THE AMERICAN ROCKETRY CHALLENGE

Rocketry Starter Kit

THE AMERICAN ROCKETRY CHALLENGE

THE WORLD'S LARGEST STUDENT ROCKET CONTEST

The American Rocketry Challenge—now in its 18th year—is the world's largest rocket contest, with nearly 5,000 students nationwide competing annually. The contest provides students in 6th – 12th grades the opportunity to design, build, and launch model rockets and gain hands-on experience solving engineering problems.

Sponsored by the Aerospace Industries Association, the National Association of Rocketry, and more than twenty aerospace industry partners, including NASA, the Federal Aviation Administration, and the Department of Defense, the challenge is the aerospace industry's flagship program designed to encourage students to study science, technology, engineering and math.

WHAT WILL MY STUDENTS GAIN FROM PARTICIPATING IN THE CHALLENGE?

- Teamwork
- Leadership Skills
- Hands-on Engineering Experience
- Problem-Solving Skills

WHAT ARE THE RULES?

Teams are made up of three to 10 students between 6th and 12th grade, a supervisor, and an official Rocketry Challenge mentor.

The rules vary slightly each year to provide a new challenge to competitors. The 2020 rules require teams to design, build, and launch a model rocket that carries one raw egg to an altitude of 800 feet, stays airborne for 40 - 43 seconds, and return the rocket to the ground safely with the egg intact.

WHAT IF I DON'T KNOW MUCH ABOUT ROCKETRY?

The American Rocketry Challenge features a nationwide network of aerospace professionals and rocketry experts from the National Association of Rocketry and the American Institute of Aeronautics and Astronautics who are willing and available to mentor your team. These mentors can help with the organizing, rocket building, and career pathway exploration.

WHAT ARE THE KEY DEADLINES?

- **Sept 1** – 2020 Registration Opens
- **Dec 1** – 2020 Registration Closes
- **Apr 6** – Qualification Flight Scores Due
- **Apr 10** – 2020 Finalists Announced
- **May 16** – 2020 National Finals

WHAT HAPPENS WHEN WE WIN?

After official qualification flights are submitted, the top 100 teams are invited to attend the National Finals in Washington, D.C.

Teams competing at the Final Fly-Off look to capture their share of over $100,000 in cash prizes. There are also special awards for activities throughout the day.

The team that places first at the National Finals wins an all-expenses-paid trip to represent the United States in the International Rocketry Challenge, hosted at the Farnborough Air Show in London, England in July 2020. The United States Rocketry Team competes against the winning teams from Japan, the United Kingdom, and France.

Contact Program Manager Jeremy Davis at RocketContest@aia-aerospace.org or 703-358-1000.

Visit RocketContest.org to learn more.

@RocketContest

The American Rocketry Challenge 2020 Explained

1

Teams of 3 to 10 students work together to design and construct a rocket.

2

The rocket must carry a payload of one raw egg and safly return it to the ground uncracked. All parts of the rocket must remain tethered or connected through takeoff and landing.

3

The rocket must reach an altitude of 800 feet. Teams are penalized one point for every foot above or below the goal.

4

All parts of the rocket must descend safely and remain connected together. Rockets must descend using at least one parachute.

5

The duration of the flight must be between 40 to 43 seconds. Teams are penalized by four points for each second outside that window.

6

At the National Finals, the rockets will be required to reach two new altitude goals of 775 or 825 feet within 39-42 seconds or 41-44 seconds respectively.

SCORING:

Teams are ranked on the combined score from their two best flights, the lower the better!

SCORING FOR EACH FLIGHT = Unbroken Eggs + # of feet over/under + (seconds over/under x 4)

FLIGHT 1 + FLIGHT 2 = TOTAL SCORE

THE AMERICAN ROCKETRY CHALLENGE

AIA AEROSPACE INDUSTRIES ASSOCIATION

THE AMERICAN ROCKETRY CHALLENGE 2020

THE WEEK BY WEEK SCHEDULE OF ACTIVITIES FOR NEW TEAMS

WEEK OF OCTOBER 14, 2019

- Ensure all team information (school and teacher information, student information, parent consent forms, etc.) is entered in properly at portal.rocketcontest.org.
  - Your registration must be paid for and submitted no later than December 1, 2019.

WEEK OF OCTOBER 21, 2019

- Assign team responsibilities (such as project manager, airframe, propulsion & ignition, launch system, fundraising etc.).
- Get a mentor (see the list of available NAR/AIAA mentors at rocketcontest.org/newcomers/mentor-list/).
- Watch the instructional video “How to Build and Fly a Model Rocket” on YouTube: https://youtu.be/gYh1pWHoQXE.
- Review the Team Handbook, 2020 Rules and the Frequently Asked Questions from www.rocketcontest.org.
- Review the recommended rocket parts and our preferred vendors (starting with the “official suppliers” listed in the Team Handbook).
- Order one of the flight-simulation and rocket-design computer programs (RockSIM or SpaceCAD), at the official team discount price directly from the vendor after you have completed your 2020 registration.
  - You can also try using the free software OpenRocket.

WEEK OF OCTOBER 28, 2019

- Purchase an inexpensive, one-stage rocket kit to familiarize your team with rocket building & flying. Estes has a number of resources available for newcomers to rocketry, and Aerospace Specialty Products has a basic kit just for new teams.
- Locate a place to fly rockets (or a nearby NAR launch to attend and fly at, see the “Launch Windows” calendar at www.nar.org or contact the nearest NAR club or section).
- Develop a plan to raise money to purchase rocket supplies for two rockets and motors for at least ten test and qualification flights. Your fundraising may also cover your travel to the Finals!

WEEK OF NOVEMBER 4, 2019

- Buy a comprehensive book on model rocketry, such as G. Harry Stine’s “Handbook of Model Rocketry” (available at http://www.nar.org/nar-products/).
- Load the rocket design and flight simulation computer program that you purchased.
- If you require “site owner” insurance for the place where you will be flying, have the teacher and at least three team members join the NAR, and order NAR site owner insurance.

WEEK OF NOVEMBER 11, 2019

- Fly a basic one-stage model rocket .
- Order your Perfectflite official altimeter with your discount code.

WEEK OF NOVEMBER 18, 2019

- Using the computer program and the knowledge gained from reading and from building basic rockets, develop a first rocket design for your entry.

DECEMBER 1, 2019 – REGISTRATION CLOSES

WEEK OF DECEMBER 2, 2019

- Using the computer program, conduct flight simulations of your design with various rocket motors on the approved motor list, to determine the best motor(s) to use .
- Locate sources for the materials needed to build your design (starting with the official vendors in the Official Handbook) and purchase required parts and rocket motors.

WEEK OF DECEMBER 9, 2019

- Design and build (or purchase) the electrical launch system and the launch pad (preferably with a one-inch rail), if you do not have a local rocket club's system available for your use.

WEEK OF JANUARY 6, 2020

- Begin construction of your initial design for your entry.
- Locate a NAR Senior (adult) member who can serve as your official observer for your qualification flights, if you do not already have an NAR Mentor who will do this.

WEEK OF JANUARY 13, 2020

- Develop a pre-flight checklist for your flight and assign responsibility for each of the duties to a member of the flight team.
- Test your launch system by test-firing igniters without installing them in rocket motors.

WEEK OF JANUARY 20, 2020

- Weigh your completed rocket and re-run computer flight simulations with actual rocket weights.

BY FEBRUARY 1 YOU SHOULD (BUT ARE NOT REQUIRED TO):

- Test-fly your initial design (without altimeter), making sure that you leave time to redesign, rebuild, and re-fly by April 6 if this initial flight/design is not successful.
- If your first flight is fully successful, test-fly again with stopwatch timing and the altimeter installed. Repeat test flights until you hit the design targets.
- If your first flight is not successful, do post-flight failure analysis and re-design.

BY MARCH 1:

- Your application for the Outreach Program must be received to be considered.

BY MARCH 1 YOU SHOULD (BUT ARE NOT REQUIRED TO):

- Make your first official qualification flight attempt in front of an NAR Senior member observer .

NO LATER THAN APRIL 6 YOU MUST:

- Make your final official qualification flight attempt (of up to three permitted) in front of an NAR Senior member observer.
- Submit your qualification flight reports at portal.rocketcontest.org, or by email.

APRIL 10

- Engineering notebooks submissions must be postmarked or emailed to rocketcontest@aia-aerospace.org no later than this date to receive consideration.
- If notified of selection to attend the flyoffs, make reservations at one of the hotels identified by the organizers and conduct fund-raising to cover travel and lodging.
- Continue test-flying to fine tune rocket design to both Finals target altitudes, 775 and 825 feet.
- If you plan to travel to the flyoff by airline, order rocket motors for flyoff to be shipped to the Finals receiving point at Aurora Flight Sciences or delivered on-site by a Finals vendor.

NO LATER THAN MAY 1

- Complete and test-fly the actual rocket to be used in the Fly-off. This Fly-off rocket must have been test-flown before arrival at the flyoff, as there is no opportunity for test-flying at the flyoff site.

THE AMERICAN ROCKETRY CHALLENGE

National Association of Rocketry

SPORT ROCKETRY: AMERICA'S SAFE, EDUCATIONAL AEROSPACE HOBBY

WHAT IS SPORT ROCKETRY?

Sport rocketry is aerospace engineering in miniature. This popular hobby and educational tool was founded in 1957 to provide a safe and inexpensive way for young people to learn the principles of rocket flight. It has grown since then to a worldwide hobby with over 12 million flights per year, used in 25,000 schools around the U.S. Its safety record is extraordinarily good, especially compared to most other outdoor activities. It is recognized and permitted under Federal and all 50 states' laws and regulations, and its safe and inexpensive products are available in toy and hobby stores nationwide. Sport rocketry has inspired two generations of America's young people to pursue careers in technology.

WHAT IS A SPORT ROCKET?

A sport rocket is a reusable, lightweight, non-metallic flight vehicle that is propelled vertically by an electrically-ignited, commercially-made, nationally-certified, and non-explosive solid fuel rocket motor. For safety reasons no rocket hobbyist is ever required or allowed to mix or load chemicals or raw propellant; all sport rocket motors are bought pre-made. Sport rockets are always designed and built to be returned safely and gently to the ground with a recovery system such as a parachute. They are always designed to be recovered and flown many times, with the motor being replaced between flights. Sport rockets come in two size classes: MODEL rockets, which are under 3.3 pounds in weight, have less than 4.4 ounces of propellant, and are generally available to consumers of all ages; and HIGH-POWER rockets, which are larger, use motors larger than "G" power, and are available only to adults.

ARE THESE ROCKETS LEGAL?

Model rockets are legal under the laws and regulations of all 50 states and the Federal government, although some local jurisdictions may have ordinances restricting their use. Model rockets are regulated by the National Fire Protection Association (NFPA) Code 1122, which is adopted as law in most states. They are specifically exempted from Federal Aviation Administration (FAA) air traffic control by Part 101.1 of Federal Aviation Regulations (14 CFR 101.1) and may be flown anywhere without FAA clearance. They are permitted for sale to children by the Consumer Product Safety Commission under their regulations (16 CFR 1500.85 (a) (8)). They are permitted for shipping (with appropriate packaging and labeling) by the Department of Transportation and U.S. Postal Service. They are not subject to regulation or user licensing by the Bureau of Alcohol, Tobacco, Firearms & Explosives (BATFE). They are endorsed and used by the Boy Scouts, 4-H Clubs, the Civil Air Patrol, and NASA.

High power rockets are regulated under NFPA Code 1127. Because of their size and power they are not available to people younger than age 18. Their flights are subject to FAA air traffic regulations, and purchase of the larger motors for these rockets generally requires user certification by a national rocketry organization, plus BATFE licensing in some cases. Despite these greater legal restrictions, high power rockets are also very popular. They also have an outstanding safety record.

IS THIS HOBBY SAFE?

Over 500 million model rockets have been launched since the hobby's founding and our simple Safety Code procedures have almost totally eliminated accidents and injuries. Injuries are rare and generally minor. They are almost always the result of failure to follow the basic safety precautions and instructions provided by the manufacturers. Sport rocketry's record shows that it is safer than almost any sport or other outdoor physical activity. The hobby operates under the simple and easy-to-follow Model Rocket and High-Power Rocket Safety Codes of the National Association of Rocketry, which have been fine-tuned by professional engineers and public safety officials over the past 50 years to maximize user and spectator safety. The foundations of these Safety Codes are that sport rockets must be electrically ignited from a safe distance with advance warning to all those nearby, must have recovery systems, must be flown vertically in a suitably-sized field with no aircraft in the vicinity, and must never be aimed at a target or used to carry a pyrotechnic payload. All sport rocket motors are subjected to extensive safety and reliability certification testing to strict NFPA standards by the National Association of Rocketry or other national organizations before they are allowed to be sold in the U.S.

AREN'T THESE ROCKETS FIREWORKS?

All Federal and state legal codes recognize sport rockets as different from fireworks. Fireworks are single-use recreational products designed solely to produce noise, smoke, or visual effect. They have few of the designed-in safety features or pre-consumer national safety testing of a reusable sport rocket, and none of the sport rocket's educational value. Fireworks are fuse-lit, an inherently dangerous ignition method that is specifically forbidden in the hobby of sport rocketry. Sport rockets are prohibited from carrying any form of pyrotechnic payload; their purpose is to demonstrate flight principles or carry educational payloads, not blow up, make noise, or emit a shower of sparks.

WHO ARE THE EXPERTS?

The oldest and largest organization of sport rocketeers in the U.S. is the National Association of Rocketry (NAR). This non-profit organization represents the hobby to public safety officials and federal agencies, and plays a key role in maintaining the safety of the hobby through rocket engine certification testing and safety code development. The NAR also publishes Sport Rocketry magazine, runs national sport rocketry events and competitions, and offers liability insurance coverage for sport rocketeers and launch site owners. You may reach the NAR at:

National Association of Rocketry
Post Office Box 407
Marion, IA 52302
http://www.nar.org

You may purchase copies of the NFPA Codes 1122 or 1127 regulating sport rocketry from:

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269-9101
http://www.nfpa.org

Typical Component Parts for a TARC Rocket and Where to Find Them

Rocket component part TARC vendors:

Estes Industries: https://estesrockets.com/product-category/accessories-parts/

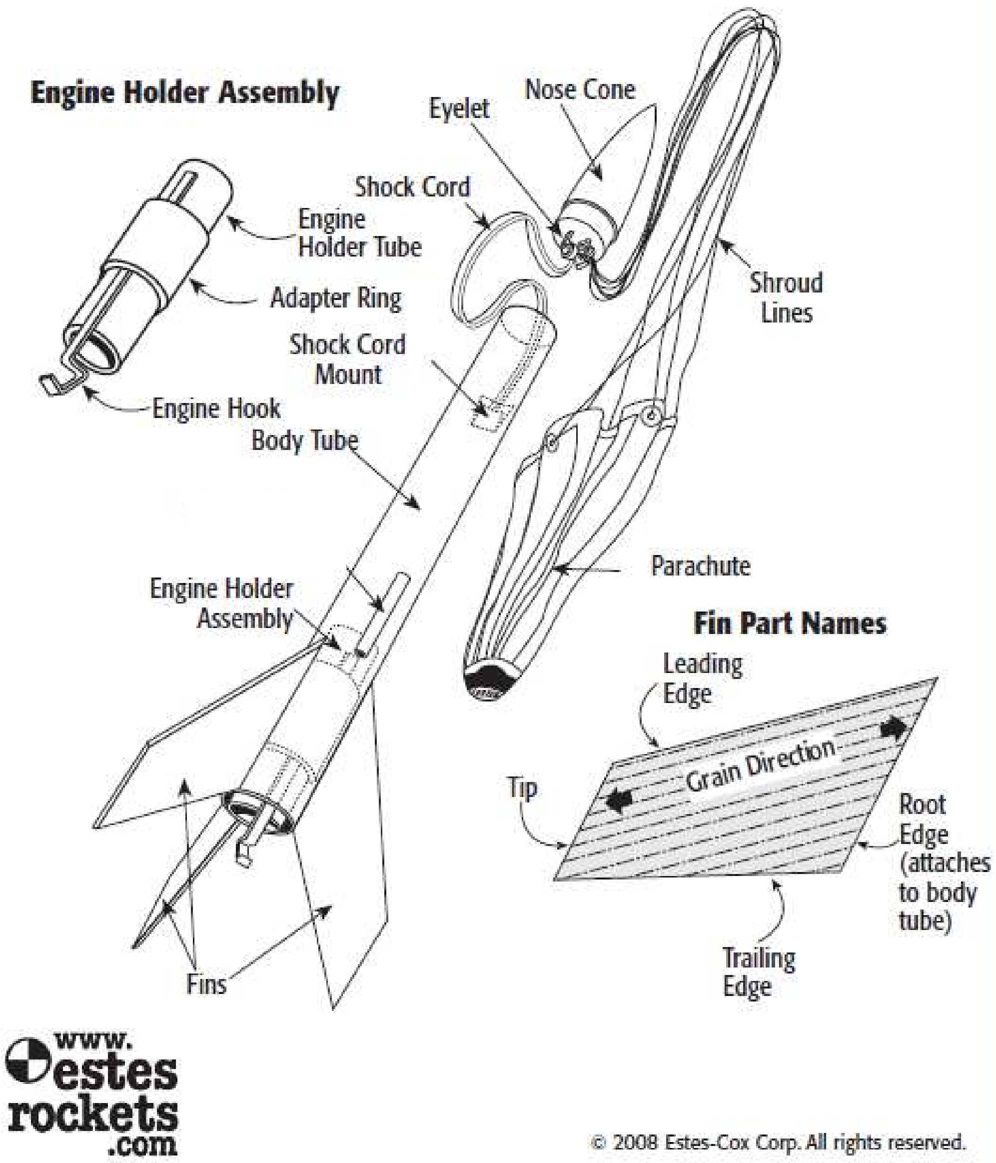
Apogee Rockets: https://www.apogeerockets.com (see the "TARC supplies" section)

Balsa Machining Service (BMS): https://www.balsamachining.com (see the "TARC parts" section)

eRockets: http://www.erockets.biz/parts-for-rockets

Aerospace Specialty Products (ASP): https://www.asp-rocketry.com

Model Rocket Nomenclature



Main Body Tube - typical choices are:

T-70/BT-70: 2.22 inch (56mm) outside diameter: Apogee (available with or without 3 fin slots); BMS (available with or without 4 fin slots); ASP (non-s slotted)

T-80/BT-80: 2.60 inch (66mm) outside diameter: Apogee (available with or without 3 fin slots); BMS (available with or without 4 fin slots); Estes or ASP (non-slotted)

Shock Cord:

2-foot “200-400-pound” (breaking strength) Kevlar cord (available from Apogee, BMS, or eRockets) wrapped around engine mount, with 2-3 feet of ¼ inch sewing elastic tied to the end which is then tied to a screw eye in the transition piece to the egg capsule

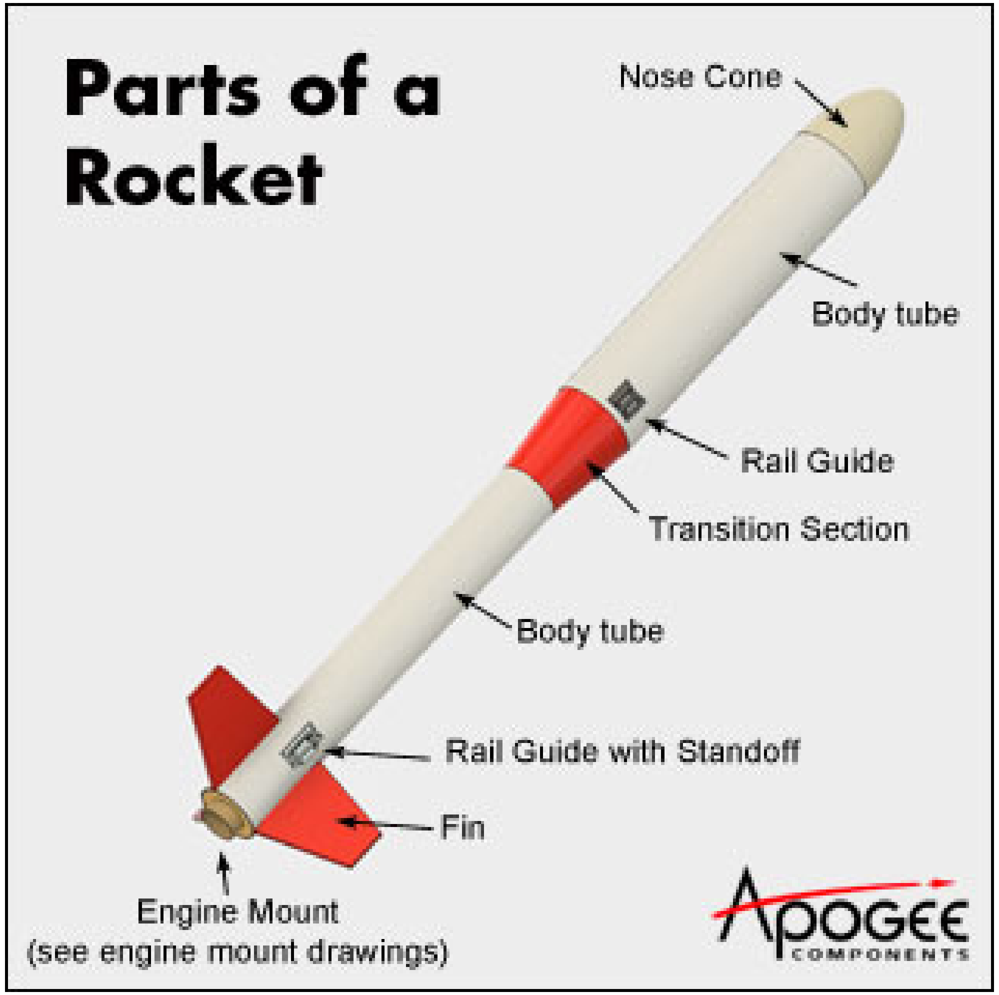
Parachute: typical choiceis nylon cloth parachutes

Sunward brand from Apogee; Topflight brand from BMS, ASP, or eRockets; or Semroc brand from eRockets

Parachute protection

9 x 9-inch reusable flameproof cloth blanket (Sunward, Madcow or Dinochutes brands) (Apogee and eRockets); Topflight brand (ASP)

Disposable flameproof paper wadding (Estes)



Nose Cone:

For T70 tubes: BNC70AJ or BNC70BB (BMS balsa); PNC-56A (Apogee plastic); or ASP (Balsa)

For T80 tubes: BNC80BB (BMS balsa) or PNC80BB (BMS plastic); NC-80B (Estes plastic); PNC-66A (Apogee plastic); or ASP (balsa)

Transition Section:

If upper and lower body tubes are the same diameter, transition section is cylindrical:

NB70 (for T70 tubes), NB80 (T80 tubes) (both BMS); "Semroc" brand balsa nose blocks (eRockets); balsa bulkheads (ASP)

If one tube is T-80 and the other is T-70, transition section is conical:

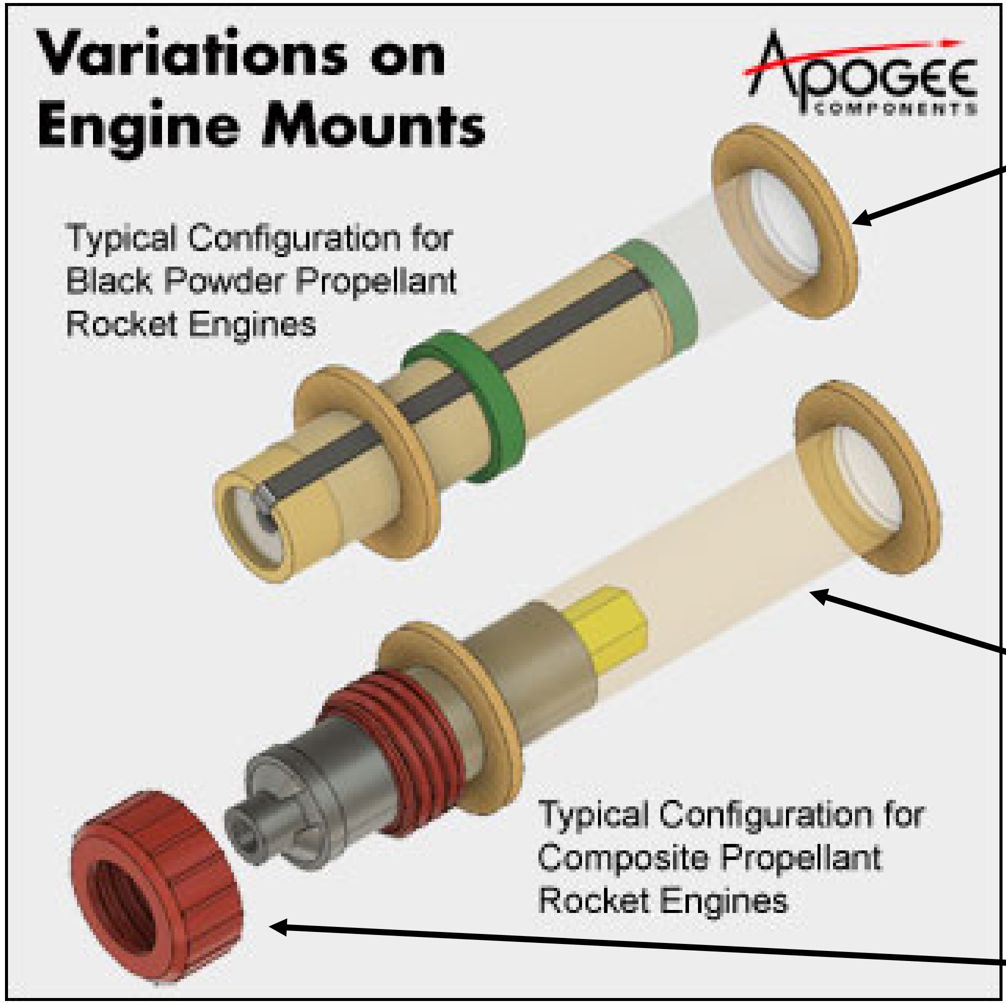
balsa TA7080 (BMS or ASP); blow mold plastic 70-80 transition (Apogee)

Fins: typical choices are 1/8-inch thickness balsa or 1/16 to 1/8 inch thickness plywood

Multiple precut shapes with through-the-wall tabs that fit in slotted body tubes (Apogee and BMS); or buy sheets of balsa at local craft store and cut your own

Rail Guide or Button: "1010" or "10/10" size

Buttons that screw on available from Apogee, ASP, BMS, or eRockets; glue-on rail guides available from Apogee



Centering rings (use plywood types):

For 24mm engines in T70: CR5070W (BMS); or from Apogee or ASP
For 24mm engines in T80: CR5080W (BMS); or from Apogee or ASP
For 29mm engines in T70: CR52H70W (BMS); or from Apogee or ASP
For 29mm engines in T80: CR52H80W (BMS); or from Apogee or ASP
For two 24mm engines clustered in T70: M2T5070W (BMS)

Engine Mount Tube:

For 24mm engines: T50 (BMS or ASP); BT-50 (Estes or Apogee)
For 29mm engines: T52H (BMS); 29mm motor mount tube (Estes or Apogee); T-29 tube (ASP)

Engine Retainer:

Engine hook for Estes engines: 2.75” for D12, 3.75” for E12. Available from Apogee, BMS, or Estes. 4.9” for Estes 29mm engines available from ASP
Screw-on cap type for Aerotech & Cesaroni engines: Estes 24mm or 29mm plastic retainer sets (Estes, Apogee, or eRockets)

How to Do Flight Testing for TARC

Trip Barber

NAR TARC Manager

The TARC Cycle

- Learn the rules and basic rocketry
- Design and “fly” your rocket on the computer
- Build your rocket to your design with real hardware
- Test-fly your rocket
- Qualify for the TARC Finals

Why Test Fly?

- Your rocket may not work perfectly the first time, or every time
  - Failure modes that happen occasionally are not likely to be discovered in just one or two test flights

- The computer software does not always accurately estimate your real rocket's flight performance even if the rocket works perfectly

- Weather conditions affect a rocket's flight performance and you need to figure out how to recognize and compensate for them

Teams that qualify for the TARC Finals typically have done at least 15 test flights

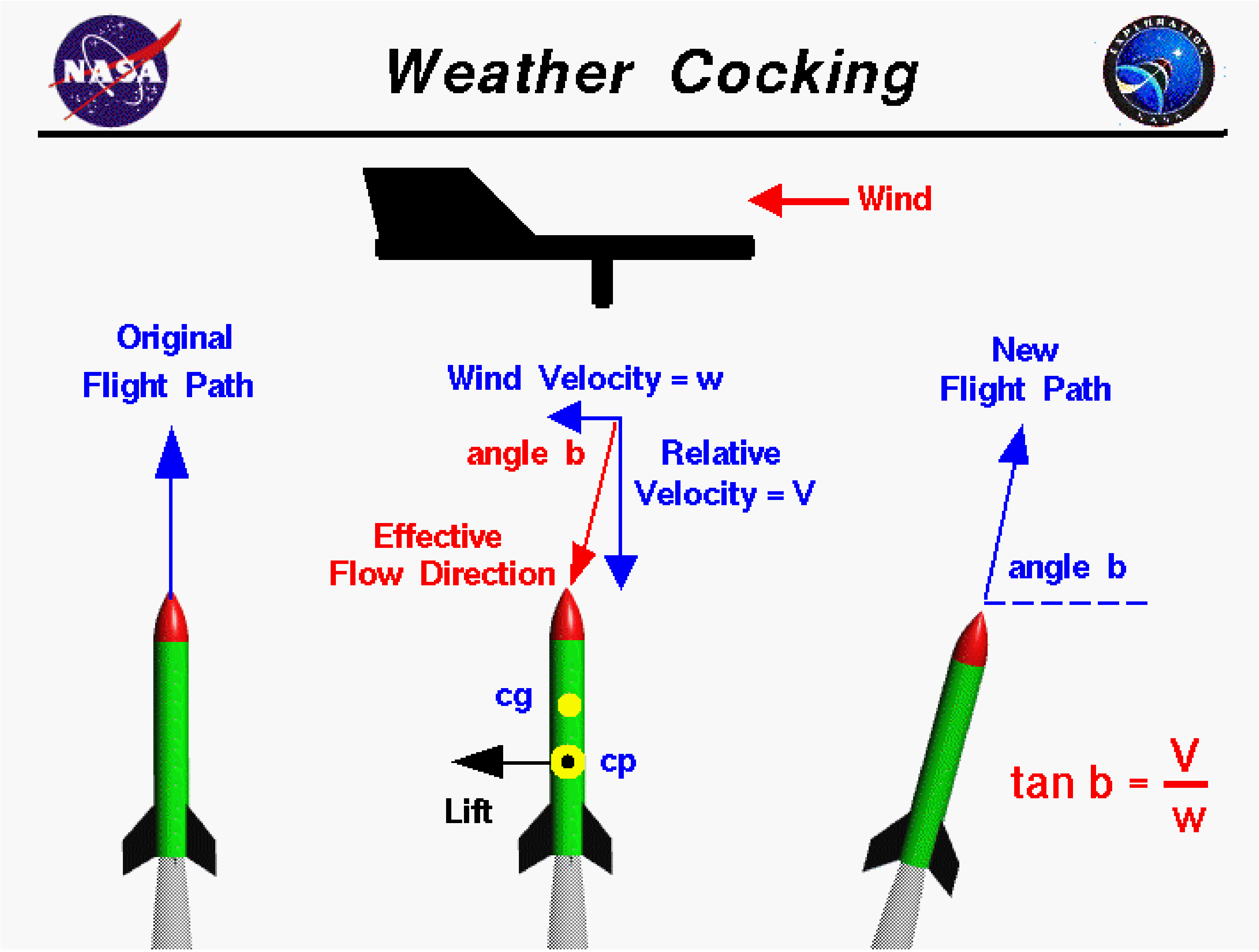
Common TARC Rocket Failure Modes

- Non-vertical flight
  - Insufficient thrust-to-weight, or launcher was angled wrong or wobbled
- Recovery device deployment incomplete
  - Not sufficiently systematic and careful about how it was packed
- Separated part
  - Connection or mount not strong enough or worn from previous flights
- Broken egg
  - Insufficient padding, particularly on the sides or between eggs
- Broken rocket part on landing
  - Landing speed too high or part materials not strong enough

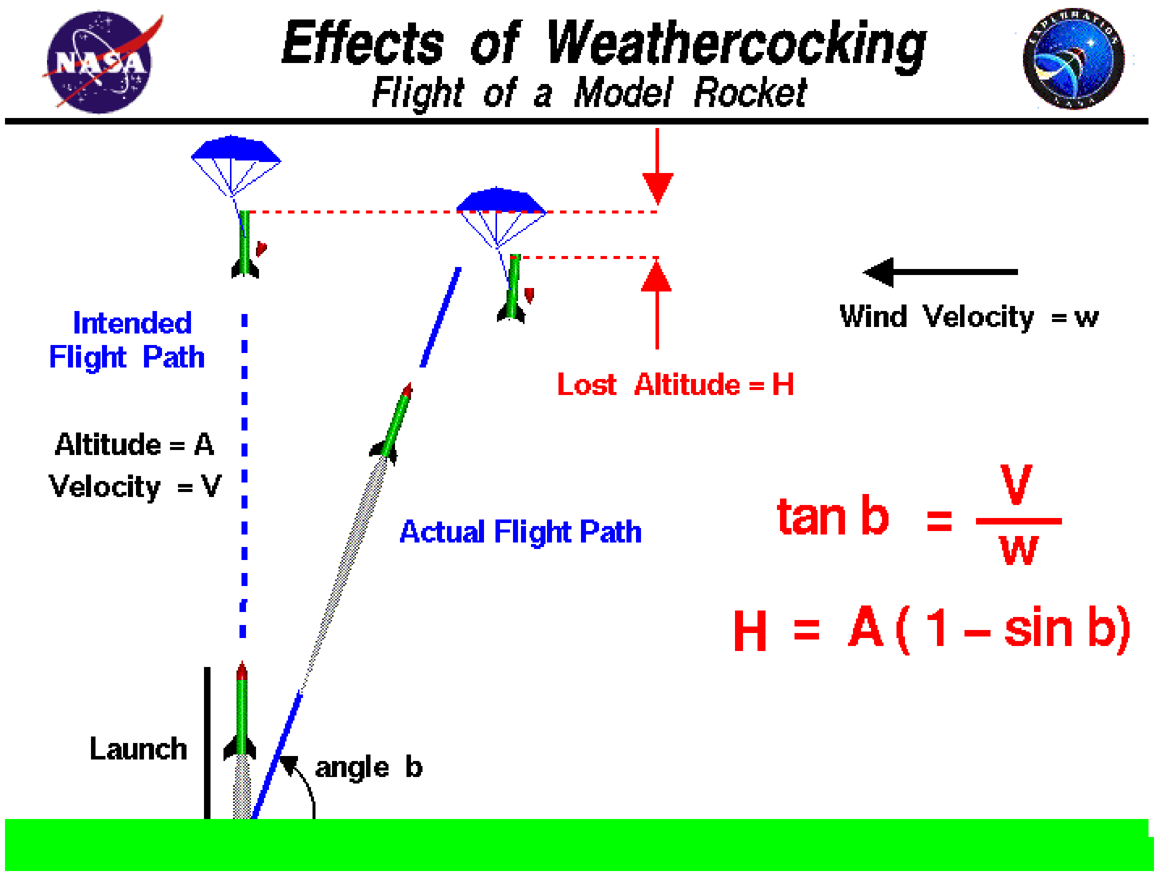
Use of checklists is a good way to help avoid making (or repeating) mistakes in flight testing

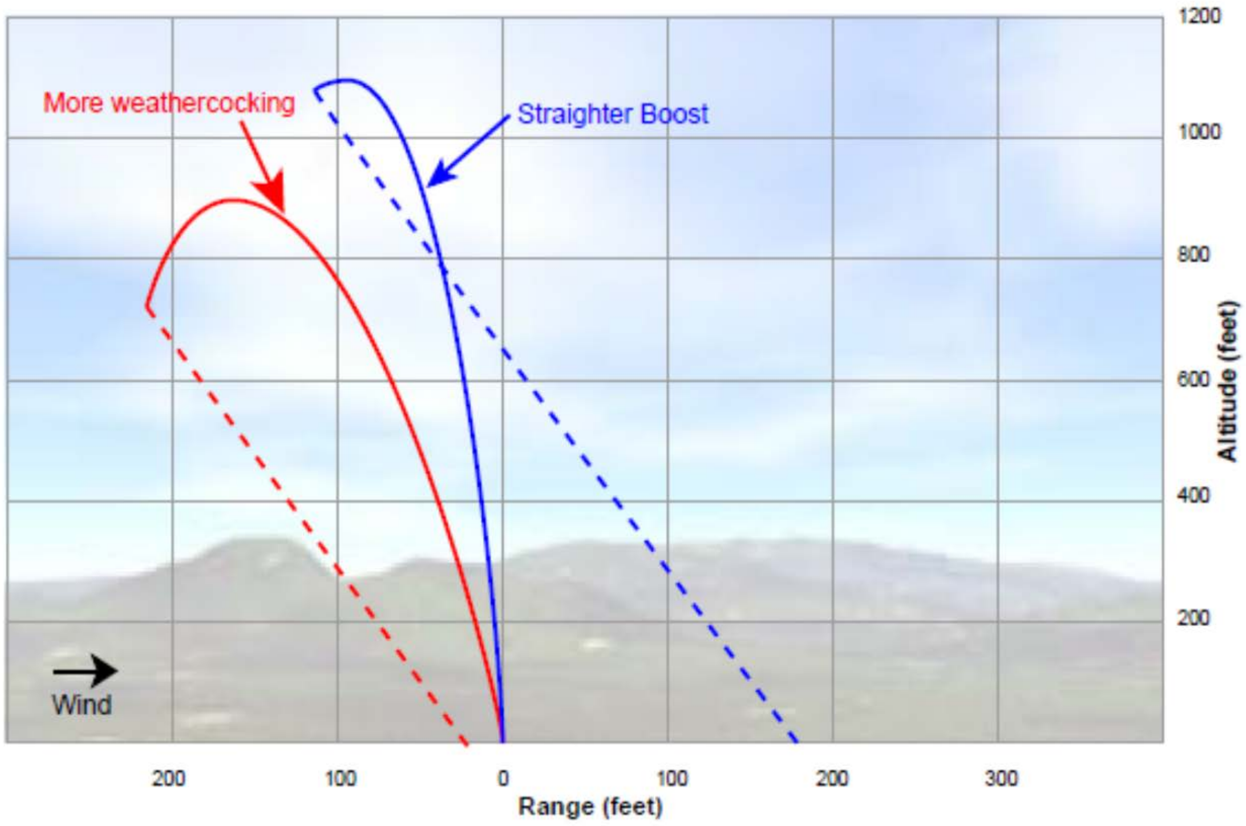
Computer vs Reality

- Computer altitude prediction may not match (and is usually higher than) actual flight altitude due to one or more of five factors:
  - Non-vertical flight - due to weathercocking in wind or launch device angle or movement
  - Rocket motor performance – may not exactly match values in computer
  - Rocket weight – may not match weight in computer
  - Atmospheric conditions – temperature, launch site elevation, humidity
  - Rocket drag – highly variable based on your personal construction techniques and flight damage
- Motor performance effects and non-vertical flights can be minimized
- Actual rocket weight and launch atmospheric conditions can be entered into the computer and will be corrected for <u>if you measure them</u> when flying
- After you’ve flown a few times you can make the computer simulation match measured actual altitude <u>from your flight data</u> by manually adjusting drag coefficient in the computer, once these other factors are controlled



Rockets with higher thrust motors get off the pad faster and have a higher V = velocity when they clear the launch device, so they are less vulnerable to weathercocking in wind. Using long (6-foot) and rigid launch devices (rails) gives the rocket more time to build up velocity.





Rockets that weathercock into the wind lose altitude because they do not fly exactly vertically. Angle the launch device in the opposite direction from the wind (away from it) to compensate and get a vertical flight. Figure out the amount of angle needed vs wind speed for your rocket in your test flights <u>by taking data</u>.

Rocket Motor Variability

AEROTECH F39

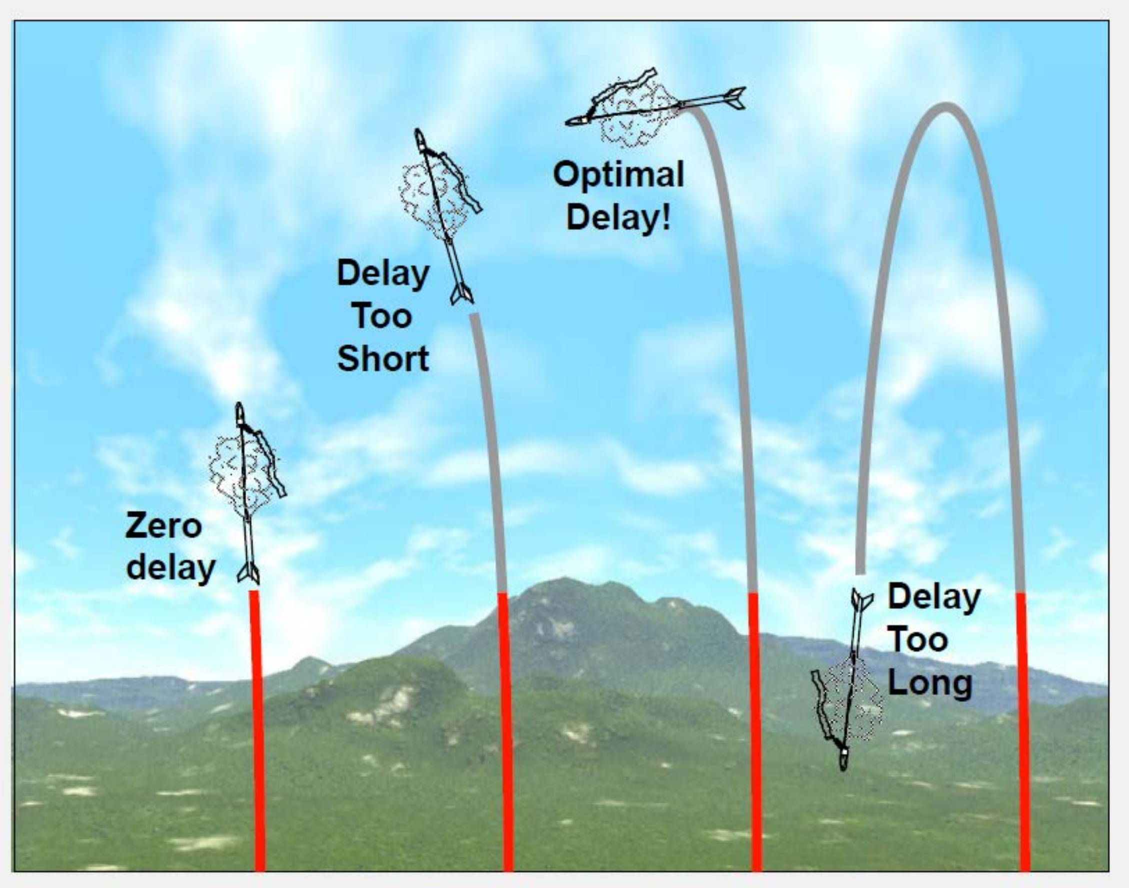
Total Impulse: 50 newton-seconds
Delays: 3, 6, 9 seconds

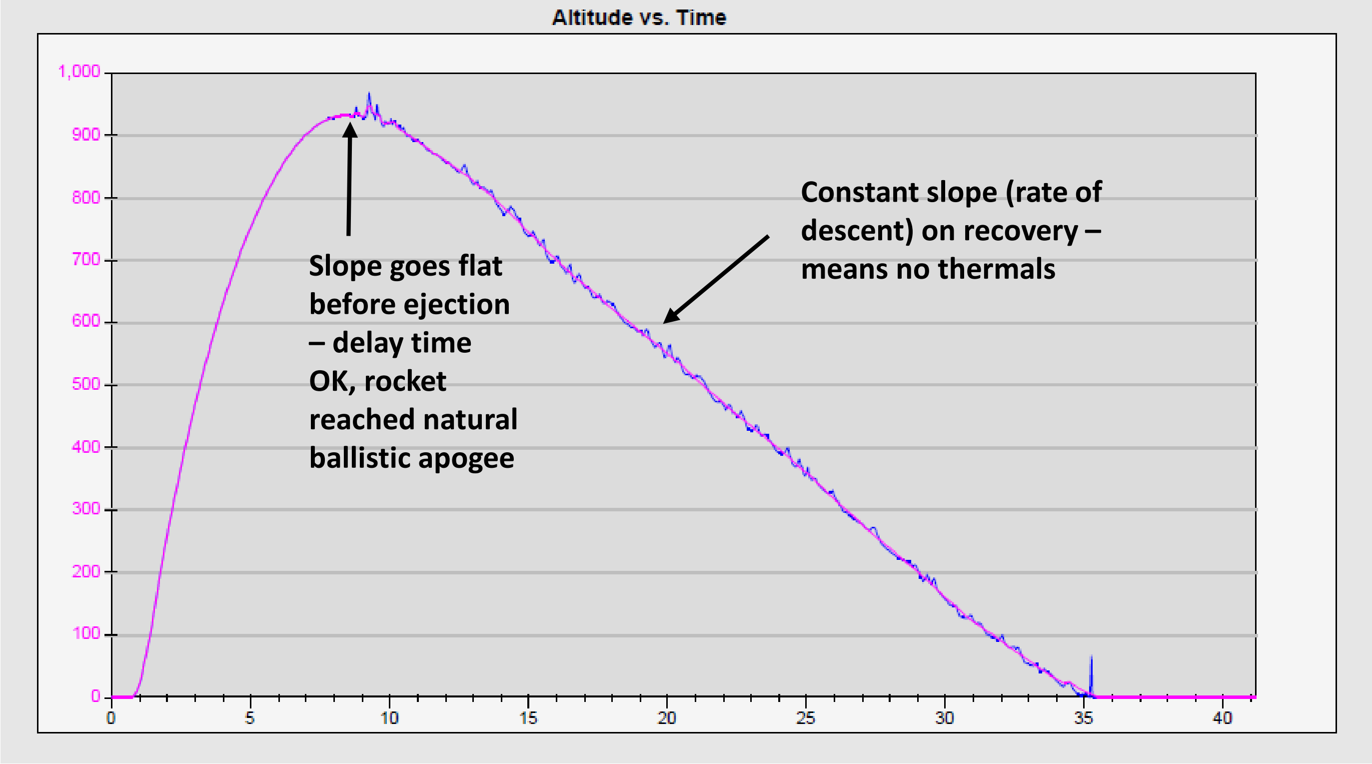
67% of motors will be within 1% of the average

Total Impulse:	49.66 newton-seconds	(σ 0.49)
Peak Thrust:	59.47 newtons	(σ 5.29)
Burn Time:	1.33 seconds	(σ 0.05)
Average Thrust:	37.34 newtons	
Mass After Firing:	30.3 grams	

Delay Time	Average Measured Delay	Initial Mass	Mfg Recommended Max Liftoff Weight
3	3.17	59.3 g	511 g
6	6.27	60.0 g	397 g
9	9.56	60.6 g	255 g

- Computer programs use average test data from NAR Standards and Testing for rocket motor performance.
- Key factors affecting altitude are total impulse (power) and delay time.
- Altitude is proportional to total impulse, and it can vary ~1% motor to motor for composite motors (more for black powder).
- Use composite motors all from the same production batch (date code) in test-flying program to minimize error.
- Use delay times that are long enough to ensure your rocket flies up through its ballistic apogee before ejection.





- If your delay is too short, the rocket will still have upward velocity at ejection that would have yielded more altitude – you will see this <u>from a recording altimeter's data</u> in your flight testing
- Because delay times are not very accurate, this early ejection will change peak altitude unpredictably
- It's better to go a little (not too much) past natural ballistic apogee before ejection; effect on duration will be small compared to the TARC score penalty from missing the altitude target.

Atmospheric Density

- Drag is the force the atmosphere exerts resisting the movement of the rocket through the air and it effects (reduces) rocket altitude.
  - Drag is proportional to the density of the atmosphere
- Atmospheric density (drag) decreases as the air gets hotter or more humid, or as launch site elevation above sea level increases
  - The same rocket will go higher on a warm or humid day, or at higher elevations, than it would on a cold or dry day, or at sea level
  - Effect of temperature on density (not altitude) is about 2% per 10 degrees F
  - Effect of site elevation is 3.4% per 1000 ft
  - Effect of humidity is comparatively negligible
- Taking weather data when you fly is critical to making adjustments to hit the TARC altitude target

Atmospheric Motion

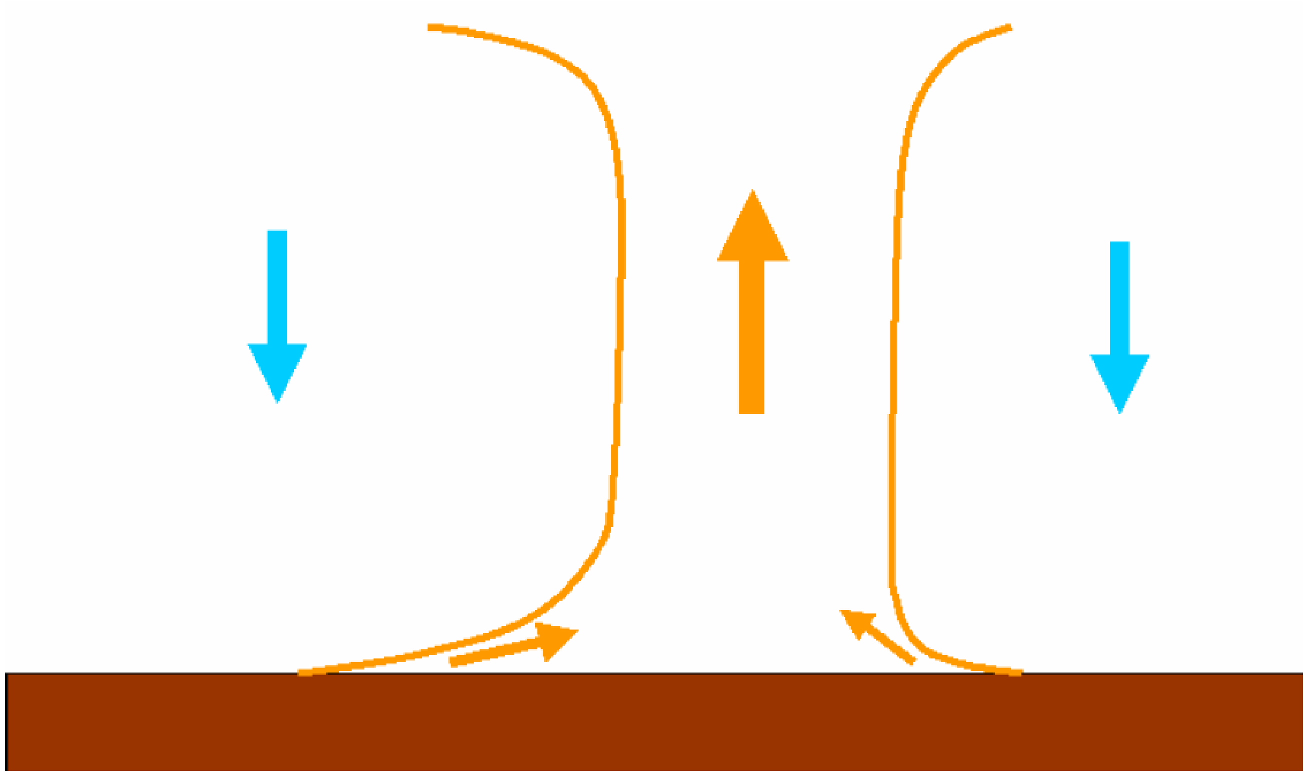


Figure 4: Side view of a thermal. Rising air is inside the orange outline.

- Wind alone does not affect rate of descent (duration) much, only how far a rocket drifts during that time
- A rocket's rate of descent through the air during recovery is generally constant, but the air itself can be rising or falling with respect to ground
- A body of rising air called a "thermal", caused by the sun heating the ground (especially plowed ground or pavement) or the accompanying falling air, will make a rocket's duration unpredictable
- Thermals increase in number and strength as the day goes on
- **Fly early in the day to minimize effect**

Successful Flight Testing

- Flight testing needs to be systematic – take data, understand what it tells you, and use it to make purposeful adjustments
- Record everything about each flight in a consistent format – rocket weight, flight characteristics, launch device angle, weather; not just altitude and duration
- Use a data-logging altimeter and evaluate the trace after each flight
- Use computer simulations adjusted with the rocket's actual weight and drag coefficient to determine how much weight change will be required to change the altitude the number of feet needed to hit the altitude target
- Adjust your rocket to hit the altitude target, then adjust the recovery device to hit the duration target – and do your qualification flights early in the day
- Figure out based on your data how to adjust your rocket's launch angle for different wind speeds to get a vertical flight and its weight for different temperature conditions to get the right altitude

Test-fly early, often, and systematically!

TexasMonthly
JULY 2019

Why Does Presidio Have One of the Best High School Rocketry Clubs in the Country?

The West Texas border town is among the poorest places in the state. But year after year its rocketeers send wealthier teams crashing back to Earth.

The Presidio High School rocketry club's team captain, Leonardo Uribe, in Presidio on May 31, 2019.
Photograph by Trevor Paulhus

It's possible to build a model rocket in the middle of the Chihuahuan Desert, but those who live in the remote West Texas border town of

Presidio face an extra challenge: the nearest Home Depot is nearly four hours away, in Odessa. So, Presidio High School's rocketry club typically goes to the local Dollar Tree to purchase many of their rocket-building materials instead.

Dish sponges and cardboard, petroleum jelly and duct tape—those are a few of the items that the group of Presidio teenagers bought for a few dollars during recent trips to the store. Once those household items were hooked up to a fifty-newton, four-inch-tall motor and fueled with a few ounces of gunpowder, they were transformed into a rocket that qualified for the world's largest student rocketry competition.
And on a warm and humid morning in mid-May, nearly two thousand miles from the Chihuahuan Desert, the students prepared to launch it nearly a thousand feet in the air.

"I'm so nervous right now," the team's captain, Presidio High senior Leonardo Uribe, said as he watched another team's rocket explode. "I just hope it doesn't blow up like that one."

His team was one of 101 that had bested 729 other middle school and high school rocket clubs to qualify for the national finals at the Team America Rocketry Challenge (TARC), held annually in The Plains, Virginia. A ticket to Paris, for the international finals, was on the line. The Virginia venue, a horse pasture forty miles west of Washington, D.C., had been converted into a rocket launch field with a perpetual "3 . . . 2 . . . 1" blaring over the loudspeakers. This year's theme: a tribute to the fiftieth anniversary of the moon landing.

Hiding his nerves, Uribe, a trim nineteen-year-old wearing a Casio calculator watch, led his seven teammates to the big white tent where they would pull the requisite parts from a yellow toolbox and, in just thirty minutes, reassemble their three-foot-tall miniature rocket. They had named it Agripino, for no reason in particular, like the way some parents in their families had picked children's names from the Mexican calendar of saints.

The team's designated artist, Paola Flotte, had painted the bottom half to look like the *Apollo 11* rocket and the top half to look like home, a landscape of cacti brushing up against a starry blue sky. To prepare it for launch, Flotte, a seventeen-year-old with a warm smile who moved to Presidio from Mexico in the third grade, sprinkled clumps of shredded newspaper into the bottom cylinder; the paper was intended to function as insulation, a wall between the gunpowder explosion and the rest of the rocket. Others greased the gunpowder-filled motor with petroleum jelly, to prevent the rocket parts surrounding the motor case from sticking during launch. The rocket, equipped with three parachutes for landing, carried three raw eggs as passengers, wrapped snugly in the dollar-store dish sponges.

Paola Flotte, the club's designated artist.
Photograph by Trevor Paulhus

This year's challenge: to launch the rocket exactly 856 feet high and land it within 43 to 46 seconds of launch. All while keeping the eggs intact. Too much firepower might hard-boil them on the way up. Too little parachute might scramble them on the way down. It was a game of physics, requiring the right touch and a bit of luck.
"Not too tight," Uribe reminded Omar Udave, the team's parachute expert, a senior with steady hands and sharp focus, as he folded the chutes into bite-size squares.

Finally ready for launch, Uribe loaded Agripino onto the launchpad—and fretted about one of the rocket's fins. It had sustained a nearly imperceptible blemish while in storage. "Some of these other rockets fly so straight," he said. "We had a little incident with this fin, so now ours spins a little bit. Which is not good."

The fin was one component they couldn't find at the Dollar Tree. The one they had damaged had been ordered online from Hobby Lobby, and there was no time to place another order in time for the finals. The nearest Hobby Lobby is also in Odessa.

Presidio Independent School District's student body is one of the poorest in Texas. Ninety-three percent of its students are economically disadvantaged and qualify for free or reduced-price lunches, and more than half are English-language learners. Yet over the past decade, the high school's rocketry club has repeatedly outperformed prestigious magnet schools and science academies with twice its budget—and easy access to big-box craft and hardware stores.

The story of how that happened begins eleven years ago, when Shella Condino decided to start a rocketry club at the high school. A 46-year-old physics teacher from the Philippines who initially came to the United States in 2002 to teach in El Paso, Condino was offered a job in Presidio in 2006, but at first she hesitated to accept. She already had an offer from the Academy for International Studies, in Houston, where she would have access to a generous budget for a rocket-club project and plenty of materials—compared with none in Presidio, at least to start. She worried that Presidio was geographically isolated, its climate arid and unforgiving. But when she saw the desert surrounding the high school, Condino felt a pull. "I thought, 'This is the perfect place for my rocket launching,'" she said.

LEFT: Aaron Bustamante and Uribe make adjustments to their rocket, Agripino, at the 2019 Team America Rocketry Challenge national finals in The Plains, Virginia, on May 18, 2019.

RIGHT: Officials time Agripino's flight.

She pitched the idea for the club to administrators, intending to use materials she had purchased herself to get it started, and they were sold. In 2008 she recruited a dozen or so students for a summer enrichment program that turned into something more when the club was invited to attend a weeklong rocketry summer camp at Texas Tech, in Lubbock. That felt like a big leap for her kids, who weren't necessarily aspiring rocket scientists. Some had just moved to Presidio from Ojinaga, Mexico, just across the border, and had nothing to do in their new town. Some didn't speak English. Some had never been to a hotel before or anywhere beyond Presidio.

Yet when Condino took them to Lubbock, they excelled. Competing against students from all over West Texas, they created one of the best-performing rockets, a testament, perhaps, to Condino's tough-love, no-excuses teaching style. And the kids grabbed opportunities that others hadn't seen. When the camp was over, they noticed that the other teams had discarded their used rockets in the trash. Strapped for resources, the Presidio students retrieved them, to reuse the materials.

"We were saving whatever we could save," Condino said. "And [the camp director] saw us doing that. I said, 'Sometimes people's trash could be somebody else's treasure.'" Weeks later, the director sent them two boxes full of reloadable motors. "I cried," Condino recalled. "We could not afford those types of metal motors. We tried to conserve all of those materials for several years."

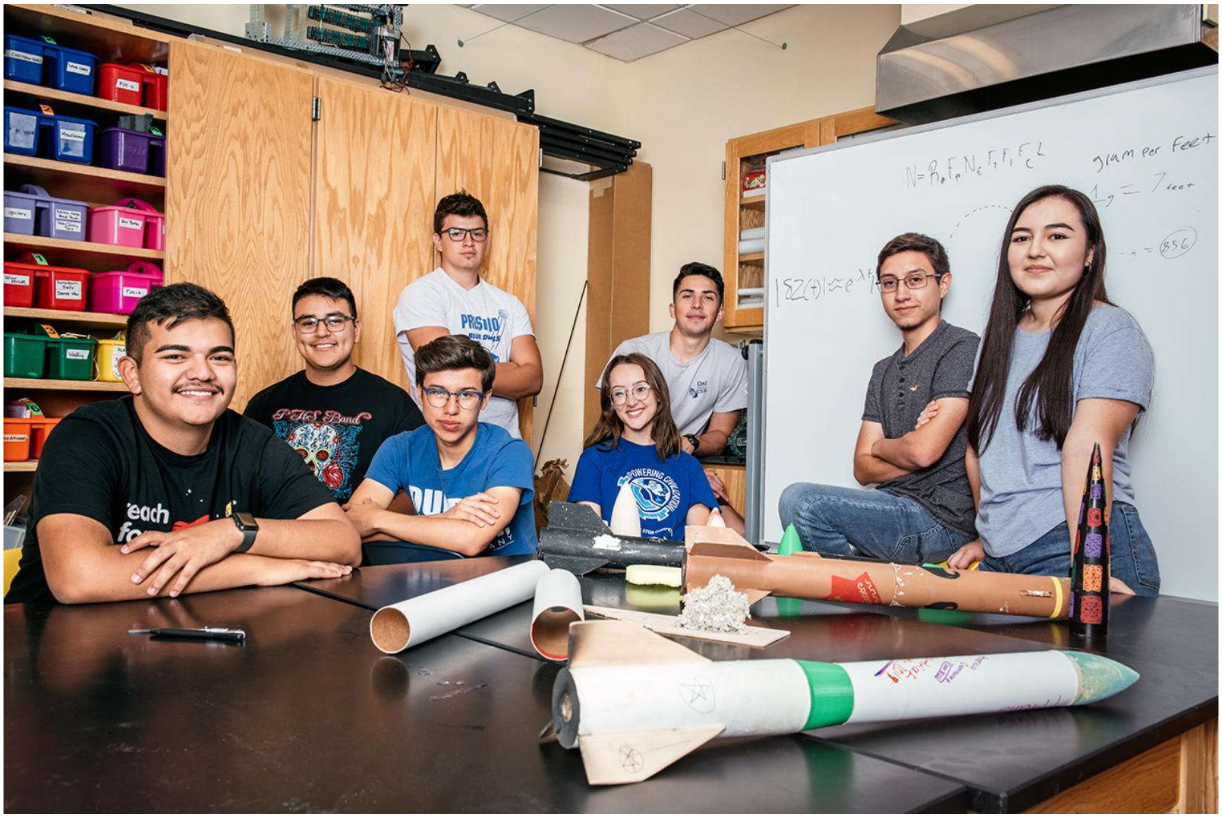
In the spring of 2009, less than a year after Condino had founded the club, it qualified for the Team America Rocketry Challenge. Admittedly, some rockets had exploded along the way. And while most teams worry that their rockets might get stuck in a tree, the students in largely treeless Presidio worry more that theirs might get stuck in Mexico, because one actually had.

But despite the fact that they didn't use any high-tech rocket pieces or have the most advanced motor, they placed nineteenth at the competition, which made them eligible to submit a rocket-design proposal to a NASA program that simulates a NASA mission from the drawing board to launch. The Presidio students got to consult with some of the nation's foremost aerospace engineers, and as they sharpened their chops, they developed a reputation for being scrappy. One story—about how the team managed to afford their first trip to Virginia—has become almost legendary among TARC officials. "The Presidio team had to auction off a goat," said Dan Stohr, a spokesman for the Aerospace Industries Association, which organizes the competition with the National Association of Rocketry. And they auctioned a goat in Presidio every year for the next five years.

Even President Barack Obama knows the story. In 2012 he invited members of the team to the White House Science Fair and highlighted their achievements in his speech. "This is part of the fourth-poorest school district in the state of Texas," he said, asking the three club members who made the trip east to stand to be recognized. "And I was told that teachers cooked food to sell after church, supporters drove two hundred miles to pick up doughnuts for bake sales. They even raffled off a goat—is that right?—just so they could raise enough money for the rocketry team to compete."

In 2014 the team placed fourth at TARC, its highest ranking so far. But two months later, Condino left Presidio to teach physics at a high school in northern Virginia. Given how central she was to the program, outsiders might have thought that the club would begin to falter. But the team's current adviser, Luzviminda Sto. Domingo, said that every teacher and teacher's assistant who has succeeded Condino has tried to follow her example—turning her teaching method into institutional knowledge.

There have been five of them over the past five years, and as it happens, all but one of them are also from the Philippines, where Presidio ISD frequently recruits math and science teachers, according to interim principal Edgar Tibayan. It's difficult, Tibayan said, to recruit U.S. teachers to move to the desert.



Sitting (left to right): Omar Udave, Adrian Escontrias, Ramon Aguirre, and Alejandrina Elms; Standing (left to right): Dale Escontrias, Aaron Bustamante, Leonardo Uribe, and Paola Flotte.

Photograph by Trevor Paulhus

Sto. Domingo, a sprightly woman with a soft manner, arrived in Presidio from her native country in October, when she learned she would be supervising the rocketry club. Though she has a master's in physics, she had no experience building rockets. Which, as it turned out, didn't really matter: the contest's rules require that she be hands-off, that she allow the students to experience trial and error themselves. She was there to supervise the launches, to order the non–Dollar Tree materials, to make sure the students' creation was safe. For the most part, she said, Uribe does the teaching.

"Leo could build a rocket in a day if he wanted to," she said. "He's very passionate. When they lost their best rocket earlier this year, he didn't eat. He skipped lunch to replace it."

Uribe has spent all of his life in the borderlands. Born in El Paso, he lived in Juárez until he was eight, when his parents felt the city was becoming too dangerous. He remembers the day his mother picked him and his brother up from school in tears. She and their father had received a phone call from men who pretended to have their sons and threatened to kill them if their parents didn't immediately wire money. Soon after that, Uribe and his brother, who are both citizens since they were born here, moved to Presidio, where an aunt and uncle lived. His parents, who had no legal status in the United States, had to stay behind in Mexico.

Uribe arrived knowing no English. At school, he didn't like language arts or, later, politics classes. "But the one thing I was really good at was math," he said. "And that's because math is the universal language."

His parents, both dentists, had encouraged him to become a doctor. But upon discovering the rocketry club as a freshman, Uribe set his sights on becoming an engineer. Aerospace engineering is his ultimate goal, but he's open to electrical and computer engineering too, enthralled by all the opportunities the field presents to create technology that could reduce fossil fuels and pollution and save the earth. In August he will matriculate at Texas A&M–College Station. "I want to be one of those people that are changing the world," he said. Condino, for one, knows it's possible: In the past six months, she has heard from two prior members of the rocketry club. One now works as an engineer for Boeing in Seattle; the other works at Aurora Flight Sciences, a Boeing subsidiary in Virginia. "The tears keep flowing every time we hear from these kids," she says.

LEFT: **The team watches the launch.** RIGHT: **Agripino's parachutes deploy.**
Photograpsh by Allison Shelley

Back at the launch field, Uribe was pacing. "I feel like I want to collapse," he said.

The team watched as, one by one, the rockets built by the teams they were competing against blasted off in a fiery burst of sparks and thick black smoke, sizzling and hissing as they soared straight up.
"Ours don't have nearly the same firepower as those ones," said Ramon Aguirre, the team's eighteen-year-old field engineer.
"I feel like ours is going to be so ordinary!" said Flotte.

When their turn came, an official stopped by to ask if they were ready. They gave him the thumbs-up and then clenched their fists or clasped their hands as the countdown began. "In 5 . . . 4 . . . 3 . . . 2 . . ." And there it went.

Agripino pierced the overcast sky, traveling in a near perfect line before splitting into two cylinders at its peak, as three parachutes—two on the top cylinder, one on the bottom—burst open. As the rocket floated back toward Earth, landing not too far from where it launched, the students checked their stopwatches. They were spot-on: 43.86 seconds.

They started running toward the rocket, like a baseball team storming the pitcher's mound at the end of an eleven-inning nail-biter. Uribe was nearly skipping, jumping every few steps and pumping his fists. They opened the cylinder to check the eggs: intact! But then they pulled out the altimeter—the device that detects the altitude the rocket reached—and grimaced. The rocket had traveled 773 feet—83 feet short of its goal. "At least it had a nice paint job," Flotte said. The team ultimately placed seventy-third, their weakest showing since 2015.

Still, from the sidelines, the school administrators were beaming like proud parents. The superintendent, Raymond Vasquez, who joined the district last fall, said that he already intended to beef up the budget for the club next school year. Sto. Domingo said she wasn't concerned about rankings.

"The rocket launched so well. It didn't explode. It wasn't disqualified. It's really an accomplishment," she said. "They've proved they can make a rocket out of Dollar Tree materials."

Leaving the launch field, Uribe was already doing the postmortem in his head, dissecting where things had gone wrong. Could they have picked lighter eggs? Should they have used a lighter acrylic paint? But there was also the factor they couldn't change: the stifling humidity, heavy on the rocket like a knit sweater. "That was it," Uribe realized, and it was the one variable they hadn't prepared for. The thing about building rockets in the desert, he said, is that there is no humidity.

Meagan Flynn, a former Texas Monthly *intern and former staffer at the* Houston Chronicle *and the* Houston Press*, is now a staff writer at the* Washington Post*.*

This article originally appeared in the July 2019 issue of Texas Monthly *with the headline "Launch and Deliver." Subscribe today.*

BIG ISLAND NOW

Future 'Rocket Scientists' at Kealakehe High School to Compete at National Level

By Big Island Now

May 10, 2019, 10:00 AM HST (Updated May 10, 2019, 9:18 AM)

Kealakehe High School students are national finalists in the Team America Rocketry Challenge, May 2019. Courtesy photo.

Two teams from Kealakehe High School in Kailua-Kona are among the 101 national finalists in the Team America Rocketry Challenge, sponsored by the Aerospace Industries Association.

The students will compete against other teams at the Team America Rocketry Challenge National Finals in Virginia on May 18, 2019. In addition to competing for a total of $100,000 in prizes, the winner of the national finals will advance to the International Rocketry Challenge at the Paris International Air Show in June against teams from the United Kingdom, France and Japan.

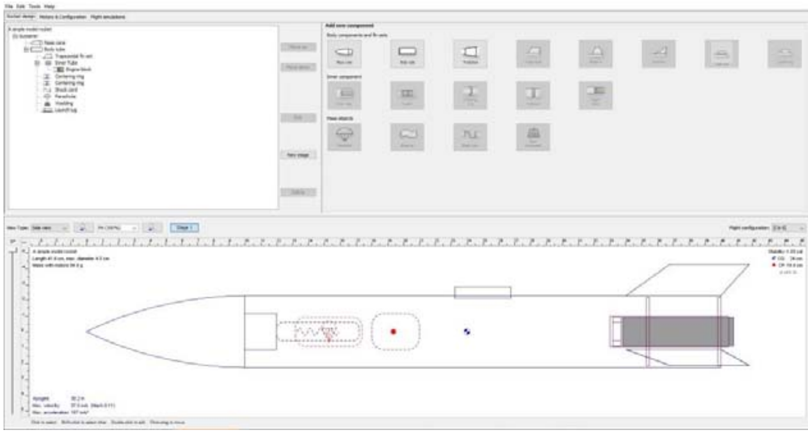
After four straight international championships, the United States looks to continue its international winning streak.

The top 20 finishers will earn a spot in next year's NASA Student Launch competition.

Kealakehe High School students are national finalists in the Team America Rocketry Challenge, May 2019. Courtesy photo.

The Big Island teams, advised by Justin Brown, are among 830 teams that entered the competition from 46 states, the District of Columbia and the U.S. Virgin Islands.

The competition, which is honoring the 50th anniversary of the Apollo 11 Moon landing, requires a team to launch a rocket carrying three raw eggs that must reach an altitude of at least 856 feet before separating and returning to Earth uncracked—all within 43 and 46 seconds and with strict height and weight requirements.



Kealakehe High School students are national finalists in the Team America Rocketry Challenge, May 2019. Courtesy photo.

The Team America Rocketry Challenge is the aerospace and defense industry's flagship program designed to encourage students to pursue study and careers in science, technology, engineering, and math (STEM). The competition challenges middle and high school students to design, build, and fly a rocket that meets rigorous altitude and flight duration parameters through a series of certified, qualifying launches.

Now in its 17th year, the Team America Rocketry Challenge has inspired more than 70,000 middle and high school students to explore education and careers in STEM.

Sponsored by the Aerospace Industries Association (AIA), the National Association of Rocketry, and more than 20 industry partners, the Team America Rocketry Challenge is the world's largest student rocket contest.

The Rocketry Challenge promotes friendly competition among teams from diverse socioeconomic backgrounds, ethnicities, and geographies—from frozen lakes in Alaska to major metropolitan areas. Numerous teams launched fundraising campaigns in their communities to make their participation this year possible.

AIA President and CEO Eric Fanning congratulated the finalists. "Qualifying for the national finals is a testament to the teamwork, critical thinking and problem-solving skills that represent the very best of aerospace and defense. Each year, this contest inspires thousands of young women and men to consider careers in STEM fields. It presents a unique opportunity to motivate the next generation of leaders who will change the way we move, connect, and explore our world."

Follow and support your local team on the road to national finals using the official hashtag: #TARC19.

For more information about the Team America Rocketry Challenge and to view the complete list of finalist teams, go to rocketcontest.org

BREAKING TOP STORY

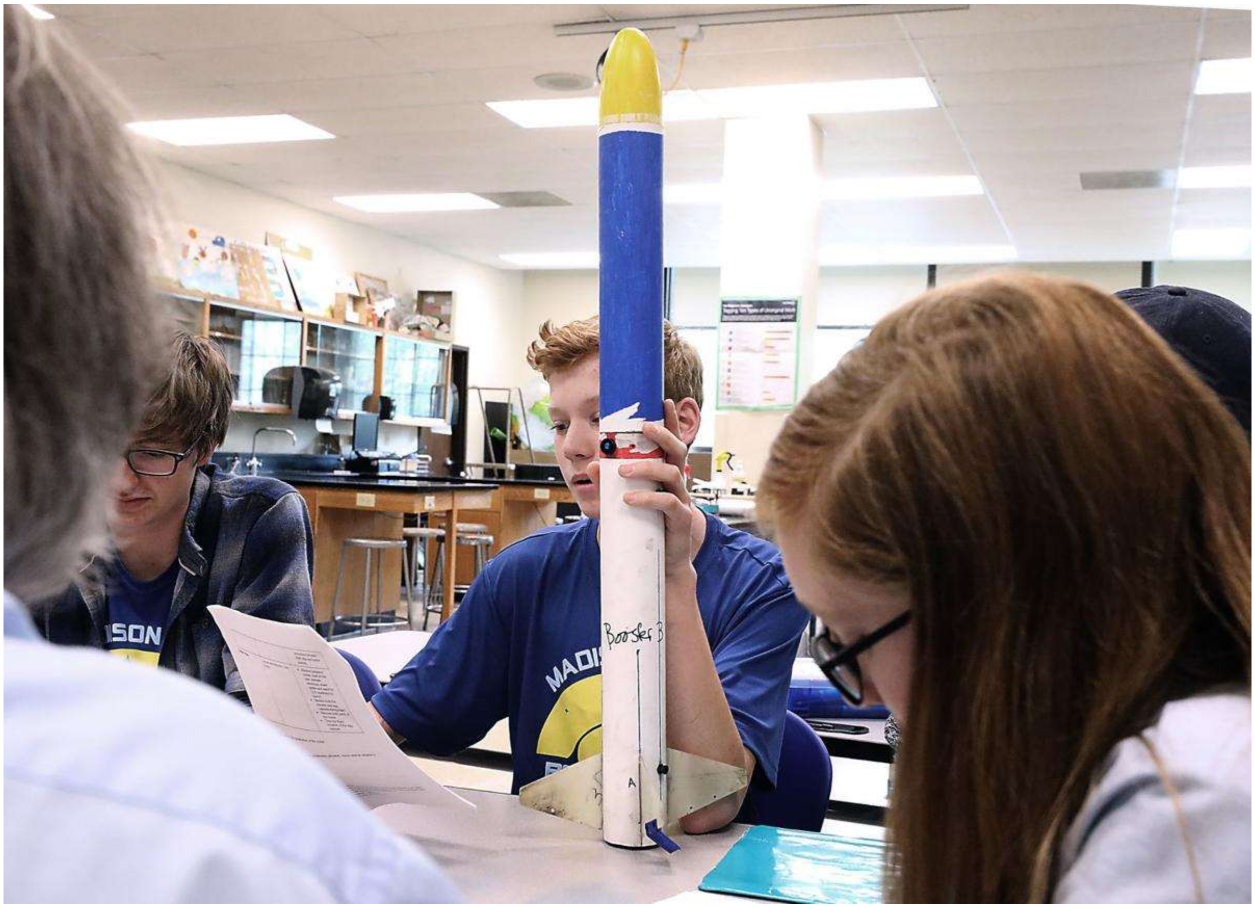
WISCONSIN STATE JOURNAL

INTERNATIONAL PARIS AIR SHOW | ROCKETRY COMPETITION

Madison West High School students to compete in international rocketry competition

BY LOGAN WROGE May 31, 2019

Members of Madison's West High School Rocket Club meet with Pavel Pinkas, the club's mentor and scientific adviser, to plan their presentation for an international model rocket competition in Paris next month. The team, nearly all freshmen, won a national competition earlier this month to qualify. JOHN HART, STATE JOURNAL



The rocket is made from lightweight, craft paper tubing, fiberglass fins and a plastic nose cone, and has two main parts — a payload and a booster. JOHN HART, STATE JOURNAL

A month before Americans celebrate the 50th anniversary of landing a man on the moon, a group of West High School students will demonstrate their own rocketry skill on an international level — ideally by sending three eggs 856 feet in the air to safely land uncracked on French soil.

The nearly all-freshmen team of Madison students will represent the United States during the International Paris Air Show next month, facing off against three other nations to determine the champion model rocket building team. The trip marks the third time West High has sent a team to the international competition, the last being in 2012.

Earlier this month, the club qualified by placing first in the Team America Rocketry Challenge, besting 100 other teams, including another from West High.

The 34-inch rocket is constructed out of lightweight, craft paper tubing, fiberglass fins and a plastic nose cone, and is divided into two main pieces — the payload portion containing three large grade A eggs and the booster component.

The eggs represent the three astronauts on the Apollo 11 spaceflight.

Nathan Wagner, 15, said the national competition, which was held near Washington, D.C., was a great team-building experience "as well as something we could show off our potential and say, 'Hey, this is what America's got, this is what West High's got, and this is what we're going to carry to internationals.'"

The goal of the competition is to design a rocket that hits a target altitude, deploys a parachute and lands, all within a set amount of time. The team with the lowest score wins.

Points are added based on the amount of time a rocket is below or above the goal of 43 to 46 seconds of airtime.

A team's score also goes up depending on how far off a rocket is from reaching 856 feet — a nod to when Neil Armstrong first planted his foot on the lunar surface at 8:56 p.m. CDT on July 20, 1969 — measured by an on-board altimeter.

At the national competition, West High had a score of 10 after two launches, beating a second-place Alabama school that scored 12.56 points.

Biology teacher and club adviser Chris Hager said she has warned the students about the media attention they'll receive in Paris, where France, Japan and the United Kingdom are also fielding teams.

“I think it’s going to be amazing. As I’ve heard, we’re going to be treated like celebrities, apparently,” said freshman Lukas Weinhold, who also noted the competition as a bonus for a resume.

Jacob Mello will be traveling out of the country for the first time. The freshman had not even been on an airplane before.

He said some of his teammates who have visited Paris are floating ideas of things to do on the trip.

“I don’t even know what most of those things are, but I’m guessing it’s going to be a blast,” Mello said.

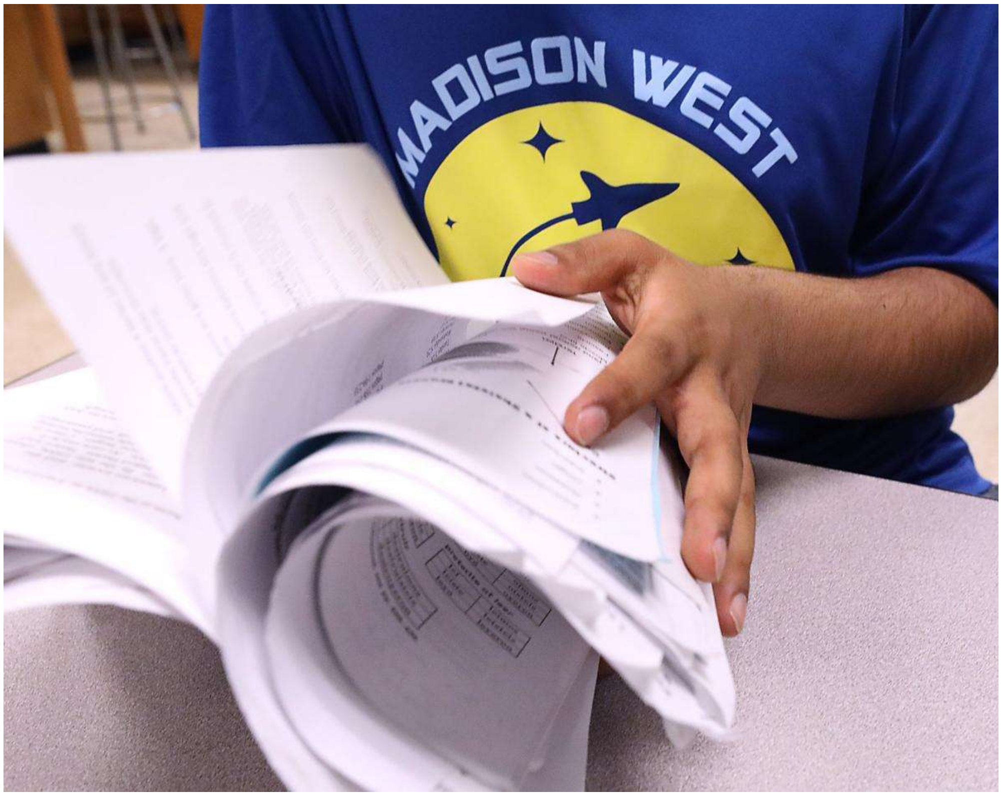
Earlier in the school year, club members designed and built individual rockets. It was Mello’s rocket that was eventually selected and refined to be used in the competition setting.

It is called the Stewart V after Mello’s nickname and the Saturn V rocket that sent the Apollo 11 crew to the moon.

“Consistency is the key to the nationals and winning it,” the 15-year-old Mello said.

For 14-year-old Alex Goff, the trip will be the third time the freshman has visited Paris. This time, he’d like to go to the Père Lachaise Cemetery, where Doors frontman Jim Morrison and Polish composer and pianist Frédéric Chopin are buried.

The trip is paid for by the Aerospace Industries Association and defense contractor Raytheon.



On Wednesday, seven of the eight members of the West High team going to the international model rocket competition practiced a presentation they'll give on their rocket, named the Stewart V, to a group of judges in Paris. JOHN HART, STATE JOURNAL

On Wednesday, seven of the eight team members gathered after school to practice the presentation portion of the international competition where they will explain their rocket to and answer questions from a group of judges.

Club mentor Pavel Pinkas quizzed them on physics questions, rocket terminology and design decisions, such as why they chose pricey but more sturdy fiberglass fins over wooden ones, occasionally joking that “this isn’t rocket science.”

With 40% of a team’s overall score coming from the presentation portion, the team practiced for more than two hours, briefly interrupted by an announcement over the speakers asking for the owner of a black Honda Civic to move their car.

The team leaves for France on June 17. The presentation will take place June 20 and the launch is scheduled for June 21.