



The Rocket Report

Inspiring Future Scientists and Engineers

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In partnership with:

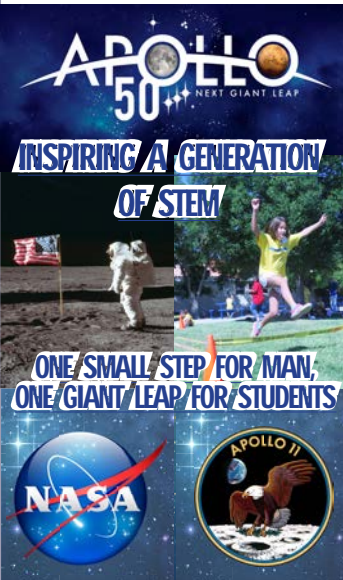


Collaborator:



Remember, Teachers:

It's never too early to make bussing arrangements for our classes and events!



Who We Are

On 20 July 1969, astronaut Neil Armstrong stepped off the ladder of lunar lander *Eagle*, planted his space boot on the moon, and said, “That’s one small step for man, one giant leap for mankind.”



The success of *Apollo 11*, the first manned mission to the moon, inspired an *entire generation* of future scientists and engineers to study science, technology, engineering, and math (STEM).



Fifty years later, we here at AFRL New Mexico STEM Academy are beaming like a moonbeam, inspiring a whole *new* generation of future scientists and engineers (S&Es), from fifth through twelfth grade, to study STEM.

We’re an Air Force Research Laboratory (AFRL) STEM education outreach program on Kirtland Air Force Base (KAFB), through a Partnership Intermediary Agreement (PIA) with New Mexico Tech.

AFRL New Mexico STEM Academy takes the study of STEM out of the textbook and into an interactive, hands-on

environment. Our activities focus on applications of basic STEM concepts behind technologies developed by AFRL’s Directed Energy and Space Vehicles Directorates here on KAFB.

Apollo 11 was one of a *series* of missions to space. Like NASA, AFRL NM STEM Academy offers several missions, designed for certain grade levels, which are aligned with *NM STEM Ready! Science* and *Common Core* standards.

Missions



The next giant leap will be from the moon to Mars. **Mission to Mars** is a classroom-based Mars colonization simulation for fifth graders.



DoD STARBASE New Mexico provides fifth graders an opportunity to explore physics, chemistry, technology, engineering, mathematics operations and applications, and STEM Careers, through five 5-hour classes on KAFB.



Technology and Engineering Challenges (TECH) Mission is out of this world. For middle schoolers, it occurs in three 5-hour classes at KAFB. Fall semester focuses on rocketry; spring semester explores STEM concepts related to satellites.



In the **Robotics Challenge**, middle school student teams explore the basics of robotics and coding at their school. Qualifying teams compete for points at the annual Robotics Challenge Expo in the spring.



STEM Challenge provides teams of 3-4 high school students an opportunity to solve a technical problem by applying the engineering design process. Qualifying teams compete for points by demonstrating their solution at the STEM Challenge Symposium in the Spring.

For more details, see pages 2-4, or contact us at: AFRL.RDMX.NMSTEMOutreach@us.af.mil.



Mission to Mars

For Fifth Graders

Mars Exoplanet Transient Satellite (METS) Mission 2019-2020

Next Giant Leap

When astronaut Neil Armstrong stepped off the ladder 50 years ago onto a powdery surface that wasn't green cheese after all, he said it was a "giant leap" for mankind.

Now NASA is thinking about mankind's *next* giant leaps. Their *Artemis* mission hopes to send another man, and the first woman, to the moon by 2024.

But *this* giant leap is only a stepping stone to the *next* great leap: A manned mission to Mars by the 2030s.



Our fifth grade **Mission to Mars** program could also be considered a stepping stone to this next great leap of mankind.

What's Mission to Mars?

Mission to Mars provides a unique hands-on learning opportunity for fifth grade students.

It's a simulated journey to Mars to establish a colony, based on the Challenger Center for Space Science Education's acclaimed *Marsville*®, *the Cosmic Village*



program—modified to include Air Force technologies and terminologies.

Students work as a habitat crew in their classroom throughout the school year on various activities, called **Base Operations**, to prepare for the journey.

These activities are designed to be motivating and hands-on, while meeting many of the *NM STEM Ready! Science and Common Core* (language arts and math) standards.

Base Operations include:

- Writing a *saga* that describes their journey to Mars,
- Designing a *mission patch*;
- Studying *Mars facts* and designing a *life support system model* based on those facts;
- *Telecommunicating* with neighboring habitat crews;
- Cutting out their 6-mil plastic *habitat* pieces;
- Planning a nutritious, space- and weight-saving *lunch*; and
- Designing a crew *uniform*.

The mission culminates in a **Link-Up Day** activity in the spring. Crews come together to simulate colonizing Mars.

Each crew progresses through a series of *holding stations* to ensure they have completed the necessary preparations for Link-Up Day, receiving points on a Crew Mission Log.

Student crews construct inflatable 12' x 12' x 8' plastic habitats, alongside crews from other schools, forming a colony neighborhood, and eat their astronaut lunch inside.



"I really like that all the activities help the students think about or simulate what would really be required on a real space mission."

--18-19 Mission to Mars teacher

"I have learned how astronauts survive on Mars, and we also did a simulation ourselves. My favorite part...is working with other schools."

--18-19 Mission to Mars student

Each crew cuts open the connecting tunnels to adjoining habitats, "linking up" the colony. Hence the name "Link-Up Day."

By the time NASA is ready for their next giant leap, one of these students may find themselves stepping off a ladder to realize that *Mars* isn't made of *red* cheese, either.

We will conduct teacher training early in the school year to help teachers understand their role in the Mission to Mars: A full-day, in-person session for teachers who have not participated in the Mission to Mars before, and a shorter in-person or online version for returning teachers.

There is a mandatory mid-year meeting for Mission to Mars teachers in February, to help prepare teachers for Link-Up Day.

Mission to Mars teachers also receive a Teacher's Resource Guide manual, and monthly newsletters with valuable Mission to Mars tips and information.



DoD STARBASE New Mexico

For Fifth Graders

Out Of This World STEM

You, too, will be over the moon when you see the STEM the fifth grade students do in DoD STARBASE New Mexico.

What's DoD STARBASE NM?

DoD STARBASE is a premier educational program sponsored by the Office of the Assistant Secretary of Defense for Reserve Affairs.

AFRL NM STEM Academy implements this program for fifth grade elementary school students as **DoD STARBASE New Mexico**.



Students come to our facility on KAFB for five non-consecutive days of hands-on activities during the school year. The inquiry-based curriculum focuses on topics which include Physics, Chemistry, Technology, Engineering, Mathematics Operations and Applications, and STEM Careers.

Air Force Core Values (*Integrity First, Service Before Self, and Excellence in All We Do*) are embedded in the activities. Teamwork is stressed as the students work together to explore, explain, elaborate, and evaluate concepts.



Out-of-this-world activities include using engineering design to construct a payload protection system for brave astronaut Eggbert as he crash-lands on the moon, and designing a space station using 3D CAD software.

Scientists, engineers, and military volunteers from AFRL and KAFB apply abstract principles to real



world situations using demonstrations of STEM in different settings and careers.

For example, AFRL S&Es use liquid nitrogen to freeze various objects as students explore states of matter and thermal dynamics, and discuss their careers.

"It was the best time of my life. I wish I could come back and do all of the cool things."

--18-19 DoD STARBASE NM student





TECH Mission

For Middle Schoolers

Technology and Engineering Challenges—Fall Rocketry and Spring Satellites Missions

It Started the Race in the First Place



The Space Race, culminating in the Apollo missions, came with a unique set of technology and engineering challenges. It depended on two things to get off the ground: *Rocketry* and *Satellites*.

After all...it was a beach ball-sized satellite named *Sputnik*, launched into Earth orbit by a rocket in October 1957, that started the whole thing.

Appropriately enough, 50 years after Apollo 11 touched down,

middle school students in our Technology and Engineering Challenges (TECH) Mission, explore STEM in three non-consecutive days of instruction at our facility, in either the *Fall Rocketry Challenge* or *Spring Satellite Challenge* semesters.

What's TECH?

Fall semester of the TECH Mission focuses on the engineering design process applied hands-on to **model rockets**.

Over three non-consecutive days, students use teamwork and engineering skills to build and launch



four-foot rockets. Students also run a computer simulation of the anticipated flight of the rocket.

Spring semester of the TECH Mission focuses on the engineering design process applied hands-on to **satellites**.



Over three non-consecutive days, students investigate hands-on STEM concepts related to specific satellite engineering disciplines such as circuitry and electronic components, and apply these concepts in activities such as soldering their own light-emitting diode (LED) badges.

"The circuit board was my favorite it was because I thought it was cool to be able to program by hand and put it together."

--18-19 TECH Mission student



Robotics Challenge

For Middle Schoolers

Rovers are Robots



Rovers were a big part of the Apollo missions to the moon 50 years ago, and they're helping us prepare for the challenge of manned missions to Mars now. And what are rovers, but glorified roving space robots?

Students challenging themselves to study robotics today can help us prepare for the challenge of the Next Great Leap tomorrow.

What's Robotics Challenge?

The Robotics Challenge Mission, for middle school students, is a school-based initiative in

which students explore the basics of coding and programming, using robotics as a theme. Student teams assemble and program small wheeled robots to run through obstacle courses and complete other challenges.

Not unlike moon and Mars rovers, who have to negotiate their way around rocks and other obstacles.

Teachers complete an on-line training where they learn the basics of assembling and programming the robots and then apply what they've learned back at their schools.

AFRL NM STEM Academy provides teachers with materials they can use to explore these concepts

"My favorite part was building and coding the robot. Especially when we found something we couldn't understand and then figured it out together."

--18-19 Robotics Challenge student

with their students over the course of the school year.

S&Es from KAFB may be available to provide assistance to the teachers and students as they work on the robots at their school sites during the school year.

After building their robots, students learn programming skills to make the robot do simple tasks and maneuver through a series of increasingly challenging obstacle courses.

Teams earn points for assign-



ments submitted online, which can be re-worked and re-submitted for maximum points. The top 30 point-earning teams compete in the annual Robotics Challenge Expo in the Spring on KAFB.

An online Teacher Training for teachers new to this activity is provided via CourseSites. At orientation, prior to the start of the mission, teachers receive support and resources from AFRL NM STEM Academy, including a green obstacle course and a binary system kit to help them with their online training.



STEM Challenge

For High Schoolers

Like Mission Control

In any manned mission to space, Mission Control performs a lot of math and engineering to calculate the best trajectory and design the best safety systems to protect their delicate projectile occupants.

What's STEM Challenge?

The STEM Challenge mission provides an opportunity for teams of 3-4 high school students to solve a similar technical problem, using the

"The engineering design process was both interesting and fun."

--18-19 STEM Challenge student

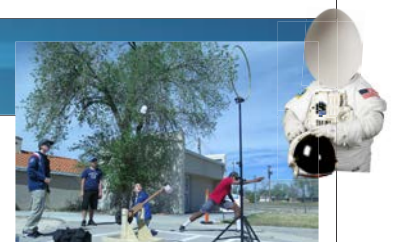
engineering design process, that requires them to research and explore concepts related to launching and payload protection devices. Specifically, through launching an egg safely through a suspended hoop and onto a target 30 feet away.

Student teams complete several assignments that guide them through the design, build, test, and modify

processes for their launching and payload protection devices.

Students conduct independent research, engage in teamwork, complete hands-on activities, and consult with mentors and coaches.

Teams earn points for assignments submitted online, which can be re-worked and re-submitted for maximum points. The top 30 point-earning teams compete in the annual STEM Challenge Symposium in the Spring.



Coach Orientation sessions are held prior to the start of the mission.

Coaches receive a Launching Device kit for each team, a project handbook, and access to the CourseSites website for receiving information, posting assignments/videos, and communicating with AFRL NM STEM Academy.



Important Terms and Acronyms

AF: Air Force

AFB: Air Force Base

AFRL: Air Force Research Laboratory

AFRL NM: AFRL New Mexico (AFRL/RD and AFRL/RV), on KAFB

AFRL/RD: The Directed Energy Directorate of the AFRL

AFRL/RV: The Space Vehicles Directorate of the AFRL

DoD: Department of Defense

KAFB: Kirtland Air Force Base, Albuquerque, NM

METS: Mars Exoplanet Transient Satellite (METS) Mission 2019-2020

MM: Mission to Mars

PRS: Phillips Research Site

S&Es: Scientists and Engineers

STEM: Science, Technology, Engineering, and Math

TECH: Technology and Engineering Challenges

USAF: United States Air Force

Remember, Teachers:
Get those EPA
Modification forms in!



Other STEM Opportunities

AFRL NM STEM Academy supports additional STEM opportunities for schools, the community, and scientists and engineers (S&Es), as resources, staff, and schedule availability permit.

For The Community STEM Expeditions

STEM Expeditions are a great way to provide STEM opportunities for local extracurricular groups such as Scout troops, Junior ROTC programs, Mathematics Engineering Science Achievement (MESA) Inc. students, and Civil Air Patrol cadets.



These short visits, typically one to two hours long, are customized for each group as schedule and facility availability permit, and can address specific STEM concepts such as Flight Simulation or Robotics.

Booths and Events

As time and scheduling permit, AFRL NM STEM Academy mans STEM booths at various local and national events such as the



Big Brothers/Big Sisters STEAM Discovery Festival, the NM Science Fiesta, and the USA Science and Engineering Festival.

For Schools STARBASE 2.0

STARBASE 2.0 is an after-school or extracurricular way for schools to extend the impact of DoD STARBASE through team mentoring and rocketry. Eligible students can prepare for and participate in this school year's Team America Rocketry Competition (TARC).

Be advised, however: This program requires a more significant commitment of time, personnel, and resources on behalf of the school and participating teacher than our other STEM opportunities do.



For S&Es/Volunteers

We provide S&Es from AFRL and elsewhere many opportunities to participate in our STEM Academy.

Flight Enthusiast

Come tell fifth graders about your experiences working with flying aircraft, and present any videos or flight gear you have available.

Rocket Enthusiast

Assist middle school students as they assemble and launch four-foot rockets at our annual Rocket Launch event in October.

Robotics Challenge Expo, STEM Challenge Symposium, and MM Link Up Day

Help judge the middle school Robotics Expo, the high school STEM Challenge Symposium, or man holding stations at the fifth grade Mission to Mars Link-Up Day.

STEM Expeditions, Booths, and STARBASE 2.0

Volunteer at one of these activities throughout the year.

STEM Demos

Our STEM Demo Lending Library, for AFRL S&Es, contains demonstration activities packaged in bins complete with all required materials, for use with student clubs, school events, etc.

STEM Bytes

AFRL Helped Put Man on the Moon

AFRL senior historian Kevin M. Rusnak says AFRL helped put man on the moon 50 years ago!



Some of the initial science behind Apollo 11's Saturn V rocket was conducted at AFRL headquarters at Wright-Patterson AFB.

Development of what became the Apollo 11 astronauts' space suits was also conducted there.

AFRL helped develop the multi-parachute system that helped Apollo 11 astronauts land back on Earth safely. <https://www.daytondailynews.com/news>.

Inspired by Apollo

Among things inspired by Apollo moon missions, and still in use:

- Airplane digital fly-by-wire systems, and cruise control and antilock brake systems in cars, are based on the Apollo computer guidance system.
- Meat, poultry, seafood, and juice producers use food safety procedures based on Apollo's *Hazard Analysis and Critical Control Point* system for ensuring astronaut food stayed safe in space.
- Mylar insulation, used in "space blankets," clothing, firefighting and camping gear, building insulation, and even MRI machines, came from Apollo spacesuits. <https://spinoff.nasa.gov/>.

Snoopy Found?

Before Apollo 11, there was Apollo 10. In May 1969 lunar module *Snoopy* buzzed the moon as a "dress rehearsal," then jettisoned out to space.

50 years later, astronomers may have found where *Snoopy* went! <https://www.universetoday.com>.

Name Leap

Your name can make the next great leap to Mars! Enter your name by **30 September 2019, 11:59 p.m. ET:** <https://mars.nasa.gov/participate/send-your-name/mars2020>. Your name will get etched on a microchip going to Mars on the Mars 2020 Rover!

