth of an active student-led extra-curricular Rocket Team team at the U of MN – Twin Cities, high-power rocketry has been slow to spread to other colleges in MN in the absence of training opportunities (despite in-state competition opportunities).

Aside:

- 2 schools are now involved in the WI Space Grant's First Nations Competition
- 2 community colleges tried participating in USLI, but only lasted 1 year each
- only 1 school (UMD) managed to establish a program without formal training

“The Solution” (that I tried)

Training concept (just for new-to-high-power rocketry colleges/universities in MN) is to provide materials and (videocon) instructions to build and fly of 1 basic high-power rocket for the experience and, hopefully, to start a sustainable high-power rocketry program.

- recruit ~1 semester in advance – did in-person visits to some prospective schools
- pre-purchase materials for ~6 identical builds – not much room for customization
- provide a tote of materials to team-build a souped-up ARR Basic Blues kit rocket (dual deploy with av-bay electronics, exteral video camera, piston eject main)
- offer training lessons mostly by videocon (kick-off, then ~6 lessons over ~2 months)
- 1-hour lessons split between vocabulary, theory, simulations, lecture slides, Q & A, as well as live-building a rocket (photo instructions); teams build between lessons
- require 1 (modest) report plus do an (individual-team) safety check-out by video
- get all teams back together with finished rockets to ground test then launch them
- note: this was a team build, so it did NOT serve to get any one person certified
- asked schools to continue with rocketry or else to return tote & unused materials

List of Lessons

Lesson 1 (in person): kick-off, at Tripoli MN club high-power monthly rocket launch
Lesson 2 (videocon): rocketry concepts; parts of kit; epoxy practice
Lesson 3 (videocon): building the airframe (this will continue for several weeks)
Lesson 4 (videocon): simulating performance (and doing design) with OpenRocket
Lesson 5 (videocon): building/wiring the av-bay and programming the altimeter
Lesson 6 (videocon): finishing the rocket
Lesson 7 (videocon): individual team flight readiness review and safety check
Lesson 8 (in person): ground ejection test; launch rockets (at North Branch launch site)

MnSGC "Remote High-Power Rocketry Lessons" Fall 2018

Links to WebEx lesson videos (we will add to this list as semester goes on)

Lesson 1 – Sept. 8, 2018 – in person in North Branch – no video recording

Lesson 2 – Sept. 21, 2018
https://umn.webex.com/umn/ldr.php?RCID=dd063c5cf76cc5685b1f50d6b11c8239

Lesson 3 – Sept. 27, 2018
https://umn.webex.com/umn/ldr.php?RCID=f32470b98594ed7ee43a01908badef05

Lesson 4 – Oct. 5, 2018
https://umn.webex.com/umn/lsr.php?RCID=09a493bcc94144498d2dd476ad0e9c19

Lesson 5 – Oct. 12, 2018

Recommended "Homework" for Rocketry Lesson 4 10/5/2018

Reading

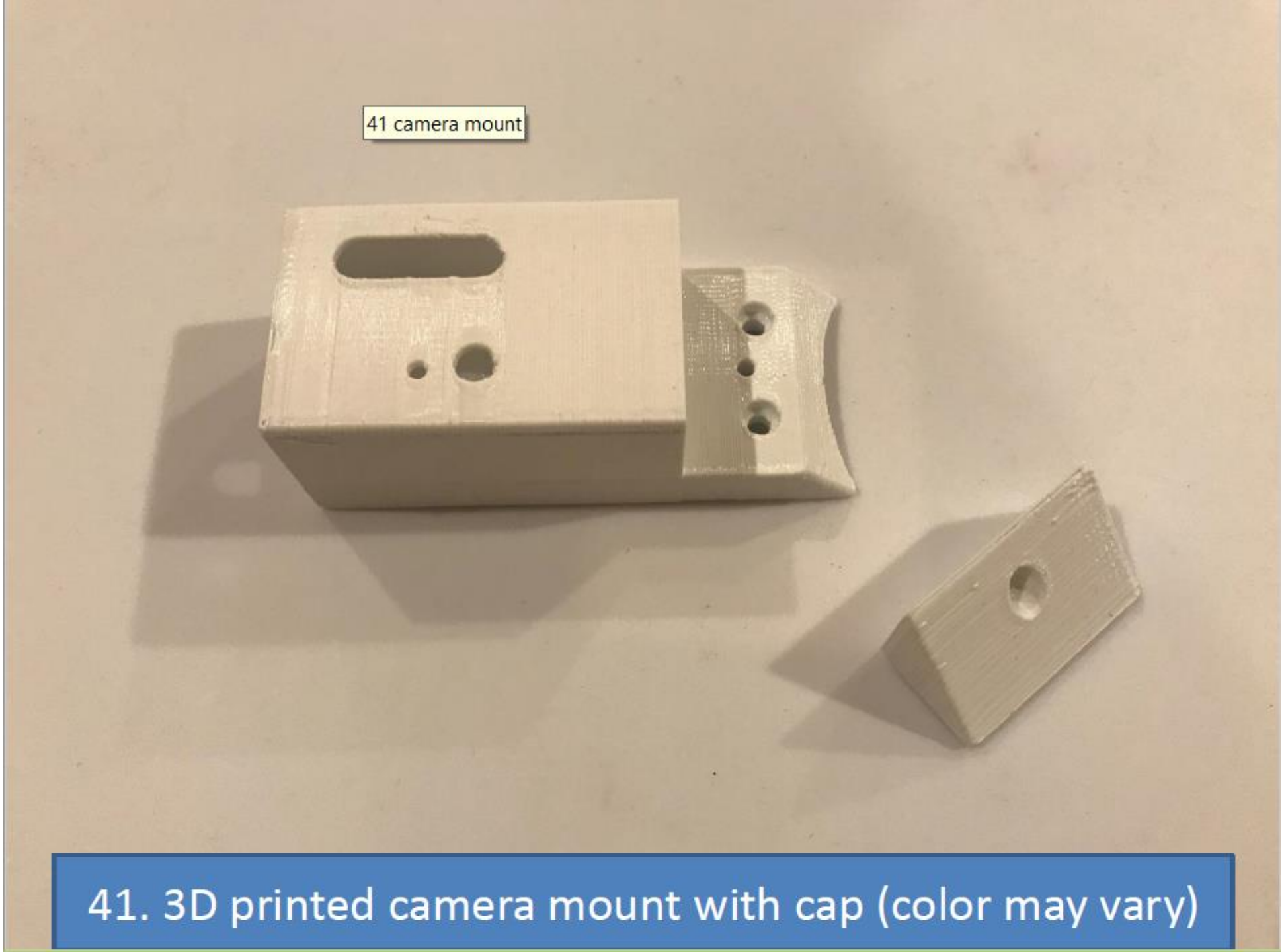
- read Chapters 5, 6, & 7 in the High-Power Rocketry book
- read Chapter 21 in the Model Rocketry book (since the High-Power book doesn't talk about simulations very much) – note that we will be using OpenRocket rather than RockSim for simulations because it is free

Exercises

- look through the "rocket motion" slides, to better-appreciate the challenge of using basic physics equations to predict rocket motion in this non-constant-acceleration situation
- download OpenRocket 15.03 and assign some people to learn to use it – practice by "flying" existing models (to better understand the graphs it generates and the options it provides) then go on to editing existing models and, ultimately, to generating models from scratch
- remember that we will be flying this fall using a Cesaroni "I-170 Classic" motor

Building

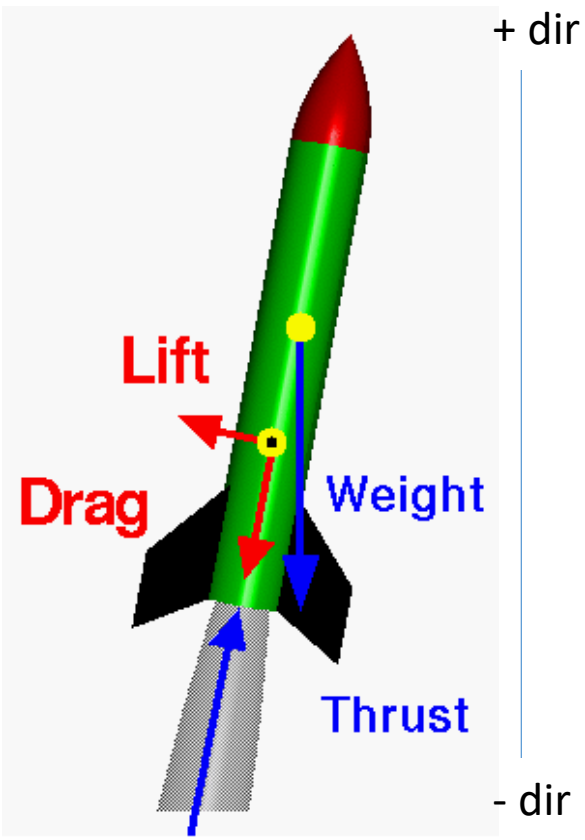
- continue to work on the airframe build, following the written build schedule – this week you should probably be gluing in the fins (one at a time) and also building the piston (and modifying the nose cone, if you didn't get that done already)
- hold off on gluing in the bottom centering ring, followed by the motor



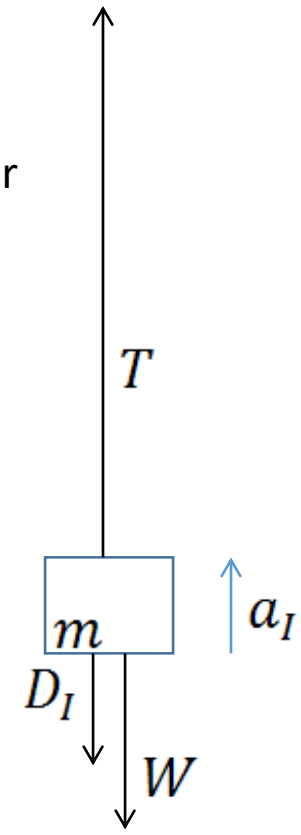
41. 3D printed camera mount with cap (color may vary)

Analysis of Phase I – boost phase to height x_1 and velocity v_1 at time t_b.

Phase I: Boost
(losing mass)



(Unrealistic) Force Diagram
(The thrust vector should be much bigger than W.)



(Simplified) Free-body Diagram

The largest force is now thrust T, which is <u>not</u> constant in time. The rocket mass goes down too, from $m_{full} \equiv m_0$ to $m_{empty} \equiv m_1$ where $m_0 = m_1 + m_{prop}$.

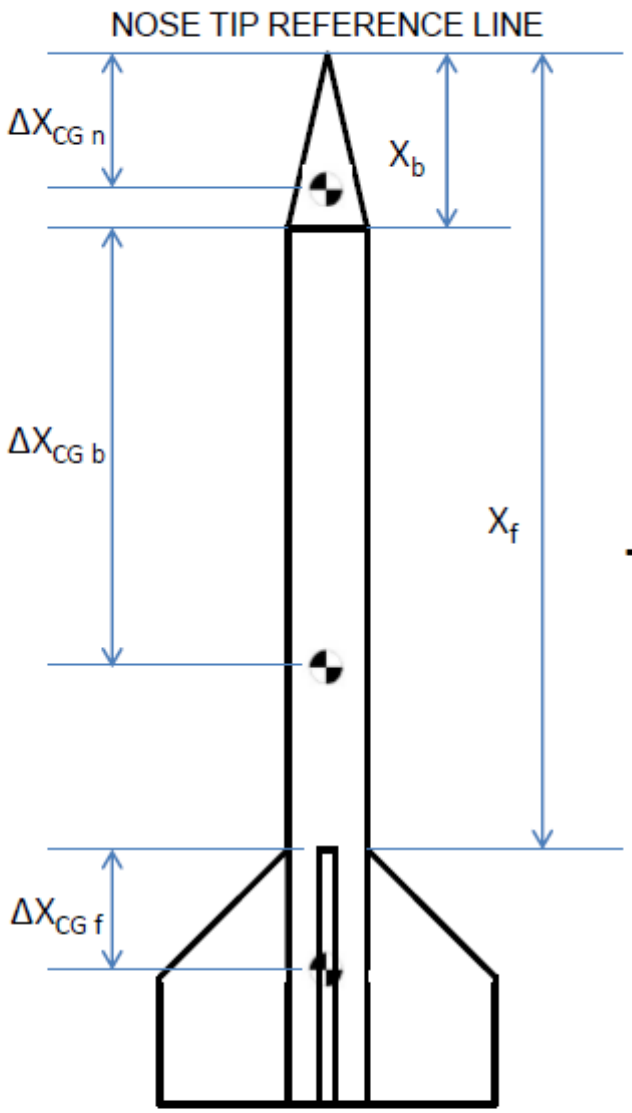
At any moment in time the weight W is related to the mass m by $W = m\,g$ where $g = 9.8\ m/s^2 = 32.2\ ft/s^2$ is the accel. of gravitational free-fall.

Drag $D_I = \frac{1}{2}\rho\, v^2\, A_R\, C_{DR}$. Here v is the (increasing) velocity and A_R is the rocket frontal area and C_{DR} is the rocket drag coeff. (streamlined ➡ small) and $\rho = 0.0749\ lb_{mass}/ft^3 = 1.20\ kg/m^3$ is the density of air (standard conditions).

Try to apply Newton's 2nd Law:

$$\sum F = T - D_I - W = m\,a_I$$

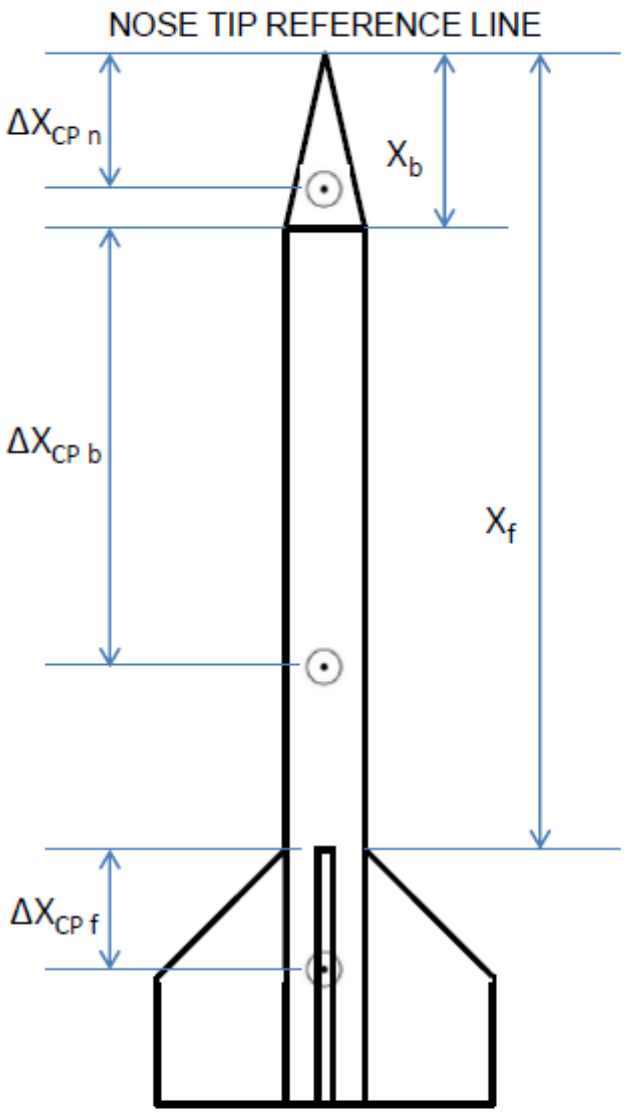
But… this is NOT constant acceleration motion!



CENTER OF GRAVITY
(CG) LOCATIONS

Defining variables for CG & GP calculations.

The offset ΔX for each component is measured from the leading edge (i.e. the top).



CENTER OF PRESSURE
(CP) LOCATIONS

Notice how no part of the eye-bolt hangs over the centering ring. This will assure that the eye-bolt does not interfere with the airframe.

NOTE: Again, yours will not have epoxy on it yet. Your forward centering ring will still be removable at this point.

Drill a hole in the upper centering ring for a forged eye bolt (which will extend above the end of the motor mount tube). Make sure you can get a nylon-insert nut onto the eye bolt and orient the eye bolt so the assembly still fits inside the airframe tube.

Photos from High-Power Rocket Lessons – Fall 2017

Participating schools: Augsburg University, Concordia College – Moorhead, Macalester College, College of St. Scholastica, University of St. Thomas

(3 schools stuck with rocketry, 1 elected not to, 1 school is still deciding)










Photos from High-Power Rocket Lessons – Fall 2018

Participating schools: Bethel University, Gustavus Adolphus College, Normandale Community College, St. Cloud State University, St. John's University, St. Paul College

(as of now 5 schools plan to stick with rocketry, 1 has elected not to do so)








The Future

- This program, to engage new schools in high-power rocketry, has basically run its course in Minnesota.
- Aside: Once rocketry is started, training of new members is also an issue, but one which I am explicitly trying to dodge (except on my own campus).

An offer

- If you think this might be worth trying in your state, whether or not you even have a foothold in high-power rocketry, I'm happy to chat and to provide more details.
- Here is what this would take (minimally) besides a desire to expand rocketry:
  - Somewhere to fly – work with a Tripoli or NAR organization with a launch site
  - Someone to teach with high-power rocketry experience (≥ Level 2 certification)
  - A mechanism to get schools to participate well in advance (for ordering purposes)
  - A funding source for all the in-common materials – perhaps about $500 per team
  - Time!
  - A vision for sustainability (that doesn't include videocon trainers indefinitely)

Comparisons to in-person ARW training format

Advanced Rocketry Workshop

- in-person
- basic kit build – no electronics
- 3 build days plus 1 a launch day
- up to 50 participants
- up to 50 rockets built (1 per person)
- solo build – possible Level 1 certification

Videocon Lessons

- by videocon; in-person start/end
- souped-up kit build – with electr.
- ~2 months including 1 launch day
- about 30 participants (~5 teams)
- about 6 rockets built (1 per team)
- team-build – no certification possible

High-Power Rocketry Lessons by Videocon

Taught by James Flaten <flate001@umn.edu> of NASA's MN Space Grant Consortium (MnSGC)
Aerospace Engineering and Mechanics Department, U of MN – Twin Cities

(about six 1-hour videocon lessons in Sept. & Oct. 2018 – launch rockets late fall 2018)

Open to college-student teams from MN schools that are new to high-power rocketry.
Materials provided by MnSGC (worth ~$500). Space is limited – sign up soon!

What you need to participate

- A student team (4-8 people is best) – perhaps Physics or Pre-Engineering students
- Tune in to all videocons – at least a team representative; preferably the whole team
- Some place to work – preferably a dedicated space (one benchtop will suffice)
- Commitment to build the rocket in between lessons – a few hours each week
- Ability for the team to bring finished rocket to North Branch, MN, to fly it (late fall)

Optional (but strongly encouraged)

- Faculty advisor - not required to take lessons, but faculty supervision usually is helpful
- Attend an in-person "kick-off" at a high-power rocket launch at North Branch – 9/8/18
- Participation in Space Grant Midwest High-Power Rocket Competition – spring 2019