

# Return to the Moon

By Barry Davidoff

*It has been thirty-one years since man last stepped on the surface of another heavenly body. The footprints of the Apollo explorers and the tracks of their Lunar Roving Vehicles have remained undisturbed. Now there are plans for these footprints to be joined by a new generation of lunar adventurers. President Bush has announced that "It is time for America to take the next steps" in space. Man is returning to the Moon.*

On January 14 President Bush announced a bold new initiative in space policy. The speech did not provide for a specific blueprint, but rather outlined the major goals of NASA for the next 25 years. The major programs include:

- Completing the construction of the International Space Station by 2010
- Retiring the aging space shuttle fleet in approximately 2010
- Developing a new spacecraft, the Crew Exploration Vehicle, with a first manned mission by 2014.
- Resuming unmanned probes on the lunar surface by 2008.
- Returning astronauts to the Moon between 2015 and 2020.
- Establishing a major manned scientific base station on the Moon.
- Flying manned missions to Mars as early as 2030
- Continuing NASA programs for the remote exploration of the solar system and the universe

## ISS and shuttle

In order to revitalize the space agency, the President had to refocus NASA away from ISS and the space shuttle. Neither has performed as expected and they have been the cause of vast cost over-runs. The space shuttle's budget is about \$4 billion a year and ISS costs about \$1 billion.

Although the space shuttle was an enormous breakthrough in technology, it averaged only five flights a year at a cost of over \$500 million per flight. Following the *Columbia* tragedy on February 2, 2003, the three remaining shuttles are grounded until at least early 2005.

The shuttle is essential to complete the construction of the ISS, since the remaining modules were designed to be orbited within the shuttle's cargo bay.

*"We chose to explore space because doing so improves our lives and lifts our national spirit"*

*President George W. Bush  
NASA Headquarters January 14, 2004*



*Footprint from Apollo 11 (NASA / Apollo 11)*

The ISS has been subjected to many reconfigurations and cutbacks. Originally designed to house at least six astronauts, the ISS is limited to a crew of two or three that devote much of their time to maintaining the station.

Rather than attempting to significantly improve the shuttle and use it to service the ISS for the next 20-30 years, it was determined to phase out the shuttle once the ISS is completed around 2010. Crews would continue to be ferried by the Russian Soyuz spacecraft. Supplies would be delivered by the Russian Progress spacecraft and a remote maneuvering module that would be launched by either the European Space Agency's Ariane V or an American expendable launcher.

## Crew Exploration Vehicle (CEV)

Returning to the moon as envisioned by President Bush is more than dusting off the design drawings of Apollo and the Saturn V. Entire new launch systems will be created which benefit from technologies developed after Apollo. The major spacecraft that will be developed is the Crew Exploration Vehicle (CEV) which will carry six astronauts. The CEV can be used either for orbital missions, including those to the ISS, or to carry crews to lunar orbit.



*Crew Control Module planned by Boeing*

The CEV will be launched by a new generation of liquid fueled rockets. The new launcher will use liquid hydro-

gen-oxygen for the upper stages and possibly for the first stage, as well. In the President's timeline the design of the CEV and its launcher will be completed by 2008, with its first manned mission by 2014.

The CEV will be a tremendous improvement over the Apollo Command Service Module (CSM). The electronic components that filled much of the CSM have been greatly reduced in size and weight enabling the CEV to carry a crew of up to 6, rather than 3 in Apollo. Components have been made more dependable through the use of microprocessors and improved materials.

Apollo was over designed, since many of the hazards of space were unknown. The CEV will benefit from the vast experience gained over the last 40 years of space flight. Whether the CEV will be reusable or not will be determined during the design stage.

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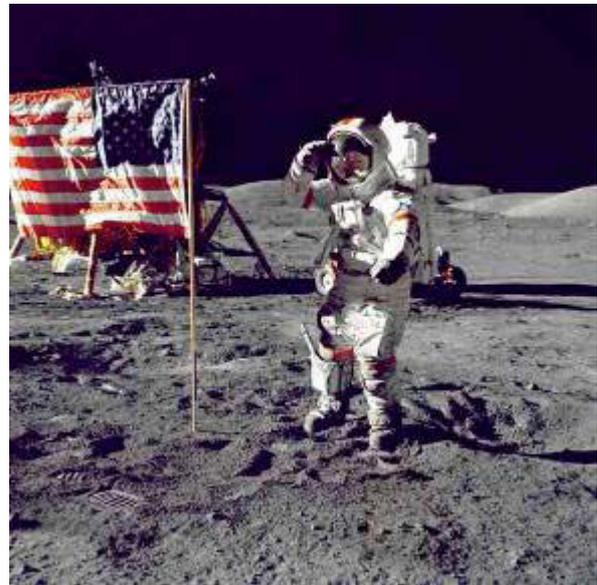
Another step in returning to the Moon is the landing of advanced robotic probes similar to Spirit and Opportunity that landed on Mars in January by 2008. There already is a wealth of information available from the Apollo program. The lunar surface has been mapped and photographed at much higher resolution than the earth itself had been in the 1960's. Twelve astronauts have walked on the Moon and returned with 380 kilograms of documented samples.

When the lunar module was created, the Ranger and Surveyor probes had not flown. The spread of the legs of the lunar module was much wider than necessary since it was feared that the lunar module would sink into possibly a very soft surface. In designing a new spacecraft to land on the Moon, all the knowledge of the extensive Apollo selenology program will be used.

A new generation of heavy lift launchers will be required to return to the Moon. NASA will use an incremental approach in developing the new launcher using already developed engine technology. The new CEV will carry the crew to lunar orbit. The new generation of landers will use lunar orbiting rendezvous for their flight paths since it offers the most efficient method of reaching and returning from the Moon.

About ten years from now, man finally will return to the Moon after more than a 40 year absence. Rather than staying for only three days on the longest Apollo mission, 4-5 people will stay on the Moon for up to two weeks initially with longer stays being possible. The crews will be aided by rovers and additional supplies and equipment that have been remotely landed ahead of the crews.

One of the people in the audience most eagerly waiting for the President's speech was Gene Cernan, who as commander of Apollo 17 was the last man on the lunar surface. (See "Apollo 17: The discoveries of the last men on the Moon" *EAF Nytt*, December 2003). Cernan knew that one day his footsteps on the Moon would be joined by others, but had hoped that a lunar return would occur at a much earlier date.



*Eugene Cernan commander of Apollo 17. The last man on the Moon.*

Beyond the timeline of the President's speech, astronauts may establish a permanent lunar colony. Although the feasibility of lunar mining will have to be determined at a future date, a lunar base will offer outstanding scientific opportunities. Lunar optical and radio telescopes, not limited by the earth's atmosphere, can provide a glimpse deeper into the cosmos.

### Exploration of Mars

The President's speech falls short of providing a time frame for the first manned mission to Mars. The consensus is that it will be in approximately 2030. Advanced robotic missions to explore the red planet will continue to be launched by NASA. A manned mission to Mars will be the fruition of returning to the moon and NASA's plans for the next quarter century. The President was exuberant about the excitement a Mars landing would generate and the discoveries that would be made.

### We chose to go to the Moon

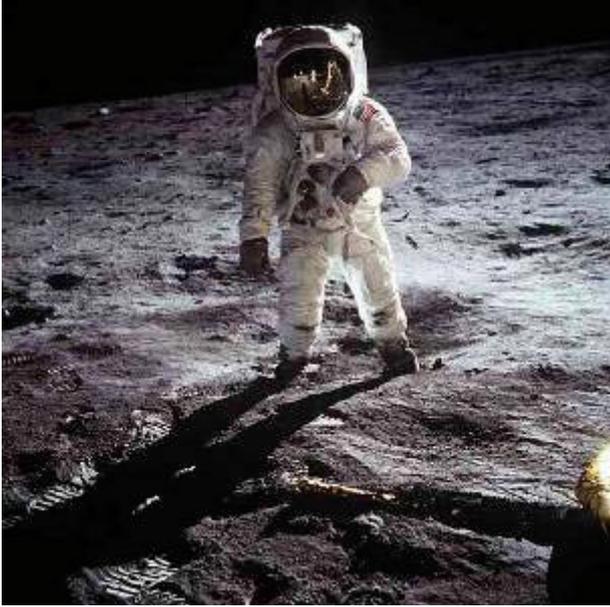
The best rationale for going to the Moon, and indeed all exploration, was written by Theodore Sorenson for President Kennedy's famed Rice University speech (see insert). Going to the Moon was *hard*. The Apollo program at its height employed over 400,000 dedicated people. Many of them devoted their lives to the space program and worked 80-90 hours every week to reach the Moon first.

Going to the Moon was *costly*. The Apollo program cost \$24 billion in 1965 dollars, which is worth between \$150-\$175 billion in today's dollars. During its height the space program consumed over 4% of the entire Federal budget, during which time the Johnson administration fought a War on Poverty and the Vietnam War. In comparison NASA's budget is currently less 1% of the budget.

Totally unknown at the time was the amount that the Russians spent on their own failed attempt to land a

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man, first. Although the Soviets formally denied any intention of ever going to the Moon, they spent \$11 billion on the secret N-1 program. This rocket exploded spectacularly on all four of its launches with a maximum duration of only 107 seconds. (See “N-1 The rocket that failed” *EAF Nytt, Mars-Juni 2003*). This Soviet expenditure represented an even greater proportion of their budget and GDP.



*Buzz Aldrin with Apollo 11*

Going to the Moon was *challenging*. Technologies that had barely been dreamed of when the program was conceived were fully realized before the landing. The Manned Spacecraft Center in Houston (MSC) owned two of the five largest IBM computers. The total data processing power of the entire MSC was 800 billion calculations a day, a very puny amount for one of today's laptops.



*NASA proposed lunar colony*

The Apollo command module had the world's most powerful and most compact mini-computer. On Apollo 7 it had a total memory of 72 kilobytes of RAM. Today, the average automobile has more computing power just to complete its normal functions.

Going to the Moon was *demanding*. When President Kennedy made his announcement of landing a man on the Moon before “this decade is out,” America had total of one 15 minute space flight with the launch of Alan Shepard in a Mercury capsule.

***“Going to the Moon was costly. The Apollo program cost \$24 billion in 1965 dollars”***

Before the first Moon landing, barely eight years later, NASA would develop proficiency in rendezvous techniques, space walks, and long duration flights of up to two weeks, as well as developing the Saturn V.

### **The best of our abilities and skills**

Going to the Moon *did organize and measure the best of America's abilities and skills* and the world has forever improved as a result of the space race. President Bush in his speech highlighted many of the benefits that the space age has provided, and used them as the major rationale for returning to the Moon and eventually to Mars. Indeed the President's penultimate line echoed directly back to the Rice University speech. President Bush stated, “We chose to explore space because doing so improves our lives and lifts our national spirit.”

Only actually sending a manned flight to the moon would have resulted in the vast technological breakthroughs. They may not have occurred if only robotic probes had been used. Manned space flight depends upon complete reliability of every component. Complete new methods of quality control and manufacturing were developed specifically. Apollo forced the creation of dependable rockets so that all 34 Saturn launches were successful. Landing on the moon required the development of liquid hydrogen-oxygen upper stages with greater thrust.

### **Benefits of the Space Age**

When the United States first made the determination to go to the Moon, the benefits were not known. Although some prophets foresaw some of the vast improvements in technology, it was impossible to foresee how deeply the world would change.

The United States poured billions of dollars into research and development, basic sciences and forcing technologies. American industry jumped ahead and created entire new technologies. The return on investment of the space program has many times exceeded its costs.

Even a brief overview of the benefits of the space program and the new industries that were spawned include:

- Telecommunications satellites
- Computer and information technology
- Weather satellites and long range forecasting
- Remote imaging of resources and crops
- Navigation and Global Positioning Systems
- Materials science including new alloys and plastics

From a purely scientific view, there is hardly a discipline that hasn't benefited from the space program. The fundamentals of astronomy have changed. There have been more discoveries since the dawn of the space age than in all the centuries preceding it. The Apollo program answered many questions about the origin of the universe and the primordial solar system.

***“The United States poured billions of dollars into research and development, basic sciences and forcing technologies.”***

Not all the benefits from NASA's new initiative can be seen today. Just as in 1962 when President Kennedy made his Rice University speech, few of the benefits of the space program were foreseen. Returning to the Moon again will force the development of new technologies in designing the CEV and its launcher. The new generation of launchers will provide lower cost and easier access to space providing new opportunities for scientific and commercial spacecraft. New materials, electronics, nuclear power supplies, and computers will be developed as part of the process.

## **Footsteps on Mars**

In pushing onwards to Mars, many new advances in many fields, especially life sciences, will be required. The trip to Mars will take two years, while the record flight on Mir was only 14 months. Returning to the Moon and extended exploration will provide the vital experience.

Since much of the trip to Mars is too far for solar cells to provide sufficient power, new nuclear systems will be developed. The first of these nuclear systems will be used on the Jupiter Icy Moons Orbiter (JIMO), which will explore several of Jupiter's moons following its launch in 2011. It will use a plutonium generator to create electricity to power the probes telemetry and systems and for ion propulsion. The development of nuclear propulsion systems, which can reduce the time for a Mars mission, is a logical corollary.

In early March the world marveled at NASA's announcement that large quantities of surface salt water had existed in the past. Data returned by Opportunity showed hematite, which is a form of iron, that can usually exist where there had been water.

The rocks near Opportunity also showed that they were sedimentary in character and that they were formed by the layering of deposits at the bottoms of lakes and ponds. The existence of large quantities of salt water in the past is a primary indicator that complex organic molecules were formed. Whether these molecules are complex enough to be described as life awaits further probes and manned exploration.

***“In pushing onwards to Mars, many new advances in many fields, especially life sciences, will be required.”***

A manned landing on Mars will be the most exciting period of discovery since the first ventures to the New

World. Many of the fundamental issues of science and philosophy will be challenged and potentially answered. These issues include; the origin of the solar system, the structure of planet and the origins of life. More profoundly a manned landing may answer the most fundamental question, “Are we alone?”

## **Improving lives and human spirit**

Returning to the Moon and pushing onwards to Mars will improve lives in so many ways not even envisioned and will lift the international spirit of science, discovery, and wonder. Just like the first lunar landing such ventures are pursued not because they are easy, but because they are hard, and they will organize and measure the best of the world's abilities and skills.

### **President Kennedy's Speech at Rice University on the Conquest of Space September 12, 1962**

In September 1962, President Kennedy journeyed to Houston for the dedication of the new Manned Spacecraft Center. America was locked in the Cold War with the Soviet Union and the space race was a critical component. President Kennedy in May, 1961 already had committed America to “landing a man on the moon and returning him safely to earth before this decade is out.” The Soviets seemingly had an insurmountable lead.

President Kennedy spoke at Rice University's football stadium, since Rice had donated the first acreage for the construction of the Manned Spacecraft Center. In a dazzling speech, the President outlined the reasons for exploring space. After noting the rapid progress of civilization and science, the President said, *But this city of Houston, this State of Texas, this country of the United States was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward--and so will space.* President Kennedy then added, *We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man...* The President talked about the benefits of the conquest of space against the specter of the Cold War. He reached the critical juncture of his speech when he talked about space, and then questioned, *“Its conquest deserves the best of all mankind, and its opportunity for peaceful cooperation may never come again. But why, some say, the moon? .... We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.”*

Less than seven years after the Rice University speech, due to the incredible work of over 400,000 people who worked on the Apollo project, President Kennedy's challenge was fulfilled with the first Moon landing.