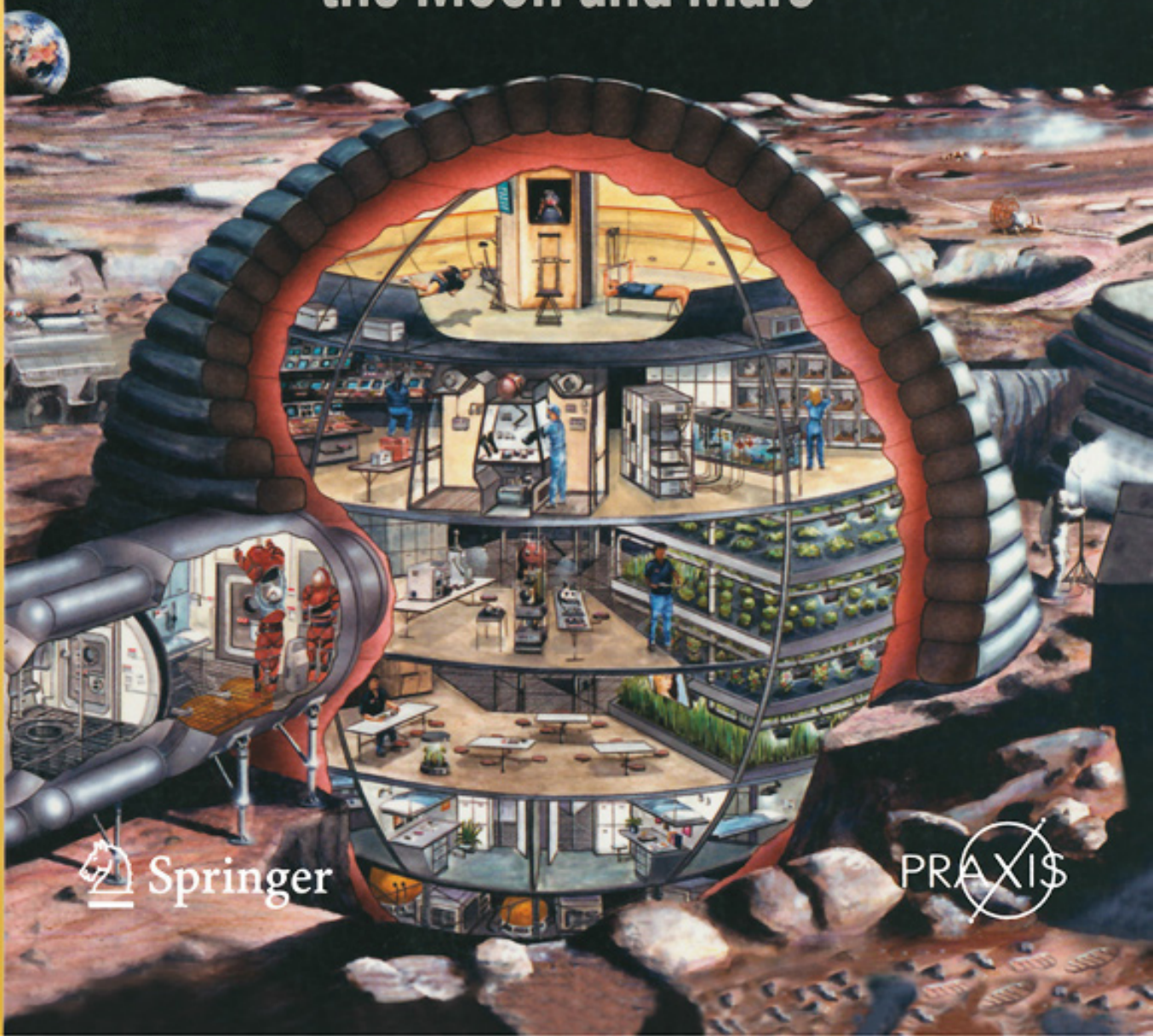
HAYM BENAROYA

# TURNING DUST TO GOLD

## Building a Future on the Moon and Mars



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# Foreword

The goal of this book is to demonstrate that expanding our civilization to the Moon and beyond is not beyond our reach, intellectually or financially. Apollo was not our last foray into the Solar System. Science fiction, as good as some of it is, will have a difficult time staying ahead of science and engineering fact. However, this book is intended to be more than purely a technical manual. Space is not, nor should it be, only of interest to aerospace engineers and cosmologists. Space needs to be of interest and of concern to all of us. It is the world's West, as in Go West for new opportunities for freedom and limitless growth. What I hope to demonstrate to you is that not only *can* we go back to the Moon to stay, but that we *must* do so. And not only for esoteric reasons, but for many reasons, some mundane, but most related to our and our children's continued prosperity, and to our continued survival as a species.

Space, whether we or our children live in it or on the Moon or Mars, will be important to all of us because of the resources it will open for our industrial societies and for the markets it will create. It would be difficult to imagine the United States as a world power if its western border was the Mississippi River. Would a North American continent of several dozen independent states modeled after Western Europe have been able to resist the totalitarian attacks that occurred in the 20th century? Alone, neither Europe nor Asia was capable.

The expansion of the best Earth has to offer in science and culture to the Moon, then Mars, and eventually the Solar System, can only strengthen humanity's core positive achievements: democracy, individual rights, equal opportunities for an individual's achievements, and all that is inherent and is based on these being in place.

This book is written from the perspective of a future observer, more than 150 years into the future, and some of the narratives based on a fictitious group of documents discovered in an old repository that chronicled the settlement of the Moon during the last half of the 21st century and first half of the 22nd century. In order to make the documents more connected and interesting to the casual reader, they have been weaved into a chronological storyline meant to trace the early days of the human return to the Moon with the aim of permanent settlement.

The interviews in this book are real and original.

# Preface

This book is an historical work based on a group of documents discovered in an old repository that chronicled the settlement of the Moon during the last half of the 21st century and into the 22nd century. There are gaps in the historical record for reasons that I won't get into here, so we have had to guess how we went from "point *a*" to "point *c*" without any detailed information about "point *b*." In order to make the documents more connected and interesting to the casual reader, I, Yerah Timoshenko, have tried as best as I can to weave the issues and concerns of an emerging spacefaring civilization into a coherent perspective. I have focused on the early days of the human return to the Moon with all its trials and tribulations. I am very pleased to have been able to include a good number of historical interviews with a cross-section of people who played a role in humanity's struggle into space. More about me and what I do later in the book.

The return to the Moon occurred at a time of great turmoil on Earth, especially the decades-long war on terrorism. Also, even though the economies of the larger countries were growing and successful, there were constant philosophical and real-world battles about the spending of scarce resources. Debt, both national and personal, was high and growing higher with no end in sight. As is common, most people were focused on the day-to-day activities and events that directly impacted their lives.

The early 21st century was heavily politicized, with all problems and all politics reduced to black and white. One was either on one side of the fence or the other. Those who recognized the gray aspects of reality usually ended up impaled on the fence that separated the camps. It was a time when democracy was spreading, but terrorism was also global. Mankind was making tremendous progress in the sciences and engineering, and the biological sciences were on the verge of breaking through to a deep understanding of the human body and the underlying causes of deadly diseases.

Many nations were once again interested in manned space travel. Rockets were the only way to bring large payloads and people into low Earth orbit and beyond. It was tremendously expensive but also the only option at the time. Space elevators, while studied and believed to be feasible, had not yet been prototyped and tested in the Earth–space environment. As we know now, the massive development of the space elevators led to a thousandfold increase in space activities by the early 22nd century.

Many of us are reminded of the California Gold Rush that began on 24 January 1848 when gold was discovered at Sutter's Mill in Coloma, California, now in the

Sacramento area. That news spread worldwide by the end of 1848, resulting in about 300,000 people coming to California over the next several years. The Rush converted San Francisco from a tent town to a small city, pushing the admission of California as a state in 1850. In the same way, once space elevator prototypes proved the technology viable, full-scale versions were built in orbit around Earth and here in orbit around the Moon.

After that, there was no stopping the flow of goods and people. The floodgates had been opened.


The California Clipper takes you to the California Gold Rush, February 1849.

Our transformation into a spacefaring species occurred in spurts. In the 1960s and 1970s we sent people to the Moon for short visits, and then we gave up on that. Then in the 1980s through the 2010s we sent people into low Earth orbit to build a space station. Somewhere around that time people in several of the more technologically advanced countries decided that it was time to rebuild the space effort with an eye to the permanent settlement of the Solar System, first the Moon, then Mars, and then – well then depended on how successful we were at the first two steps. But so far, in 2169, we have thousands of people on dozens of bodies in the Solar System.

We worked steadily at getting humans and machines into space and to the Moon. We always knew we could do it – what we did not know was whether the political support could be borne over such long time periods. So we started out as turtles with rockets, but ended up as hares with elevators. The rest is history.

This book is a commemorative as well as a selective accounting of some of the key events that punctuated our short history in space. It is published in 2169, two

hundred years after the first men landed on the Moon. There are discussions of some of the technical and other issues that were of great concern – some of which are still baffling our pioneers today.

So this story is a snapshot of how all that we see today, on the Moon, Mars, and beyond, evolved.

# Acknowledgements

I gratefully acknowledge all the people who have deliberated about space and its challenges. I could not have written about such a broad subject without the insights of the community of scholars and practitioners. My interpretation of their work is subject to my perspectives and may have missed the mark – for which I take full responsibility.

I am thankful for the support and encouragement of Praxis Publishing, in particular, Clive Horwood, who accepted this project and graciously and patiently waited for me to complete the book over many missed deadlines. I am grateful to Dr John Mason who provided insightful suggestions for improving the style, content and organization of the manuscript, as I am to Rachael Wilkie who edited this work. And I appreciate the fine work with the LaTeX formatting of the manuscript by Frank Herweg, without whose efforts the book would not look as good as it does.

The book is more interesting due to the numerous images, many of which come from the NASA archives. I tip my hat to them for the development of such a collection, one that is indicative of all the great work of the NASA teams over the past six decades of trailblazing the space frontier. I sincerely thank all the creative people who generously granted permission to use their images. And I can never repay those who granted me interviews and trusted me to put their words in a book that they will hopefully find to be a good home.

I am grateful to and wish to highlight the two images created by my daughter Ana. And, last but not least, my sincere thanks go to my son, Adam, and my closest friend, Mark Nagurka of Marquette University, for their major editing of this book – resulting in a much improved style.

# Dedication

I humbly dedicate this book
to all those who commit their lives
to enable the exploration of space
by humans and machines.
To those who make it possible by their engineering,
scientific and medical research,
by their creative achievements and imaginative practice.
To those who are now still in elementary school,
are able to look forward to the joy of discovery,
and will be the ones who return to the Moon,
take the first steps on Mars, the outer planets and their moons.
And last but certainly not least,
this book is dedicated to the men and women who spend their lives
– sometimes sacrificing their lives –
protecting the rest of us and our democracies
so that we can spend our lives
creating new worlds.

# 1 Go west ... settle space

*"Beautiful, beautiful. Magnificent desolation."*

Buzz Aldrin

In the year 2169, as we commemorate the 200th anniversary of humans landing on the Moon in 1969, we try to imagine how difficult it was during the early part of the last century as proponents of manned space travel and space settlement found themselves regularly discouraged by the progress they were witnessing. After all, only a few viewed space as a critical avenue for human creativity. It was viewed by many as a "special interest" for those who would find financial benefits as a result of manned space activity.[1] At that time, many problems existed on Earth (when was this not true!). Therefore, many preferred to minimize public expenditures for NASA and space in the U.S. Many teenagers had no interest in a return to the Moon, and roughly a quarter thought that the Apollo landings were faked!

Some of that thinking changed as a result of 43rd U.S. President George W. Bush's 14 January 2004 speech challenging and charging the U.S. to return to the Moon, to stay, as a first step in mankind's expansion to Mars and the remainder of the Solar System. His speech: *New Vision for Space Exploration Program*, given at NASA Headquarters, Washington, D.C. is presented below. This speech can be viewed as a turning point in the world's view on space exploration and settlement. Subsequently, the European Union, China, Japan and Russia, all committed their nations and organizations to a manned return to the Moon. Unfortunately, funding levels did not match the boldness of the vision.

### 1.0.1 Bush 2004 speech

**President Bush:** Thanks for the warm welcome. I'm honored to be with the men and women of NASA. I thank those of you who have come in person. I welcome those who are listening by video. This agency, and the dedicated professionals who serve it, have always reflected the finest values of our country – daring, discipline, ingenuity, and unity in the pursuit of great goals.

[1] No one who worked in space and aerospace was viewed as a neutral party in supporting a manned return to the Moon. They were viewed as a special interest rather than as an educated participant and supporter of one of the greatest adventures of humanity!

America is proud of our space program. The risk takers and visionaries of this agency have expanded human knowledge, have revolutionized our understanding of the universe, and produced technological advances that have benefited all of humanity.

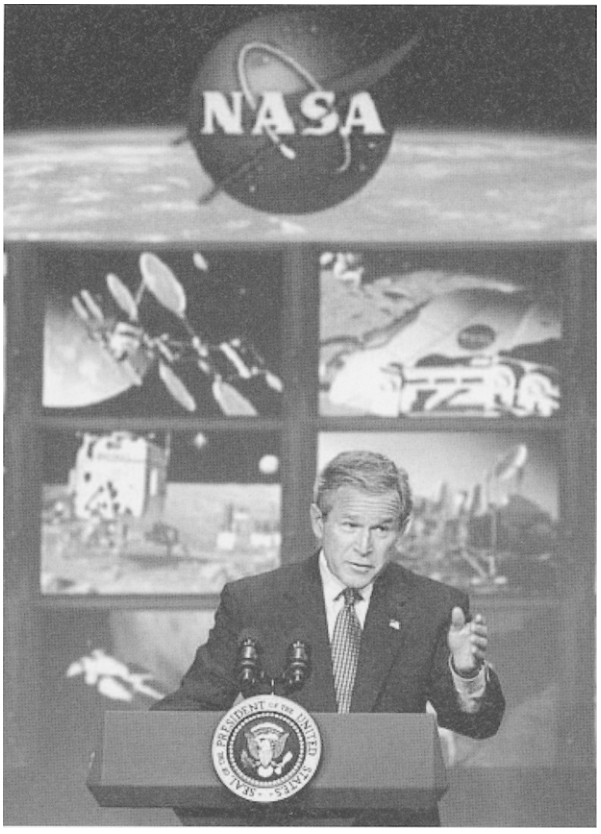


**Fig. 1.1** President George Bush presenting his *New Vision for Space Exploration Program.* 14 January 2004. (Courtesy NASA)

Inspired by all that has come before, and guided by clear objectives, today we set a new course for America's space program. We will give NASA a new focus and vision for future exploration. We will build new ships to carry man forward into the universe, to gain a new foothold on the Moon, and to prepare for new journeys to worlds beyond our own.

I am comfortable in delegating these new goals to NASA, under the leadership of Sean O'Keefe. He's doing an excellent job. I appreciate Commander Mike Foale's introduction – I'm sorry I couldn't shake his hand. Perhaps, Commissioner, you'll bring him by – Administrator, you'll bring him by the Oval Office when he returns, so I can thank him in person.

I also know he is in space with his colleague, Alexander Kaleri, who happens to be a Russian cosmonaut. I appreciate the joint efforts of the Russians with our

country to explore. I want to thank the astronauts who are with us, the courageous spacial entrepreneurs who set such a wonderful example for the young of our country.

And we've got some veterans with us today. I appreciate the astronauts of yesterday who are with us, as well, who inspired the astronauts of today to serve our country. I appreciate so very much the members of Congress being here. Tom DeLay is here, leading a House delegation. Senator Nelson is here from the Senate. I am honored that you all have come. I appreciate you're interested in the subject – it is a subject that's important to this administration, it's a subject that's mighty important to the country and to the world.

Two centuries ago, Meriwether Lewis and William Clark left St. Louis to explore the new lands acquired in the Louisiana Purchase. They made that journey in the spirit of discovery, to learn the potential of vast new territory, and to chart a way for others to follow.

America has ventured forth into space for the same reasons. We have undertaken space travel because the desire to explore and understand is part of our character. And that quest has brought tangible benefits that improve our lives in countless ways. The exploration of space has led to advances in weather forecasting, in communications, in computing, search and rescue technology, robotics, and electronics. Our investment in space exploration helped to create our satellite telecommunications network and the Global Positioning System. Medical technologies that help prolong life – such as the imaging processing used in CAT scanners and MRI machines – trace their origins to technology engineered for the use in space.

Our current programs and vehicles for exploring space have brought us far and they have served us well. The Space Shuttle has flown more than a hundred missions. It has been used to conduct important research and to increase the sum of human knowledge. Shuttle crews, and the scientists and engineers who support them, have helped to build the International Space Station.

Telescopes – including those in space – have revealed more than 100 planets in the last decade alone. Probes have shown us stunning images of the rings of Saturn and the outer planets of our Solar System. Robotic explorers have found evidence of water – a key ingredient for life – on Mars and on the moons of Jupiter. At this very hour, the Mars Exploration Rover Spirit is searching for evidence of life beyond the Earth.

Yet for all these successes, much remains for us to explore and to learn. In the past 30 years, no human being has set foot on another world, or ventured farther upward into space than 386 miles – roughly the distance from Washington, D.C. to Boston, Massachusetts. America has not developed a new vehicle to advance human exploration in space in nearly a quarter century. It is time for America to take the next steps.

Today I announce a new plan to explore space and extend a human presence across our Solar System. We will begin the effort quickly, using existing programs and personnel. We'll make steady progress – one mission, one voyage, one landing at a time.

Our first goal is to complete the International Space Station by 2010. We will finish what we have started, we will meet our obligations to our 15 international partners on this project. We will focus our future research aboard the station on the long-term effects of space travel on human biology. The environment of space is hostile to human beings. Radiation and weightlessness pose dangers to human health, and we have much to learn about their long-term effects before human crews can venture through the vast voids of space for months at a time. Research on board the station and here on Earth will help us better understand and overcome the obstacles that limit exploration. Through these efforts we will develop the skills and techniques necessary to sustain further space exploration.

To meet this goal, we will return the Space Shuttle to flight as soon as possible, consistent with safety concerns and the recommendations of the Columbia Accident Investigation Board. The Shuttle's chief purpose over the next several years will be to help finish assembly of the International Space Station. In 2010, the Space Shuttle – after nearly 30 years of duty – will be retired from service.

Our second goal is to develop and test a new spacecraft, the Crew Exploration Vehicle, by 2008, and to conduct the first manned mission no later than 2014. The Crew Exploration Vehicle will be capable of ferrying astronauts and scientists to the Space Station after the shuttle is retired. But the main purpose of this spacecraft will be to carry astronauts beyond our orbit to other worlds. This will be the first spacecraft of its kind since the Apollo Command Module.

Our third goal is to return to the Moon by 2020, as the launching point for missions beyond. Beginning no later than 2008, we will send a series of robotic missions to the lunar surface to research and prepare for future human exploration. Using the Crew Exploration Vehicle, we will undertake extended human missions to the Moon as early as 2015, with the goal of living and working there for increasingly extended periods. Eugene Cernan, who is with us today – the last man to set foot on the lunar surface – said this as he left: "We leave as we came, and God willing as we shall return, with peace and hope for all mankind." America will make those words come true.

Returning to the Moon is an important step for our space program. Establishing an extended human presence on the Moon could vastly reduce the costs of further space exploration, making possible ever more ambitious missions. Lifting heavy spacecraft and fuel out of the Earth's gravity is expensive. Spacecraft assembled and provisioned on the Moon could escape its far lower gravity using far less energy, and thus, far less cost. Also, the Moon is home to abundant resources. Its soil contains raw materials that might be harvested and processed into rocket fuel or breathable air. We can use our time on the Moon to develop and test new approaches and technologies and systems that will allow us to function in other, more challenging environments. The Moon is a logical step toward further progress and achievement.

With the experience and knowledge gained on the Moon, we will then be ready to take the next steps of space exploration: human missions to Mars and to worlds beyond. Robotic missions will serve as trailblazers – the advanced guard to the unknown. Probes, landers and other vehicles of this kind continue to prove their worth, sending spectacular images and vast amounts of data back to Earth. Yet the human thirst for knowledge ultimately cannot be satisfied by even the most

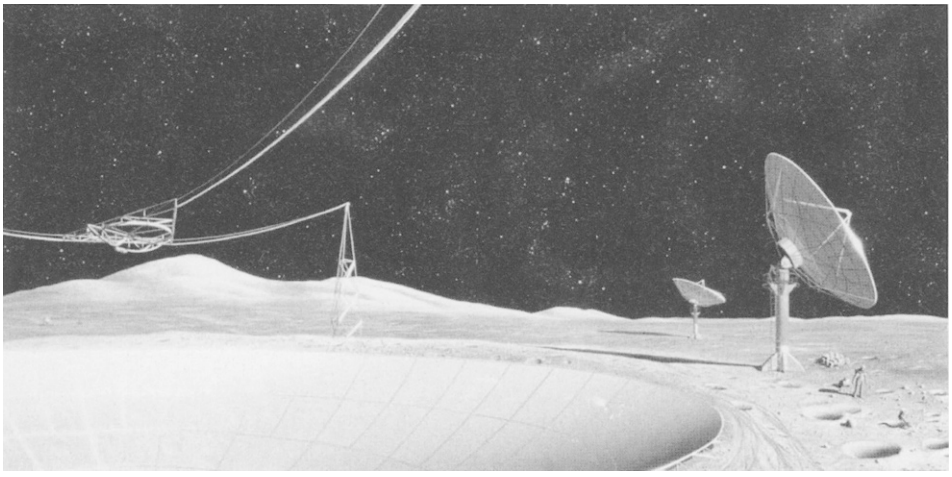

**Fig. 1.2** This is an artist's concept depicting a possible scene of an observatory on the far side of the Moon. The artwork was part of NASA's new initiatives study which surveyed possible future manned planetary and lunar expeditionary activity. The objective of the lunar observatory case study is to understand the effort required to build and operate a long-duration human-tended astronomical observatory on the moon's far side. Some scientists feel that the lunar far side – quiet, seismically stable and shielded from Earth's electronic noise – may be the Solar System's best location for such an observatory. The facility would consist of optical telescope arrays, stellar monitoring telescopes and radio telescopes, allowing nearly complete coverage of the radio and optical spectra. The observatory would also serve as a base for geologic exploration and for a modest life sciences laboratory. In the left foreground, a large fixed radio telescope is mounted on a crater. The telescope focuses signals into a centrally located collector, which is shown suspended above the crater. The lander in which the crew would live can be seen in the distance on the left. Two steerable radio telescopes are placed on the right; the instrument in the foreground is being serviced by scientists. The other astronaut is about to replace a small optical telescope that has been damaged by a micrometeorite. A very large baseline optical interferometer system can be seen in the right far background. (The painting was done by Mark Dowman and Doug McLeod. S89-25054, January 1989. Courtesy NASA)

vivid pictures, or the most detailed measurements. We need to see and examine and touch for ourselves. And only human beings are capable of adapting to the inevitable uncertainties posed by space travel.

As our knowledge improves, we'll develop new power generation propulsion, life support, and other systems that can support more distant travels. We do not know where this journey will end, yet we know this: human beings are headed into the cosmos.

And along this journey we'll make many technological breakthroughs. We don't know yet what those breakthroughs will be, but we can be certain they'll come, and that our efforts will be repaid many times over. We may discover resources on the Moon or Mars that will boggle the imagination, that will test our limits to dream. And the fascination generated by further exploration will inspire our young

people to study math, and science, and engineering and create a new generation of innovators and pioneers.

This will be a great and unifying mission for NASA, and we know that you'll achieve it. I have directed Administrator O'Keefe to review all of NASA's current space flight and exploration activities and direct them toward the goals I have outlined. I will also form a commission of private and public sector experts to advise on implementing the vision that I've outlined today. This commission will report to me within four months of its first meeting. I'm today naming former Secretary of the Air Force, Pete Aldridge, to be the Chair of the Commission. Thank you for being here today, Pete. He has tremendous experience in the Department of Defense and the aerospace industry. He is going to begin this important work right away.

We'll invite other nations to share the challenges and opportunities of this new era of discovery. The vision I outline today is a journey, not a race, and I call on other nations to join us on this journey, in a spirit of cooperation and friendship.

Achieving these goals requires a long-term commitment. NASA's current five-year budget is $86 billion. Most of the funding we need for the new endeavors will come from reallocating $11 billion within that budget. We need some new resources, however. I will call upon Congress to increase NASA's budget by roughly a billion dollars, spread out over the next five years. This increase, along with refocusing of our space agency, is a solid beginning to meet the challenges and the goals we set today. It's only a beginning. Future funding decisions will be guided by the progress we make in achieving our goals.

We begin this venture knowing that space travel brings great risks. The loss of the Space Shuttle Columbia was less than one year ago. Since the beginning of our space program, America has lost 23 astronauts, and one astronaut from an allied nation – men and women who believed in their mission and accepted the dangers. As one family member said, "The legacy of Columbia must carry on – for the benefit of our children and yours." The Columbia's crew did not turn away from the challenge, and neither will we.

Mankind is drawn to the heavens for the same reason we were once drawn into unknown lands and across the open sea. We choose to explore space because doing so improves our lives, and lifts our national spirit. So let us continue the journey.

May God bless.

* * *

Even with this shot in the arm, many were skeptical of the desirability for such an "adventure." Few had the vision to think beyond the predictable and consider the possible and the desirable. Such linear thinking almost always leads to lower expectations and less action. We generally think linearly, meaning that we extrapolate the present into the future without accounting for the unexpected. Of course, the unexpected is, well, not expected! For example, in the year 1807, very few people would have extrapolated to the Wright Brothers' human flight one hundred years later. In 1869, only science fiction writers envisioned landing people on the Moon in 1969. Similarly, other great inventions in mechanics and electronics

were not envisioned and therefore the technologies to which those inventions gave birth could not have been foreseen except by a tiny group of visionaries.

Therefore, in 2004, when President Bush gave his speech, those who supported his vision understood the potential benefits of charting a course back to the Moon. They supported this action not because of what could be predicted as the possible benefits, but for all the unpredictable outcomes and synergies. This kind of non-linear thinking is useful because it opens up our minds to the impossible as well as the possible. "The possible requires a lot of hard work; the impossible takes a little longer."

**Fig. 1.3** Yuri Alekseyevich Gagarin. (Official Soviet photograph)

The first person in space and the first to orbit the Earth on 12 April 1961 was the Soviet cosmonaut Yuri Alekseyevich Gagarin (9 March 1934 – 27 March 1968). On 5 May 1961, Mercury Astronaut Alan B. Shepard, Jr. blasted off in his Freedom 7 capsule atop a Mercury-Redstone rocket. His 15-minute suborbital flight made him the first American in space.

The race to the Moon began at this time.[2] It was an outgrowth of the political and military rivalry between the United States and the Soviet Union. We know that the Americans landed with men on the Moon first, but once this was achieved, interest quickly waned and resources were pulled from NASA. The initiation of the American response to Gagarin's flight was with President Kennedy's speech before Congress.

[2] *The Decision to Go to the Moon – Project Apollo and the National Interest*, J.M. Logsdon, MIT Press, 1970.

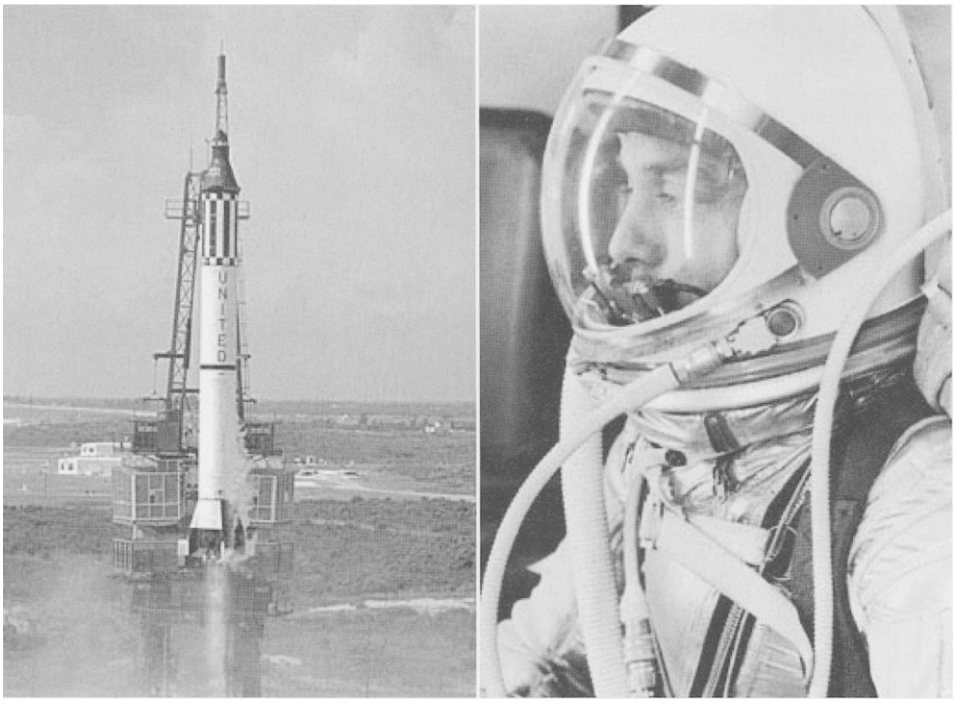


**Fig. 1.4** Mercury astronaut Alan B. Shepard, Jr. and his Freedom 7 capsule atop a Mercury-Redstone rocket, 5 May 1961. (Courtesy NASA)

### 1.0.2 Kennedy 1961 speech

The following is the speech delivered by the 35th U.S. President John F. Kennedy before a joint session of Congress on 25 May 1961 titled "Special Message to the Congress on Urgent National Needs." This is the famous "Moon" speech where he committed the nation to send men to the Moon before the end of the decade. As we see, the space component of the speech is a small part of the overall speech, supporting the historical claim that the Apollo program was in reality a part of the Cold War and political program. The complete speech is reproduced here to provide the reader with the larger context of the "Space Race."

One cannot underestimate the importance of context in trying to understand how space plays out politically. Space enthusiasts from the dawn of Apollo have tried to justify spacefaring in isolation, trying to claim that the return to the Moon and then to Mars would justify the expense and benefit all of humanity. While true — and from this vantage point in the future, obviously true — it was always necessary to put space in the larger context. Once that was done, resistance died away quickly and spacefaring was "obvious."

**President Kennedy:** Mr. Speaker, Mr. Vice President, my copartners in Government, gentlemen and ladies:

The Constitution imposes upon me the obligation to "from time to time give to the Congress information of the State of the Union." While this has traditionally

**Fig. 1.5** Special Message to the Congress on Urgent National Needs, delivered by President John F. Kennedy, delivered to a joint session of Congress, 25 May 1961.

been interpreted as an annual affair, this tradition has been broken in extraordinary times.

These are extraordinary times. And we face an extraordinary challenge. Our strength as well as our convictions have imposed upon this nation the role of leader in freedom's cause.

No role in history could be more difficult or more important. We stand for freedom.

That is our conviction for ourselves – that is our only commitment to others. No friend, no neutral and no adversary should think otherwise. We are not against any man – or any nation – or any system – except as it is hostile to freedom. Nor am I here to present a new military doctrine, bearing any one name or aimed at any one area. I am here to promote the freedom doctrine.

I.

The great battleground for the defense and expansion of freedom today is the whole southern half of the globe – Asia, Latin America, Africa and the Middle East – the lands of the rising peoples. Their revolution is the greatest in human history. They seek an end to injustice, tyranny, and exploitation. More than an end, they seek a beginning.

And theirs is a revolution which we would support regardless of the Cold War, and regardless of which political or economic route they should choose to freedom.

For the adversaries of freedom did not create the revolution; nor did they create the conditions which compel it. But they are seeking to ride the crest of its wave – to capture it for themselves.

Yet their aggression is more often concealed than open. They have fired no missiles; and their troops are seldom seen. They send arms, agitators, aid, technicians and propaganda to every troubled area. But where fighting is required, it is usually done by others – by guerrillas striking at night, by assassins striking alone – assassins who have taken the lives of four thousand civil officers in the last twelve months in Vietnam alone – by subversives and saboteurs and insurrectionists, who in some cases control whole areas inside of independent nations.

[At this point the following paragraph, which appears in the text as signed and transmitted to the Senate and House of Representatives, was omitted in the reading of the message:

They possess a powerful intercontinental striking force, large forces for conventional war, a well-trained underground in nearly every country, the power to conscript talent and manpower for any purpose, the capacity for quick decisions, a closed society without dissent or free information, and long experience in the techniques of violence and subversion. They make the most of their scientific successes, their economic progress and their pose as a foe of colonialism and friend of popular revolution. They prey on unstable or unpopular governments, unsealed, or unknown boundaries, unfilled hopes, convulsive change, massive poverty, illiteracy, unrest and frustration.]

With these formidable weapons, the adversaries of freedom plan to consolidate their territory – to exploit, to control, and finally to destroy the hopes of the world's newest nations; and they have ambition to do it before the end of this decade. It is a contest of will and purpose as well as force and violence – a battle for minds and souls as well as lives and territory. And in that contest, we cannot stand aside.

We stand, as we have always stood from our earliest beginnings, for the independence and equality of all nations. This nation was born of revolution and raised in freedom. And we do not intend to leave an open road for despotism.

There is no single simple policy which meets this challenge. Experience has taught us that no one nation has the power or the wisdom to solve all the problems of the world or manage its revolutionary tides – that extending our commitments does not always increase our security – that any initiative carries with it the risk of a temporary defeat – that nuclear weapons cannot prevent subversion – that no free people can be kept free without will and energy of their own – and that no two nations or situations are exactly alike.

Yet there is much we can do – and must do. The proposals I bring before you are numerous and varied. They arise from the host of special opportunities and dangers which have become increasingly clear in recent months. Taken together, I believe that they can mark another step forward in our effort as a people. I am here to ask the help of this Congress and the nation in approving these necessary measures.

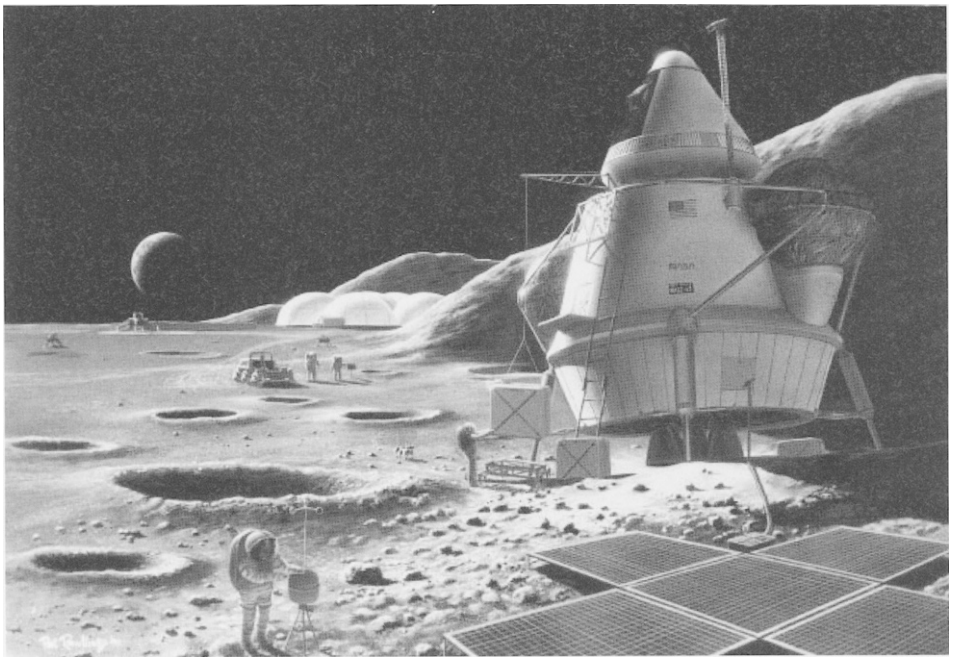

**Fig. 1.6** Earth's Moon, just 3 days away, is a good place to test hardware and operations for a human mission to Mars. A simulated mission, including the landing of an adapted Mars excursion vehicle, could test many relevant Mars systems and technologies. (Artwork done for NASA by Pat Rawlings, of SAIC. S95-01563, February 1995. Courtesy NASA) See Plate 1 in color section.

## II. ECONOMIC AND SOCIAL PROGRESS AT HOME

The first and basic task confronting this nation this year was to turn recession into recovery. An affirmative anti-recession program, initiated with your cooperation, supported the natural forces in the private sector; and our economy is now enjoying renewed confidence and energy. The recession has been halted. Recovery is under way.

But the task of abating unemployment and achieving a full use of our resources does remain a serious challenge for us all. Large-scale unemployment during a recession is bad enough, but large-scale unemployment during a period of prosperity would be intolerable.

I am therefore transmitting to the Congress a new Manpower Development and Training program, to train or retrain several hundred thousand workers, particularly in those areas where we have seen chronic unemployment as a result of technological factors in new occupational skills over a four-year period, in order to replace those skills made obsolete by automation and industrial change with the new skills which the new processes demand.

It should be a satisfaction to us all that we have made great strides in restoring world confidence in the dollar, halting the outflow of gold and improving our balance

of payments. During the last two months, our gold stocks actually increased by seventeen million dollars, compared to a loss of 635 million dollars during the last two months of 1960. We must maintain this progress – and this will require the cooperation and restraint of everyone. As recovery progresses, there will be temptations to seek unjustified price and wage increases. These we cannot afford. They will only handicap our efforts to compete abroad and to achieve full recovery here at home. Labor and management must – and I am confident that they will – pursue responsible wage and price policies in these critical times. I look to the President's Advisory Committee on Labor Management Policy to give a strong lead in this direction.

Moreover, if the budget deficit now increased by the needs of our security is to be held within manageable proportions, it will be necessary to hold tightly to prudent fiscal standards; and I request the cooperation of the Congress in this regard – to refrain from adding funds or programs, desirable as they may be, to the Budget – to end the postal deficit, as my predecessor also recommended, through increased rates – a deficit incidentally, this year, which exceeds the fiscal 1962 cost of all the space and defense measures that I am submitting today – to provide full pay-as-you-go highway financing – and to close those tax loopholes earlier specified. Our security and progress cannot be cheaply purchased; and their price must be found in what we all forego as well as what we all must pay.

## III. ECONOMIC AND SOCIAL PROGRESS ABROAD

I stress the strength of our economy because it is essential to the strength of our nation. And what is true in our case is true in the case of other countries. Their strength in the struggle for freedom depends on the strength of their economic and their social progress.

We would be badly mistaken to consider their problems in military terms alone. For no amount of arms and armies can help stabilize those governments which are unable or unwilling to achieve social and economic reform and development. Military pacts cannot help nations whose social injustice and economic chaos invite insurgency and penetration and subversion. The most skillful counter-guerrilla efforts cannot succeed where the local population is too caught up in its own misery to be concerned about the advance of communism.

But for those who share this view, we stand ready now, as we have in the past, to provide generously of our skills, and our capital, and our food to assist the peoples of the less-developed nations to reach their goals in freedom – to help them before they are engulfed in crisis.

This is also our great opportunity in 1961. If we grasp it, then subversion to prevent its success is exposed as an unjustifiable attempt to keep these nations from either being free or equal. But if we do not pursue it, and if they do not pursue it, the bankruptcy of unstable governments, one by one, and of unfilled hopes will surely lead to a series of totalitarian receiverships.

Earlier in the year, I outlined to the Congress a new program for aiding emerging nations; and it is my intention to transmit shortly draft legislation to implement this program, to establish a new Act for International Development, and to add

to the figures previously requested, in view of the swift pace of critical events, an additional 250 million dollars for a Presidential Contingency Fund, to be used only upon a Presidential determination in each case, with regular and complete reports to the Congress in each case, when there is a sudden and extraordinary drain upon our regular funds which we cannot foresee – as illustrated by recent events in Southeast Asia – and it makes necessary the use of this emergency reserve. The total amount requested – now raised to 2.65 billion dollars – is both minimal and crucial. I do not see how anyone who is concerned – as we all are about the growing threats to freedom around the globe – and who is asking what more we can do as a people – can weaken or oppose the single most important program available for building the frontiers of freedom.

## IV

All that I have said makes it clear that we are engaged in a world-wide struggle in which we bear a heavy burden to preserve and promote the ideals that we share with all mankind, or have alien ideals forced upon them. That struggle has highlighted the role of our Information Agency. It is essential that the funds previously requested for this effort be not only approved in full, but increased by 2 million, 400 thousand dollars, to a total of 121 million dollars.

This new request is for additional radio and television to Latin America and Southeast Asia. These tools are particularly effective and essential in the cities and villages of those great continents as a means of reaching millions of uncertain peoples to tell them of our interest in their fight for freedom. In Latin America, we are proposing to increase our Spanish and Portuguese broadcasts to a total of 154 hours a week, compared to 42 hours today, none of which is in Portuguese, the language of about one-third of the people of South America. The Soviets, Red Chinese and satellites already broadcast into Latin America more than 134 hours a week in Spanish and Portuguese. Communist China alone does more public information broadcasting in our own hemisphere than we do. Moreover, powerful propaganda broadcasts from Havana now are heard throughout Latin America, encouraging new revolutions in several countries.

Similarly, in Laos, Vietnam, Cambodia, and Thailand, we must communicate our determination and support to those upon whom our hopes for resisting the communist tide in that continent ultimately depend. Our interest is in the truth.

## V. OUR PARTNERSHIP FOR SELF-DEFENSE

But while we talk of sharing and building and the competition of ideas, others talk of arms and threaten war. So we have learned to keep our defenses strong – and to cooperate with others in a partnership of self-defense. The events of recent weeks have caused us to look anew at these efforts.

The center of freedom's defense is our network of world alliances, extending from NATO, recommended by a Democratic President and approved by a Republican Congress, to SEATO, recommended by a Republican President and approved by a

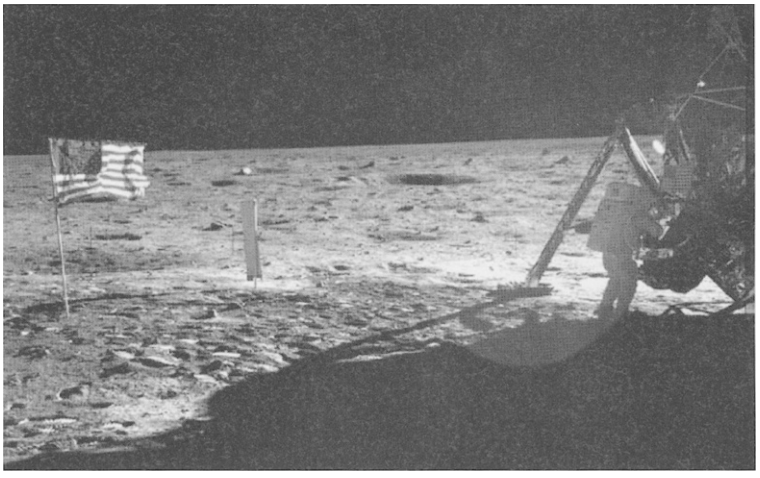

**Fig. 1.7** Apollo 11 Commander Neil Armstrong working at the modularized equipment stowage assembly of Eagle, the lunar module. (Courtesy NASA)

Democratic Congress. These alliances were constructed in the 1940's and 1950's -- it is our task and responsibility in the 1960's to strengthen them.

To meet the changing conditions of power – and power relationships have changed – we have endorsed an increased emphasis on NATO's conventional strength. At the same time we are affirming our conviction that the NATO nuclear deterrent must also be kept strong. I have made clear our intention to commit to the NATO command, for this purpose, the 5 Polaris submarines originally suggested by President Eisenhower, with the possibility, if needed, of more to come.

Second, a major part of our partnership for self-defense is the Military Assistance Program. The main burden of local defense against local attack, subversion, insurrection or guerrilla warfare must of necessity rest with local forces. Where these forces have the necessary will and capacity to cope with such threats, our intervention is rarely necessary or helpful. Where the will is present and only capacity is lacking, our Military Assistance Program can be of help.

But this program, like economic assistance, needs a new emphasis. It cannot be extended without regard to the social, political and military reforms essential to internal respect and stability. The equipment and training provided must be tailored to legitimate local needs and to our own foreign and military policies, not to our supply of military stocks or a local leader's desire for military display. And military assistance can, in addition to its military purposes, make a contribution to economic progress, as do our own Army Engineers.

In an earlier message, I requested 1.6 billion dollars for Military Assistance, stating that this would maintain existing force levels, but that I could not foresee how much more might be required. It is now clear that this is not enough. The present crisis in Southeast Asia, on which the Vice President has made a valuable report – the rising threat of communism in Latin America – the increased arms traffic in Africa – and all the new pressures on every nation found on the map

by tracing your fingers along the borders of the Communist bloc in Asia and the Middle East – all make clear the dimension of our needs.

I therefore request the Congress to provide a total of 1.885 billion dollars for Military Assistance in the coming fiscal year – an amount less than that requested a year ago – but a minimum which must be assured if we are to help those nations make secure their independence. This must be prudently and wisely spent – and that will be our common endeavor. Military and economic assistance has been a heavy burden on our citizens for a long time, and I recognize the strong pressures against it; but this battle is far from over, it is reaching a crucial stage, and I believe we should participate in it. We cannot merely state our opposition to totalitarian advance without paying the price of helping those now under the greatest pressure.


**Fig. 1.8** The official emblem of Apollo 11, the United States' first scheduled lunar landing mission. The Apollo 11 crew were the astronauts Neil A. Armstrong, commander, Michael Collins, command module pilot, and Edwin E. Aldrin, Jr., lunar module pilot. The NASA insignia design for Apollo flights is reserved for use by the astronauts and for the official use as the NASA Administrator may authorize. (S69-34875, June 1969. It is being reproduced here with the specific permission of NASA.)

## VI. OUR OWN MILITARY AND INTELLIGENCE SHIELD

In line with these developments, I have directed a further reinforcement of our own capacity to deter or resist non-nuclear aggression. In the conventional field, with one exception, I find no present need for large new levies of men. What is needed is rather a change of position to give us still further increases in flexibility.

Therefore, I am directing the Secretary of Defense to undertake a reorganization and modernization of the Army's divisional structure, to increase its non-nuclear

firepower, to improve its tactical mobility in any environment, to insure its flexibility to meet any direct or indirect threat, to facilitate its coordination with our major allies, and to provide more modern mechanized divisions in Europe and bring their equipment up to date, and new airborne brigades in both the Pacific and Europe.

And secondly, I am asking the Congress for an additional 100 million dollars to begin the procurement task necessary to re-equip this new Army structure with the most modern material. New helicopters, new armored personnel carriers, and new howitzers, for example, must be obtained now.

Third, I am directing the Secretary of Defense to expand rapidly and substantially, in cooperation with our Allies, the orientation of existing forces for the conduct of non-nuclear war, paramilitary operations and sub-limited or unconventional wars.

In addition our special forces and unconventional warfare units will be increased and reoriented. Throughout the services new emphasis must be placed on the special skills and languages which are required to work with local populations.

Fourth, the Army is developing plans to make possible a much more rapid deployment of a major portion of its highly trained reserve forces. When these plans are completed and the reserve is strengthened, two combat-equipped divisions, plus their supporting forces, a total of 89,000 men, could be ready in an emergency for operations with but 3 weeks' notice – 2 more divisions with but 5 weeks' notice – and six additional divisions and their supporting forces, making a total of 10 divisions, could be deployable with less than 8 weeks' notice. In short, these new plans will allow us to almost double the combat power of the Army in less than two months, compared to the nearly nine months heretofore required.

Fifth, to enhance the already formidable ability of the Marine Corps to respond to limited war emergencies, I am asking the Congress for 60 million dollars to increase the Marine Corps strength to 190,000 men. This will increase the initial impact and staying power of our three Marine divisions and three air wings, and provide a trained nucleus for further expansion, if necessary for self-defense.

Finally, to cite one other area of activities that are both legitimate and necessary as a means of self-defense in an age of hidden perils, our whole intelligence effort must be reviewed, and its coordination with other elements of policy assured. The Congress and the American people are entitled to know that we will institute whatever new organization, policies, and control are necessary.

## VII. CIVIL DEFENSE

One major element of the national security program which this nation has never squarely faced up to is civil defense. This problem arises not from present trends but from national inaction in which most of us have participated. In the past decade we have intermittently considered a variety of programs, but we have never adopted a consistent policy. Public considerations have been largely characterized by apathy, indifference and skepticism; while, at the same time, many of the civil defense plans have been so far-reaching and unrealistic that they have not gained essential support.

This Administration has been looking hard at exactly what civil defense can and cannot do. It cannot be obtained cheaply. It cannot give an assurance of blast protection that will be proof against surprise attack or guaranteed against obsolescence or destruction. And it cannot deter a nuclear attack.

We will deter an enemy from making a nuclear attack only if our retaliatory power is so strong and so invulnerable that he knows he would be destroyed by our response. If we have that strength, civil defense is not needed to deter an attack. If we should ever lack it, civil defense would not be an adequate substitute.

But this deterrent concept assumes rational calculations by rational men. And the history of this planet, and particularly the history of the 20th century, is sufficient to remind us of the possibilities of an irrational attack, a miscalculation, an accidental war, [or a war of escalation in which the stakes by each side gradually increase to the point of maximum danger] which cannot be either foreseen or deterred. It is on this basis that civil defense can be readily justifiable – as insurance for the civilian population in case of an enemy miscalculation. It is insurance we trust will never be needed – but insurance which we could never forgive ourselves for foregoing in the event of catastrophe.

Once the validity of this concept is recognized, there is no point in delaying the initiation of a nation-wide long-range program of identifying present fallout shelter capacity and providing shelter in new and existing structures. Such a program would protect millions of people against the hazards of radioactive fallout in the event of large-scale nuclear attack. Effective performance of the entire program not only requires new legislative authority and more funds, but also sound organizational arrangements.

Therefore, under the authority vested in me by Reorganization Plan No. 1 of 1958, I am assigning responsibility for this program to the top civilian authority already responsible for continental defense, the Secretary of Defense. It is important that this function remain civilian, in nature and leadership; and this feature will not be changed.

The Office of Civil and Defense Mobilization will be reconstituted as a small staff agency to assist in the coordination of these functions. To more accurately describe its role, its title should be changed to the Office of Emergency Planning.

As soon as those newly charged with these responsibilities have prepared new authorization and appropriation requests, such requests will be transmitted to the Congress for a much strengthened Federal-State civil defense program. Such a program will provide Federal funds for identifying fallout shelter capacity in existing, structures, and it will include, where appropriate, incorporation of shelter in Federal buildings, new requirements for shelter in buildings constructed with Federal assistance, and matching grants and other incentives for constructing shelter in State and local and private buildings.

Federal appropriations for civil defense in fiscal 1962 under this program will in all likelihood be more than triple the pending budget requests; and they will increase sharply in subsequent years. Financial participation will also be required from State and local governments and from private citizens. But no insurance is cost-free; and every American citizen and his community must decide for themselves

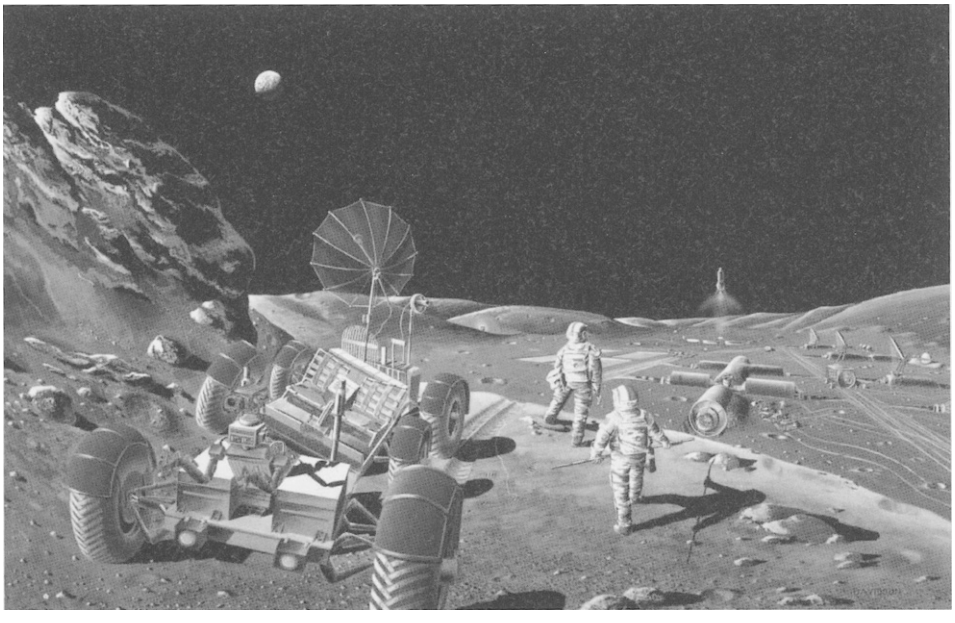

**Fig. 1.9** This artist's concept of a lunar base and extra-base activity was revealed during a 1986 Summer Study on possible future activities for NASA. A roving vehicle similar to the one used on three Apollo missions is depicted in the foreground. (Artwork was done by Dennis Davidson. S86-27256, June 1986. Courtesy NASA)

whether this form of survival insurance justifies the expenditure of effort, time and money. For myself, I am convinced that it does.

## VIII. DISARMAMENT

I cannot end this discussion of defense and armaments without emphasizing our strongest hope: the creation of an orderly world where disarmament will be possible. Our aims do not prepare for war – they are efforts to discourage and resist the adventures of others that could end in war.

That is why it is consistent with these efforts that we continue to press for properly safeguarded disarmament measures. At Geneva, in cooperation with the United Kingdom, we have put forward concrete proposals to make clear our wish to meet the Soviets half way in an effective nuclear test ban treaty – the first significant but essential step on the road towards disarmament. Up to now, their response has not been what we hoped, but Mr. Dean returned last night to Geneva, and we intend to go the last mile in patience to secure this gain if we can.

Meanwhile, we are determined to keep disarmament high on our agenda – to make an intensified effort to develop acceptable political and technical alternatives to the present arms race. To this end I shall send to the Congress a measure to establish a strengthened and enlarged Disarmament Agency.

## IX. SPACE

Finally, if we are to win the battle that is now going on around the world between freedom and tyranny, the dramatic achievements in space which occurred in recent weeks should have made clear to us all, as did the Sputnik in 1957, the impact of this adventure on the minds of men everywhere, who are attempting to make a determination of which road they should take. Since early in my term, our efforts in space have been under review. With the advice of the Vice President, who is Chairman of the National Space Council, we have examined where we are strong and where we are not, where we may succeed and where we may not. Now it is time to take longer strides – time for a great new American enterprise – time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on Earth.

I believe we possess all the resources and talents necessary. But the facts of the matter are that we have never made the national decisions or marshalled the national resources required for such leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment.

Recognizing the head start obtained by the Soviets with their large rocket engines, which gives them many months of lead time, and recognizing the likelihood that they will exploit this lead for some time to come in still more impressive successes, we nevertheless are required to make new efforts on our own. For while we cannot guarantee that we shall one day be first, we can guarantee that any failure to make this effort will make us last. We take an additional risk by making it in full view of the world, but as shown by the feat of astronaut Shepard, this very risk enhances our stature when we are successful. But this is not merely a race. Space is open to us now; and our eagerness to share its meaning is not governed by the efforts of others. We go into space because whatever mankind must undertake, free men must fully share.

I therefore ask the Congress, above and beyond the increases I have earlier requested for space activities, to provide the funds which are needed to meet the following national goals:

First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish. We propose to accelerate the development of the appropriate lunar space craft. We propose to develop alternate liquid and solid fuel boosters, much larger than any now being developed, until certain which is superior. We propose additional funds for other engine development and for unmanned explorations – explorations which are particularly important for one purpose which this nation will never overlook: the survival of the man who first makes this daring flight. But in a very real sense, it will not be one man going to the Moon – if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there.

Secondly, an additional 23 million dollars, together with 7 million dollars already available, will accelerate development of the Rover nuclear rocket. This gives

promise of some day providing a means for even more exciting and ambitious exploration of space, perhaps beyond the Moon, perhaps to the very end of the Solar System itself.

Third, an additional 50 million dollars will make the most of our present leadership, by accelerating the use of space satellites for world-wide communications.

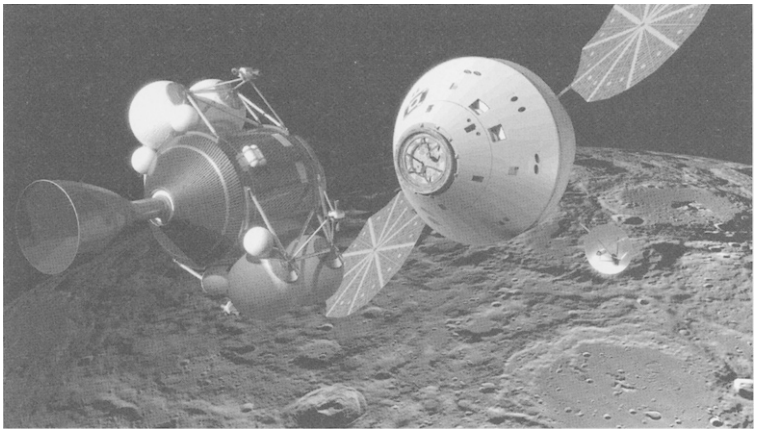

**Fig. 1.10** NASA artist rendering of the Altair lunar lander's ascent stage docking with the Orion crew exploration vehicle after a mission to the lunar surface. (JSC2007-E-113274 Courtesy NASA)

Fourth, an additional 75 million dollars – of which 53 million dollars is for the Weather Bureau – will help give us at the earliest possible time a satellite system for world-wide weather observation.

Let it be clear – and this is a judgment which the Members of the Congress must finally make – let it be clear that I am asking the Congress and the country to accept a firm commitment to a new course of action, a course which will last for many years and carry very heavy costs: 531 million dollars in fiscal '62 – an estimated seven to nine billion dollars additional over the next five years. If we are to go only half way, or reduce our sights in the face of difficulty, in my judgment it would be better not to go at all.

Now this is a choice which this country must make, and I am confident that under the leadership of the Space Committees of the Congress, and the Appropriating Committees, that you will consider the matter carefully.

It is a most important decision that we make as a nation. But all of you have lived through the last four years and have seen the significance of space and the adventures in space, and no one can predict with certainty what the ultimate meaning will be of mastery of space.

I believe we should go to the Moon. But I think every citizen of this country as well as the Members of the Congress should consider the matter carefully in making their judgment, to which we have given attention over many weeks and months, because it is a heavy burden, and there is no sense in agreeing or desiring that the United States take an affirmative position in outer space, unless we are

prepared to do the work and bear the burdens to make it successful. If we are not, we should decide today and this year.

This decision demands a major national commitment of scientific and technical manpower, materiel and facilities, and the possibility of their diversion from other important activities where they are already thinly spread. It means a degree of dedication, organization and discipline which have not always characterized our research and development efforts. It means we cannot afford undue work stoppages, inflated costs of material or talent, wasteful interagency rivalries, or a high turnover of key personnel.

New objectives and new money cannot solve these problems. They could in fact, aggravate them further – unless every scientist, every engineer, every serviceman, every technician, contractor, and civil servant gives his personal pledge that this nation will move forward, with the full speed of freedom, in the exciting adventure of space.

## X. CONCLUSION

In conclusion, let me emphasize one point. It is not a pleasure for any President of the United States, as I am sure it was not a pleasure for my predecessors, to come before the Congress and ask for new appropriations which place burdens on our people. I came to this conclusion with some reluctance. But in my judgment, this is a most serious time in the life of our country and in the life of freedom around the globe, and it is the obligation, I believe, of the President of the United States to at least make his recommendations to the Members of the Congress, so that they can reach their own conclusions with that judgment before them. You must decide yourselves, as I have decided, and I am confident that whether you finally decide in the way that I have decided or not, that your judgment – as my judgment – is reached on what is in the best interests of our country.

In conclusion, let me emphasize one point: that we are determined, as a nation in 1961 that freedom shall survive and succeed – and whatever the peril and setbacks, we have some very large advantages.

The first is the simple fact that we are on the side of liberty – and since the beginning of history, and particularly since the end of the Second World War, liberty has been winning out all over the globe.

A second real asset is that we are not alone. We have friends and allies all over the world who share our devotion to freedom. May I cite as a symbol of traditional and effective friendship the great ally I am about to visit – France. I look forward to my visit to France, and to my discussion with a great Captain of the Western World, President de Gaulle, as a meeting of particular significance, permitting the kind of close and ranging consultation that will strengthen both our countries and serve the common purposes of world-wide peace and liberty. Such serious conversations do not require a pale unanimity – they are rather the instruments of trust and understanding over a long road.

A third asset is our desire for peace. It is sincere, and I believe the world knows it. We are proving it in our patience at the test ban table, and we are proving it in the UN where our efforts have been directed to maintaining that organization's

usefulness as a protector of the independence of small nations. In these and other instances, the response of our opponents has not been encouraging.

Yet it is important to know that our patience at the bargaining table is nearly inexhaustible, though our credulity is limited that our hopes for peace are unfailing, while our determination to protect our security is resolute. For these reasons I have long thought it wise to meet with the Soviet Premier for a personal exchange of views. A meeting in Vienna turned out to be convenient for us both; and the Austrian government has kindly made us welcome. No formal agenda is planned and no negotiations will be undertaken; but we will make clear America's enduring concern is for both peace and freedom – that we are anxious to live in harmony with the Russian people - that we seek no conquests, no satellites, no riches that we seek only the day when "nation shall not lift up sword against nation, neither shall they learn war any more."

Finally, our greatest asset in this struggle is the American people – their willingness to pay the price for these programs – to understand and accept a long struggle – to share their resources with other less fortunate people – to meet the tax levels and close the tax loopholes I have requested to exercise self-restraint instead of pushing up wages or prices, or over-producing certain crops, or spreading military secrets, or urging unessential expenditures or improper monopolies or harmful work stoppages – to serve in the Peace Corps or the Armed Services or the Federal Civil Service or the Congress – to strive for excellence in their schools, in their cities and in their physical fitness and that of their children – to take part in Civil Defense to pay higher postal rates, and higher payroll taxes and higher teachers' salaries, in order to strengthen our society – to show friendship to students and visitors from other lands who visit us and go back in many cases to be the future leaders, with an image of America and I want that image, and I know you do, to be affirmative and positive – and, finally, to practice democracy at home, in all States, with all races, to respect each other and to protect the Constitutional rights of all citizens.

I have not asked for a single program which did not cause one or all Americans some inconvenience, or some hardship, or some sacrifice. But they have responded and you in the Congress have responded to your duty and I feel confident in asking today for a similar response to these new and larger demands. It is heartening to know, as I journey abroad, that our country is united in its commitment to freedom and is ready to do its duty.

* * *

President Kennedy was not really interested in space. The motivation for his proposal to go to the Moon was the Bay of Pigs fiasco which was shortly followed by Gagarin's flight. This has been the subject of much research and is well documented. "John Kennedy made the lunar landing decision because his definition of the national interest led him to conclude, under the stimulus of the Gagarin flight, that a prestige-oriented space program was an appropriate, even though very costly, instrument of American foreign policy."[3] As we read in Kennedy's speech, space

[3]"The Apollo Decision and Its Lessons for Policy-Makers," John M. Logsdon, from *The Moon Decision: Project Apollo and the National Interest*, MIT Press, 1970.

was viewed as one arena of the Cold War between the United States and the Soviet Union. There was no way to deliberate on what path the nation should follow in space without putting the decision in the larger context. "The notion that the United States should enter a contest with the Soviet Union for the prestige accruing from space success was based on the rationale that this prestige was an element in the Cold War competition for national power and international influence. Such a competition was, from the U.S. point of view, part of an effort to contain the expansion of Soviet power."[4]

### 1.0.3 A positive view of space

Thousands of essays have been written on the importance of space for humanity's development. In the United States, there was a perpetual battle between those who saw space exploration and the human settlement of the Moon and Mars as an obvious path to take, and those who believed that, while worthy, the money could be better used for more pressing needs.

Americans were shaken by the difficult economic times at the beginning of the 21st century and the worldwide battle with terrorism. The world went through a serious economic crisis between 2008 and 2012. There were numerous financial fluctuations locally and globally. The United States saw a major increase in government involvement in the running of businesses while Europe generally moved to a more free market system. National debts continued to rise. Countries from the former Soviet block had adopted flat-tax systems that free market economists supported.

The rapid economic development of China and India, as well as other countries, created a more competitive world economy. With that interest in space, activities emerged at various levels around the world. There were conflicting approaches to space. Some nations, such as China, became leaders national pride drove them to Apollo-like efforts. Other nations saw themselves in supporting, and important, roles whereby they created niches at which they excelled, for example, in robotics and manufacturing.

The creation of space technologies, especially for human spaceflight, drew the greatest technological talents of a nation. The "best and the brightest" gravitated to the mental challenges and large time commitments required to be successful as engineers or scientists because of the space program. Nations knew that their whole economies would benefit as a result of a robust space program – it was viewed as a win-win effort.

The following discussions highlight some of the issues that were examined during those early days.

#### A post-Apollo review

A post-Apollo evaluation of the need for a lunar base had been made in the U.S. with the following reasons given for such a base: advance lunar science and astronomy, provide economic rewards for the benefit of Earth, support general scientific

[4] Loc. cit.

advancement, develop technologies that would support national security, stimulate other space technologies, provide a test bed for future human expansion into the Solar System, establish a U.S. presence, stimulate interest among American students in science and engineering, help in the long-range survival of the species,[5] support manifest destiny, and create an epic vision.

During the late 1990s and early 2000s, few Americans pursued an engineering or scientific education. This, coupled with major increases in the numbers of engineers that graduated in the developing world, in particular China and India, was of concern to Americans. A robust and significant space program was viewed as a magnet to quantitatively capable students. A case in point was that during the Apollo program there was a spike in enrollment in engineering and science programs in the United States. This benefit alone attracted the attention of all nations.

### Back to the Moon for the sake of America and humanity

By virtue of its dominance of the night sky, the Moon has embedded itself in humanity's psyche, as part of our lore, as the moonlight that has turned battles, and as the familiar "face" upon which we have all gazed many times. As a destination for people, it has been the focus of science and science fiction. Science fiction dreamt the impossible that science and engineering later made possible, often much sooner than anyone could have anticipated.

On 21 July 1969, at 0256 GMT, Neil Armstrong and "Buzz" Aldrin of Apollo 11 walked for the first time on the lunar surface to the amazement and cheers of most people around the world. These first steps were repeated with two men from each of Apollos 12, 14, 15, 16 and 17. These first expeditions were intended to mark the initiation of a permanent manned presence on the Moon, and eventually Mars and beyond. That dream was abruptly put on hold even before the first men walked on the Moon, until it was reinvigorated in a serious way by President G.W. Bush in 2004.

With President Bush's visionary and very specific speech of 14 January 2004, we were finally placed on track for the return to the Moon, this time to stay and settle, and then after creating a lunar infrastructure move onward to Mars and beyond. The President resumed the journey abandoned over 30 years earlier. With this act, and assuming the goals are fulfilled, he initiated what can arguably be viewed as one of the most far-reaching efforts of humanity.

While most individuals supported the vision and the need for our return to space, the cry was often heard that problems still existed on Earth – let us solve them first, went the refrain. There always have been and always will be problems on Earth. Certainly if discretionary spending were to be zeroed out until all problems are solved, we should also not spend any money on museums and concert halls, and similar luxuries. It became clear that if we were to wait until all the problems were solved before going back to the Moon, then we, as a species, would end our lives on Earth. Those problems will never be fully solved.

Expenditures on space result in a significant return to the civilian economy in the form of advanced technologies across all sectors. Particular examples include

[5] *The Survival Imperative*, W.E. Burrows, Forge Books, 2006.


**Fig. 1.11** Neil Armstrong in full suit, 1 July 1969. (Courtesy Neil Armstrong and NASA)

medicine, materials, and electronics. The economy grows because of the advanced technologies that are derived from space development. In other words, space development increases the size of the pie, but it has always been difficult to sustain political support for space exploration except during the Cold War.[6]

There were numerous reasons to rebuild the space program around a manned return to the Moon. These included the recovery of resources from the Moon, and the setting up of outposts to monitor meteorite activity far enough in advance to deflect those that might approach Earth. But it was also understood that the return to the Moon would be a vision to excite young people on how fantastic the future could be, and how they could play a role in creating that future. What follows is a quote from an article of the time:

> In the United States there are difficulties in attracting enough young people to the disciplines of engineering, science and mathematics. Society depends on there being enough technically versed people who are eager to address the problems we all face. Whether in medicine, environmental protection, agriculture, electronics, or the design of a multitude of products,

[6] D.A. Broniatowski, A.L. Weigel, "The political sustainability of space exploration," *Space Policy*, Vol. 24, 2008, pp. 148 157.