Lunar Librarian Newsletter
July 2007

Vol. 2. Issue. 7

LRO News

LRO's Propulsion System Begins Integration and Testing at NASA's Goddard Space Flight Center

By Natalie L. Simms

A team of engineers at NASA's Goddard Space Flight Center (GSFC) in Greenbelt, MD is putting the finishing touches on the propulsion sub-system for NASA's next mission to the Moon, the Lunar Reconnaissance Orbiter (LRO). The propulsion system provides the velocity needed for lunar orbit insertion and helps keep the reaction wheels (which keep the spacecraft properly oriented) from saturation. This goal would not have been met without the expertise of the team members working on this project. The team of 12 technicians and engineers is led by Chuck Zakrzwski, Lead Propulsion Engineer; Dr. Eric Cardiff, Lead Propulsion Hardware Engineer; and Mark Fiebig, Lead Propulsion Integration and Test Engineer.

Single Prop Tank in Clean Tent

It was six years ago that Dr. Cardiff focused on his thesis work on solid propellants, spacecraft design, and electric propulsion. Upon completion, he was hired as an engineer at GSFC. And now as Lead Propulsion Hardware Engineer for LRO, Dr. Cardiff manages all propulsion hardware. In reference to his work on the propulsion system, he says "it will be a chance to demonstrate that we at Goddard can innovate and produce a propulsion system very quickly and demonstrate how practical it is, efficient, cost-effective, and more importantly, of superior quality."

Mark Fiebig, Propulsion Integration and Test Lead Engineer, thinks back to his initial desire to become an engineer. "I think it all started with the Star Wars movies. Watching those movies really worked my imagination. It was my high school physics class that solidified my interest in science and engineering." He further gained knowledge from his graduate work in aerospace, specializing in gas dynamics; and his experience with SDO, where his main role was module welding operations. Mr. Fiebig is enthusiastic and happy to be a part of the team as he comments, "we are propulsion and we are there for a reason. It is great to look at what the propulsion team is contributing to the program. I am thrilled to be a part of the exploration initiative where new discoveries will be made."

The bulk of the LRO propulsion hardware originated from the Hubble Space Telescope Robotic Vehicle (HRV) servicing and deorbiting mission, which was decommissioned in 2005. This LRO propulsion system, made up of 2 propellant tanks and 12 monopropellant thrusters, has multiple objectives. Cardiff explains that "once we leave the Earth's atmosphere, bound on a trajectory to the Moon, then you actually have to enter orbit and that is what our propulsion system will be used for." Once LRO orbits the Moon, it is the propulsion system that will help maintain the orbital altitude. The propulsion system is also used to reduce some of the momentum that will be built up on the spacecraft.

The team is currently integrating and testing the system. Fiebig says in summary, "we are currently welding and testing component modules, performing tank thermal and electrical integration, and assembling the orbit insertion thruster deck. We will soon be integrating the propellant tanks, orbit insertion thruster deck, attitude control thrusters, and component modules with the main deck and cylinder."

Stay tuned for more LRO project updates. Some food for thought is how would all this work without power? Stay tuned for the next article in this series on LRO's power sub-system.

NASA News

The Phoenix rises from the ashes… Off to Mars we go!!

As early as August 3, the beginning of a three week launch window, Phoenix may be on its way to Mars. Once on its way, Phoenix will have a risky decent to land on Mars in early spring 2008.

This mission will be different than previous missions to Mars. Unlike previous landers, the Phoenix will not rove over the Martian surface, but crawl. Its investigation of the surface will be centered in the artic region of the northern hemisphere to look at the frozen terrain. As Phoenix crawls over the surface, it will attempt to determine if the frozen water on the surface might or might have contained viable life.

"Phoenix has been designed to examine the history of the ice by measuring how liquid water has modified the chemistry and mineralogy of the soil," said Peter Smith, the Phoenix principal investigator at the University of Arizona, Tucson.

"In addition, our instruments can assess whether this polar environment is a habitable zone for primitive microbes. To complete the scientific characterization of the site, Phoenix will monitor polar weather and the interaction of the atmosphere with the surface." (http://www.nasa.gov/mission_pages/phoenix/news/phoenix-20070709.html)

The lander, as shown in the artist rendition above, will be about 5 feet long and 18 feet wide with the two side solar panels unfurled. Phoenix will also have a 7.7 foot robotic arm that will be able to dig in the upper few inches of the icy, layer surface. The collected material, soil and possible ice, will be examined by a camera and a conductivity probe. Next the samples will be lifted to two instruments on the lander deck. "One will use heating to check for volatile substances, such as water and carbon-based chemicals that are essential building blocks for life. The other will analyze the chemistry of the soil." (http://www.nasa.gov/mission_pages/phoenix/news/phoenix-20070709.html)

You would think just that would be enough for this lander, but it will also be a Martian weather station. For a planned three-month mission (Martian spring and summer), Phoenix will use a laser to asses the water and dust in the atmosphere. Also onboard are two cameras, one of which is a stereo camera, and two microscopes.

Landing on Mars will be tricky. Since 2003, engineers have been testing the landing systems to identify and address any problems that may exist. In order to land on the area of Mars, which is at equivalent latitude of northern Alaska, the Phoenix will use pulsed thrusters as a method of deceleration. Phoenix will also use its heat shield to slow down the high-speed entry, which will be then assisted by a supersonic parachute. This will allow the lander to slow to approximately 135 mph. Once the lander separates from the parachute, it will used pulsed descent rockets to slow to about 5.5 mph. Phoenix will finally come to a landing on its three legs.

For more on Phoenix, please see: http://www.nasa.gov/mission_pages/phoenix/news/phoenix-20070709.html and http://www.nasa.gov/phoenix.

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!

Thinking Big About Space Telescopes
NASA's next Moon rocket is still on the drawing board, but already scientists are dreaming up big new things to do with it--such as launching giant telescopes into space.
http://science.nasa.gov/headlines/y2007/25jun_l2.htm?list907815

Summer Moon Illusion
For sky watchers in the northern hemisphere, this weekend is the best time of the year to experience the mysterious and beautiful Moon Illusion.
http://science.nasa.gov/headlines/y2007/27jun_moonillusion.htm?list907815

Risky Descent
NASA's Mars rover Opportunity is scheduled to begin a descent down a rock-paved slope into the Red Planet's massive Victoria Crater. This carries real risk for the long-lived robotic explorer, but NASA and the Mars Rover science team expect it to provide valuable science.
http://science.nasa.gov/headlines/y2007/28jun_descent.htm?list907815

The Adventures of ASTRO and NextSat
A pair of robots named ASTRO and NextSat have been working together in Earth orbit, docking, undocking, flying around and refueling, as if they have minds of their own. Their adventures may herald a revolution in the way we explore space. http://science.nasa.gov/headlines/y2007/06jul_astroandnextsat.htm?list907815

Great Perseids
The Perseid meteor shower is coming, and experts say it should be a great show.
http://science.nasa.gov/headlines/y2007/11jul_greatperseids.htm?list907815

Librarian News

Summer programs are in full swing. What have you done or are planning to do this summer for your children? Are you doing a space theme? A discovery theme? What have the children enjoyed the best?

Please feel free to share your activities and adventures with the other Lunar Librarians throughout the country. All you have to do is drop me a line or email.

Arizona:
Maya Castillo & John Muno of the Valencia Branch Library, Tucson, Arizona are planning a series of programs in July and August on LRO and the Moon. More information about their program can be found at the two links below.

- http://www.tppl.org/calendar/calendar.cfm?Action=viewMonth&TheDate=2007-07-01&&TheLocationID=16&TheCategoryID=1&TheSearch=moon
- http://www.tppl.org/calendar/calendar.cfm?Action=viewMonth&TheDate=2007-08-01&&TheLocationID=16&TheCategoryID=1&TheSearch=moon

Did you know?? Where can I find??

So you're looking LRO shirts…. Look no farther… If you are interested in ordering your own LRO paraphernalia check out: http://lro.eliteimagestore.com/home/

Links of the Month…

- "LIFEONTERRA is a collaborative filmspace and laboratory exploring the questions and ideas on the cutting-edge of science and at the farthest horizons of the natural world." http://www.lifeonterra.com/

- Lunacy. This is one of the videos available on TERRA. Some of the images may be familiar to you from previous NASA animations. http://www.lifeonterra.com/episode.php?id=98

- Did you ever want to take a "Field Trip to the Moon"? The American Museum of Natural History is running a program that allows the audience to experience the thrills of a NASA rocket launch and an astronaut's view of the Earth. http://education.amnh.org/school_groups/offering.php?id=85

- Space Weather: Ever wonder what the weather is going to be like today or tomorrow? Oh sure, you watch the news or check out the radar at the NWS, but what about space weather? Will you be able to see an aurora tonight? Will you cell phone stop working tomorrow due to a solar storm? For more information, check out: http://spaceweather.com

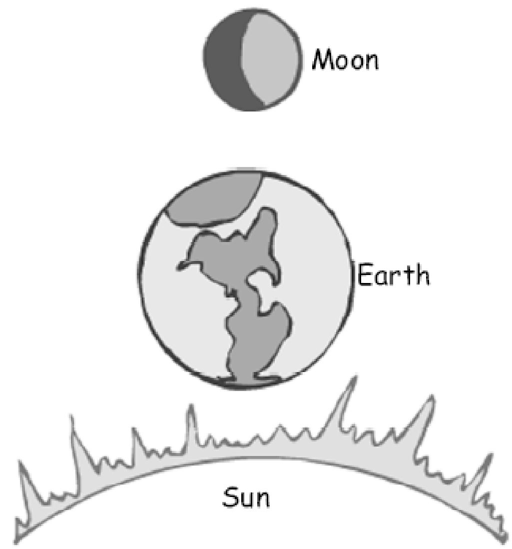
Just a reminder: We will resume our newsletter in September. Please enjoy your summer!!!

Monthly Lunar Activity

Earth, Moon, Mars Balloons

Introduction:

How big is the Moon? How far from Earth is the Moon? Earth science and astronomy books depict a moon that is much closer and much larger than in reality. The example below is typical of what is found in textbooks:



This balloon activity will allow students the opportunity to construct a scale model of the Earth-Moon system, both in terms of planetary sizes and distances. In addition, students make a scale model of Mars, and discover how far one might have to travel to visit the most Earth-like planet in our Solar System. This activity is also a good introduction at the beginning of a unit on the Solar System, to pre-assess student knowledge of planetary distances.

Materials (for a class of 27):

_ 1 bag blue balloons (at least 9 per bag)
_ 1 bag white balloons
_ 1 bag red balloons
_ 27 copies of Planetary Data Handout
_ Rulers/measuring devices in inches or centimeters

Step-By-Step Instructions:

1. Obtain balloons. The best are balloons with 2 1/2 inch diameter when deflated, but most round balloons will work. An easy way to do this activity is to purchase balloons that are colored. The red, white, and blue balloons can be used for Mars, Moon, and Earth. using green for Earth and yellow for the Moon are also fine.
2. Discuss the question of size of the Earth relative to the Moon. Determine what misconceptions the students may have.
3. Distribute balloons. It is best to provide one third of the class with “Earth” (i.e. blue), one third with “Moon” (i.e. white), and one third with “Mars” (i.e. red).
4. Distribute Planetary Data Handout Sheet, one per student.
5. Tell students that the Earth balloon will have a diameter of 20 cm (approximately 8 inches). Have them figure out the scale (divide the Earth’s actual diameter by 20 cm. Earth is about 63,800,000 times larger than 20 cm). Ask students with Earth balloons to inflate their model to this scale (obviously the balloon is not a perfect sphere, but neither is the Earth).
6. Ask students to look at the handout and calculate the size that the Moon and Mars should be, using the same scale as the Earth model. The teacher’s copy has the answers: the Moon should be about 5 cm (2 in) and Mars about 11 cm (4 in).
7. Have students inflate their Mars or Moon balloons.
8. Ask students, at this scale, how far apart are the Earth and Moon? The diagrams seen in common textbooks might lead many of them to suggest that the Moon balloon should be held less than a meter from the Earth balloon.

9. Have students calculate the distance from Earth to the Moon at the same scale as the balloon models. The distance is about 6 meters. Have students holding the Earth models stand at one side of the room, and a partner holding a Moon model about 6 meters (20 ft) away.
10. Point out to students that they now have a scale model of the Earth-Moon system. The distance between the two is the distance traversed by the Apollo astronauts who went to the Moon in the 1960’s and 70’s. (Have students recall the film Apollo 13).
11. Compare the size of the Mars model with the Earth and Moon model. Look at the distance between Earth and the Moon.
12. Ask students how far away they think Mars will be at this scale. Have students attempt to demonstrate it in the classroom.
13. Have students calculate the distance to Mars at this scale. The answer is about 12,000 cm, which in more familiar terms is 3/4 of a mile! Have students identify a local landmark that is about 3/4 of a mile away.
14. Discuss the relative distance between Earth and Mars in the context of a human trip. How long did it take for Apollo astronauts to get to the Moon? (3 days) How long would it take for astronauts using similar technology to get to Mars? Mars Pathfinder, which launched in December 1996, arrived at Mars on July 4, 1997 (7 months). Mars Global Surveyor, which launched in November 1996, arrived at Mars in September 1997 (11 months).

Extensions:

1. Ask students to make models of the Martian moons, Phobos and Deimos, at the same scale as the balloon models. They can calculate their scale diameters from the enclosed chart. It turns out that they are about the same size of a small grain of sand!
2. Have students convert all metric measurements into the English system. |
   1 inch = 2.54 cm, 1 mile = 1.6 km

Answers to balloon exercise:

Scale Distances		(km) ÷ 638 =	(cm)
Earth	Moon	3.84×10^5	600 cm = 20 ft
Earth	Mars	7.80×10^7	1.2 x 105 cm = 3/4 mi

Credit: ASU Mars K-12 Education Program

http://marsprogram.jpl.nasa.gov/classroom/pdfs/earthmoonmarsballoons.pdf

Planetary Data

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Distance from the Sun (AU)	0.387	0.723	1	1.524	5.203	9.537	19.191	30.069	39.481
Approximate Distance from the Sun (10^3km)	57,910	108,200	149,600	227,940	778,400	1,429,725	2,870,980	4,498,250	5,906,370
Radius	2,439.7	6,051.8	6,378.14	3,397.2	71,492	60,268	25,559	24,764	1,195
Mass (Earth = 1)	0.054	0.88	1	0.149	1,136	755	52	44	0.005
Density (gm/cm^3)	5.43	5.24	5.515	3.94	1.33	0.70	1.30	1.76	1.1
Rotation Period (day length)	58.65	-243.02	0.99	1.03	0.41	0.44	-0.72	0.67	-6.39
Orbital Period (year in days)	88	225	365	687	4,333	10,760	30,685	60,190	90,800
Sideral Period (length of year in Earth years)	0.24	0.62	1	1.88	11.86	29.42	83.75	163.72	248.02
Orbital Tilt (degrees)	0	177.3	23.45	25.19	3.12	26.73	97.86	29.58	119.61
Satellites	0	0	1	2	16	18	15	8	1

Balloon Exercise

Body	Diameter (km) / 638 =	Approximate Scale (cm)
Earth	12,756	~20 cm
Moon	3,476	~5 cm
Mars	6, 794	~11 cm
Phobos	22	~0.03 cm

Scale Distances		(km)	/ 638 =	(cm)
Earth	Moon	3.84×10^5		600 cm = 20 ft
Earth	Mars	7.80×10^7		1.2 x 105 cm = 3/4 mi

Glossary

AU - astronomical unit, the distance between Earth and Sun ($\sim 1.495 * 10^8$).

Rotation Period - the length of the day.

Orbital Period - the length of the year in Earth days.

Retrograde - when a celestial body rotates in the opposite direction of the Earth or clockwise.

Satellite - another name for a moon.

Sideral Period - the length of a planet's year in Earth years.

Tilt - how a far a planet is tilted sideways on its axis, measured in degrees.