NASA'S SPACE GRANT 2017-2018 MIDWEST HIGH-POWER ROCKET COMPETITION – THE "ROLL/ORIENTATION" CHALLENGE

SPRING 2018
COMPETITION LAUNCH
HOSTED BY THE MN SPACE GRANT CONSORTIUM AND BY TRIPOLI MN

Informational telecon slides: September 26, 2017
Repeated: January 18, 2018

Introductions

- MN Space Grant Organizer

  U of MN's Prof. James Flaten

  <flate001@umn.edu>

- Technical Advisor

  Tripoli MN's Gary Stroick

  <president@offwegorocketry.com>

- Round Robin Introductions

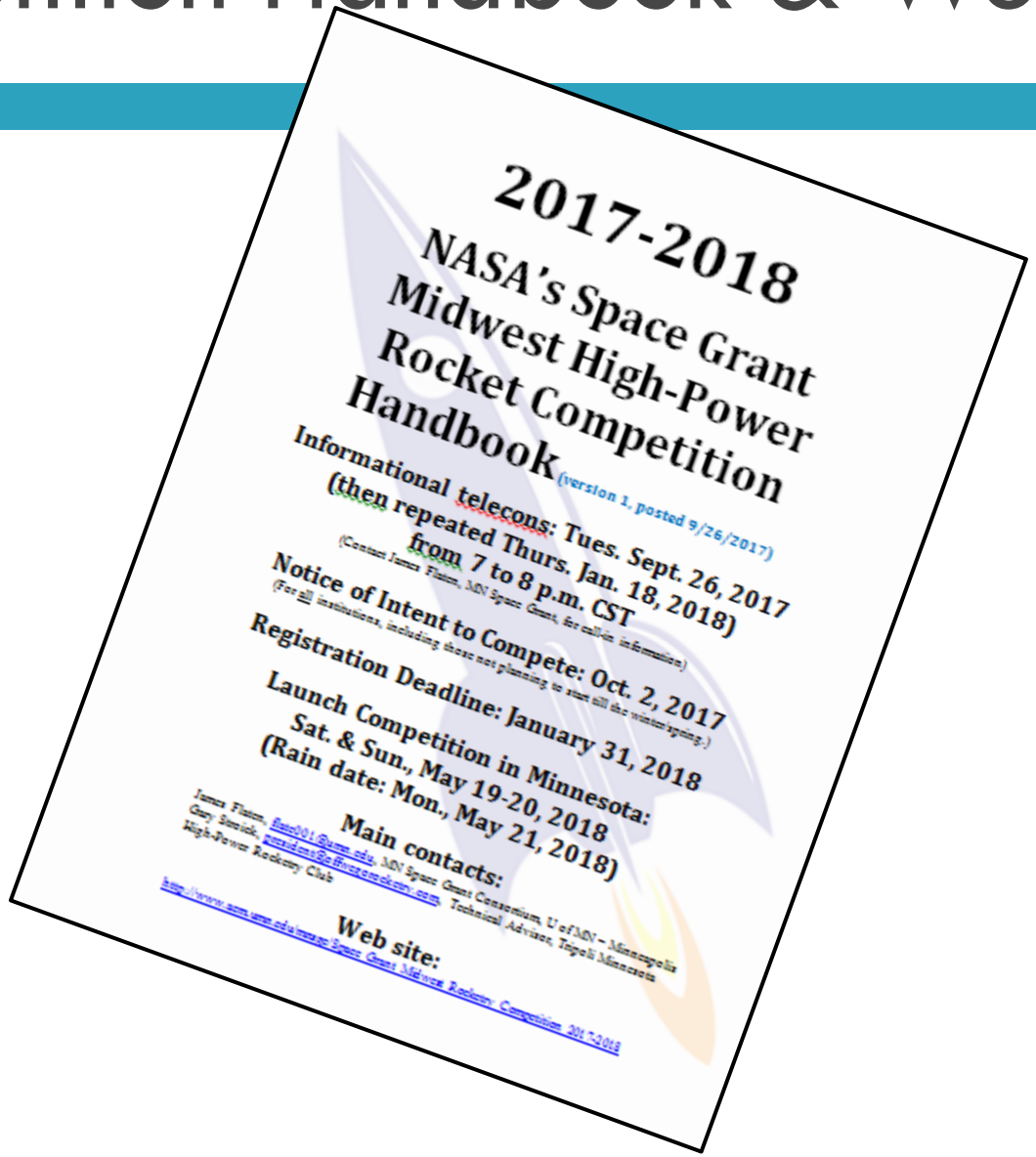
Number of Teams Participating

- Teams competing last year (2016-2017)
  - 18 teams, mostly from the Space Grant "Great (Lakes) Midwest" Region, but open to entire nation
  - MN (8), WI (4), IL (2), IA (1), KS (1), OH (1), VA (1)
  - 4 of the teams made progress but ultimately had to withdraw before the competition in May 2017
- This year we will continue to encourage teams from all across the country to participate and are hoping to attract over 20 teams.

What you need to know

- Competition Handbook
- Fees & Supplied Equipment
- Schedule
- Competition Parameters
- Pre-Competition Requirements
- Five Aspects of the Competition
- Flight Safety
- Judging
- Q & A

Competition Handbook & Website



Website: http://www.aem.umn.edu/msgc/Space_Grant_Midwest_Rocketry_Competition_2017_2018/

Fees & Supplied Equipment

- Registration Fee: $400* (due January 31, 2018)
- The Registration Fee Covers (on Launch Day):**
  - Competition Flight Data Recorder (one Altimeter Two per rocket) to monitor altitude and other basic parameters
  - Two Competition Motor Reloads & Igniters – AeroTech or Cesaroni I or J (teams must pay the difference if the two motors chosen cost more than $100 total)
  - Note: Teams are allowed to bring additional motors, or purchase more at the competition, and fly more than twice

**Tentative value – might possibly go up or down (a little) depending on the number of teams that sign up and our success in finding outside sponsors – changes, if any, will be announced by December 31, 2017.*

***If we garner enough outside sponsorship support we may be able to provide more things or possibly reduce the registration fee. Additional details, if any, announced no later than December 31, 2017.*

Space Grant "Sponsorship"

To help us keep tabs on participants for Space Grant Reporting, we require that every team contact their state's Space Grant to "get sponsorship." We are not suggesting to Space Grants what "sponsorship" might mean for them – this is to be negotiated on a case-by-case basis. For example, such sponsorship doesn't necessarily entail full (or even partial) financial support, so most teams will need to find other sources of funding.

However we hope that Space Grants will at least consider helping with some basic competition expenses such as:

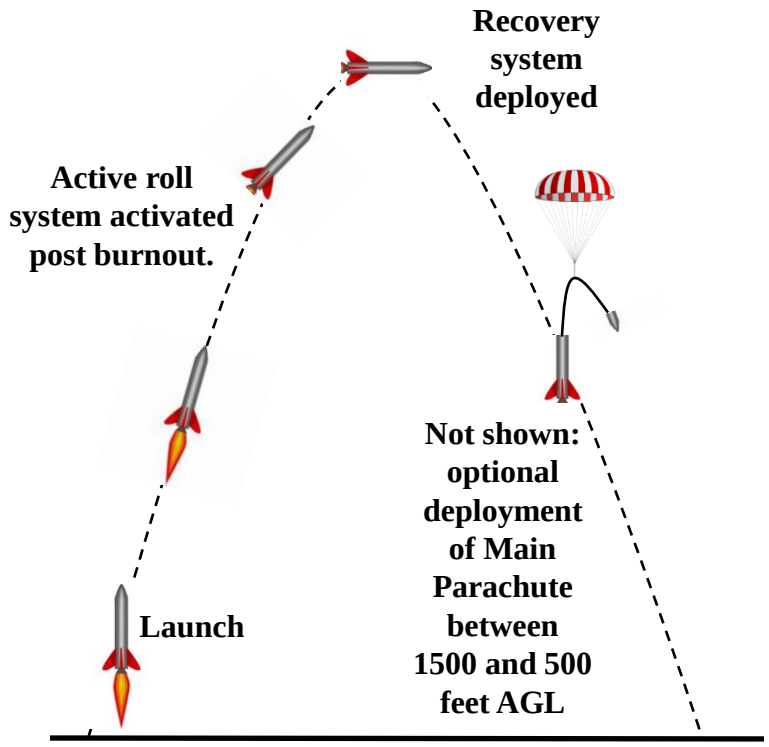
(a) registration fee ($400)
(b) travel to MN for the competition launch in May, 2018 (cost varies widely)
(c) building and instrumenting the rocket itself (cost varies; about $500-1500)
(d) paying for motor casings, with closures (depends on the motors selected, ~$70 to $150)
(e) buying motor(s) for the required practice launch and, potentially, additional test launches (~$50 to $150).

2017-2018 Competition Parameters

The "Roll/Orientation" Challenge:

In this competition student teams will design and construct an active roll/orientation single stage high-power rocket system (dual deploy optional) that will fly twice on the same I-class or J-class motor and be recovered safely and in flyable condition. The students must implement a roll-control mechanism (without using canards) that can minimize roll (on the first flight) then follow a set of commands to roll to a series of specific orientation angles then hold each orientation for about 1 second (on the second flight). Students must construct a non-commercial on-board data-logging sensor package that can log roll orientation (at least) at 10+ Hz, for comparison with orientation as documented by a downward looking video camera. Bonus challenge: Implement an XBee-radio-based communication system so that the orientations requested can be reprogrammed at a distance and so that orientation data (and possibly other sensor data) can be sent down to a ground station by radio while the rocket is still in flight. More points for teams able to control roll and hold orientation effectively. More (bonus) points for teams able to send commands and data through their communications system quickly and reliably. Note that all fabrication work on the rocket (except for possible machining of plastic and/or metal parts) must be performed by students.

2017-2018 Competition Parameters



Active roll rocket flight profile.

RULES/CONSTRAINTS

- Fly on two identical I-or-J-class competition motors from Cesaroni or Aerotech. Consult Gary Stroick about motor availability and cost.
- Level 2 or higher certified mentor and faculty adviser both required.
- At least one test flight on competition I-or-J-class motor, with active roll system activated. Additional test flights highly recommended.
- Any external parts of the active roll system must wait until after motor burnout before they are activated. Initiation time will be no more than 3 seconds after motor burnout.
- Teams must be able to prep their rocket for flight within 1 hour.
- If the rocket is dual deploy (i.e. has two parachutes – this is optional) then the drogue parachute should be deployed post-apogee (but near apogee) and the main parachute must fully inflate between 1500 and 500 feet above ground level during descent.
- All parts of the recovery system must be electronically deployed using a commercially-available altimeter. The motor eject must also remain in place, as a back-up to the drogue/apogee parachute deployment.
- One competition data logger will be provided – an "Altimeter Two."
- Radio-tracking of rocket is now required – see handbook for details.
- Also required – non-commercial measurement and logging of roll angle.
- Required down-looking video – wide angle lens recommended.
- Rocket must have $1 \leq$ static margin ≤ 5 at all times during ascent.
- See handbook for formula used to calculate flight score – the ability to quash roll and to control orientation angle are equally weighted.

Pre-Competition Requirements

Educational Outreach

- Validated by each State's Space Grant
- State Space Grant Notifies Technical Advisor
- Must be completed and submitted no later than May 4, 2018
- Failure to Complete on time: 10% Score Reduction

Pre-Competition Requirements

Model Rocket Demonstration Flight

- **Purpose**
  - Demonstrate a minimum knowledge of rocketry
- **How to do it**
  - Purchase a model rocket flight kit
  - Assemble
  - Successfully fly and recover the rocket
  - Document the flight with before and after photos of the rocket and the team "in the field"
  - E-mail photos to the MN Space Grant along with flight date and location no later than March 9, 2018 (PDR due date)
- **Potential Waivers**
  - If your whole team has high-power rocketry experience, you may request of Gary Stroick a waiver from this requirement
  - If you prefer to build and fly a standard (non-competition) high-power rocket instead of a model rocket, that is acceptable

Graded Aspects of the Competition

- Preliminary Design (Written) Report (30%)
- Fight Readiness (Written) Report (15%)
- Fight Readiness (Oral) Presentation (15%)
- Competition Flight Performance (20%)
- Post-Flight Performance Report (20%)

Note 1 – There is a10% overall reduction if you do not complete the Educational Outreach component of this program.

Note 2 – Written reports are due by e-mail to the Technical Advisor by 5:00 p.m. Central Time on the dates specified in the schedule. Scores for late reports will be reduced by 20% for each portion of a day that they are late.

Note 3 – Mentor's must submit mentor report form by report dates specified in the schedule.

Five Aspects to the Competition

Preliminary Design (Written) Report (30%)

- Communicate the engineering and design effort
  - Provide detailed design and diagrams
  - Analysis of predicted performance
  - Analysis of non-“pre-qualified” components
- Estimated Budget
- 25 pages MAX
- Due March 9, 2018
- If doing the Bonus Challenge, write that up separately on no more than 3 additional pages
- Competition motor order due

Five Aspects to the Competition

Flight Readiness (Written) Report (15%)

- SHOW the construction and completed rocket
  - Construction pictures, diagrams, etc.
- Test Flight(s) (at least 1 flight with competition motor)
  - Flight Performance Analysis
  - Flight Results Discussion
  - Improvements planned prior to competition
- Actual Budget
- 25 pages MAX
- Due May 4, 2018
- Extra 3 pages allowed to write up Bonus Challenge

Five Aspects to the Competition

Flight Readiness (Oral) Presentation (15%)

- Communicate the design and engineering effort
- Organization and presentation
- Rocket Construction (especially AV-bay)
- VISUAL AIDS
- 10 minutes for presentation plus 3 for Q&A
- 2 extra minutes for slides about Bonus Challenge
- Separate time for safety check and to show judges the inside of your AV-bay
- Saturday afternoon into the evening, May 19, 2018

Five Aspects to the Competition

Competition Flight (20%)

- Each successful flight requires:
  - Rocket launches, flies vertically, flies stably all the way to apogee
  - Recovery system(s) successfully deployed
  - Safely lands all parts of rocket under 24 ft/sec
  - Rocket recovered in re-flyable condition
- Flight Scoring:
  - Two successful flights (see above)
  - Timely prep of rocket for both flights (no more than 1 hour prep each)
  - See handbook p. 26-27 for the scoring formula – points on first flight for ability to minimize roll – points on second flight for ability to roll to specific orientation angles then hold them for ~1 sec each angle
  - No bonus for going over 3000 ft but stiff deductions for not going as high as 3000 ft AGL on the lower of the two flights (see handbook)

Five Aspects to the Competition

Post-Flight Performance (Written) Report (20%)

- Flight Performance Comparison
  - Actual vs simulated flight performance analysis
  - Graphs, charts, stills from videos, etc.
  - Performance results; discrepancy discussion
- 15 pages MAX
- Extra 3 pages allowed to write up Bonus Challenge
- Due May 30, 2018

Safety Reviews

- Each team must go through a safety review in their home state prior to coming to the competition launch
- Each team will go through a safety review with Tripoli MN the evening of their oral presentation
- On the day of the launch:
  - Each rocket must be examined for flight safety by the Range Safety Officer (RSO)
  - **The Tripoli MN RSO has the final word on flight safety!**

Judging

- Separate from safety checks by Tripoli MN, the written and oral reports and the performance in the competition flight itself will be evaluated according to the rubrics in the handbook by a panel of judges from industry and/or academia.
- **Each Space Grant sponsoring more than one rocket will be expected to provide <u>one</u> judge.** If you don't have someone from your state you'd like to send to MN for the competition dates, contact Gary Stroick about possibly retaining someone from Tripoli MN to serve as "your" judge. Typically judges' travel expenses are reimbursed (at least). Please identify your judge no later than January 31, 2018.

Schedule Summary

- Oct 2, 2017 – Notice of Intent to Compete (non-binding)
- Jan 31, 2018 – Formal Team Registration (pay $)
- Jan 31, 2018 – All states' judges identified
- Feb 9, 2018 – Declaration of Competition Attendance
- Mar 9, 2018 – Preliminary Design (Written) Report (PDR) along with Competition Motor Order and Model Rocket Flight documentation
- April 30, 2018 – Test Flight(s) done no later than this date (preferably done well in advance of the end of April)
- May 4, 2018 – Flight Readiness (Written) Report (FRR)
- May 19-20, 2018 – Competition (includes Oral FRR)
- May 30, 2018 – Post Flight Performance Report (PFPR)
- June 8, 2018 – Competition Results Announced

$$v_x = v\cos\theta$$

$$v_y = v\sin\theta$$

$$x = v\cos\theta \cdot t$$

$$y = \left(v\sin\theta - \frac{g}{2}t\right) \cdot t$$

Comments or Questions?