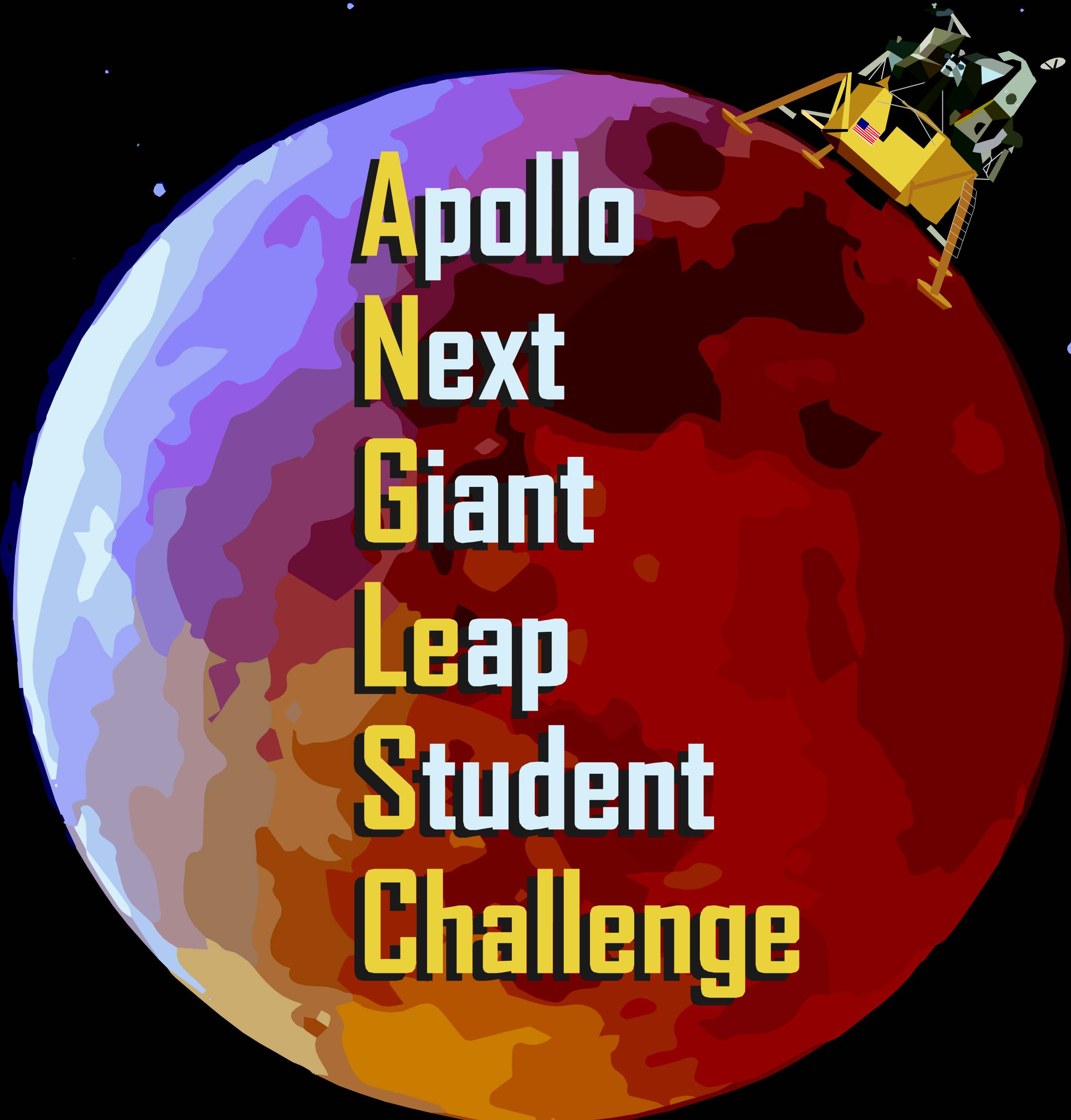

# Apollo Next Giant Leap Student Challenge

## OFFICIAL MANUAL

#Apollo50 #ApolloNextGiantLeap

Version 1.0

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# 1 INTRODUCTION

## 1.1 About Northwest Earth and Space Sciences Pipeline

The Northwest Earth and Space Sciences Pipeline (NESSP) brings NASA science to the Northwest — from Oregon and Washington inland to Montana and the Dakotas. Funded through the NASA Science Mission Directorate, NESSP operates out of the University of Washington in Seattle where it's co-located with the Washington NASA Space Grant Consortium.

NESSP's goals are to strengthen science, technology, engineering, and math (STEM) education region wide and to serve as a bridge into other NASA experiences for teachers and students. Ultimately, we seek to increase pathways for students towards careers in STEM, particularly in underserved communities.

Our efforts, all of which support Next Generation Science Standards, comprise three types of activities:

- Outreach events in local communities, providing hands-on science exploration.
- Extended experiences, such as camps, providing immersive student opportunities.
- Teacher professional development, ranging from just one day to an entire week.

The Apollo 50th Next Giant Leap Student Challenge leverages NESSP expertise to engage students in technologies relevant for today's society and tomorrow's careers. The challenge also gives students the opportunity to sense the spirit of achievement and exploration exemplified by all those who contributed to the successful landing of the Apollo 11 spacecraft on the Moon 50 years ago.

Visit our website: http://nwessp.org/

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# 1.2 About the Apollo 50th Next Giant Leap Student Challenge

On June 20, 1969, NASA landed the first humans on the Moon. To mark the 50th anniversary of this achievement, the week of July 16-20, 2019, will see student teams across the U.S. simulate the Apollo 11 Moon landing.

In celebration of Neil Armstrong's "one small step" — and to prepare students for the next "giant leap for mankind" — NESSP is pleased to present the Apollo 50th Next Giant Leap Student Challenge (ANGLeS). This nationwide event for middle and high school levels invites students to celebrate the history of the Apollo program while giving them hands-on experience with current technology. ANGLeS provides students the opportunity to experience NASA-like engineering challenges and decision-making, opening the door to students' eventual participation in the development of new technologies to study Earth and beyond.

Student teams will build a replica of an Apollo Lunar Module that will be flown — using a drone, technically known as an Uncrewed Aerial Vehicle (UAV) — and landed on the Moon, represented by a high resolution map of the actual Apollo 11 landing site. Once the module has landed, students will place a Lunar Rover at their landing site and apply on-the-spot programming changes to deliver their team-built payload and collect lunar samples. Student teams may design the robot to look like an astronaut or a rover and will assemble a creative and meaningful payload.

Students participating in ANGLeS will develop an understanding of remote sensing of Earth and places beyond. The program promotes cooperative learning, quantitative problem solving, and critical thinking in a science and engineering environment using hands-on problems.

## 1.2.1 Broadening Access

ANGLeS provides an outstanding opportunity for formal and informal educators to gain experience with the technologies necessary for the challenge — UAVs and robotics. Professional development (see Section 1.4) will be available through regional face-to-face workshops, video conferencing, and online resources. ANGLeS will also offer basic challenge supplies, with a preference given to organizations that currently do not have LEGO equipment and programming skills and/or access to UAVs, depending on availability of resources. See Support section for more information.

As part of NESSP's commitment to broadening STEM access for diverse communities, ANGLeS will provide students with skills that will serve them well in their next giant leap towards STEM applications in tomorrow's world.

NESSP has co-created Regional Challenge Hubs (RCH) spanning the country to bring together student teams across the U.S. and Puerto Rico.

## 1.3 Important Dates & Deadlines

| | |
|---|---|
| JANUARY, 2019 | Official announcement of Apollo 50th Next Giant Leap Student Challenge |
| JANUARY 30, 2019 | ANGLeS Kickoff Event |
| FEBRUARY 1, 2019 | Registration opens, Manual released |
| FEBRUARY 28, 2019 | Regional Supplementary Manuals released |
| MARCH 1, 2019 | Crowdsourcing opens |
| MARCH 31, 2019 | Local Organization Registration closes |
| MARCH 30-JUNE 24 | Local Organization Challenges and Team Selection |
| APRIL 19, 2019 | Mission Patch due |
| MAY 3, 2019 | Social media post due |
| MAY 31, 2019 | Organizations nominate one team to for a Regional Challenge Hub Event |
| JUNE 17, 2019 | Regional Hub Challenge Event invitations issued |
| JUNE 28, 2019 | Teams confirm Regional Hub Challenge Event attendance and submit travel support requests |
| JULY 12, 2019 | Regional hubs respond to travel requests |
| JULY 16-20, 2019 | Apollo 11 50th anniversary week, Regional Challenge Events |
| AUGUST 7-9, 2019 | Winners showcase and tour at Johnson Space Center, Houston, Texas |

### 1.3.1 Summer Camp Schedule

Summer camps will have alternate dates for team nomination, social media posts, invitation and confirmation. All other dates are the same as above. If you are planning to run your program as a summer camp, make sure to note this in your registration.

| | |
|---|---|
| JUNE 24, 2019 | Organizations nominate one team to for a Regional Challenge Hub Event. Social media and Mission Patch posts also due. |
| JULY 1, 2019 | Regional Hub Challenge Event invitations issued |
| JULY 8, 2019 | Teams confirm Regional Hub Challenge Event attendance and submit travel support requests |

## 1.4 Professional Development

Each Regional Challenge Hub will provide training focused on the basics of UAV flight and LEGO Mindstorms programming. This training will provide the fundamentals needed for anyone who will be a Flight Director (see Section 3.1.1).

## 1.5 Extended Curriculum Opportunities

Curriculum will be available to run an after school program or summer camp on all key concepts relevant to the challenge. Video chats with subject matter experts will be available.

It is not required for Summer Camp teams to participate in the regional challenge event.

## 1.6 Supporting Science and Programming Standards

The Apollo 50th Next Giant Leap Student Challenge is designed not only to celebrate the achievements of the Apollo era but also to increase educator and student engagement in computer science, Earth sciences, and engineering. NESSP seeks to introduce students to the abundant opportunities for them and their communities, in order to create broader and more successful pathways into STEM careers, with an emphasis on including underserved communities.

Students will gain experience in the core concepts of computer science, including how to:

- Understand the use and limitations of different networked systems.
- Compare different algorithms that may be used to solve the same problem but have different speeds and/or flexibility.
- Develop programs, both independently and collaboratively, that include sequences with nested loops and multiple branches.
- Interpret the flow of execution of algorithms and predict their outcomes.
- Decompose a problem into parts and create solutions for each part.
- Design and develop a software artifact working in a team.
- Integrate grade-level appropriate mathematical techniques, concepts, and processes in the creation of computing artifacts.

### 1.6.1 Next Generation Science Standards

By participating in ANGLeS, students will gain experience in the full engineering design process. In particular, the challenge supports middle and high school Engineering Design standards from the Next Generation Science Standards (NGSS), including how to:

- Research material for the different systems.
- Image the pickup and release mechanism for the Lunar Module.
- Design the more interesting solutions.
- Build a prototype.
- Test and evaluate.
- Improve the design as needed.
- Determine whether the system meets the requirements.

Other science standards supported in the challenge exercises include how to:

| | |
|---|---|
| MS-LS2-1 | Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. |
| MS-LS2-3 | Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. |
| MS-ESS3-1 | Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. |
| MS-PS2-2 | Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. |
| MS-PS2-4 | Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. |
| HS-PS2-1 | Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. |
| HS-PS2-2 | Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. |
| HS-PS4-5 | Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. |

# 2 SAFETY

## 2.1 UAV Safety

All activities for the Apollo 50th Next Giant Leap Student Challenge will take place indoors. To prepare for the challenge, all practice sessions — especially UAV practice — should also be conducted indoors. UAVs operated indoors are not affected by Federal Aviation Administration (FAA) regulations Part 107 regarding small Unmanned Aircraft Systems (sUAS).

Any and all UAV flight outdoors, however, is subject to FAA regulations and common sense. **NESSP and ANGLeS do not sanction outdoor UAV flight in relation to this challenge.**

UAVs are increasingly common and the ANGLeS challenge is an excellent opportunity for gaining familiarity with this technology. NESSP offers the following section on safety as advice on how to stay safe and operate within the law.

### 2.1.1 UAV Safety Tips for Practicing

Here are some tips to help ensure a safe space for learning to fly a UAV and practicing for ANGLeS. Start by choosing a safe and suitable environment for flying:

- Make sure that all necessary parts of the UAV are installed properly to ensure a stable and safe flight.
- Choose an indoor flying area with plenty of open space, a high ceiling, and little HVAC draft, such as a gymnasium.
- Make sure to clear the flying area of any obstacles.
- Ensure that everyone in and around the flying area is aware and actively paying attention. Other activities can be a distraction and hazard to the UAV operator and to the participants of this other activity.

When learning to fly, trying to control a UAV can quickly become disorienting or overwhelming. It is best to start with small, progressive goals, and a lot of patience before attempting to fly around the room or far away.

- When taking off, quickly bring the UAV to eye level and away from the launch surface. UAVs are heavily affected by ground effect, which is a phenomenon where turbulent airflow from the drone hits a surface and recirculates back through the rotors. Ground effect makes UAVs very difficult to fly close to the ground or near ceilings and walls.
- On your first flight, once the UAV is at eye level, let go of the left control stick (if the drone model will allow you to) and only use the right control stick to control forward, backward, right, and left translation. The left control stick controls altitude and yaw, which can quickly become disorienting for a new pilot. Try to hover over the same spot
- Use slow, smooth inputs with the controls. New pilots often push too much on the controls or "tap" the controls to try to make small adjustments, however UAVs do not respond well to this type of input. Instead, be slow, smooth, and steady.

- Once you can hover, try to fly around the room, still just using the right control stick for translation. Once you are comfortable, use the left control stick to yaw the UAV and try repeating the same maneuvers. Some pilots find it helpful to rotate their body and the controller to the same direction the UAV is facing and turn their head to track it.
- Keep the UAV in sight at all times! When practicing for the lunar landing portion of the challenge, make sure to have an another Flight Crew member keep an eye on the UAV and alert the pilot of any difficulty.

### 2.1.2 UAV Safety at Challenge Events

While a UAV is in the air, no one may be between the Lunar Surface Mat and the launch area. Once the UAV has returned to position on the launching pad, the Flight Crew is allowed to congregate around the Lunar Surface Mat— but stepping onto the mat is prohibited.

If at any time the UAV flies more than 4 feet out of bounds, or if instructed by an event official, the Flight Crew must land the UAV and shut it off immediately. If the team does not respond promptly to any requests from an event official, the team will be disqualified.

Additional safety rules may be added at any given Regional Hub depending on their local requirements. For example, some events may require the UAV to be tethered during the challenge.

For more information about UAV safety and FAA regulations, please see the FAA UAV Information at the end of this document.

# 3 TEAMS

## 3.1 Team Structure

### 3.1.1 Flight Director

Each team requires one adult Flight Director to act as the team coach and primary point of contact between the team, NESSP, and the Regional Challenge Hub. The Flight Director is also responsible for the organization and safety of the team. A person may serve as Flight Director for multiple teams. The Flight Director must be 18 years or older and may be a teacher, educator, team parent or guardian, or other community member.

### 3.1.2 Student Members

Student teams will work together to prepare for all aspects of the challenge, from flying the UAV to designing the payload, from learning to identify lunar rocks to creating social media posts, and so on. Each team must have at least a Flight Crew, as defined in Section 3.1.3, but teams may have many additional members. Neil Armstrong, Buzz Aldrin, and Michael Collins may have been the astronauts onboard, but it took a team of scientists, engineers, programmers, and even expert seamstresses to make the Moon landing happen.

Team members must be enrolled in primary or secondary school or under the age of 18 at the time of registration to participate on the team. The team may be mixed grade. Mission objectives vary for middle and high school teams and are determined using the highest grade level within the team at the time of registration.

ANGLeS incorporates a variety of subject matters, so we strongly encourage teams to be interdisciplinary with diverse backgrounds and skills.

We encourage all eligible students to participate. All Challenge Events will be accessible for students with disabilities. Contact your Regional Hub (see https://nwessp.org/apollo50/) to make arrangements for any specific accommodations your team needs to complete the challenge or attend an event. For example, teams with sight-impaired members may request adding one or more sighted assistants to accompany the Flight Crew onto the challenge field.

### 3.1.3 Flight Crew

The Flight Crew consists of 5 team members who will be responsible for activities at the Challenge Events. The Flight Crew must be in grades 5-12 or under the age of 18 on the date of registration. At Challenge Events, the Flight Crew are the only team members allowed on the challenge field and should have the following roles:

**COMMANDER** A Challenge Event may require that the UAV is tethered for safety. If a tether is required, the Commander is responsible for managing it during the challenge to keep the UAV in a safe operating range.

**LUNAR MODULE PILOT** The Lunar Module Pilot is responsible for piloting the UAV.

| | |
|---|---|
| EVA OFFICER | The Extravehicular Activity Officer, or EVA Officer, is the primary team member responsible for operating, adapting, and executing the Lunar Rover programs. |
| SCIENCE OFFICER | The Science Officer is responsible for the identifying the rock samples retrieved by the Lunar Rover. |
| CAPCOM | The Spacecraft Communicator, or CAPCOM, may give verbal or visual signals as guidance to the Lunar Module Pilot during Mission Objective 1: Lunar Landing. |

Flight Crew should have some type of uniform so they can be easily distinguished. The uniform could be that of an astronaut or school colors or other culturally relevant attire. Be original and creative as it will be part of the team's overall score.

### 3.1.4 Mentors

In addition to the Flight Director, anyone who wishes to help and mentor the team members are encouraged to do so. Mentors may be a teacher, educator, team parent or guardian, older student (e.g. a high school student may mentor a middle school team), or other community member.

## 3.2 Registration

Teams are required to be affiliated with an organization such as a school, library, museum, after school program, or club. Organizations must select a Regional Challenge Hub with which to register. Regional Challenge Hubs will hold the Regional Challenge Events and will be the main point of contact for teams. Organizations may register as many teams as they wish. Organizations should hold a local challenge to determine which teams to nominate. **All** organizations must register by March 31, 2019, to participate in ANGLeS, regardless of whether they intend to participate in a Regional Challenge Event. Organizations may continue to register teams until nominations are due.

Complete registration and Regional Challenge Hub information can be found online at:

https://nwessp.org/Apollo50/.

### 3.2.1 Regional Challenge Event Invitation and Confirmation

Organizations that plan to participate in a Regional Challenge Event must submit their team nominations by May 31, 2019, using the form at the following link:

https://nwessp.org/apollo50/

Regional Challenge Hubs will send Regional Challenge Event invitations by June 17, 2019, to selected teams. Teams must respond to confirm they will attend the event and submit any requests for travel assistance by 11:59 p.m. (Pacific Time) on June 28, 2019. If for any reason a team is not able to attend an event for which it is registered, please notify the Regional Challenge Hub so another team may have the opportunity to participate. Regional Challenge Events will be one-day events held during the week of July 16-20, 2019, the 50th Anniversary of the Apollo 11 mission. Please see the Regional Supplemental Manual for information specific to a Regional Challenge Event.

The winning team from each Regional Challenge Event will send 5 team members and 1 adult to participate in an ANGLeS showcase and a tour of Johnson Space Center in Houston, Texas, on August 7-9, 2019.

## 3.3 Support

### 3.3.1 Funding

NESSP will assist registered teams to participate in crowd sourced sponsorships.

### 3.3.2 Supply Lending

NESSP has a small number of supply kits available for lending to qualifying programs. To qualify, a program must demonstrate both strong student participation, particularly in underserved communities, and need, defined as a student population where more than 50% of students are eligible for free/reduced lunch. If approved, supplies will be provided at no cost and will include one Force1 U49W Blue Heron WIFI FPV Drone and one LEGO Mindstorms EV3 Education Edition kit. To apply for borrowing, organizations must request support in the registration form.

### 3.3.3 Travel Support

Travel support for Regional Challenge Events may be available through your Regional Hub. Please check the Regional Supplemental Manual for your hub at https://nwessp.org/apollo50/ for information regarding travel support.

Travel support requests may also be submitted through the Regional Challenge Event confirmation. Upon invitation to the event, teams will be provided a form with which to confirm attendance and request travel support.

# 4 CHALLENGE

## 4.1 Equipment and Software

### 4.1.1 Lunar Module

Teams will need to create a replica of the Apollo Lunar Module. The Lunar Module can be seen in *Figure 1*, on the right.

*Figure 1: Apollo Lunar Module*

Teams will use a UAV to land the Lunar Module.

The official UAV of ANGLeS is the Force1 U49W Blue Heron WIFI FPV Drone. Other small UAVs may be used as long as they conform to the following rules:

- Must weigh less than 0.55 lb (250 g) including battery and any other necessary flight hardware included from the factory. Anything added by the team to the UAV, including the Lunar Module and any decoration, does not count toward this weight.
- May have an altitude hold system and an auto-land function.
- May have WiFi, camera, and FPV capability.
- Must not receive or use GPS.
- Must not have any object avoidance systems.

All control of the UAV must be through direct inputs to the controller by the Lunar Module Pilot, without any autopilot, flight, or navigational aids, with the exception of auto takeoff and landing functions.

Teams using a UAV that does not conform to these rules will not be permitted to use it at a Challenge Event. Depending on availability, the team may be permitted to borrow a UAV for the event.

The UAV may be modified to land the Lunar Module (LM). The LM should be constructed separately and hang from a cable or string (see Mars Science Library Sky Crane).

Points will be awarded for the creativity, structural integrity, and width-to-mass ratio of the Lunar module.

### 4.1.2 Lunar Rover

Lunar Rovers must be built using LEGO Mindstorms. All equipment must be made of LEGO brand building parts in original factory condition, with the following exceptions:

- String may be used.
- Wire ties, string, stickers, or other items may be used for cable management.
- Stickers or paper may be used for decoration or identification.
- Other material may be used for decoration.

NESSP recommends programming the rovers using the LEGO Mindstorms Education Edition Software, however teams may use whatever programming language or suite they wish. All NESSP trainings will use LEGO Mindstorms EV3 Education Edition hardware and software.

Points will be awarded for creativity of the design of the Lunar Rover.

## 4.2 Pre-Event Components

Teams are encouraged to post to social media using the hashtags #Apollo50 and #ApolloNextGiantLeap.

One mission patch post can be posted and submitted by April 19, 2019 for 10 points.

One other social media post can be posted and submitted by May 3, 2019 for 10 points

Both posts must include the hashtags and be submitted to the ANGLeS website:

https://nwessp.org/apollo50/

Each regional hub will select one mission patch and one social media post as the winner, gaining an additional 4 points each.

### 4.2.1 Mission Patch

Every NASA mission has a mission patch that illustrates the goal and spirit of the project, where the project originates from, and which institutions are participating. *Figure 2* shows the Apollo 11 mission patch as well as some more entertaining mission patches from other missions. NASA's description of the Apollo 11 patch states[1]:

> The American eagle, symbolic of the United States, was about to land on the Moon. In its talons, an olive branch indicated the crew "came in peace for all mankind." The Earth, the place from which the crew came and would return safely in order to fulfill President John F. Kennedy's challenge to the nation, rested on a field of black, representing the vast unknown of space.

[1] https://history.nasa.gov/SP-4029/Apollo_18-18_Mission_Insignias.htm, more information available here


*Figure 2: Apollo 11 Mission Patch*

Each team is encouraged to create and submit a Mission Patch. We encourage teams to get creative and design a mission patch that represents themselves, their community, and their mission in the Apollo 50th Next Giant Leap Student Challenge.

### 4.2.2 Social Media Posts

To ensure that students' efforts are recognized and appreciated nationwide, as was the Apollo Program itself, we encourage teams to post their efforts on social media with the hashtags #Apollo50 and #ApolloNextGiantLeap. The posts should be fun and appropriate. Suggested content includes your practice sessions, developmental stages of your Lunar Module or robot, your local challenge event — but teams should explore their own creativity and style in their posts!

## 4.3 Main Event Components

The overall goal of the challenge is to simulate and learn what is required to build and launch a payload to a distant world. To accomplish this task, scientists, engineers, and designers have to work together to overcome a host of problems. The Apollo 50th Next Giant Leap Student Challenge will take the team along a similar journey with the aim of increasing their skill and interest in science and engineering.

The challenge has several components as outlined below. More detail can be found in the following sections:

1. Build a replica of the Apollo Lunar Module and use a UAV to land it at the Apollo 11 lunar landing site.
2. Design and build a robotics system replicating an Apollo astronaut or rover to navigate the surface of the Moon and complete a series of challenges.
3. Develop a scientific or cultural payload that the robot delivers to the surface of the Moon.
4. Retrieve a sample from nearby the crater and transport it to the Lunar Module.
5. Identify a rock sample associated with the sample retrieved by the Lunar Rover.
6. Depart the Moon by having the UAV recover the Lunar Module from the Moon and return it to the starting location (high school required, middle school optional).

### 4.3.1 Mission Objective 1: Lunar Landing

BACKGROUND: Most spacecraft landings are accomplished by pre-programmed systems. The Apollo Lunar Module, which carried the astronauts from lunar orbit to the surface of the Moon and back, used a combination of automated computer control for descent and direct manual control by the astronauts onboard for landing. In the case of Apollo 11, last minute adjustments had to be made as the Armstrong and Aldrin saw the guidance system was sending them toward a boulder field.

OBJECTIVE: Land the Lunar Module as close to the designated landing site as possible, marked as location #1 in *Figure 3: Landing Site Map*. The Lunar Module Pilot must control the drone from behind the control table. Teams may also use a camera mounted directly on the UAV, although it does not have to be in its original position. In addition, may give verbal and visual guidance to the Lunar Module Pilot.

Once the landing has been made, the UAV needs to leave the Lunar Module in place and fly back to base.

Points will be awarded both on distance of the Lunar Module to the marked landing site and on landing the module upright without dragging it.

TECHNICALLY: The Lunar Module location will be judged by the landing leg closest to landing site using concentric circles as shown below. Teams will have up to 3 minutes to land their Lunar Module.

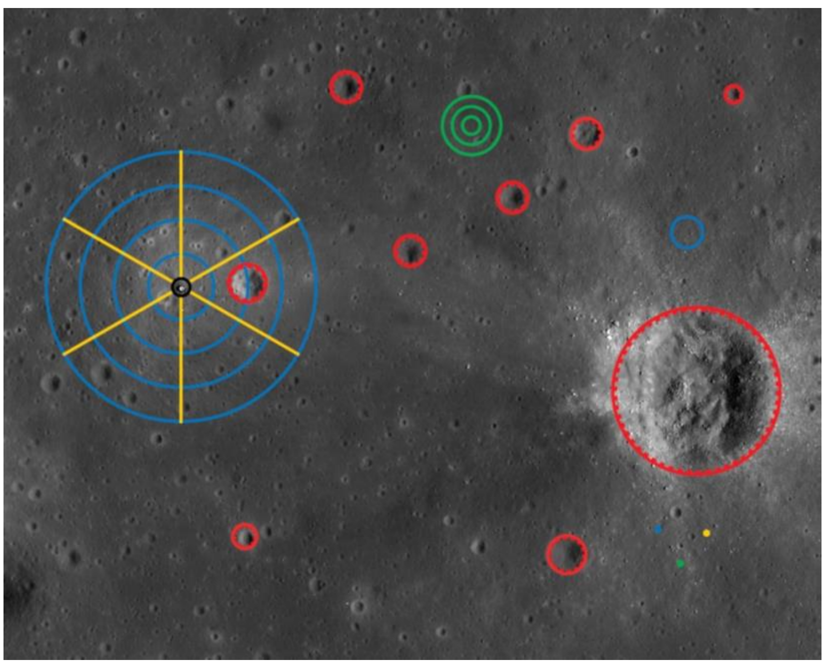

*Figure 3: Landing Site Map: 1. landing site, 2. payload placement, 3. sample retrieval.*

### 4.3.2 Mission Objective 2: Navigation

OBJECTIVE (MIDDLE SCHOOL): Once the team has landed the Lunar Module, teams must place their rover on the center of the landing target.

From the landing target, the rover must traverse the surface to the complete Mission Objective 3: Payload Delivery and Mission Objective 4: Rock Sample Retrieval. The rover will be deducted points for crossing into or over any craters. The rover will score points for up to 4 narrations and points for successfully navigating back to the landing target.

OBJECTIVE (HIGH SCHOOL): Once the team has landed the Lunar Module, teams must place their rover on the lunar surface next to it.

From the Lunar Module, the rover must traverse the surface to the complete Mission Objective 3: Payload Delivery and Mission Objective 4: Rock Sample Retrieval. The rover will be deducted points for crossing into or over any craters. The rover will score points for up to 4 narrations and points for successfully navigating back to the landing target.

TECHNICALLY: The rover must be placed within 1 inch of the Lunar Module (High School) or the center of the landing target (Middle School).

All functions of the rover must be done through programs and not via remote control of any form. Programs may be enabled by selecting them on the rover programming brick or with a computer or tablet via Bluetooth.

The rover will be deducted points for crossing into or over any craters. Crossing into a crater is defined as any part of the rover that normally touches the ground, such as a wheel or leg, or any part of the rover contained within that area crossing over a red boundary circle marking.

### 4.3.3 Mission Objective 3: Payload Delivery

BACKGROUND: The Apollo missions brought several important scientific instruments to place on the Moon. One example was a Laser Ranging Retroreflector, shown in *Figure 4*, which provided a means to determine the exact distance between the Earth and Moon.

Astronauts also left some items of personal importance, from a falcon feather to a family photo to golf balls. The Apollo 11 astronauts left items in memory of astronauts and cosmonauts who had lost their lives. They left an Apollo 1 Teams are encouraged to post to social media using the hashtags #Apollo50 and #ApolloNextGiantLeap.

One mission patch post can be posted and submitted by April 19, 2019 for 10 points.

One other social media post can be posted and submitted by May 3, 2019 for 10 points

Both posts must include the hashtags and be submitted to the ANGLeS website:

https://nwessp.org/apollo50/

Each regional hub will select one mission patch and one social media post as the winner, gaining an additional 4 points each.

Mission Patch, shown below in *Figure 4*, and two medals awarded to Soviet cosmonauts Yuri Gagarin and Vladimir Komarov.

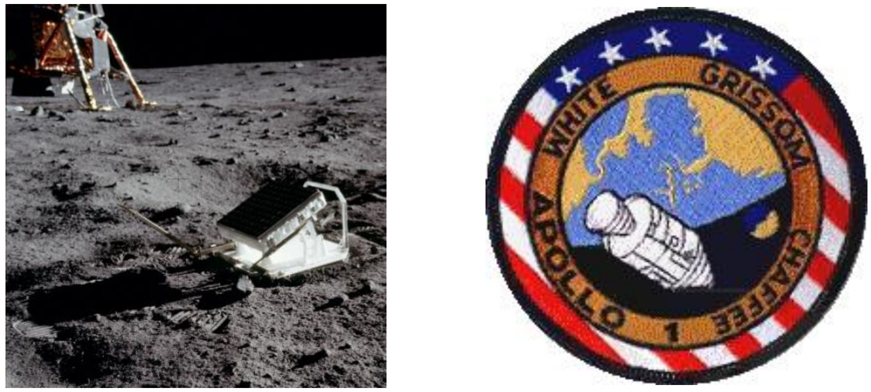


*Figure 4: Items left on the Moon by Apollo 11 include the Laser Ranging Retroreflector and the Apollo 1 mission patch.*

**OBJECTIVE:** Place a scientific instrument or item of cultural significance on the surface of the Moon. Teams are encouraged to design a payload that carries the ideals and ingenuity of the Apollo era but features the aspirations of their community and the hopes for the future. The item must be placed at location #2 in *Figure 3*.

**TECHNICALLY:** Teams will be scored on how close their rover places the item to the center of the circle at location #2 on the map in *Figure 3*, the condition of the payload after delivery (upright and intact), and on the creativity of the payload.

### 4.3.4 Mission Objective 4: Rock Sample Retrieval

**BACKGROUND:** While most people think of the Apollo astronauts as fighter pilots and military men, they had to be trained in every aspect of their missions to visit the Moon. For example, some astronauts were trained in geology so they could learn to recognize and gather significant and unique rock samples to bring back to Earth to be studied.

**OBJECTIVE:** Teams must retrieve a specified rock sample from the south side of West Crater and return it to the Lunar Module. The sample location is shown at location #3 on the map in *Figure 3*.

Teams will gain points for navigating to the correct sample, collecting the sample, and bringing the sample back to the landing site.

**TECHNICALLY:** In order to determine which of the designated rock samples to retrieve, the Lunar Rover must move the boulder location #3 in *Figure 3* to uncover a colored marker. The color of the marker will be randomized between rounds and will indicate which of the three samples to recover from the south side of the crater at location #4. The Lunar Rover must retrieve the rock sample and return it to the Lunar Module. This rock sample will be used in Mission Objective 5: Rock Sample Identification. The rock samples will be made of LEGO parts; an example can be seen in *Figure 5*.

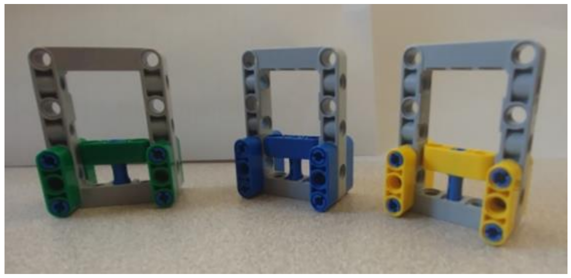

*Figure 5: Lunar Rock Samples*

### 4.3.5 Mission Objective 5: Rock Sample Identification

OBJECTIVE: The color of the rock sample retrieved in Mission Objective 4: Rock Sample Retrieval will be matched to one of the three types of rock most commonly found on the Moon. Teams must identify the rock sample.

TECHNICALLY: Teams will earn points if the Science Officer can identify the rock sample associated with the sample retrieved by the Mission Objective 4: Rock Sample Retrieval.

### 4.3.6 Mission Objective 6: Ascent & Return (High School Only)

OBJECTIVE: Fly the UAV back to the Lunar Module, pick it up, and fly it back to the starting area.

Teams will gain points for capturing the Lunar Module, and also for transporting it back to the landing zone.

TECHNICALLY: While the Lunar Rover is attempting Mission Objectives 2-4, the Flight Crew may modify the UAV for retrieving the Lunar Module.

When the Lunar Rover has completed Mission objectives 2-4, the Flight Crew must replace the Lunar Module at the landing location, with the assistance of a referee if necessary.

## 4.4 Challenge Field

The floor lay for the challenge is shown in Figure 6: Challenge Event layout The lunar landscape of the Apollo 11 landing site at the Regional Hubs will be on an 8-foot by 10-foot print. The UAV and robot operators will be behind a table approximately 10 feet beyond the print of the landing site. The table will be able to hold any laptops needed for the operation of the UAV and robot.

The robot must be controlled by programming from a laptop or similar device and not driven by any joystick application.

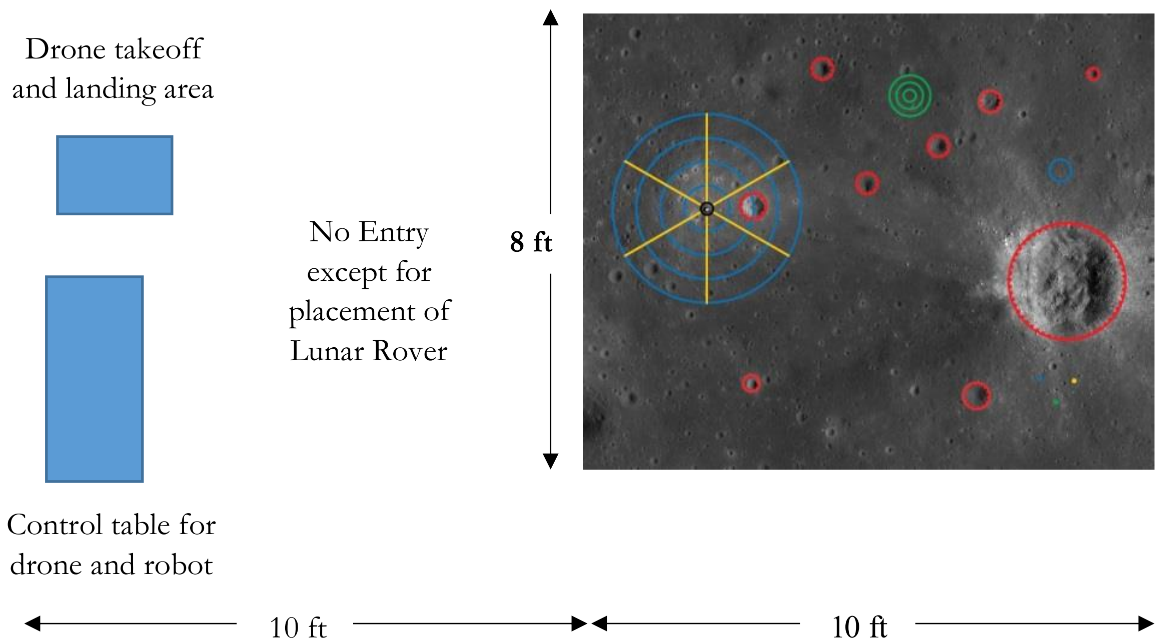


*Figure 6: Challenge Event layout*

# GLOSSARY

Above Ground Level (AGL)

Apollo 50th Next Giant Leap Student Challenge (ANGLeS)

Drone

Flight Crew

Autonomous

Flight Director

Guidance Officer

Lunar Module

Lunar Rover

Lunar Surface Mat

Moon

Small Unmanned Aircraft System

# FAA UAV INFORMATION

This section is to provide some clarification on the FAA regulations regarding UAVs and how these apply ANGLeS and provide some tips on staying within the regulations. Keep in mind all official activities for ANGLeS will take place indoors and therefore any practice required should be able to take place indoors. The FAA regulations do not apply to indoor flight[2], but any and all outdoor flight is subject to FAA regulations and guidelines, even if it is over your own property[2].

The information contained here is taken and interpreted from the FAA website on Unmanned Aircraft Systems[3], FAA *Advisory Circular 107-2*[4], the FAA's *Memorandum: Educational Use of Unmanned Aircraft Systems (UAS)*[5], and conversations certified flight instructors and an FAA representative. The information in this document does not constitute legal advice and it is always recommended to get the most up to date information directly from the FAA website:

www.faa.gov/uas/

When referencing drone licenses and drone registration, there is often confusion between these terms and to what they apply. For clarity, the terms used by the FAA and in this document, are Remote Pilot Certificate (RPC), what some may refer to as a drone pilot license, and Unmanned Air System (UAS) Registration, which is a registration just for the drone. Both are governed under the FAA's Part 107 regulations for Small Unmanned Air Systems (SUAS), but the applicability of each is completely different and independent of the other.

Starting with the UAS Registration, any drone between 0.55 lb and 55 lb (250 g and 25 kg) needs to be registered with the FAA, whether it is used for "recreational, commercial, government, or other purposes."[6] Basically, any drone that weighs between 0.55 lb and 55 lb needs to be registered, regardless of the intended use or who is flying it.

The UAVs permitted to be used in ANGLeS, as discussed in Section X, are required weigh less than 0.55 lb (250 g). Therefore, all drones allowed in ANGLeS do not need to be registered with the FAA.

The Remote Pilot Certificate (RPC) is required for anyone flying a small unmanned aircraft, unless for hobby or recreation, as stated in *Advisory Circular 107-2*[7]:

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2 FAA. Unmanned Aircraft Systems (UAS) Frequently Asked Questions, Registration. Retrieved in December 2018 from https://www.faa.gov/uas/faqs/#reg.

3 FAA. Unmanned Aircraft Systems. Retrieved in December 2018 from https://www.faa.gov/uas/.

4 FAA. *Advisory Circular 107-2*. Retrieved in December 2018 from https://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf.

5 FAA. *Memorandum: Educational Use of Unmanned Aircraft Systems (UAS)*. Retrieved in December 2018 from https://www.faa.gov/uas/resources/uas_regulations_policy/media/Interpretation-Educational-Use-of-UAS.pdf.

6 FAA. FAADroneZone. Retrieved in December 2018 from https://faadronezone.faa.gov/#/.

7 FAA. *Advisory Circular 107-2*, 4.1 Applicability, p. 4-1. Retrieved in December 2018 from https://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf

**Applicability.** This chapter provides guidance regarding the applicability of part 107 to civil small UA operations conducted within the NAS. However, part 107 does not apply to the following:

1. Model aircraft that are operated in accordance with part 101 subpart E, Model Aircraft), which applies to model aircraft meeting all of the following criteria:
   - The aircraft is flown strictly for hobby or recreational use;
   - The aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization;
   - The aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization;
   - The aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft;
   - When flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control (ATC) tower (when an air traffic facility is located at the airport) with prior notice of the operation;
   - The aircraft is capable of sustained flight in the atmosphere; and
   - The aircraft is flown within Visual Line of Sight (VLOS) of the person operating the aircraft.
2. Operations conducted outside the United States;
3. Amateur rockets;
4. Moored balloons;
5. Unmanned free balloons;
6. Kites;
7. Public aircraft operations; and
8. Air carrier operations.

It is important to note that RPC applicability is given in regards to the use of the UAV and not whether the drone is a registered drone. Thus, an RPC is required for all non-hobby/recreation operation, regardless of whether the drone needs to be registered. The FAA clarifies hobby and recreation stating[8]:

> In the FAA's Interpretation… the FAA relied on the ordinary, dictionary definition of these terms. UAS use for hobby is a "pursuit outside one's regular occupation engaged in especially for relaxation." UAS use for recreation is "refreshment of strength and spirits after work; a means of refreshment or diversion."

[8] FAA. Unmanned Aircraft Systems (UAS) Frequently Asked Questions, Flying for Fun Under the Special Rule for Model Aircraft. Retrieved in December 2018 from https://www.faa.gov/uas/faqs/#ffr:

In regards to educational use, the FAA issued a memorandum[9] that covers many cases and can get confusing, but has a clear intention: the FAA does not want a person or business getting compensated for giving drone flight lessons without an RPC. Students may fly UAVs for education purposes, with adults or staff present for safety, but no flight instruction should be given.

All outdoor UAV operation should always be conducted in accordance to FAA regulations[10]:

**Part 107 Operating Rules**

- Unmanned aircraft must weigh less than 55 pounds, including payload, at takeoff
- Fly in Class G airspace
- Keep the unmanned aircraft within visual line-of-sight
- Fly at or below 400 feet
- Fly during daylight or civil twilight
- Fly at or under 100 mph
- Yield right of way to manned aircraft
- Do not fly directly over people
- Do not fly from a moving vehicle, unless in a sparsely populated area

If you or your students are interested in obtaining an RPC, the requirements are fairly simple[11]:

**To become a pilot you must:**

- Be at least 16 years old
- Be able to read, speak, write, and understand English (exceptions may be made if the person is unable to meet one of these requirements for a medical reason, such as hearing impairment)
- Be in a physical and mental condition to safely operate a small UAS
- Pass the initial aeronautical knowledge exam at an FAA-approved knowledge testing center

**Pilot certificate Requirements**

- Must be easily accessible by the remote pilot during all UAS operations
- Valid for 2 years – certificate holders must pass a recurrent knowledge test every two years

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[9] FAA. *Memorandum: Educational Use of Unmanned Aircraft Systems (UAS)*. Retrieved in December 2018 from https://www.faa.gov/uas/resources/uas_regulations_policy/media/Interpretation-Educational-Use-of-UAS.pdf.

[10] FAA. Fly under the Small UAS Rule. Retrieved in December 2018 from https://www.faa.gov/uas/getting_started/part_107/

[11] FAA. Becoming a Pilot. Retrieved in December 2018 from https://www.faa.gov/uas/getting_started/part_107/remote_pilot_cert/.