2.00AJ / 16.00AJ Exploring Sea, Space, & Earth: Fundamentals of Engineering Design
Spring 2009

2.00AJ/16.00AJ Prelab 1: Exploration on the Moon (aka, Killian Court): Mission Planning for EVA and Geology

Exploration Lab sessions:
Tuesday March 10, 2:30-4pm
Thursday March 12, 2:30-4pm

Background:

"From the time of our birth, our instinct is to explore. To map the lands, we must explore. To chart the seas, we must explore. To make new discoveries, we must explore."

–Neil Armstrong

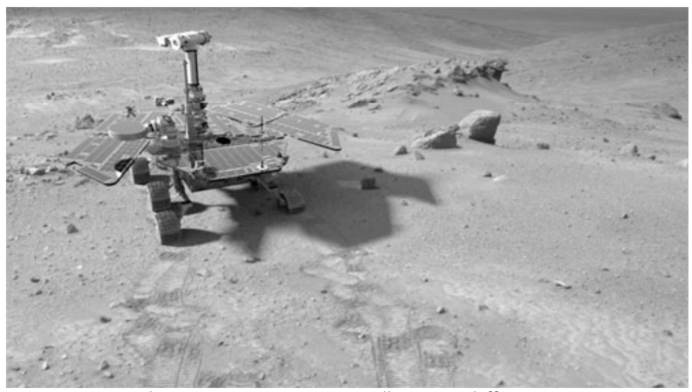
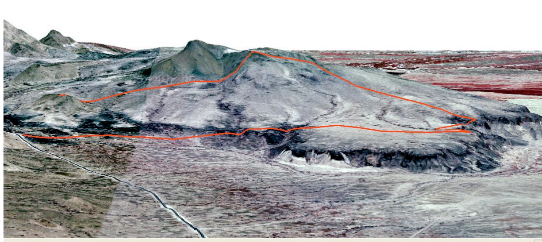
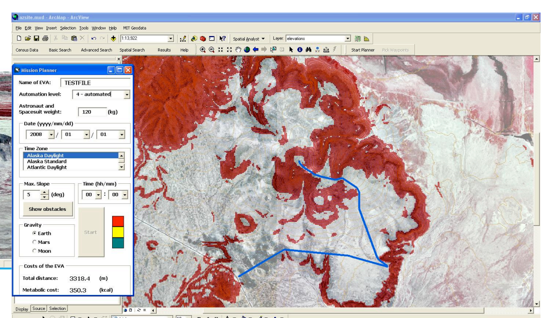


Photo credits : http://www.nasa.gov/centers/ames/images/; http://marsrover.nasa.gov/gallery/specialEffects/spirit

Courtesy NASA/JPL-Caltech.





Images: Prof. Dava Newman

Several days ago, a rover sent through the Killian terrain identified various regions of distinct geological formations. Within each region, the rover mapped the locations of several sites where highly interesting geological samples may be collected. In response to this exciting discovery, a team of astronauts and rovers nearby on the surface has been re-directed to the Killian region in order to examine and bring back these samples. Nearing the end of their scheduled surface mission duration, the team has enough resources remaining for roughly 8 hours of work toward exploring Killian before they must return to the lunar module. In response to this change of plans, Mission Control must now develop a strategy to maximize the scientific return from Killian before returning the surface team home safely.

Lab Overview:

The class will perform a Space/Earth Mission Planning Exploration laboratory by gaining field experience (outside exploration) and mission control experience (simulated mission operations). During the laboratory hours, students will participate in two teams (Shackleton[1] and EARLE[2]) and be given the task of planning and conducting a geological-style surface extravehicular activity (EVA) with spacesuited astronauts, robots, and mission control crewmembers. The exploration terrain will be Killian Court, while Mission Control will be located in Room 3-471. Team members will specialize into distinct roles as outlined in the next section. After a planning phase, team Shackleton will perform the first EVA mission. This will be followed by a brief discussion period, and then team EARLE will perform the second EVA mission. Those on the surface team for Shackleton will be operating mission control for EARLE, and likewise the Shackleton mission control team will be on the surface for EARLE. The lab session will conclude with a debriefing to discuss what was learned, challenges faced, different strategies, how contingencies affected the mission, and the application to real lunar space EVA missions.

Shackleton's Endurance

Photo credits: http://www.shackleton-endurance.com/

Image removed due to copyright restrictions.

Please see http://www.sciencefriday.com/images/shows/2005/111805/earle.jpg

[1] Sir Ernest Shackleton, Antarctic explorer, attempted the first transcontinental crossing of Antarctica (1914-1916) as he had already been beaten to the South Pole by Amundsen and Scott. Shackleton's legendary survival story exemplifies great leadership, teamwork and perseverance, and was a complete failure in terms of exploration, but one of the greatest exploration stories of all time. Trapped in the Weddell Sea and crushed by ice, the Endurance sunk, stranding the crew. In their epic struggle for survival, Shackleton ensured the rescue of all of the *Endurance* crew. (http://www.pbs.org/wgbh/nova/shackleton/). The Schackleton crater lies at the South Pole of the moon.

[2] Dr. Sylvia Earle (1979), undersea explorer, walked untethered on the ocean sea floor at a lower depth than any living human being before or since. In the pressurized (101 KPa (1 atm.) Jim suit, she was carried by a submersible down to the depth of 381 m (1,250 ft) below the ocean's surface off of the island of Oahu, Hawai´i. Dr. Earle detached from the vessel and explored the depths for two and a half hours with only a communication line connecting her to the submersible, and nothing at all connecting her to the world above. She described this adventure in her 1980 book: *Exploring the Deep Frontier*. (http://www.jeannineatkins.com/books/jcahowhigh.html).

Team Format:

<u>Lunar Exploration Surface Team</u>

Astronauts (4) The astronauts will be physically moving ("loping" is the preferred means of locomotion by lunar astronauts) about Killian Court, wearing Apollo "space suits". Astronauts must stick together. The lunar astronauts will communicate with Mission Control via walkie-talkie. Each astronaut will be able to carry one "sample" at a time.

Rovers (6) The lunar rovers will be three RC robots, and are part of the exploration team investigating Killian Court. Unlike astronauts, rovers do not need to stick together and can move wherever commanded. The rovers will be equipped with wireless cameras fed back to Mission Control. RC rover motion will be controlled by human operators out in the field who will receive commands from Mission Control via a text messaging system. Operators (considered part of Mission Control) may not physically assist the rovers; however, an astronaut can move or carry a rover should it get stuck or run out of battery power. Rovers cannot carry "samples."

<u>Lunar Exploration Mission Control Team</u>

Director (1) The Director oversees the mission and makes final decisions regarding how to proceed. All other Mission Control positions report to the Director.

Communicator (2) The Communicator is an astronaut, and the only person who may communicate with the exploration astronauts via walkie-talkie. The second communicator is responsible for commanding the rovers.

Positioning (2) The Positioning Officer(s) will update and display current astronaut and rover positioning on a real-time map display. The Positioning Officer will also need to keep track of distance traveled, inform the Director of astronaut constraints (i.e. distance to return 'home', etc.), and report if/when the exploration activity needs to end.

Medical (2) The Medical Officer will update and monitor the astronaut heart rate and oxygen levels and detects any problems. They will inform the Director of the astronaut status (i.e., metabolic workload, oxygen remaining, heart rate, etc.) and if/when the exploration activity must end based upon data.

Rover Tech. (2) The Rover Technician(s) will monitor the video feed from the rovers and track battery life. Rover positioning commands will need to be given to the Communicator, and visual data provided to the Geologist. They will inform the Director of rover activity status and if/when the activities must end based upon data.

Geologist (2) The Geologist in Mission Control will be provided with data regarding samples of interest to be collected by the field astronauts. Based upon this data, the Geologist will advise the Director as to which sites are most valuable for scientific return.

***Mission specifics (objectives, resources, etc.) will be provided in the in-lab assignment handout.