Lunar Librarian Newsletter
June & July 2009

Vol. 4. Issue. 6 & 7

LRO News

LRO has Launched!!! We are on our way to the MOON!!!

CAPE CANAVERAL, Fla. – Fire signals liftoff of the Atlas V/Centaur carrying NASA's Lunar Reconnaissance Orbiter, or LRO, and NASA's Lunar Crater Observation and Sensing Satellite, known as LCROSS lunar impactor to the Moon under overcast skies June 18 at 5:32pm EDT, from Launch Complex 41 at Cape Canaveral Air Force Station in Florida. The tower at left is part of the lightning protection system on the pad. LRO and LCROSS are the first missions in NASA's plan to return humans to the moon and begin establishing a lunar outpost by 2020. The LRO also includes seven instruments that will help NASA characterize the moon's surface: DIVINER, LAMP, LEND, LOLA , CRATER, Mini-RF and LROC. It will have the highest resolution camera yet sent into lunar orbit and should be able to resolve details at the Apollo and other unmanned landing sites. Photo by Ben Cooper.

For launch photos:

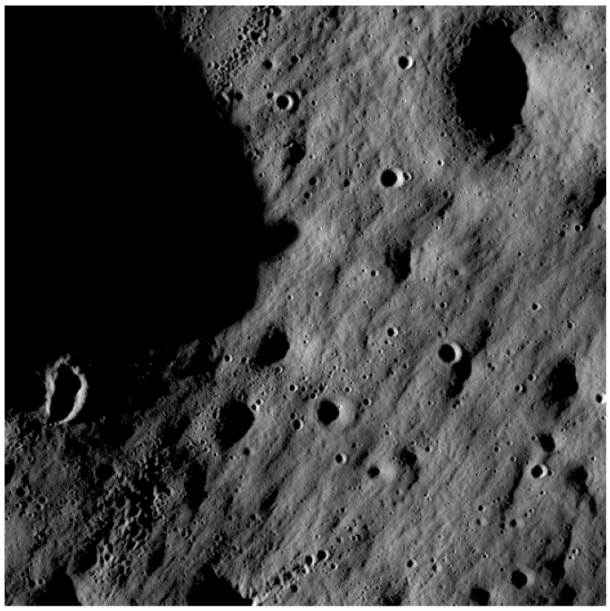
- http://mediaarchive.ksc.nasa.gov/search.cfm?cat=201
- http://www.launchphotography.com/LRO.html
- http://lunar.gsfc.nasa.gov/gallery-launch.html

LRO's First Moon Images

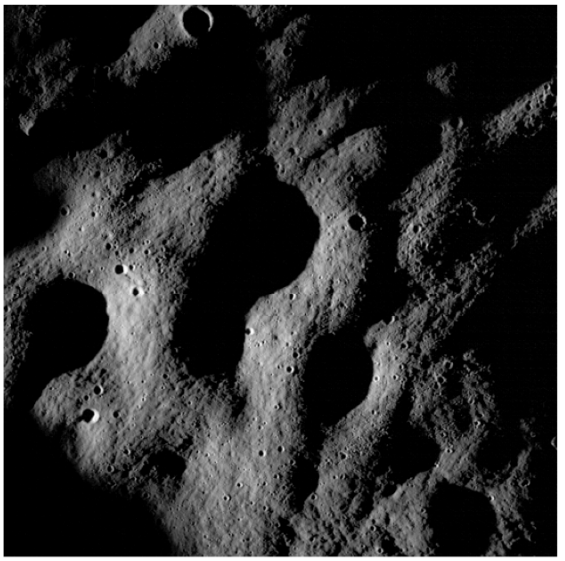
NASA's Lunar Reconnaissance Orbiter has transmitted its first images since reaching the moon on June 23. The spacecraft's two cameras, collectively known as the Lunar Reconnaissance Orbiter Camera, or LROC, were activated June 30. The cameras are working well and have returned images of a region in the lunar highlands south of Mare Nubium (Sea of Clouds).

As the moon rotates beneath LRO, LROC gradually will build up photographic maps of the lunar surface.

"Our first images were taken along the moon's terminator -- the dividing line between day and night -- making us initially unsure of how they would turn out," said LROC Principal Investigator Mark Robinson of Arizona State University in Tempe. "Because of the deep shadowing, subtle topography is exaggerated, suggesting a craggy and inhospitable surface. In reality, the area is similar to the region where the Apollo 16 astronauts safely explored in 1972. While these are magnificent in their own right, the main message is that LROC is nearly ready to begin its mission."



http://www.nasa.gov/mission_pages/LRO/multimedia/lroimages/lroc_20090702_a.html



These images show cratered regions near the moon's Mare Nubium region, as photographed by the Lunar Reconnaissance Orbiter's LROC instrument. Impact craters feature prominently in both images. Older craters have softened edges, while younger craters appear crisp. Each image shows a region 1,400 meters (0.87 miles) wide, and features as small as 3 meters (9.8 feet) wide can be discerned. The bottoms of both images face lunar north.

The image to the left shows the location of these two images in relation to each other. The locator image shows an area 3,542 meters (2.2 miles) wide by 14,000 meters (8.7 miles) long. The scene is at the lunar coordinates 34.4 degrees South by 6.0 degrees West.

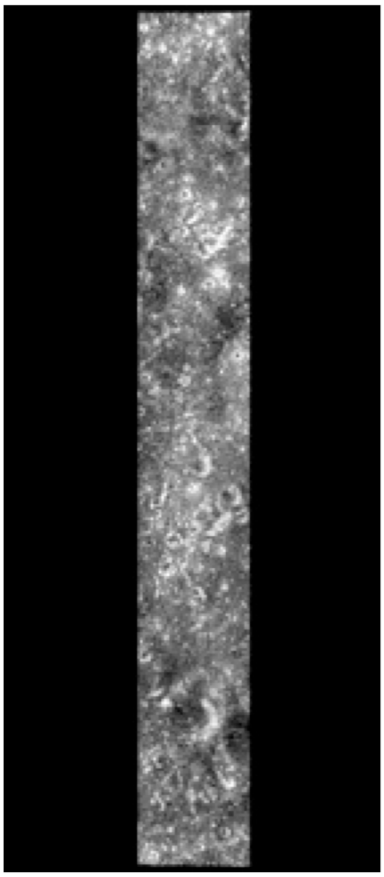
Credit: NASA/Goddard Space Flight Center/Arizona State University

Check out our totally awesome images at: http://www.nasa.gov/ and http://lroc.sese.asu.edu

New Images from Mini-RF
From: http://www.nasa.gov/mission_pages/Mini-RF/news/radar_tandem_searches.html

Besides receiving images of the Moon from LROC, NASA has also received first images of the Moon's permanently shadowed regions from Mini-RF (Miniature Radio Frequency). Mini-RF for its primary mission, to create detailed images of the moon's darkest areas, to scan the lunar surface for hints of water ice and demonstrate new communications technologies.

There is already a version of LRO Mini-RF circling the Moon on the Indian Space Research Organization's Chandrayaan-1 spacecraft called Mini-SAR (Synthetic Aperture Radar). Since Chandrayaan-1 orbital operations began in late 2008,Mini-SAR has mapped about 80 percent of both of the moon's poles and provided images of areas never seen from Earth. Its second imaging period is set to begin in mid-August, opening the possibility of unique, joint measurements between Chandrayaan-1 and LRO that would enhance the hunt for ice.



"The Mini-RF team has reached a significant milestone, two payloads now in operation at the moon, "says Jason Crusan, program executive for the Mini-RF program, from NASA's Space Operations Mission Directorate, Washington, D.C. "Having two very complementary instruments orbiting the moon on two different spacecraft shows how truly international the exploration of the moon can be."

Mini-RF sends radio pulses to the Moon from the orbiting spacecraft and then precisely records the radio echoes that bounce back from the surface, along with their timing and frequency. From these data scientists can build images of the Moon that not only show the terrain in areas they otherwise couldn't see, such as the permanently-shadowed areas near the lunar poles, but also contain information on the physical nature of the terrain.

"We're uncovering the moon's coldest, darkest regions, looking into craters and at other mysterious areas that never receive sunlight, yet preserve materials from the solar system's earliest days," says Ben Bussey, Mini-RF deputy principal investigator from the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Md. "The exploration potential of these regions is also significant, since any ice deposits we locate would be valuable to future human lunar explorers."

And the Images Keep Coming: LRO Sees Apollo Landing Sites

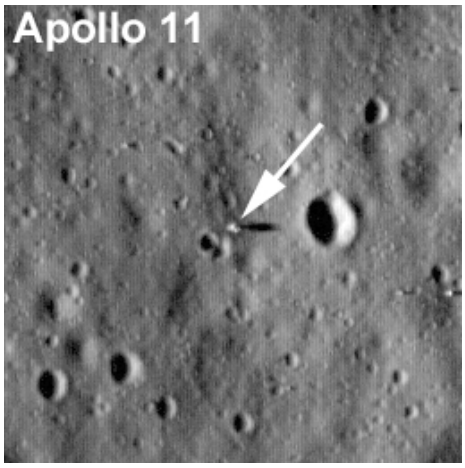
http://www.nasa.gov/mission_pages/LRO/multimedia/lroimages/apollosites.html

NASA's Lunar Reconnaissance Orbiter, or LRO, has returned its first imagery of the Apollo moon landing sites. The pictures show the Apollo missions' lunar module descent stages sitting on the moon's surface, as long shadows from a low sun angle make the modules' locations evident.

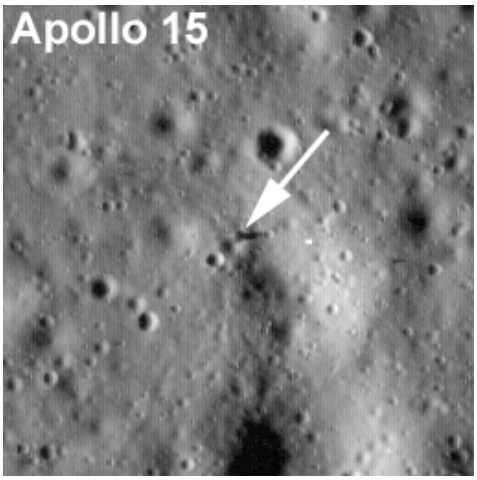
The Lunar Reconnaissance Orbiter Camera, or LROC, was able to image five of the six Apollo sites, with the remaining Apollo 12 site expected to be photographed in the coming weeks.

The satellite reached lunar orbit June 23 and captured the Apollo sites between July 11 and 15. Though it had been expected that LRO would be able to resolve the remnants of the Apollo mission, these first images came before the spacecraft reached its final mapping orbit. Future LROC images from these sites will have two to three times greater resolution.

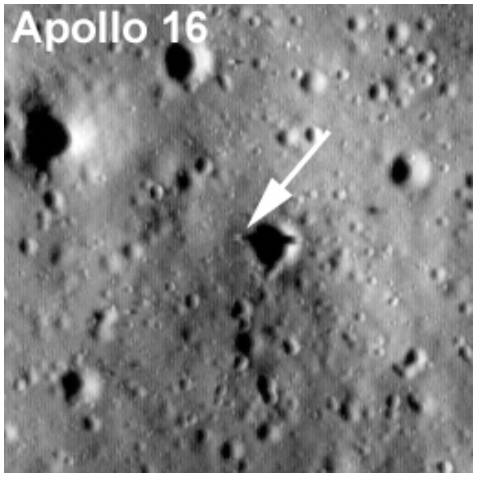
All images credit: NASA/Goddard Space Flight Center/Arizona State University



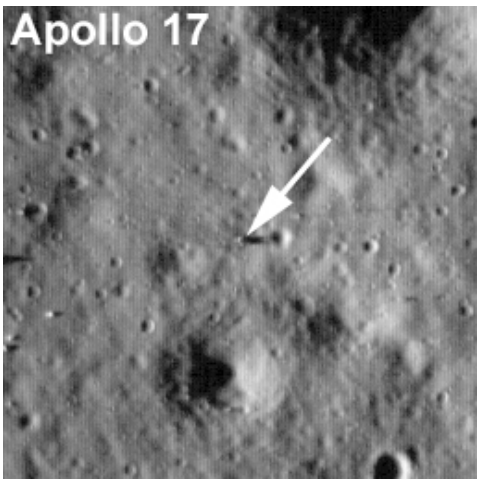
Apollo 11 lunar module, Eagle.
Image width: 282 meters (about 925 ft.)



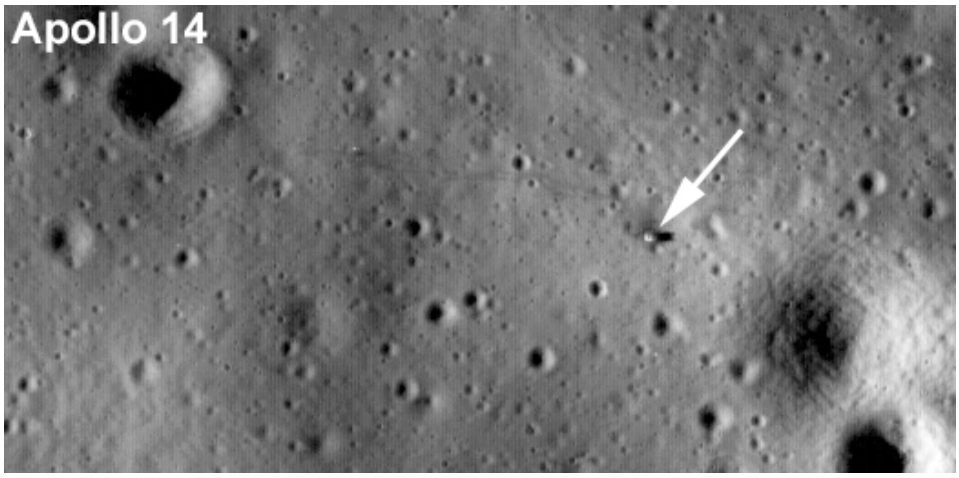
Apollo 15 lunar module, Falcon.
Image width: 384 meters (about 1,260 ft.)



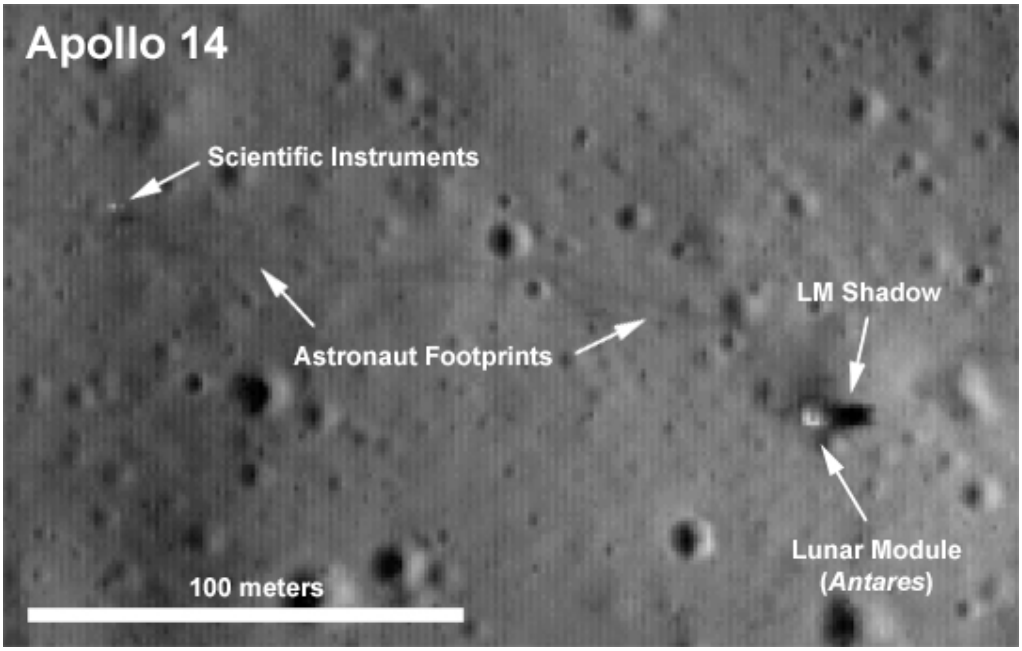
Apollo 16 lunar module, Orion.
Image width: 256 meters (about 840 ft.)



Apollo 17 lunar module, Challenger.
Image width: 359 meters (about 1,178 ft.)



Apollo 14 lunar module, Antares.
Image width: 538 meters (about 1,765 ft.)



"The LROC team anxiously awaited each image," said LROC principal investigator Mark Robinson of Arizona State University. "We were very interested in getting our first peek at the lunar module descent stages just for the thrill -- and to see how well the cameras had come into focus. Indeed, the images are fantastic and so is the focus."

This photograph shows Apollo 11 astronaut Buzz Aldrin in front of the lunar module. The photo helps provide a scale to the LROC images shown above. **Credit:** NASA/Neil Armstrong

Although these pictures provide a reminder of past NASA exploration, LRO's primary focus is on paving the way for the future. By returning detailed lunar data, the mission will help NASA identify safe landing sites for future explorers, locate potential resources, describe the moon's

radiation environment and demonstrate new technologies.

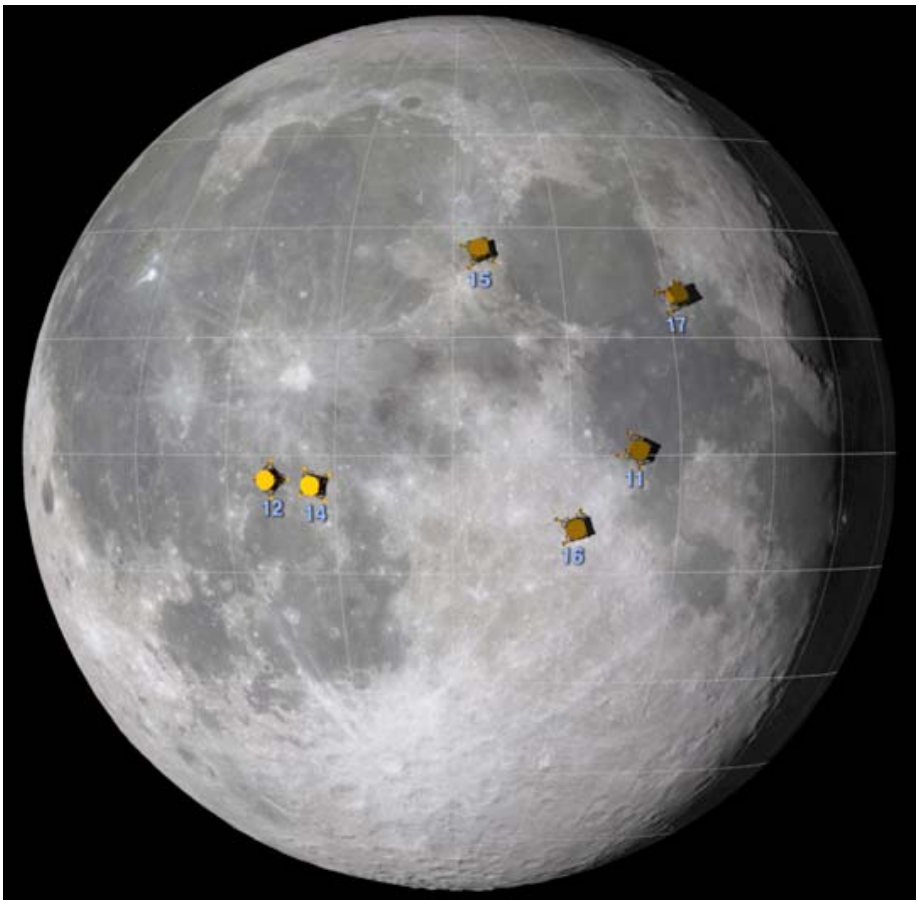
"Not only do these images reveal the great accomplishments of Apollo, they also show us that lunar exploration continues," said LRO project scientist Richard Vondrak of NASA's Goddard Space Flight Center in Greenbelt, Md. "They demonstrate how LRO will be used to identify the best destinations for the next journeys to the moon."

The spacecraft's current elliptical orbit resulted in image resolutions that were slightly different for each site but were all around four feet per pixel. Because the deck of the descent stage is about 12 feet in diameter, the Apollo relics themselves fill an area of about nine pixels. However, because the sun was low to the horizon when the images were made, even subtle variations in topography create long shadows. Standing slightly more than ten feet above the surface, each Apollo descent stage creates a distinct shadow that fills roughly 20 pixels.

The image of the Apollo 14 landing site had a particularly desirable lighting condition that allowed visibility of additional details. The Apollo Lunar Surface Experiment Package, a set of scientific instruments placed by the astronauts at the landing site, is discernable, as are the faint trails between the module and instrument package left by the astronauts' footprints.

Launched on June 18, LRO carries seven scientific instruments, all of which are currently undergoing calibration and testing prior to the spacecraft reaching its primary mission orbit. The LROC instrument comprises three cameras -- two high-resolution Narrow Angle Cameras and one lower resolution Wide Angle Camera. LRO will be directed into its primary mission orbit in August, a nearly-circular orbit about 31 miles above the lunar surface.

Goddard built and manages LRO, a NASA mission with international participation from the Institute for Space Research in Moscow. Russia provided the neutron detector aboard the spacecraft.



This graphic shows the approximate locations of the Apollo moon landing sites.

Credit: NASA's Goddard Space Flight Center Scientific Visualization Studio

Tracking the Moon

Abstract from *The Lunar Reconnaissance Orbiter Laser Ranging Investigation:*
http://lunar.gsfc.nasa.gov/lola/images/zuber_LR_SSR.pdf

The laser ranging facility at Goddard Space Flight Center tracks LRO as it orbits around the Moon.

The objective of the Lunar Reconnaissance Orbiter (LRO) Laser Ranging (LR) system is to collect precise measurements of range that allow the spacecraft to achieve its requirement for precision orbit determination. The LR will make one-way range measurements via laser pulse time-of-flight from Earth to LRO, and will determine the position of the spacecraft at a sub-meter level with respect to ground stations on Earth and the center of mass of the Moon. Ranging will occur whenever LRO is visible in the line of sight from participating Earth ground tracking stations. The LR consists of two primary components, a flight system and ground system. The flight system consists of a small receiver telescope mounted on the LRO high-gain antenna that captures the uplinked laser signal, and a fiber optic cable that routes the signal to the Lunar Orbiter Laser Altimeter (LOLA) instrument on LRO. The LOLA instrument receiver records the time of the laser signal based on an ultrastable crystal oscillator, and provides the information to the onboard LRO data system for storage and/or transmittal to the ground through the spacecraft radio frequency link. The LR ground system consists of network of satellite laser ranging stations, a data reception and distribution facility, and the LOLA Science Operations Center. LR measurements will enable the determination of a three-dimensional geodetic grid for the Moon based on the precise seleno-location of ground spots from LOLA.

The LRO/LCROSS Launch – In Prospective of Those Who Work on the Mission

LRO Launch!
Brooke Hsu, LRO E/PO Lead

Seriously. I have to keep pinching myself to see if it's really real. This despite a first-person eyewitness of the launch, numerous phone calls from my hubby about how well things are going, and lots and lots of rocket eye candy. This week at Cocoa Beach has been a whirlwind experience. As soon as I landed on Thursday June 11th, I hit the ground running. Lots of organization, making sure speakers were well taken care of, planning, re-planning, and stressing out over making sure that everything went smoothly. Then the news that the Saturday expected launch of STS-127 was scrubbed (the news came at a brutal 3:45 am) due to a hydrogen leak in the tank, and that the window for our launch was being "negotiated." Admittedly, my Type-A self didn't take this news very well. I had been planning for this week for what seemed like forever, and to me it was a no-brainer as to the fact that LRO should clearly get our entire window. Us getting pushed meant that we had to scramble to find people to cover the exhibits and public presentations at the Visitor Center. So I was stressed. A. Lot.

Then we found out that the second attempt for STS-127 was scrubbed, and that we would get our first opportunity to launch on the second day of our window - June 18th. Now we're talking!

Launch day arrived. My stress levels had miraculously decreased. I felt calm, cool, and for the first time in several weeks, actually excited about our launch! We loaded the first bus (well, we hadn't planned on it, but that's the way it worked out) to the Banana Creek viewing site. We're ready for launch! A few hours of hanging out, eating a soft pretzel and ice cream, picking primo seats in the bleachers, and playing the waiting game for launch. While we were waiting, we had news that the weather was looking grave, and there was a better chance of the weather clearing if we pushed forward to our last opportunity at 5:32 pm. I had promised I would call in to the auditorium at Goddard where employees were gathered to give my perspective on the launch. Given the weather situation, I asked everyone in the auditorium to take a deep breath and blow in the southeast direction to clear out the storm clouds. Talk about timing, because right after I said that, a voice came over the speaker and announced that our weather conditions turned to green! We're go for launch!

What a sight. The engines lit, and our little spacecraft that could was carried up into the sky and ahead to its destination - the Moon! I cried. And I cried some more. And I cried so much that the next day my eyelids were swollen. All of that time, energy, stress, excitement, anticipation, and joy were wrapped up in that one moment in time. LRO lifted off at 5:32:00.1 pm EDT - one tenth of one second late. That moment, that singular point in time is forever recorded in my brain as the moment that all of our collective dreams became a reality. I could feel all of the people who have worked on this mission at that moment.

And all of that was just the beginning. LRO is on its way to the Moon!

My perspective on LRO's launch
Lora Bleacher, LOLA E/PO Lead

I feel very lucky to have been able to see the launch of LRO. After working on the LRO education and public outreach team over the past year and a half and talking about it at every day, at every workshop, at every public event, etc. it was nice to see it finally go. Since it was also built here at Goddard, it was also nice to see it built before my eyes and to see the hard work, long hours, and dedication of so many people pay off. It was the first time that I got to see a science payload launch (I was lucky to have been able to see a shuttle launch when I was in high school). It really made it hit home that I work for NASA and that I know the people who are capable of actually building and sending a spacecraft to the Moon!! That's so cool! Now I can't wait to actually see the images and data that LRO will return, especially the images of the Apollo landing sites and the artifacts the astronauts left behind. It's like waiting for your birthday because you'll know you'll have presents to open. It was also cool for me to be able to view the launch with my husband and daughter, who joined me down in FL. My daughter is 5.5 months old. Watching the launch got me thinking about the career path my life has taken and made me even more curious about the kinds of things that she might do in her lifetime, such as actually being one of the astronauts to walk on the Moon or Mars!

My First Launch By Heather Weir

I started working on the LRO mission in January 2006. Little did I know then that LRO would become a big part of my life. When my husband and I talked about having children, I was adamant that we were going to plan around the LRO launch. This of course was when LRO was supposed to have launched the end of October 2008. As you can see, my daughter learned about LRO from an early age.

Although we did not launch in Fall 2008, the E/PO team remained busy and very much looking forward to it launching. I have to admit after several slips, the group was hoping LRO would launch sooner than later.

When the Shuttle launch slipped on June 13th, I thought that my mom, my daughter, and I were going to have a double opportunity to see a Shuttle launch and a rocket. Sadly to say, the Shuttle was delayed again, but we found out that LRO was **go** for the next day, June 18th.

It was great to share the excitement of the launch with the visitors to KSC. Some of the visitors were there for the launch while others were just visiting. When we were finally bused out to the viewing site, which was next to the Saturn V center (http://www.kennedyspacecenter.com/apollo-saturn-v-center.aspx), you really got a

sense of how far NASA has come in the process of getting humans to the Moon. The Saturn V rocket was huge. I could not imagine being on top of that while it launched. Talk about G-Forces!

As the time for launch drew closer, so did the clouds. We had a few drops of rain and a rumble of thunder. I thought for sure launch would be scrubbed. Launch was held, so the 5:12pm and 5:22pm launch times were now out of the picture. The only one left was 5:32pm for the day. Low and behold, we got lucky. We were going to launch!

From where we were viewing the launch (see picture to the left), you could see a bright light and smoke from the rocket. It took several seconds before we actually heard the rumble of the rocket going up. It was quite an experience.

I was sad to see LRO go, but I am very excited to see the images and the results produced by this mission. I still want to be able to see a Shuttle launch before they are phased out, but I can say for sure that I got to see NASA return mission to the Moon.

Reflections on a Launch

Brian Day, LCROSS E/PO Lead

There is no such thing as a boring launch. Any time you watch a tower of high-explosive go thundering into space, you can't help but be thrilled. That being said, the launch of LRO and LCROSS had a level of excitement that was unmatched by any other launch I've seen, manned or unmanned.

OK, I'll admit to some bias on this one. I've been involved with the LCROSS mission since it was just a proposal. My coworkers on both the LCROSS and LRO missions have become my friends. Our combined personal investment of long hours and hard labor led to that shining, steaming rocket on the pad becoming a central part of all of our lives.

But all of that aside, there was something special going on here. I took a minute to reflect on this as I gazed across the murky water of Banana Creek at the launch pad. The normal tension of the last few minutes of countdown was accented by something more.

Part of it could have been the destination. With this launch, we would finally begin our return to the Moon. All of the launches I had witnessed before had been destined for low Earth orbit. But this launch would recapture some of the adventure of those Moon missions of decades past; missions that inspired many of us to take the career paths that brought us together at the cape on this day.

Part of it was the wild rollercoaster ride leading up to the launch. The team's collective mood rose and fell with each adjustment to our launch opportunity as NASA worked to best coordinate our launch with that of the Shuttle, still sitting one pad to the north. Then, after we had finally been given the go for June 18, and as the countdown progressed through the hot, steamy afternoon, a line of nearby thunderclouds resulted in holds that ate through the first two of the three opportunities in our 20-minute window. The tension built as we and about 1,000 of our friends, coworkers, and family watched the agonizing progress of the dark, ominous

clouds to the west. As all hope seemed to fail in the growing gloom, the meteorologist surprised us all with an announcement that we would be clear for launch at the final minute of our window. The collective cheer was almost as loud as a launch. It doesn't get much more dramatic than that.

As the final seconds ticked down, what was really making this launch so special became clear. There at the viewing site, among all the missions' NASA civil servants, contractors, and their families were many members of the general public who had become direct participants in these missions. These were the lunar librarians and teachers who had attended workshops and were helping students to appreciate what it meant to be going back to the Moon. These were the Solar System Ambassador and Night Sky Network volunteers helping to lead the missions' outreach efforts. These were the students who would track and monitor the health and status of the LCROSS mission in flight by taking control of one of the giant 34-meter Goldstone Deep Space Communication dishes from their classrooms. These were the amateur astronomers who would image the LCROSS spacecraft in flight, record LCROSS' impact, and help analyze LRO's imagery. The public had adopted this launch. These were their missions sitting atop that beautiful Atlas V. The enthusiasm and anticipation on their faces made it clear; these missions belonged to them as much as they did to us.

With the final tick of the countdown clock, the sudden flash of ignition across the water brought a deafening roar well before the sound of the rocket's engine could reach us. The cheering of the crowd intensified as the rocket rose impossibly slowly from the pad. The deep bass thunder of the Atlas' engine finally joined our cheers. After the rocket disappeared into the clouds, I turned to look at the yelling, laughing, crying volunteers, students, teachers, and citizen scientists around me. This wasn't just NASA launching another rocket. This was all of us going back to the Moon together. This was an exceptionally exciting launch.

Impressions of Launch by Brian Mitchell

Personally:
I've worked on the Shuttle Program, Space Station, and more shuttle payloads than I can remember. I've seen and worked a few launches too. But, this launch was different. Talk about putting your own blood, sweat, and tears into something… this was much more emotional than I expected. I saw hardened launch veterans misty-eyed and screaming. The suspense driven by the shuttle launch slips along with the approaching anvil clouds, made the launch feel like a last second field goal at a Super Bowl. No matter how many launches I see, I think that will always be my most memorable.

Professionally:
I know I have said it a dozen times before, but, I have never worked with a better, more professional team. There were a lot of long days for a lot of EPO folks. Even with all the re-planning, and shuffling of schedules, everyone marched on without complaint. I would see someone coming off a 16 hour day, still, buzzed from getting to see, or, maybe even touch the rocket. If I ever have the opportunity to work another launch like this, I hope I have all the same people around me. I wouldn't change a thing.

Blog Entries:

http://blogs.nasa.gov/cm/blog/moon_missions

LCRSS Observation: http://groups.google.com/group/lcross_observation?hl=en&lnk=

NASA News

Apollo 11: 40th Anniversary

Where were you 40 years ago when humans landed on the Moon? Do you remember that day? Check out what others had to say about this life-changing event. Where will you be when humans return there again?

Resources are available on the NASA Apollo 11 40th anniversary website:
http://www.nasa.gov/mission_pages/apollo/40th

- http://www.lpi.usra.edu/resources/apollo/
- http://apollo.sese.asu.edu/

Science News

NASA Science News has published several articles last month. Please follow the links to read the full stories. Check out our RSS feed at http://science.nasa.gov/rss.xml!

The Phantom Torso Returns
The Phantom Torso is back on Earth and he has quite a story to tell about the perils of space radiation.
http://science.nasa.gov/headlines/y2009/27may_phantomtorso.htm?list907815

Eerie Red Glow Traces Ocean Plant Health
NASA's Aqua satellite has detected a red glow coming from phytoplankton in Earth's oceans. This unique signal allows researchers to monitor the health of ocean plants in a new and telling way.
http://science.nasa.gov/headlines/y2009/28may_redglow.htm?list907815

New Solar Cycle Prediction
An international panel of experts has issued a new prediction for the solar cycle which takes into account the surprisingly deep solar minimum of 2008-2009. Read today's story to find out when they think solar maximum will return. http://science.nasa.gov/headlines/y2009/29may_noaaprediction.htm?list907815

Fake Astronaut Gets Hit by Artificial Solar Flare
Researchers are about to subject a fake astronaut complete with blood cells and simulated human tissue to an artificial solar flare. How the unlucky volunteer emerges from the radiation storm will reveal for the first time how much of a threat severe solar flares pose to astronauts en route to the Moon and Mars.
http://science.nasa.gov/headlines/y2009/03jun_fakeastronaut.htm?list907815

Return of the Mars Hoax
There's an email going around claiming that Mars will look as big as a full Moon on August 27th. Could this possibly be true? http://science.nasa.gov/headlines/y2009/09jun_marshoax.htm?list907815

Running Out of This World
With NASA poised to launch the world's most famous treadmill (COLBERT) to the International Space Station, an astronaut describes what it's like to run in space where sweat floats and there is no gravity to hold your feet to the ground. http://science.nasa.gov/headlines/y2009/15jun_running.htm?list907815

Mystery of the Missing Sunspots, Solved?
Where have all the sunspots gone? Scientists studying a jet stream deep inside the sun may have found the answer. http://science.nasa.gov/headlines/y2009/17jun_jetstream.htm?list907815

Satellites Guide Relief to Earthquake Victims
In the aftermath of a recent, deadly earthquake, the NASA-led SERVIR program orchestrated use of satellite data to show Central American disaster officials where help was needed most.
http://science.nasa.gov/headlines/y2009/18jun_servir.htm?list907815

Space Station Room With a View
Astronauts are looking forward to an unprecedented view of the cosmos when the largest window ever built for space is installed on the International Space Station.
http://science.nasa.gov/headlines/y2009/26jun_cupola.htm?list907815

Space Station Marathon
The International Space Station (ISS) is about to make a remarkable series of flybys over the United States. Beginning this 4th of July weekend, the station will appear once, twice, and sometimes three times a day for many days in a row. http://science.nasa.gov/headlines/y2009/03jul_sightings.htm?list907815

Wide Awake in the Sea of Tranquility
Why couldn't Neil Armstrong fall asleep on the Moon?
http://science.nasa.gov/headlines/y2009/16jul_wideawake.htm?list907815

Exploring the Moon, Discovering Earth
Forty years ago, Apollo astronauts set out on a daring adventure to explore the Moon. They ended up discovering their own planet.
http://science.nasa.gov/headlines/y2009/17jul_discoveringearth.htm?list907815

Apollo Landing Sites Photographed
NASA's Lunar Reconnaissance Orbiter has returned its first imagery of Apollo landing sites. The pictures show lunar module descent stages, scientific instruments and even 40-year-old foot trails made by astronauts walking across the dusty lunar surface. http://science.nasa.gov/headlines/y2009/17jul_lroc.htm?list907815

Longest Solar Eclipse of the 21st Century
The longest solar eclipse of the 21st century takes place this Wednesday, July 22nd. The path of totality crosses many major cities, setting the stage for possibly the best-observed eclipse in human history.
http://science.nasa.gov/headlines/y2009/20jul_longestsolareclipse.htm?list907815

Librarian News

For those of you who were able to come to launch, what did you think? Please send comments and pictures to heather_weir@ssaihq.com.

Links of the Month…

- Follow Spirit's story as engineers work to free Spirit from its sand trap. http://marsrovers.nasa.gov/newsroom/free-spirit.html
- Women in Space and Aviation:

    - http://www.hq.nasa.gov/office/pao/women_gallery/sitemap.htm
    - http://history.nasa.gov/women.html
    - http://www.nasa.gov/vision/space/preparingtravel/women_at_nasa.html
    - http://quest.nasa.gov/women/intro.html
- Dust storms off of the Sahara Desert: http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=39154
- Video about Mercury: http://www.youtube.com/watch?v=rZU8Y9DIBtI

Monthly Activity

LRO Paper Model: http://lunar.gsfc.nasa.gov/images/LRO_PaperModel.pdf

Lunar Reconnaissance Orbiter

The Lunar Reconnaissance Orbiter (LRO) is NASA's first step in returning humans to the Moon.

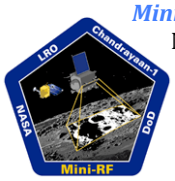
LRO focuses on the selection of safe landing sites, identification of lunar resources and the study of how the lunar radiation environment will affect humans. LRO will collect the data to allow scientists to create the comprehensive atlas of the Moon's features and resources necessary to design and build the lunar outpost.

Diviner Lunar Radiometric Experiment (DLRE)

DLRE will chart the temperature of the entire lunar surface to identify cold-traps and potential ice deposits. DLRE measurements may also be used to characterize lunar environments for habitability, determine rock abundances by mapping nighttime surface temperatures in multiple spectral channels, and map variations in silicate mineralogy.

Lunar Exploration Neutron Detector (LEND)

LEND will provide the observational data necessary for global mapping of the hydrogen content in the lunar sub-surface. These measurements will also allow for the characterization of the neutron component of the lunar radiation environment. Based on these measurements, LEND can be used to search for evidence of water ice in the sub-surface, and will provide space radiation environment measurements that may be useful for future human exploration.



Mini-RF Technology Demonstration

Mini-RF's primary goal is to search for subsurface water ice deposits. In addition, Mini-RF will take high-resolution imagery of permanently shadowed regions.

Cosmic Ray Telescope for the Effects of Radiation (CRaTER)

CRaTER will investigate the effects of galactic cosmic rays and solar energetic particles on tissue-equivalent plastics as a constraint on models of biological response to background space radiation.

Lyman Alpha Mapping Project (LAMP)

LAMP will map the entire lunar surface in the far ultraviolet and search for surface ice and frost in the polar regions illuminated only by starlight. LAMP will also serve as the first space exploration demonstration of military night vision technology.

Lunar Orbiter Laser Altimeter (LOLA)

LOLA will determine the global topography of the lunar surface at high resolution, measure landing site slopes, surface roughness, and search for possible polar surface ice in shadowed regions.

Lunar Reconnaissance Orbiter Camera (LROC)

LROC will acquire targeted narrow angle images of the lunar surface capable of resolving meter-scale features to support landing site selection, as well as wide-angle images to characterize polar illumination conditions and identify potential resources.

LRO Model Instructions

PRINT ON CARDSTOCK (AT LEAST 90 POUND BOND)
Materials Needed: scissors (or X-acto™ Knife), white glue, push pin, black marker or paint, Popsicle stick (optional)
~ About 2 hours to complete

A- Instrument Module

1. **Instrument Module (A)**
   a. Cut out Instrument Module A, (including extra line marked "cut").
   b. Cut white line slits on the black circles.
   c. Cut out hole labeled AD.
   d. Fold white flaps A-1, A-1a, A-1b, A-1c under. Do the same for all connecting rectangles

2. **LROC NAC (AA)**
   a. Cut out both AA-1-AA-2 pieces and do the following for both pieces.
   b. Color the backside of the strips black.
   c. Glue AA-1 under AA-2 to form rings.
   d. Insert the tabs into the slits (from step 1b) on instrument module around black circles.
   e. Glue down the tabs on back.
   f. Cut around both pieces AA3-AA5.
   g. Fold 2 sides inward around the center square (color side up).
   h. Fold and Glue white tabs AA-3, AA-4, to underside of AA-5.
   i. On the instrument module, connect flaps A-1a, A-1b, A-1c to A-1, with A-1 on the outside and glue.
   j. Pinch edge A-2 upward so it forms a right angle.
   k. Glue tab A-3 under to Instrument Module.
   l. Attach LROC NAC radiators AA3-5 to Instrument Module labels AA facing up.

3. **Star Trackers (AB & AC)**
    a. Cut out the 4 pieces.
    b. Poke holes on the blacks dots on both AB-2's.
    c. Fold the outer squares in for both AB-2 and outer tabs for AB-1.
    d. Glue the AB-2 squares over the AB-1 tabs.
    e. Glue tab AC-1 under AC-2.
    f. Glue the points of AC to the holes in AB.
    g. Glue both Star Trackers to Instrument Module where labeled AB.
4. **LOLA (AD)**
    a. Cut out LOLA.
    b. Glue AD-1 under AD-2.
    c. Glue small end into the hole you cut out on Instrument Module labeled AD.
5. **LAMP (AE)**
    a. Cut out LAMP.
    b. Fold and glue AE-1a, AE-1b, AE-1c under AE-1.
    c. Attach to Instrument Module A labeled LAMP.

B - Solar Array System and Base

a. Cut out both pieces, B-1 and B-2.
b. Glue a Popsicle stick to one of the backsides connecting the Solar Panel and base across the connector (Optional for stability).
c. Glue the backs of both sides B-1 and B-2 together.
d. Fold up white tabs (side B-2 faces up).

C - Propulsion Module

a. Cut out Propulsion Module.
b. Cut all black lines to the circle line.
c. Fold the outer white tabs under.
d. Fold all inner tabs back at a slight angle.
e. Glue all outer tabs C-1 to the base labeled Propulsion so that they are hidden.

D - High Gain Antenna System

a. Cut out antenna and dish.
b. Glue tab D-1 under D-2.
c. Connect and glue D-3 to D-4 by rolling it into a long tube.
d. Set and glue dish into D-6 tabs.
e. Glue the D-5 tab onto the base.

E – Mini-RF

a. Cut out Mini-RF.
b. Bend the white tab E-2 up slightly.

F - Spacecraft Bus

a. Cut out Spacecraft Bus including the indicated line E-1 for the Mini-RF.
b. Insert Mini-RF into E-1 and glue E-2 to the backside of the Spacecraft Bus (it should bend outward slightly).
c. Fold and glue F-4 to F-3.
d. CRaTER: Fold B back and glue to A.
e. Fold at the dark lines forming a square then attach and glue F-2 to the back of F-1.
f. Fold the white flaps down and glue them inside.
g. Attach the Instrument Module where labeled on the Spacecraft Bus (Star Trackers facing up).
h. Glue the open-ended side of the Spacecraft Bus down over the white tabs on the B (base), with instrument module opposite of the Solar Array System.

G - LEND

a. Cut out LEND.
b. Glue tab G-1 under G-2.
c. Fold white tabs on G-3 and G-4 down and glue inside the tube.
d. Glue the white side to Spacecraft Bus F on the tab labeled LEND.

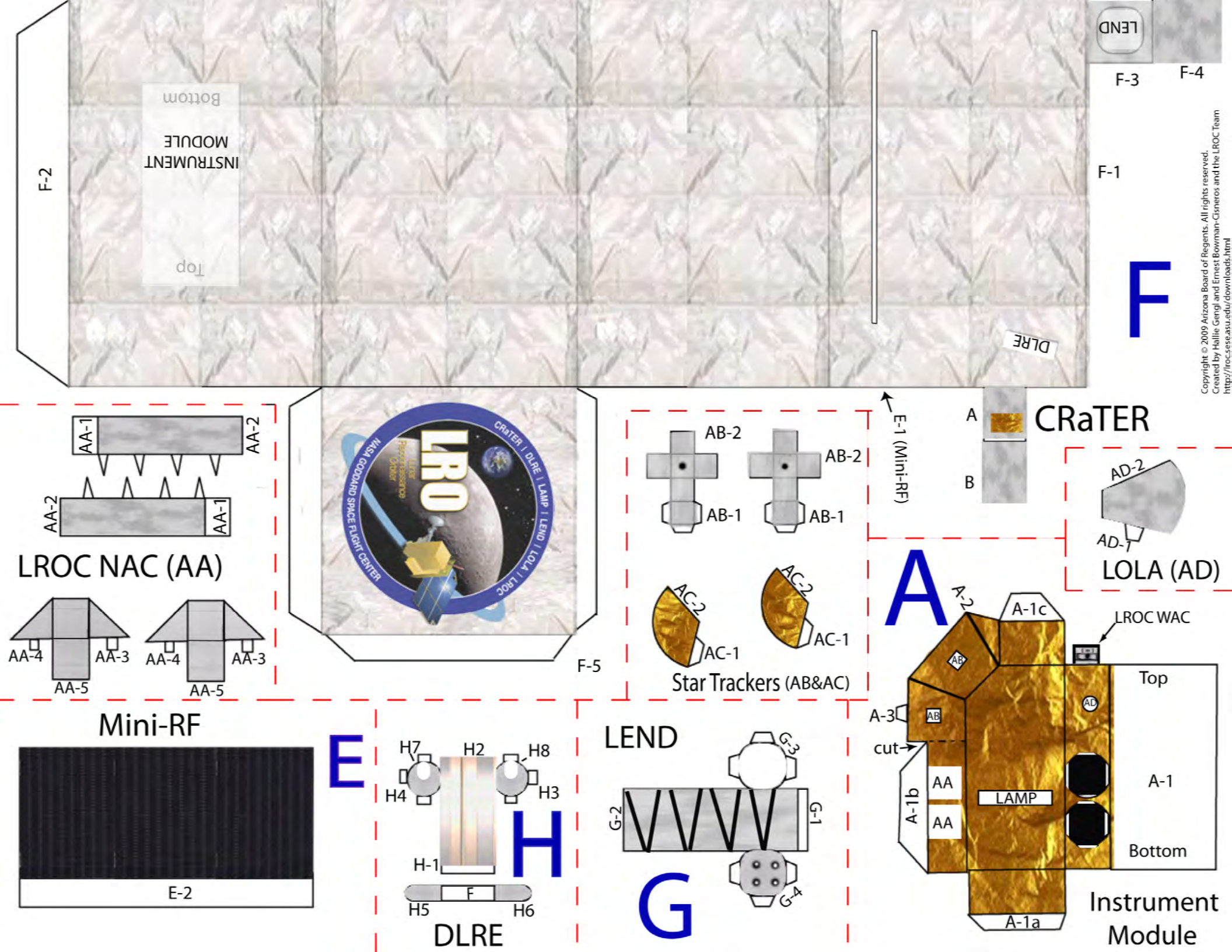
H - DLRE

a. Cut out both pieces of DLRE.
b. Glue H-2 over H-1.
c. Fold H-3 and H-4 tabs down and glue them to the inside of the tube.
d. Fold H-5 down and then glue over H-7 then fold H-6 down and then glue over H-8.
e. Glue the white tab labeled F to the Spacecraft Bus F where labeled DLRE.

ENJOY!!

ASU School of Earth & Space Exploration
Arizona State University

Created by Hallie Gengl and Ernest Bowman-Cisneros and the LROC Team
http://lroc.sese.asu.edu/downloads.html


F-2
INSTRUMENT MODULE
Bottom
Top
F-3
LEND
F-4
F-1
DLRE
F
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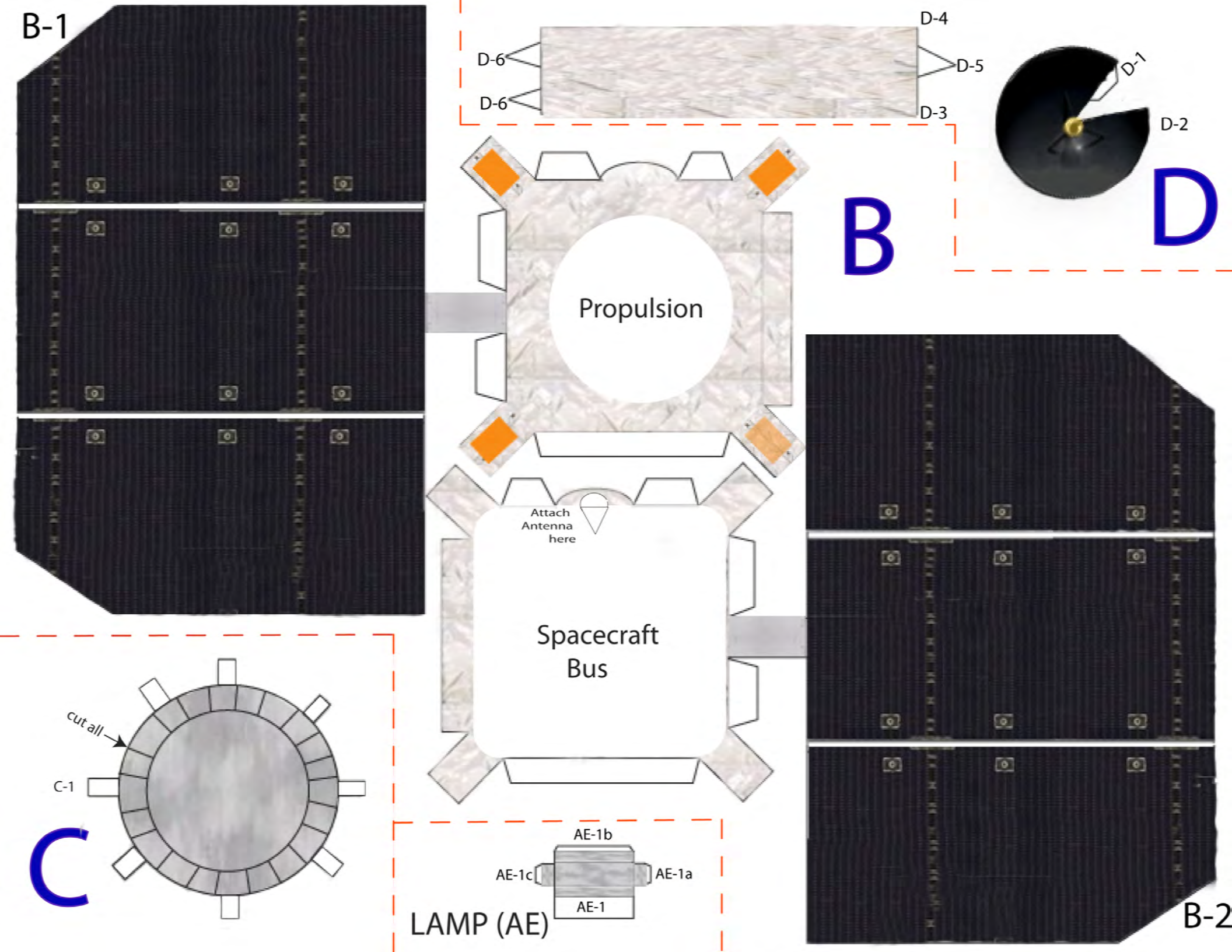
http://lroc.sese.asu.edu/downloads.html
AA-1
AA-2
AA-2
AA-1
LROC NAC (AA)
AA-4
AA-3
AA-5
AA-4
AA-3
AA-5
Mini-RF
E-2
E
LRO
CRaTER / DLRE / LAMP / LEND / LOLA / LROC
NASA GODDARD SPACE FLIGHT CENTER
F-5
H7
H2
H8
H4
H3
H-1
H
F
H5
H6
DLRE
AB-2
AB-2
AB-1
AB-1
AC-2
AC-2
AC-1
AC-1
Star Trackers (AB&AC)
E-1 (Mini-RF)
A
B
CRaTER
AD-2
AD-1
LOLA (AD)
A
A-2
A-1c
LROC WAC
AB
AD
A-3
AB
cut
A-1b
AA
AA
LAMP
Top
A-1
Bottom
A-1a
Instrument Module
LEND
G-3
G-2
G-1
G-4
G


B-1
D-4
D-6
D-5
D-6
D-3
D-1
D-2
B
D
Propulsion
Attach
Antenna
here
Spacecraft
Bus
cut all
C-1
C
AE-1b
AE-1c
AE-1a
AE-1
LAMP (AE)
B-2