The slide features a blue background with a white title and author information. At the top, there is a horizontal strip showing an aerial view of a city on the left and a satellite view of Mars on the right. At the bottom, there is another horizontal strip showing a close-up view of the Martian surface.

Robots: Earth, Moon, Mars

Prof. Rob Maher
*Electrical and Computer Engineering
Montana State University*

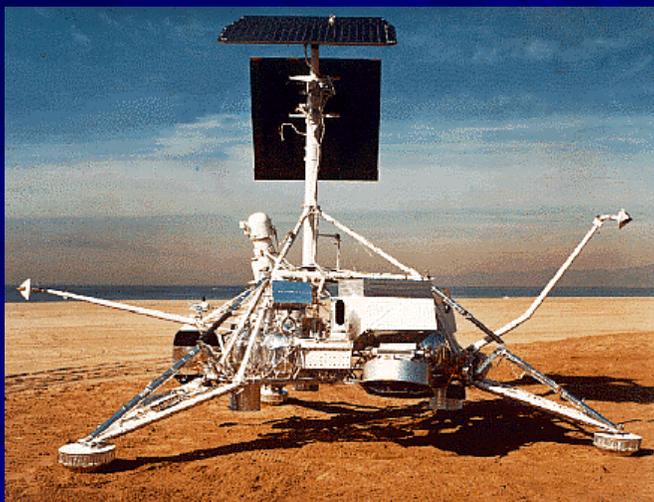
A quick aside: ROBOT

- What is a good definition of the word ROBOT?
- Is your car a “robot”?
- What makes a robot a robot?

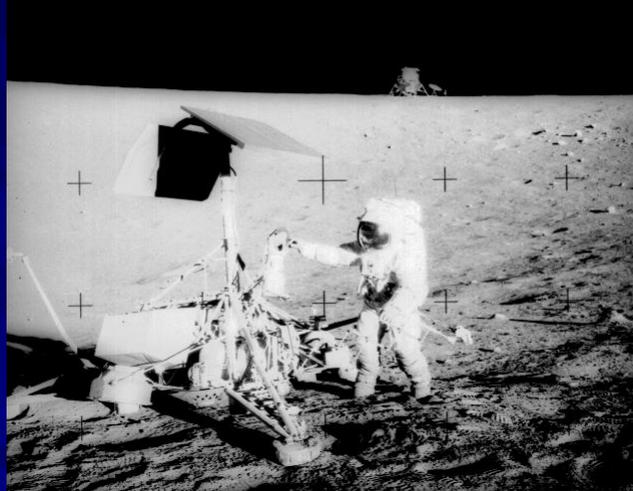
Robots for Space Exploration

What are the advantages *and* disadvantages of using robots for space exploration?

Robots to the moon: Surveyor

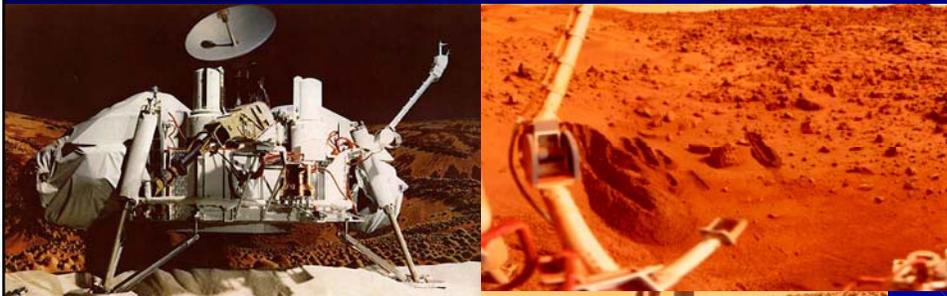


Apollo 12 visits Surveyor 3



Surveyor 3: April, 1967
Apollo 12: November, 1969
Astronaut Pete Conrad (photo by Astronaut Alan Bean)

Robots to Mars: Viking 1&2



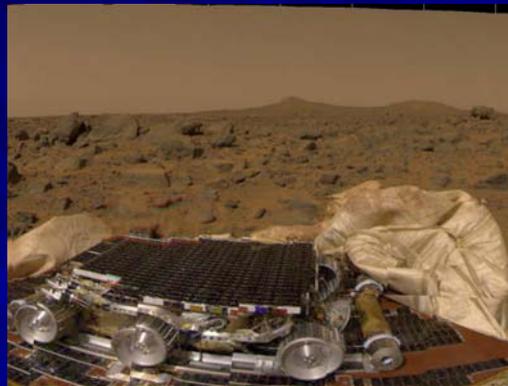
July, 1976



Mars and Earth: Quick Facts

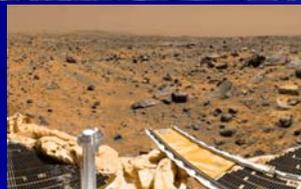
- Diameter  
Mars: 6,794 km ; Earth: 12,756 km
- Day length
Mars: 24.6 hours; Earth: 24 hours
- Year length
Mars: 687 earth days; Earth: 365 earth days
- Mars and Earth are close in orbit approximately every 26 months (35-40 million miles)

Mars Pathfinder: A Test Mission

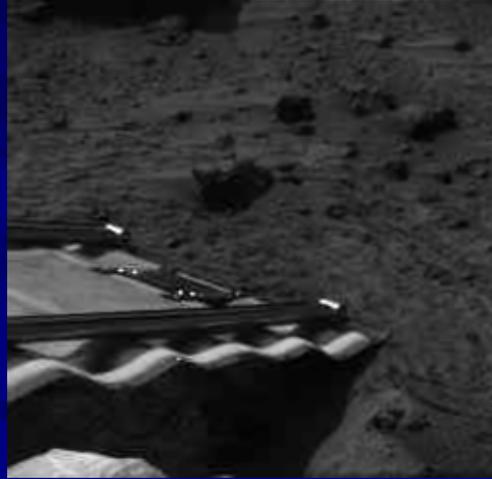


July, 1997

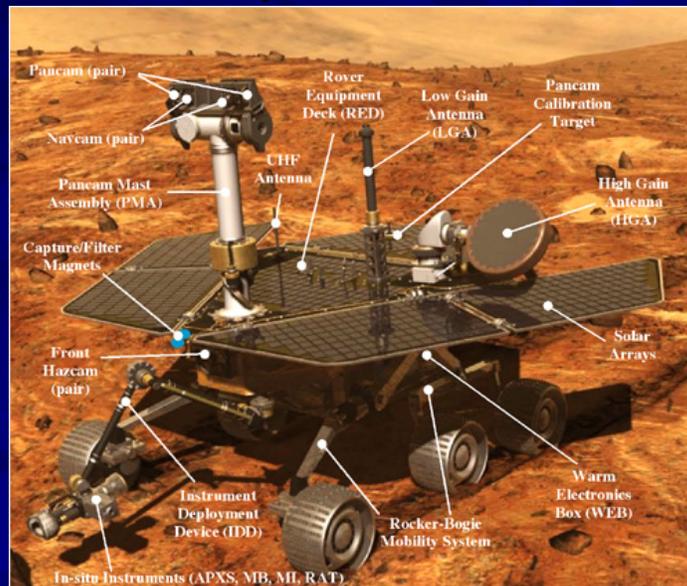
22 End of Day



Mars Pathfinder: Sojourner



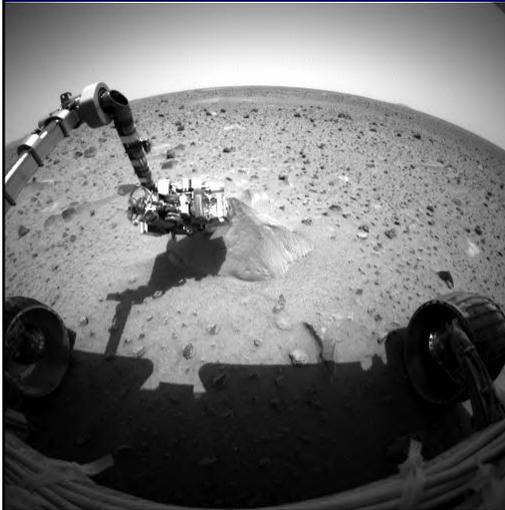
Mars Exploration Rovers



Rovers: Spirit and Opportunity



Robot Arm



“Your” Mission Expenses

- Launch cost: >\$10,000 per kg payload
(2003 rover missions: each 1,063 kg = \$10.6M)
- Design and construction
- Testing
- Communication and support during mission
- Data archiving and analysis
- Opportunity cost

Design Questions

- How do engineers select the *best* solution?
 - They use knowledge and experience
 - They employ a consistent methodology
 - They need to *formulate the right questions*