Mission to the Moon

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Background

Scientists wouldn’t send a rover to the moon without a detailed plan. There are numerous scientific and engineering considerations that would come into play in deciding what research a lunar rover will conduct, including where it will land. Scientists use imaging data from satellites orbiting the moon to learn about its surface and guide their decision-making to choose scientifically significant landing sites.

Astro-visualization software tools allow users to visualize the universe. Some of these tools incorporate NASA data, which NASA scientists use to plan and interpret scientific observations from space-based instruments aboard robotic spacecraft.

Your challenge is to use NASA data to create a lunar rover mission plan to the moon, and to use astro-visualization to identify and evaluate possible landing sites for a lunar rover.

Potential Considerations

As you develop your mission plan and visualization, you may consider the following criteria for choosing a moon-landing site for a lunar rover:

- What are the scientific goals of your mission? What do you hope to learn?
- Will a rover be able to land safely and travel easily at the landing site?
- Is it possible for a rover to search for water at the landing site?
- How much of the moon’s geological past can be studied at the landing site?

Earth to Moon Transit Aspects

Getting the Payload there:-

LEO to Lunar Orbit – Transfer Options

Journeys from Earth to the Moon involve solving a number of variable problems. Not just the simple 2-body problems, but the three and four body problems also.

The document at <http://my.lunarmissionone.com/schools-files/Higher-School/Mission%20manoeuvres,%20James%20Foggin.pdf> has some information on orbit transfer optimisation. Further work will be needed though.

Earth to Moon Transit Risk Factors

Operation	Hazard	Mitigation	Risk Factor
Stable Low Earth Orbit	Space Debris and other equipment in LEO	Monitoring and Avoidance Strategies	
Transfer from LEO to HEO (Highly Eliptical Orbit).	Space Debris and other equipment in all Earth orbits.	Monitoring and Avoidance Strategies combined with Pre-planning thruster burns.	
Transfer to Lunar Orbit	Missing Destination		
Transfer to Lunar Orbit	Other Lunar Orbiting Equipment.		
Transfer to Lunar Orbit	Unexpected Lunar Surface Impact		

Landing Site Selection

Useful paper from Amy Gardiner (Nuffield-Summer-Placements) <http://my.lunarmissionone.com/schools-files/Higher-School/Site%20selection%20and%20hazard%20avoidance,%20Amy%20Gardiner.pdf> We are probably looking for the most suitable hectare of lunar real estate that is:-

- moderately flat and level,
- not too littered with large boulders,
- sufficently geologically stable to support the lander mass in its landed attitude.

Use of LRO data during project planning.

NASA's LRO data website contains images with specified coverage size per pixel of image. Thus, dimensioning to a moderate accuracy can be achieved from the image. LRO data is also available as

multi-image overlays with a variety of spectral sensitivities. Thus, almost 3D imaging of Lunar landscape features can be pre-determined. See <https://lunar.gsfc.nasa.gov/> for access to the imagery.

Pre-landing Orbital Operations

Multi-staging the probe project into pre-landing orbital survey operations can improve the gathering of more site specific data by guiding a range of sensors and imaging equipment to observe the surface. Stereoscopy, multi-pass stereoscopy, Laser reflection land-mass height determination, and radar observations cann all combine data to build the bigger picture (whether the processing for such is done on Earth or in the probe). Such observation will then permit the final selection to be made on close quarters observational data, especially if low pass swoops were incorporated as a mode of orbital observation profiling.

Landing Site Pre-marking

Following final landing site selection, the dropping of several beacon devices that land around the selected site can be considered as triangulation devices for correcting the final landing site identification. Similar to providing radio beacons for ILS systems.

Lunar Surface Exploration

Roving Around

Rovers are popular for traversing the locality around the landing site. Such rovers will have to be designed for operation in the vacuum of space, and the presence of a dusty surface. It is understood that Lunar Regolith Dust can be extremely abrasive between moving parts of equipment. Being in a vacuum does not bode well for grease based lubrication. Additionally, the likely surface temperature range from -173ºC (100ºK) to 127ºC (400ºK) will pose problems for greases and water based solutions. The tyres for a rover will also need special consideration, to ensure they are robust enough to continue fault free operation on the lunar surface.

Sampling Tools

- Scoops
- Drills
- Seismic Impactors and Sensors
- Scrapers