Originally Processed With FOIA(s):
S; 1999-0093-F

FOIA Number:
S

FOIA MARKER

This is not a textual record. This is used as an administrative marker by the George Bush Presidential Library Staff.

Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Speechwriting, White House Office of
Series: Speech File Backup Files
Subseries: Chron File, 1989-1993

OA/ID Number: 13678
Folder ID Number: 13678-005

Folder Title:
20th Anniversary of Apollo Moon Landing 7/20/89 [OA 6266] [2]

Stack:	Row:	Section:	Shelf:	Position:
G	26	19	2	5

(54-7/13/4:00PM) (Beale/Shattan)

VICE PRESIDENT'S REMARKS

GENERAL DYNAMICS
SAN DIEGO, CALIFORNIA
July 18, 1989 - 9:00 a.m.

In his Inaugural Address last January, President Bush characterized our era as a time of new beginnings. "There are times when the future seems thick as a fog," the President declared. "But this is a time when the future seems like a door you can walk right through into a room called tomorrow." I am pleased to be here today with some of the men and women who are opening that door to tomorrow. And, having seen your ...., I feel that I myself have gotten a brief glimpse of the future.
On behalf of President Bush and the American people, I want to congratulate you for all you have done to advance the frontiers of knowledge, and to make technology the handmaiden of policy, and not its master.

In my remarks to you this morning, I thought I'd try to describe some of the features of tomorrow's world --the world that all of you are helping to build. I recognize that prophecy can be a pretty hazardous business. Human beings are so unpredictable, technological change is so rapid, and history is filled with so many twists and turns that it's impossible to describe tomorrow's world in any detail. Nevertheless, I believe that certain broad trends are discernible -- trends which make it possible to foretell at least the general outlines of the next century.

Thus, it is becoming increasingly clear that democracy -- personal freedom within a framework of representative government -- is the wave of the future politically. In Latin America, for example, most nations have either recently achieved democracy or are moving clearly in that direction, while in Asia, old traditions of authoritarian rule are fading from the scene. Even the communist world is in ferment. At the same time, free markets and private initiative are the new guideposts to economic development, for the simple reason that those principles of economic organization clearly work. For these reasons, the 21st Century is likely to be a period of unprecedented liberty and opportunity, a period when -- for the first time in recorded history -- the vast majority of mankind will finally be free.

What will humanity do with its newly-found freedom? It's impossible to answer this question with certainty, yet I am convinced that once the human spirit is finally liberated from the political and economic shackles that have constrained it in the past, our innate desire for knowledge and adventure, for learning and discovery, will give birth to a new Age of Exploration -- an Age of Space Exploration. And I believe that just as America has been in the forefront of the struggle to expand the boundaries of freedom during the 20th Century, so will we be in the forefront of the struggle to escape the boundaries of the earth -- to explore and settle space -- during the 21st Century.

This vision of America's future in space is one that President Bush and I both share. The President and I are committed to American leadership in the exploration, understanding, economic use and eventual settlement of space. We Americans have been pushing back frontiers throughout our history. Today, space is America's frontier, and America's destiny is to discover and pioneer in space.

The Bush Administration fully intends to help America realize this destiny by providing vibrant, forward-looking leadership. We believe that the potential gains from space are literally infinite. Space can inspire current and future generations of the American people; it can further scientific understanding by many orders of magnitude; it can provide incentives to reinvigorate education in this country; it can provide the basis for whole new industries, spur the economy and add technologies which will improve the life of mankind and further the competitiveness of American industry. In sum, space is a high-yield investment -- a <u>very</u> high yield investment -- in our nation's future.

For these reasons, the Bush Administration is moving forward to put the pieces in place for another great leap forward in space. If 1969 -- the year America landed on the moon -- can be compared to 1492 -- the year Columbus discovered the New World -- then the time is now at hand for Americans to begin preparing for 1620 -- the year the Pilgrims landed on the shores of Plymouth Bay. We, too, must begin to think about the voyage of a new Mayflower -- about expanding the human presence beyond earth orbit into the Solar System -- as a long-term goal.

The National Space Council, which I chair, was established on April 20 to provide a high-level Administration focus on space. With many of the President's top advisors participating, the Council will provide clarity, coherence and continuity to our space efforts.

In the brief period since its establishment, the Space Council has already made its mark. It has provided clear guidance and set our course on the Nation's civil earth remote sensing program. As a result, the LANDSAT program will make a long term contribution to global change research and form the basis for the "Mission to Planet Earth" program -- a coordinated long-term effort to study and understand global change and the processes that contribute to environmental balance.

The Space Council has also provided recommendations on the National Aerospace Plane Program -- or NASP -- which will result in a strong, forward-looking research effort to support many needs in the early 21st Century. NASP research will increase U.S. industrial competitiveness, contribute to a positive balance of trade and provide technologies with wideranging applications to benefit Americans. In the long term, NASP will form the basis for future aerospace transportation systems, just as the X-15 research jet allowed development of both the Space Shuttle and high speed military aircraft.

Finally, the Space Council has revised, enhanced and revalidated our National Space Policy. The broad goals of our space policy are easily stated:

- We believe space leadership is critically important for achieving economic, scientific, technical, national security and foreign policy goals.
- We believe in the importance of exploring and using outer space for the benefit of mankind.
- We believe that encouraging private sector investment in space related activities will benefit our economy and national wellbeing.
- We believe our space programs must be geared to improving our quality of life on earth and to

strengthening our national security.

- o And we believe in the long-term goal of pioneering space -- pushing back the frontiers of our Solar System.

Beyond defining the broad goals of our space policy, the National Space Council also provides specific guidelines on a number of policy issues. These include assuring access to space for civil, commercial and national security activities and achieving a permanent manned presence in space through Space Station Freedom.

However, to be successfully implemented, these policies require specific goals, concrete plans and real actions. We need hard-headed strategies for turning our dreams into reality, and we are now in the process of defining these strategies. We must ask ourselves where we want to be in space by the dawn of the 21st Century, and then work out the best route to get there.

Where, then, do we want to be 11 short years from now? In my opinion, by the year 2,000, we must:

- o have a vital, vibrant economic sector creating jobs, revenue, and "better ideas" to benefit our people;
- o be able to enforce a safe and stable space environment, one in which we can ensure that our interests are protected;

- be on our way to pioneering our Solar System and establishing outposts on the Moon and Mars;
- provide the inspiration necessary to encourage learning and substantially increase the number of our children seeking scientific and technical educations;
- and reestablish our role as the dominant leader among spacefaring nations.

We need to provide the resources to achieve these goals. We truly believe that investing in space is investing in the future -- our future. Nowhere else is the excitement of scientific discovery or the inspiration and motivation of our children more compelling then in our national space program. Space is vital to our international competitiveness, to our continued economic growth, and, indeed, to our very survival as a Nation. This is why the United States must continue to press ahead in space.

I therefore call on the Congress to join us in this great national undertaking. As a first step, Congress should support full funding for Space Station Freedom, and for the National Aerospace Plane. We are a compassionate Nation that looks to the safety and welfare of our people first, but we are also a people that look to the future -- the future of our posterity and the future of our planet.

Only by continuing to push the frontier forward, can we hope to provide the same kinds of opportunities for succeeding generations that our forefathers provided for us: the opportunity to lead, to explore and to "find new worlds."

Two days from now -- on July 20 -- Americans will celebrate the 20th anniversary of the Moon landing. We will recall the heroism of Apollo 11 astronauts Neal Armstrong and Edwin Aldrin -- two Americans who, it was rightly said, "opened the door to infinity." And we will remember the words of John F. Kennedy: "We choose to go to the Moon in this decade," President Kennedy said at the ground-breaking of the Manned Spacecraft Center in Houston back in 1961, "not because [it] is easy, but because [it] is hard... 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 mankind.... And therefore, as we set sail, we ask God's blessing on the most hazardous and dangerous and greatest adventure on which man has ever embarked."

That adventure has not ended; indeed, it has just begun. Having opened the door to the infinite reaches of space with Apollo 11, we must not hesitate at the threshold. We have the resources necessary to follow up on the achievements of Apollo 11, and the courage necessary to open a new chapter in human history. We are a Nation of pioneers, and we welcome the challenge of the unknown. As President Bush has said, "We must keep America first in space." And with your help, we shall.

Thank you and God Bless you.

ID# 036362

FG006-03

THE WHITE HOUSE
CORRESPONDENCE TRACKING WORKSHEET

INCOMING

DATE RECEIVED: MAY 15, 1989

NAME OF CORRESPONDENT: MR. WILLIAM CLARK

SUBJECT: APPRECIATION FOR CHIEF OF STAFF IMPLEMENTING THE TECHNOLOGY ADOPTION IN NEW HAMPSHIRE AND COMMENTS THE 12 ASTRONAUTS WHO LANDED ONMOON HAVE NEVER RECEIVED A MOON ROCK

ROUTE TO: OFFICE/AGENCY (STAFF NAME)	ACTION: ACT CODE	ACTION: DATE YY/MM/DD	DISPOSITION: TYPE RESP	DISPOSITION: C D	DISPOSITION: COMPLETED YY/MM/DD
JOHN SUNUNU	ORG	89/05/16		C	89/6/09 CJ
REFERRAL NOTE:					
		/ /			/ /
REFERRAL NOTE:					
		/ /			/ /
REFERRAL NOTE:					
		/ /			/ /
REFERRAL NOTE:					
		/ /			/ /
REFERRAL NOTE:					

COMMENTS:

ADDITIONAL CORRESPONDENTS: M

CS MAIL USER CODES: (A)

Bob Simon

****
*ACTION CODES: *DISPOSITI
*
*A-APPROPRIATE ACTION *A-ANSWERE
*C-COMMENT/RECOM *B-NON-SPE
*D-DRAFT RESPONSE *C-COMPLET
*F-FURNISH FACT SHEET *S-SUSPEND
I-INFO COPY/NO ACT NEC * OUTGOING *
*R-DIRECT REPLY W/COPY * * *
*S-FOR-SIGNATURE * * *
*X-INTERIM REPLY * * *
****

REFER QUESTIONS AND ROUTING UPDATES TO CENTRAL REFERENCE (ROOM 75,OEOB) EXT-2590
KEEP THIS WORKSHEET ATTACHED TO THE ORIGINAL INCOMING LETTER AT ALL TIMES AND SEND COMPLETED RECORD TO RECORDS MANAGEMENT.

036362

Optical Data Corporation

May 8, 1989

Mr. John Sununu
Chief of Staff
The White House
Washington, D. C. 20500

THE CHIEF of STAFF has seen

Dear Mr. Sununu,

Several weeks ago I had the pleasure of visiting the White House with my colleagues from ABC News and sharing with you the work we are doing in educational videodisc publishing. While the focus of the meeting was on ABC News' *The '88 Vote*, I genuinely appreciated the opportunity to thank you for implementing the technology adoption in New Hampshire. At the time, the adoption was a major boost for videodisc technology and our small, fledgling company. Again, thanks for the vision and political commitment.

On a totally unrelated topic, I recently had dinner with Gene Cernan, commander of Apollo 17. As a citizen and taxpayer, I was amazed and somewhat embarrassed to learn NASA had never awarded even token moon rocks to the 12 brave souls who descended to the lunar surface. Obviously these rocks are public property and national treasures. However, release of a few grams of common lunar basalt will not diminish the Apollo science legacy. Over the years, moon rocks have been distributed widely for research and display. It would be admirable for the White House and Congress to get together on this for the 20th anniversary of Apollo 11 in July.

POTUS present?

get info

30 Technology Drive
Box 4919
Warren, NJ 07060

201-668-0022

Fax 201-668-1322

Meeting w/ Kristol, Grady, McNally 7/10/89

not all well - complacency over 20 years

1969 = 1492 landed, came home
didn't leave anything

time to move on to new phase
dedicated

VP introduces PRES on 7/20

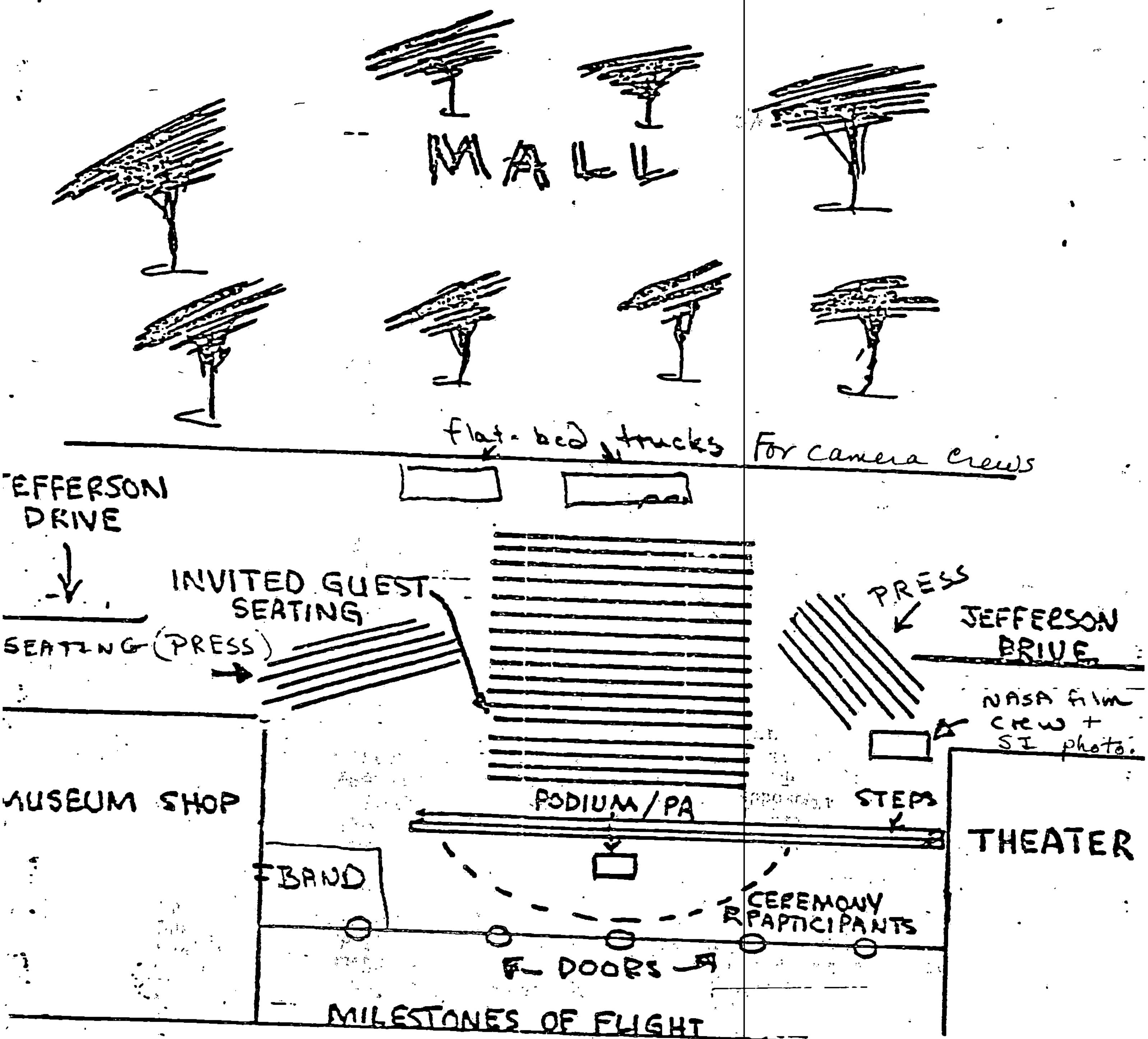
charge to VP
- to Mars?
- how fast?
- to moon first as base?
- report "as soon as possible"

HEADLINES: BUSH COMMITS TO MARS MISSION
BUSH ASKS FOR PLAN TO MARS

✓ Nixon - Mars 1972
✓ RR - 82

Mark Albrecht - 6175

PUBLIC CEREMONY LOCATION PLAN



Ford: 7-1-76

Collins suit in Columbia Ap 11 ~~com~~ CM
epoxy w/stainless stell honeycomb

ascent stage of Eagle still orbiting the moon ; all others ~~stat~~ crashed into moon on purpose

4-13-61 The Race in Space: headline NYT

Eagle landing was manual ; Armstrong took control when computers got overloaded + they were going to land in crater almost out of fuel : 30 seconds

Shepard – six iron

collected 47 pounds of lunar material

"Here men from the planet Earth first set foot upon the moon July 1969 A.D. We came in peace for all mankind."
signed by 3 astronauts + Nixon

Apollo 17 plaque: "Here man completed his first explorations of the moon December 1972 A.D. May the spirit of peace in which we came be reflected in the lives of all mankind."

signed by 3 astronauts & Nixon

A very Good, concise statement of why we need Space Station Freedom.

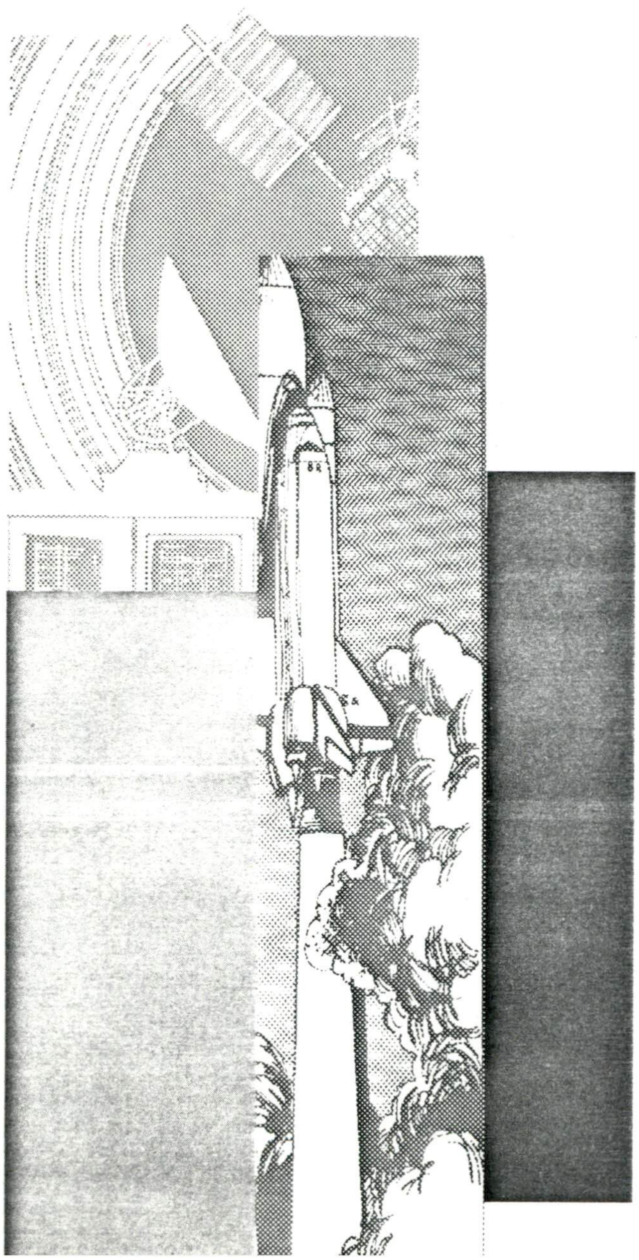
Space Station *Freedom*

Today's Investment for the Future

Aerospace
Industries
Association

The first obligation of each generation is to invest in the next.

Space Station *Freedom* is essential to continued U.S. leadership not only just in space but also as a world power. The permanently-manned research laboratory, with its associated observation and production facilities, will—based on past experience—lead to an improved quality of life for the United States and all mankind as well. America was built on exploration: our scientific, technological, and economic preeminence is built on extending the frontiers of the unknown.



Technology derived from *Freedom's* development and operation should enable continued U.S. leadership in new products and processes. This, in turn, could lead to increased employment, an improved balance of trade, and sustained economic growth. Such developments are expected to hasten the opening of space as a new commercial endeavor with even greater benefits.

Space-based research is expected to yield new information about medicines and the processes of nature. Such research has already accelerated drug research and provided insight to improving our long-term health. Planned studies on the effects of long-duration weightlessness on humans might not only pave the way for the future exploration of the universe but also could enhance our understanding and treatment of ailments on Earth as well.

Freedom's observation platforms are being designed to address our most pressing needs about understanding and protecting our fragile environment. Earth will be studied as never before, enhancing our ability to predict, and perhaps avoid, the destruction of hurricanes, tornadoes, drought, and crop disease. We should also be better able to understand and monitor the effects of man-made changes to the environment—such as pollution and ozone depletion—and their potential greenhouse effect. Additionally, Space Station facilities will provide a nearly perfect location for the study of the universe and insight into our beginnings as well as our future.

The Space Station program has become the symbol of our commitment to our allies, our national will to our adversaries, and our strength to the emerging Third World. With the growth in technology and all its holds for the future, it is imperative that we set the pace with our allies and friends. If we do not continue our leadership, nations will seek partners other than the U.S. to benefit from space and we will lose the close ties that now bind us and will continue to bind us in the future.

Man's permanent presence is essential to obtain the full benefits of Space Station *Freedom*. Robotics will play a critical role in *Freedom's* development, assembly, and operation. However, no machine has yet been devised that can provide the integrated and compact perception, logic, creativity, and dexterity of man.

The Space Station program is a symbol of our nation's commitment to the peaceful use of space for the benefit of all mankind. Now, more than ever, we must extend a hand to the next generation—our children—to give them the edge in technology, invention, and discovery so that they will continue our role in world leadership and our efforts toward an improved quality of life.

Exploration Leading to Innovation

Our existing space program has already contributed significantly to a higher quality of life on Earth.

Technology Twice Used

For more than three decades NASA has been instrumental in developing critical aeronautical and astronautical technologies that have been the cornerstone of many U.S. industries while providing a better quality of life for all people on Earth.

Many of the technical advancements that NASA used to put a man on the moon and today's satellite system in place have found their way into our day-to-day lives. NASA appropriately calls this "technology twice used." Some of the impacts have been so subtle that many of us do not realize their origin.

It is impossible to catalog all of the areas where those technologies have found direct application. However, some of the more public applications are:

Medicine and Public Safety

- ▲ Lightweight fire protection clothing and rescue operation breathing apparatus
- ▲ Blood gas monitors, implantable medicine dispensers
- ▲ Image processing hardware/software for medical applications: computerized axial tomography (CAT scan), diagnostic radiography, nuclear magnetic resonance imaging (MRI)
- ▲ Single-lever controls for vehicles, giving the physically impaired greater mobility and freedom
- ▲ Foam cushioning
- ▲ Automobile braking design and structural/aerodynamic analysis
- ▲ Image processing software for skin care

Environment, Weather, and Communications

- ▲ Real-time TV and telephone
- ▲ Severe storm (hurricane and tornado) prediction and monitoring
- ▲ Improved, long-range weather forecasting (crop status, drought minimization)
- ▲ Understanding the environment, monitoring pollution and ozone levels
- ▲ Detection of oil spills and acid rain
- ▲ Charting of ocean currents for fishing and shipping

Recreation

- ▲ Composite rackets, clubs, rods, skis, and shock absorbent, lightweight running shoes
- ▲ Space-age survival blankets
- ▲ Compact disk recorders
- ▲ Stadium roof enclosures
- ▲ Velcro fasteners

Other Technology

- ▲ Personal computers
- ▲ Facsimile machines
- ▲ Improved coal combustion in steam plants for pollution reduction and increased efficiency
- ▲ History and archaeology of the Amazon, Africa
- ▲ Natural air and water pollution control (hybrid plant/microbe systems)

Benefits can be derived from permanent human presence aboard an orbiting national laboratory in space

Future Benefits from Space

Scientific research on Space Station *Freedom* will have three unique features currently unavailable on Earth:

- A gravity very near zero,
- The continual presence of men and women to conduct experiments, and
- An unsurpassed vantage point 250 miles above Earth for observing the stars and planet Earth.

These resources open exciting new paths of research in biology, physics, chemistry, and observational sciences.

Once we learn how life forms react to reduced gravity, we will have increased our knowledge of life itself. In the presence of microgravity, scientists will study the human cardiovascular system, sense of balance, muscle atrophy, and bone and mineral loss. It is very likely that new information will be obtained...and it is probable that modern medicine will advance because of it.

In the microgravity of space, the problems of convection and imperfect mixing, which plague our Earthbound experiments, essentially disappear. We can produce near-perfect compounds in liquid, crystalline, and solid forms. Compounds of purity and perfection never before achieved will lead to new knowledge of the physical and chemical laws governing their formation. This new knowledge will enhance our ability in many areas of materials processing:

- The production of pure crystals vital to the electronic revolution;
- The creation of new, high-strength metals and temperature-resistant glasses (essential to such product improvement as jet engines and optical communication systems); and
- The separation of biological materials important to pharmaceutical manufacturing.

Finally, *Freedom's* facilities will provide space observation capabilities we have not had before: capacity, longevity, and accessibility. There will be an area large enough to accommodate observing instruments and large attachments, and its power and data systems exceed the capacity of most satellites. Most importantly, man's presence on board Space Station *Freedom* will provide a unique ability to process observations as well as learn and adapt to special opportunities that is far beyond the capability of machines.

Because of these characteristics, Space Station *Freedom* will

1. **Provide a versatile research facility for space science and applications.**
2. **Contribute to U.S. leadership in space during the 1990s and beyond.**
3. **Enhance our national competitiveness.**
4. **Build stronger relationships with our friends and allies.**
5. **Enable a broad range of activities and serve as part of an infrastructure critical to future space efforts.**
6. **Provide extensive precursor life sciences study, which is mandatory for longer-term exploration missions.**
7. **Stimulate the development of advanced technologies.**
8. **Encourage science and engineering students at all levels from our primary and secondary schools to our universities.**
9. **Stimulate the pioneering spirit in the United States.**

The next major goal has been set, the next logical step has been defined: To move forward with a permanent presence in space that will carry us into tomorrow.

Time for Resolve

Space Station *Freedom* is moving ahead now with a well-defined and supported program. The National Research Council has reviewed the program, and numerous executive branch and congressional studies have been done over the past five years. These studies concluded that a space station is appropriate and necessary.

The United States has a viable space program that—with Space Station *Freedom* as the centerpiece—will make possible the dramatic exploration contemplated for the 21st Century. Our country has carefully prepared and is developing *Freedom* with its best industry and government teams. Delay will only result in increased program costs and missed opportunities.

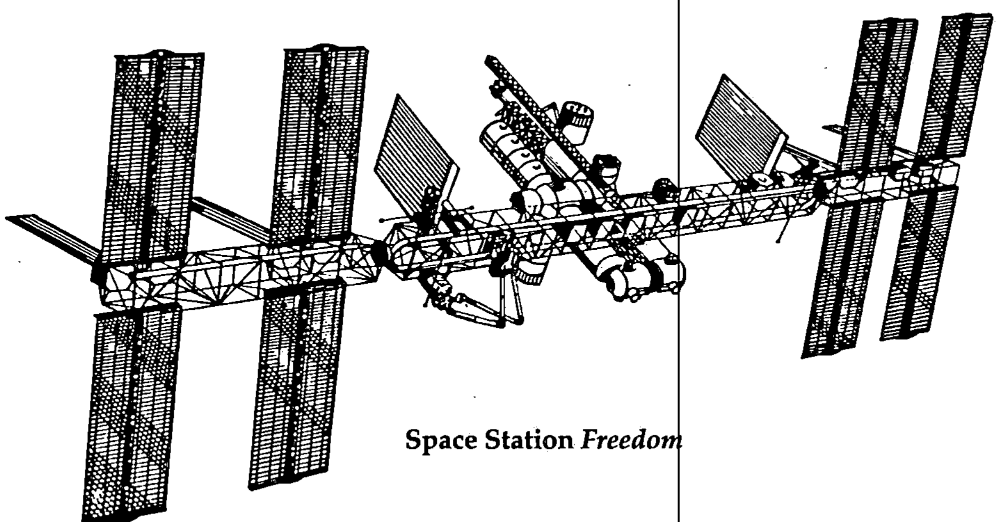
It is time now to continue, unabated, our national support for Space Station *Freedom*.

AIA Position

U.S. science, space, and technology programs are integral to the nation's continued economic, social, and technological leadership. Recently, our investments in the future have slackened while those of our competitors have increased; they have closed the gap and, in some cases, have surpassed us.

Continued support for science, space, and technology programs is essential to our future. These programs not only give us immediate results but also provide the foundation for educating the next generation of scientists and engineers, the individuals who will lead the battle against disease, famine, and poverty toward an improved quality of life. Through their efforts our understanding of ourselves, the Earth, and the universe will be expanded.

Space Station *Freedom* is necessary to sustain our leadership in space. The Aerospace Industries Association supports its continued development and urges a level of funding consistent with the current program schedule.



Space Station *Freedom*

Aerospace Industries Association 1250 Eye Street, N.W., Washington, D.C. 20005

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

EXCERPTS FROM REMARKS PREPARED FOR DELIVERY:
PATHWAY TO THE PLANETS CONFERENCE
WASHINGTON, D.C.; MAY 31, 1989

RICHARD H. TRULY
NASA ACTING ADMINISTRATOR

Thank you very much, and good morning.

I am very pleased to be here today and to add my welcome on behalf of all of us at NASA.

This is a timely and exciting conference.

It is timely because this nation has a national goal, stated in our National Space Policy, of expanding the human presence into the solar system. And if we are to achieve that goal given a reasonable timetable leading early into the next century, we must begin now to explore the options and opportunities it presents.

And it is exciting because rarely in human history has civilization progressed into an era such as this. We live in one of those rare ages when technological progress has kept pace with human imagination and vision.

Because this is so, we find ourselves with unparalled challenges and opportunities.

Consider this .... Within the span of just one human lifetime, we moved from the sands of Kitty Hawk to the deserts of the Moon; from state-of-the art biplanes made of cloth and wood to the world's first reusable spacecraft, the Space Shuttle, which orbits the Earth at Mach 25.

And what is even more incredible ... we are just beginning! The return of the Space Shuttle to flight last September was a heroic achievement and a signal for even greater accomplishments to come. I am proud to have been part of that immense effort. And NASA and the nation are proud of the skill and dedication of the thousands on the NASA/industry team who made it possible.

- more -

With the start of the Magellan voyage to the planet Venus this very month, a golden age of space science has begun and the United States is leading the way. This year and through 1993, the United States plans 36 space science launches. They include Galileo to the planet Jupiter; the Hubble Space Telescope, the first of the Great Observatories; the Gamma Ray Observatory, the second Great Observatory; the Mars Observer and Ulysses to the Sun. Thirty-six launches in five years. That's the highest launch rate for space science missions in the history of the United States space program.

Desite occasional comments to the contrary, it is clear that NASA has maintained a steady and substantial allocation for space science programs through the years. I can assure you that as Administrator, I will be personally committed to maintaining a balanced NASA program across the board.

Just as it's impossible to predict what new knowledge will flow from future NASA missions, we cannot even imagine what technological advances our children and their children will experience during their lives. We can be proud that our generation has planted the seeds of unprecedented technological growth and progress on Earth and in space. And I trust that we'll continue to nurture those seeds so that future generations will reap the benefits of our continuing exploration and quest for knowledge.

In pursuing that quest, it's pretty clear that in the 21st century humans will go beyond Earth and its immediate orbital environment and strike out into the solar system. The two most promising destinations are the Moon and Mars, the planet more like Earth than any other known planet.

During this conference, you will be hearing much about NASA's efforts to increase our understanding of what it will take to pursue the options and opportunities for this inevitable human exploration of the solar system. I expect that this work may lead to a recommendation to the President in the early 1990s on an appropriate exploration goal beyond Earth's boundaries.

I don't doubt that this nation will be sending men and women on voyages of interplanetary exploration in the years ahead. I believe we're destined to become a multi-planet species, with both the Moon and Mars in our future. We at NASA are working to understand the best long-term approach to take. But it's clear that whatever path we choose, certain conditions will have to be met for the enterprise to be successful.

First and foremost, we will need a long-term national commitment from our leadership - the President and the Congress - and from the American people. Twenty years ago this coming July 20, we saw the fruits of such a commitment when Neil Armstrong and Buzz Aldrin made the first manned lunar landing as Michael Collins orbited the Moon in their capsule "Columbia." Our goal of a lunar landing was accomplished openly within a set timetable for all the world to see. It demonstrated to us and to the world that there's no limit to what men and women can accomplish when we work together to meet great goals and back our determination with adequate resources.

Clearly, broad public support means that a stable funding profile must be established for the life of the program. This may very well be difficult to achieve, as we have seen over the past few years, with budget battles in Congress over funding Space Station Freedom. In this era of fiscal austerity, many in Congress are reluctant to commit short-term resources to projects like the space station that are necessary to achieve long-term objectives.

As a great nation, the United States cannot afford to deny resources to the future. Space Station Freedom is our future, and I intend to do everything I can to ensure that we commit the necessary resources for its completion on schedule, that is, by the mid-1990s. This will protect our options, while, at the same time, provide near-term benefits and experience.

For the near-term, Space Station Freedom will serve as a materials science and life science laboratory. For the long-term, Freedom Station is vital to achieve the goal of future manned solar system exploration for three major reasons.

First, it is only on this permanent manned orbital research facility that we can test the systems and technologies required for living and working in space for extended periods.

Second, working together with our international partners on Freedom, we will learn better how to cooperate with other nations in managing this largest international cooperative project of the Space Age. This knowledge will be essential in light of growing cooperation among spacefaring nations in both space exploration and in Mission to Planet Earth - the study of the Earth from space.

In that connection, let me say that our international partnerships with our friends and allies in Japan, Europe and Canada are firm and their work on the Space Station is moving ahead in concert with ours. Cancellation of Space Station Freedom because of inadequate funding would send a clear signal to other nations that the United States is not a reliable partner, not only in space ventures, but in other areas as well. That is not the message America wants to send out.

Finally, Freedom eventually will serve as an in-orbit depot and assembly location for the space transfer vehicles that will carry people and cargo to the Moon and/or to Mars. It is vital that we protect that option.

There are many other foundation programs necessary to carry out the goal of human exploration of the solar system.

Clearly, we will need to rebuild our heavy-lift launch capability. The current fleet of Space Shuttles and expendable launch vehicles is inadequate to launch efficiently the millions of pounds of equipment, supplies and fuel required for an ambitious program of human exploration. All preliminary NASA studies indicate that a heavy-lift rocket will be needed to deliver that material to space most efficiently and effectively.

Advanced technologies to provide the tools for living and working in space also will be required. An internal NASA assessment of key technologies required for future human exploration places high priority on investments in research in several key areas. They include propellant transfer and refueling in space; closed life-support systems; automated rendezvous and docking capabilities; in-orbit assembly and construction; and advanced chemical and possibly nuclear propulsion.

We all know it takes 8 to 12 years from the time technology research is initiated until the results are ready for mission application of complex space systems. That underscores how urgent it is to invest now in technology research of the types I've just described.

Another pressing need for a program of expanded human space exploration is to augment life sciences research. There are many areas to investigate regarding human health, safety and productivity.

We need to increase our understanding of the effects of long-term weightlessness on the body's physical and mental processes.

It's vital to know more about whether crews can travel long journeys in zero gravity and arrive at their destination mentally and physically capable of performing their mission. The question of creating artifical gravity in space needs an answer. When we go to Mars, it is very possible that such research will have an impact on the design of the spacecraft to get us there.

NASA's vision is to expand the frontiers of discovery, understanding, human experience and technology to enrich our country's future and to capture the benefits of space for future generations.

I am fully committed to working to fulfill that vision. The extension of the human presence into the solar system will drive our technologies and imagination like no other engine.

It has been 16 1/2 years since man last walked on the Moon. Many Americans are too young to remember when man first set foot on another celestial body 20 years ago this July. Yet those steps changed forever our view of ourselves and the planet we inhabit.

Apollo at its peak consumed nearly four per cent of the total Federal budget. And it returned seven to eight dollars in benefits to our economy for every dollar invested in it. A program of human exploration of the solar system, the greatest adventure of our time, will require a significant increase in NASA's budget, which now stands at only one per cent of our entire national budget. But the returns will be incalculable.

At a recent White House ceremony naming the new Space Shuttle Endeavour, President Bush spoke of the "orbiter lifting off ... and Americans cheering its safety and success and dreaming of the new worlds and far away heavens which form America's destiny."

I believe in that destiny, and in the new worlds and far away heavens it will reveal to us. By keeping alive that vision, together we can and will build a better tomorrow for the young Americans of today.

A hundred years from today, the NASA Administrator will address a conference like this one ... and talk of how we returned to the Moon ... and journeyed to Mars ... and did a thousand other things. And our world will be a better place for having done them!

Thank you very much.

rating wildly. Stafford soon took over manually and finally regained control. A switch was in the wrong position, Houston claimed. (For a more detailed account of this event, read Chapter 5, "space Disasters and close calls.")

Snoopy's descent to some 9 miles (14.5 kilometers) above the moon's surface and the rendezvous and docking had taken almost eight hours. The crew rested and did more moon reconnaissance before firing up on May 24 and beginning their fifty-four hour return to earth, which brought them safely down in the Pacific, 395 miles (636 kilometers) east of Pago Pago on May 26, 1969, after a flight lasting 192.1 hours. Up next: *Apollo 11*.

Apollo 11: Columbia *and* Eagle

A Dangerous Descent. On a Sunday afternoon in the late 1960s, the earth changed forever. It was Sunday, July 20, 1969. The time was 4:17:43 P.M. Eastern Daylight Time. After a dangerous descent, Neil Alden Armstrong and Edwin Eugene "Buzz" Aldrin, Jr. soft-landed their moonship, the *Eagle*, in the powdery, ash-like soil of the desolate and windless Sea of Tranquillity.

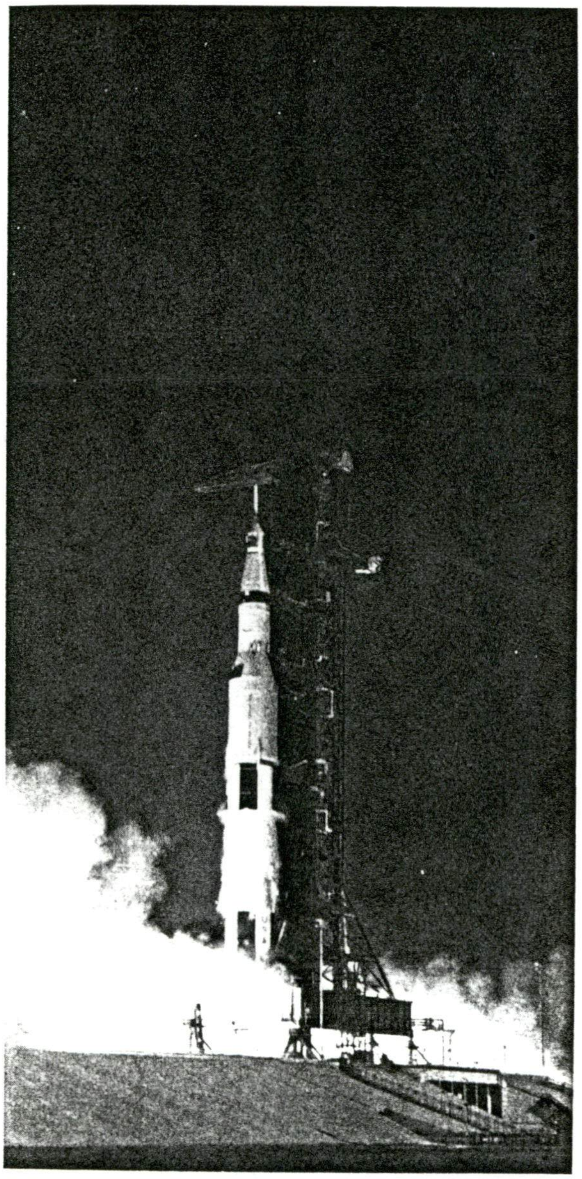
This moment of lunar landfall, and the moment of Neil Armstrong's first steps in the ancient moon soil some six and a half hours later, symbolize humankind's never-ending reach outward. When all else is forgotten in the twentieth century, *Apollo 11* and the other voyages of Apollo to the moon will be remembered. The year 1969 will be known to future generations as the year that humankind burst from its terrestrial bonds. After the *Eagle* descended onto the dry lunar sea, the human mind would never again be the same. The event created the twentieth-century pyramids: pyramids made not of stone, but of new ideas filled with human possibility, thrust inside humanity's head by the triumph of *Apollo 11*.

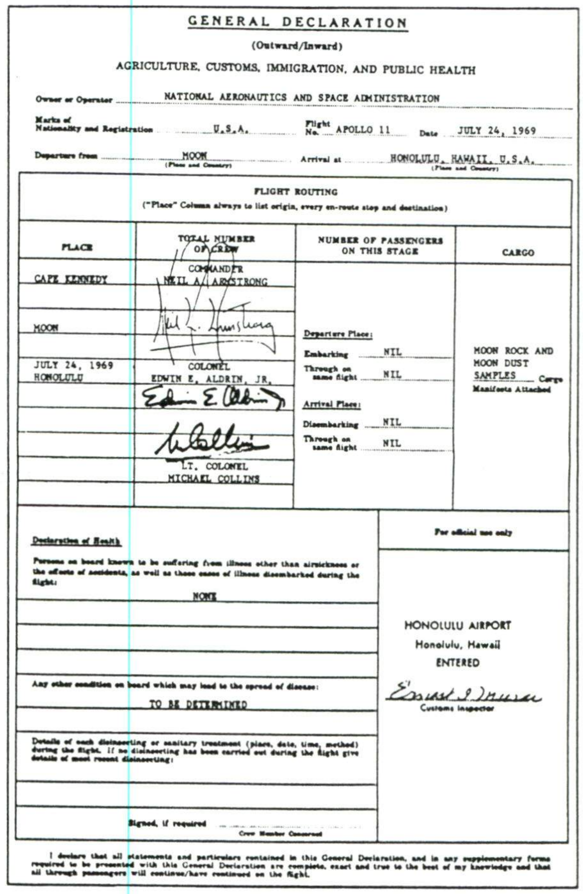
Every baby boomer remembers where he or she was on that summer afternoon in July 1969, when commander Armstrong's *Eagle* touched

FACING PAGE LEFT: *The historic blast-off of* Apollo 11, *which would take men to the surface of the moon for the first time in human history.* ABOVE: *The signed* Apollo 11 *insignia was reproduced on an invitation to the* Apollo 11 *prelaunch briefing at the Cocoa Beach Theatre.* FACING PAGE RIGHT: *Also shown is the most unusual customs declaration ever filed.* Courtesy NASA.

down on the moon, his heart pounding more than twice its normal beat—156 beats a minute—as he accomplished one giant leap for mankind. But many *Star Wars* kids were not even born; others were too young to remember. For them, and for those of us who will never forget, this is a recounting of the dramatic and dangerous descent of the moonship *Eagle* to the Sea of Tranquillity.

On Sunday morning, July 20, 1969, the lunar module *Eagle* undocked from *Columbia*, the command ship. "The *Eagle* has wings," Armstrong radioed to earth. The two spacecraft then flew in formation, and Michael Collins in *Columbia* visually inspected the *Eagle* to ensure it was not damaged and would function properly. Collins reported that everything appeared ready for descent. "I think you've got a fine looking flying machine down there, despite the fact that you're upside down," Collins quipped. Houston





GENERAL DECLARATION

(Outward/Inward)

AGRICULTURE, CUSTOMS, IMMIGRATION, AND PUBLIC HEALTH

Owner or Operator: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Marks of Nationality and Registration: U.S.A. Flight No. APOLLO 11 Date JULY 24, 1969

Departure from: MOON (Place and Country) Arrival at: HONOLULU, HAWAII, U.S.A. (Place and Country)

FLIGHT ROUTING

("Place" Column always to list origin, every en-route stop and destination)

PLACE	TOTAL NUMBER OF CREW	NUMBER OF PASSENGERS ON THIS STAGE	CARGO
CAPE KENNEDY MOON JULY 24, 1969 HONOLULU	COMMANDER NEIL A. ARMSTRONG COLONEL EDWIN E. ALDRIN, JR. LT. COLONEL MICHAEL COLLINS	Departure Place: Embarking NIL; Through on same flight NIL Arrival Place: Disembarking NIL; Through on same flight NIL	MOON ROCK AND MOON DUST SAMPLES Cargo Manifests Attached

Declaration of Health

Persons on board known to be suffering from illness other than airsickness or the effects of accidents, as well as those cases of illness disembarked during the flight:

NONE

Any other condition on board which may lead to the spread of disease:

TO BE DETERMINED

Details of each disinsecting or sanitary treatment (place, date, time, method) during the flight. If no disinsecting has been carried out during the flight give details of most recent disinsecting:

Signed, if required ______ Crew Member Concerned

For official use only

HONOLULU AIRPORT
Honolulu, Hawaii
ENTERED
Customs Inspector

I declare that all statements and particulars contained in this General Declaration, and in any supplementary forms required to be presented with this General Declaration are complete, exact and true to the best of my knowledge and that all through passengers will continue/have continued on the flight.

gave *Eagle* a go for powered descent. An hour after undocking, on the far side of the moon, the *Eagle*'s descent engine was fired, making the first of two engine burns to reach the moon's surface, a descent that would last only 12 minutes and 34 seconds after millions of man-hours and billions of dollars had been spent to prepare for it. *Eagle* was still some 60 miles (95.5 kilometers) above the surface when Armstrong and Aldrin initiated the first engine burn, which would take them to an altitude of 50,000 feet (15,240 meters) above the moon.

At five minutes into the burn, as the *Eagle* descended to 6,000 feet (1,829 meters), a yellow caution light came on.

"Program alarm!" Armstrong reported loudly. "It's a 1202!" Houston came back with a go. The 1202 was an executive overflow of the onboard computer, which meant that the computer was forced to postpone some things because it had too much to do at once. At about 3,000 feet (914 meters) above the surface, the yellow caution light flashed again, this time a 1201 program alarm, another overflow condition. Again the ground told the crew that descent was still go and to ignore the alarm.

Armstrong and Aldrin kept on responding to four more such alarms in about four minutes. Steve Bales, the computer flight controller back in Houston, who made the go decision, was "believing" the landing radar. As it turned out he was right; it was the rendezvous radar, not the landing radar, causing the computer overload. Had Steve Bales thought otherwise, the *Eagle* would never have landed—Bales would have ordered a mission abort.

The alarms and instrument readings had taken the crew's full attention, and they were unable to look out the window from an altitude of 5,000 feet (1,524 meters) to determine their location. When they finally could look out, they were only 1,968 feet (600 meters) above the lunar surface and had only three minutes of fuel left. Immediately Armstrong saw that they were heading for a large boulder field that surrounded a crater; and the larger boulders were 16 feet (5 meters) in diameter, big enough to burst open the belly of the *Eagle*. It was here that Armstrong's heart rate soared to 156 beats a minute.

Aldrin continued to call out the descent and feet-per-second forward motion rates. They were now about 300 feet (90.5 meters) above the moon. It was then that Armstrong decided he must take manual control of the moonship and fly over the West Crater and boulder field in search of a smoother landing area. Ground control noticed that *Eagle's* forward speed suddenly shot up to 80 feet (24 meters) per second—about 55 miles (88.5 kilometers) per hour. This was *not* according to the flight plan.

As he searched for a landing site, Armstrong asked Aldrin how much descent fuel was left, but Aldrin was too busy watching the computer; he didn't hear him. Armstrong then slowed the forward speed. They were only 100 feet (30.5 meters) above the moon. Finally he found a small smooth clearing about the size of a house lot and headed for it: On one side were craters; on the other side was a field of boulders. Then, abruptly, a red light flashed on the control panel, and a warning came on in Mission Control back on earth. Only 5 percent of their descent fuel remained. If they were not on the surface within ninety-four seconds, they would be forced to abort and fire *Eagle*'s ascent engine.

Only sixty seconds of fuel remained. Lunar dust kicked up by the descent engine obscured Armstrong's view. It was like a ground fog, but it had movement and made it impossible for Armstrong to judge his altitude or forward motion. He tried to judge by picking out large rocks and watching them through the haze!

Thirty seconds of fuel remained! At 33 feet (10 meters) above the surface, *Eagle* started slipping to the left and moving backward. But there was no rear window. What dangerous obstacles were behind him? The rim of a crater?

Armstrong stopped the backward motion, but not the drift to the left. He didn't want to slow the descent any more; there were only seconds of fuel left. He was concentrating so hard that he did not feel the first touch on the moon's surface or hear Aldrin call out "contact light" when the footpad probes brushed the surface. The landing was gentle, at about 1 foot (0.3 meters) per second. They were down, with only twenty seconds of fuel left! *Eagle* was on the moon at a slight tilt—about 4.5 degrees from the vertical—some 4 miles (6.4 kilometers) beyond the programmed landing area. The first words from the moon were Aldrin's: "Okay, engine stop." And then seconds later, Neil Armstrong's famous "The *Eagle* has landed." The moon dust cleared. The blazing bright moonscape revealed itself. The earth had changed. Two men were on the moon.

Setting Up Tranquillity Base. Moonship *Eagle* remained on the moon's surface for 21.6 hours. About six and a half hours after landing the hatch was opened and Neil Armstrong backed out onto the lunar module's "front porch." It was 10:39 P.M. Eastern Daylight Time—prime TV time in the United States. Seventeen minutes later, Armstrong planted his left boot on the surface of the moon and spoke his "small step . . . giant leap," phrase that will never be edited out of the history books.

"The surface is fine and powdery . . . . I can pick it up loosely with my toe. It does adhere in fine layers like powdered charcoal to the sole and sides of my boots. I only go in a small fraction of an inch, maybe an eighth of an inch . . . . It's actually no trouble to walk around."

Aldrin followed at 11:11 P.M. When he plant-

Nat'l. Geographic Dec. 1969

III: The Flight of Apollo 11:

By KENNETH F. WEAVER, Assistant Editor

TWO THOUSAND FEET above the Sea of Tranquillity, the little silver, black, and gold space bug named *Eagle* braked itself with a tail of flame as it plunged toward the face of the moon. The two men inside—standing like the motorman in a 19th-century trolley car—strained to see their goal. Guided by numbers from their computer, they sighted through a grid on one triangular window.

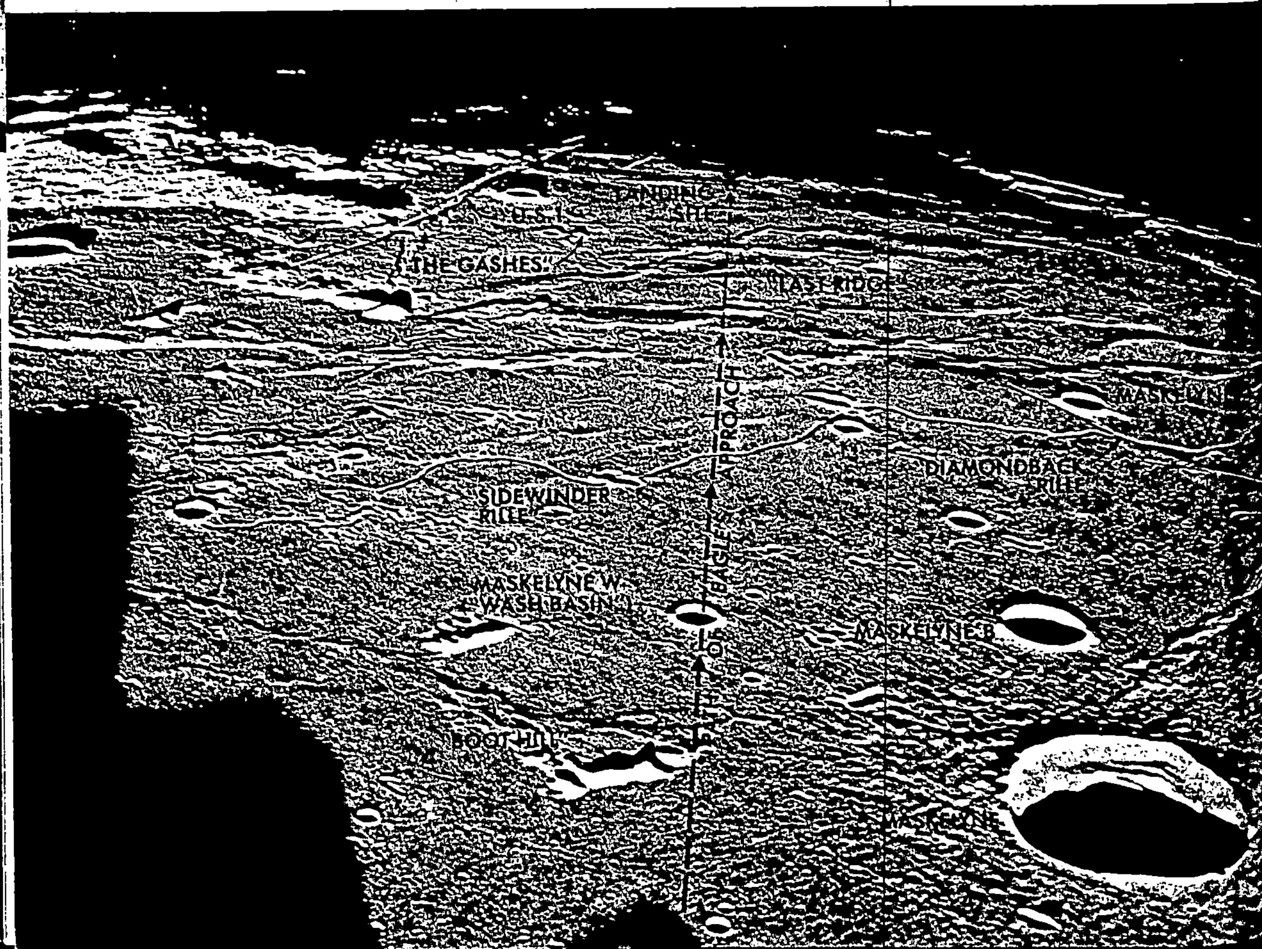
Suddenly they spotted the onrushing target. What they saw set the adrenalin pumping and the blood racing. Instead of the level, obstacle-free plain called for in the Apollo 11 flight plan, they were aimed for a sharply etched crater, 600 feet across and surrounded by heavy boulders.

For Astronaut Neil Armstrong, at the controls of the frail, spidery craft, a crisis in flight was nothing new. In 1966 he had subdued the wildly gyrating Gemini 8 when one of its thrusters stuck. More recently, he had ejected safely from the "flying bedstead," a jet-powered lunar-landing training vehicle, just before it crashed. Now he would need all the coolness and skill acquired during 500 earthbound hours in simulators and during years test-flying the X-15 and other experimental aircraft for the National Aeronautics and Space Administration.

The problem was not completely unexpected. Shortly after Armstrong and his companion, Edwin (Buzz) Aldrin, had begun their powered dive for the lunar surface ten minutes earlier, they had checked against landmarks such as crater Maskelyne (below) and discovered that they were going to land some distance beyond their intended target.

And there were other complications. Communications with earth had been blacking out at intervals. These failures had heightened an already palpable tension in the control room in Houston. This unprecedented landing was the trickiest, most dangerous part of the flight. Without information and help from the ground, *Eagle* might have to abandon its attempt.

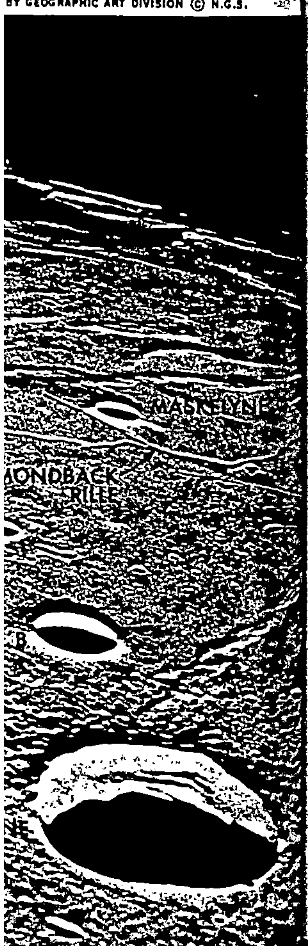
EKTACHROME, NASA; OVERLAY BY GEOGRAPHIC ART DIVISION © N.G.S.



)ollo 11: "One giant leap for mankind"

Now he would need all
acquired during 500
imulators and during
-15 and other experi-
National Aeronautics
ion.
not completely unex-
mstrong and his com-
ldrin, had begun their
unar surface ten min-
hecked against land-
Maskelyne (below) and
re going to land some
ntended target.
complications. Com-
h had been blacking
failures had height-
le tension in the con-
This unprecedented
iest, most dangerous
out information and
Eagle might have to

BY GEOGRAPHIC ART DIVISION © N.G.S.



Moreover, the spacecraft's all-important computer had repeatedly flashed the danger signals "1201" and "1202," warning of an overload. If continued, it would interfere with the computer's job of calculating altitude and speed, and neither autopilot nor astronaut could guide *Eagle* to a safe landing.

Eagle's Descent Fuel Runs Low

Armstrong revealed nothing to the ground controllers about the crater ahead. Indeed, he said nothing at all; he was much too busy. The men back on earth, a quarter of a million miles away, heard only the clipped, deadpan voice of Aldrin, reading off the instruments.

"Hang tight; we're go. 2,000 feet."

Telemetry on the ground showed the altitude dropping . . . 1,600 feet . . . 1,400 . . . 1,000. The beleaguered computer flashed another warning. The two men far away said nothing.

Not till *Eagle* reached 750 feet did Aldrin speak again. And now it was a terse litany: "750 [altitude], coming down at 23 [feet per second, or about 16 miles an hour] . . . 600 feet, down at 19 . . . 540 feet, down at 15 . . . 400 feet, down at 9 . . . 8 [feet per second] forward . . . 330, 3½ down." *Eagle* was braking its fall, as it should, and nosing slowly forward.

But now the men in the control room in Houston realized that something was wrong. *Eagle* had almost stopped dropping, but suddenly—between 300 and 200 feet altitude—its forward speed shot up to 80 feet a second—about 55 miles an hour! This was strictly not according to plan.

At last forward speed slackened again and downward velocity picked up slightly.

"Down at 2½ [feet per second], 19 forward . . . 3½ down, 220 feet [altitude] . . . 11 forward, coming down nicely, 200 feet, 4½ down . . . 160, 6½ down . . . 9 forward . . . 100 feet."

And then, abruptly, a red light flashed on *Eagle*'s instrument panel, and a warning came on in Mission Control. To the worried flight controllers the meaning was clear. Only 5 percent of *Eagle*'s descent fuel remained. By mission rules, *Eagle* must be on the surface within 94 seconds or the crew must abort—give up the attempt to land on the moon. They would have to fire the descent engine full throttle and then ignite the ascent engine to get back into lunar orbit for a rendezvous with *Columbia,* the mother ship.

When only 60 seconds remained, the countdown began. The quivering second hands on stopwatches began the single sweep that would spell success or failure.

"Sixty seconds," called Astronaut Charles Duke, the capsule communicator (CapCom) in Houston. Sixty seconds to go. Every man in the control center held his breath.

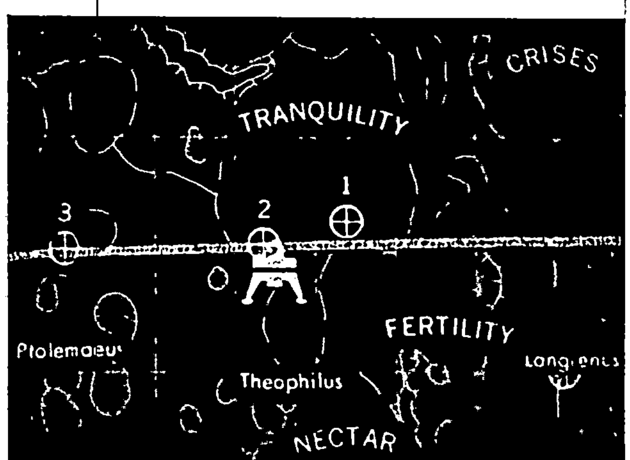
Failure would be especially hard to take now. Some four days and six hours before, the world had watched a perfect, spectacularly beautiful launch at Kennedy Space Center, Florida. Apollo 11 had flown flawlessly, uneventfully, almost to the moon. Now it could all be lost for lack of a few seconds of fuel.

"Light's on." Aldrin confirmed that the

(Continued on page 762)

Orbiting 70 miles above the moon, *Eagle*'s astronauts spy out their shadowy landing site. The site near the dawn line was chosen so that the men, in landing, would have the sun behind them and low enough to show surface features in sharp relief. The astronauts had nicknames—here quoted—for many lunar landmarks. One of *Eagle*'s thrusters creates the silhouette at left.

"They made it!" The jubilant cry rings out in Houston's Mission Control when a display panel (right) flashes a likeness of *Eagle* touching down at Landing Site 2. Place names in capitals are Anglicized versions of Latin-named *maria,* or "seas." Craters Ptolemaeus, Theophilus, and Langrenus honor early astronomers.



EKTACHROME BY A. PATNESKY, NASA

(Continued from page 753)
astronauts had seen the fuel warning light.

"Down 2½ [feet per second]," Aldrin continued. "Forward, forward. Good. 40 feet [altitude], down 2½. Picking up some dust. 30 feet. 2½ down. Faint shadow."

He had seen the shadow of one of the 68-inch probes extending from *Eagle*'s footpads.

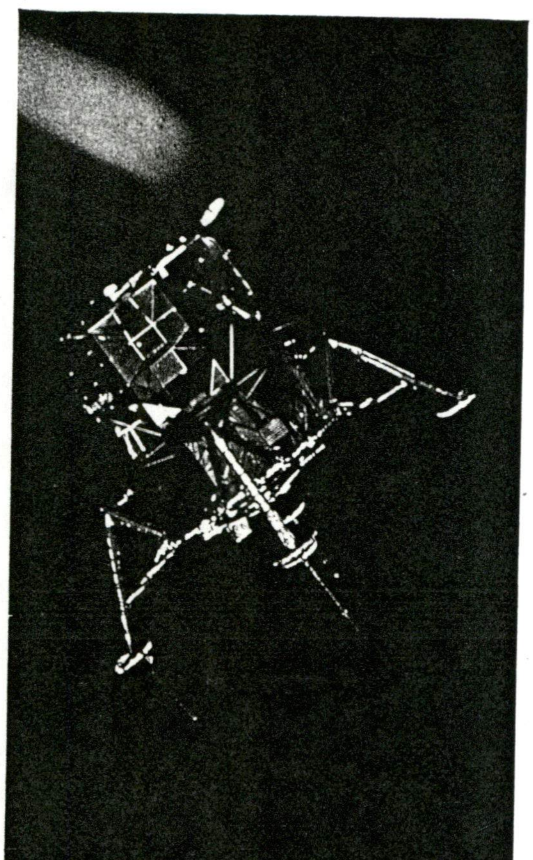
"Four forward . . . 4 forward, drifting to the right a little."

"Thirty seconds," announced CapCom. Thirty seconds to failure. In the control center, George Hage, Mission Director for Apollo 11, was pleading silently: "Get it down, Neil! Get it down!"

The seconds ticked away.

"Forward, drifting right," Aldrin said.

And then, with less than 20 seconds left, came the magic words: "Contact light!"



EKTACHROME BY MICHAEL COLLINS, NASA

"The *Eagle* has wings," Armstrong radios after separating from the mother ship. Collins made this picture from *Columbia* while inspecting the LM to be sure it functioned properly.

"It looked more like a praying mantis than a first-class flying machine," Collins said of the craft, "but it was a beautiful piece of machinery."

The spacecraft probes had touched the surface. A second or two later Aldrin announced, "O.K., engine stop."

Still later, the now-famous words from Neil Armstrong: "Tranquillity Base here. The *Eagle* has landed."

And, with joy in his voice, CapCom replied: "Roger, Tranquillity, we copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot."

It was 4:17:43 p.m., Eastern Daylight Time, Sunday, July 20, 1969.

Feat Watched by the World

Man's dream of going to the moon was fulfilled. The most exciting adventure in human memory now neared its climax as the two men prepared to step out on the lunar surface, while their fellow crew member, Mike Collins, kept vigil in his orbiting command module, *Columbia,* 70 miles above.

To me, it is impossible to compare this exploit with the epic feats of the great 15th- and 16th-century navigators, of the 20th-century polar explorers, or of Lindbergh in 1927. The differences are too profound, and one of the most important of those differences is that the whole world was watching.

According to estimates, one out of every four persons on the face of the earth watched or heard the astronauts by television or radio as they ventured to the moon. Nearly 850 foreign journalists, representing 55 countries and speaking 33 languages, reported the story from Cape Kennedy and Houston.

Americans abroad were thrilled by the impact of the flight on foreign peoples. Dr. Louis B. Wright, former Director of the Folger Shakespeare Library and a National Geographic Society Trustee, observed the effect firsthand in Italy. With 25,000 other people he was attending a performance of *Aïda* in the Roman Arena at Verona on that Sunday night.

"At the first intermission," Dr. Wright recalls, "an announcement was made in four languages: 'The Americans have just landed on the moon at 10:17.' My watch said 10:28.

"The crowd applauded wildly. Here and there spectators pulled little United States flags from their pockets and waved them. And for days afterward, when Italians met me on the street, they all had one word for the flight—*'Fantastico!'* "

And so it was—with different inflections—in Buenos Aires and Sydney, Tokyo and Delhi, Dublin and Madrid.

The thrill of a race had added to the excitement. Since 1961, when President John F.

Kennedy had announced
decade is out, of landing
and returning him safely
people had firmly belie
Union was racing to p
moon first.

In the past year or so
seemed to dim, but as A
the moon, the news that
in lunar orbit lent color
the Soviets hoped to lan
scoop up some lunar s
earth before the Ame
could get home. Only w
in Mare Crisium—the
500 miles from Tranq
way clear for the U. S.

That triumph was an
for those who argued
manned space flight. W
controls, they pointed
most certainly have cras
ing field of boulders.

The full story became
astronauts returned to e
strong first spotted the
the grid on his windo
know where he was.
toward which he was l
fied as "West Crater" (
was just within the s
planned landing ellipse
long and 3.2 miles wide
marks the astronauts h
fully before the flight
hind them, and were o

Armstrong had no d
what to do; he had fa
many times before in t

Taking over partial
autopilot, he ordered
the craft at a steady al
its head, reducing the

Prelude to touch
Apollo 11 brakes
(red, **1**). Two revo
module engine fir
orbit circular (blu
undock (**3**), and C
make sure everyth
The two craft dra
to lower its orbi
final approach. Se
to touchdown (**7**)

Cutaway painti
alone in *Columbi*
together in *Eagle*

August 8, 1988

The Vice President
The White House
Washington, D. C.

Dear Mr. Vice President:

We, the undersigned Astronauts, urge your continued support for NASA and the permanently manned Space Station in your campaign and future administration. The Space Station is the key to the future of the U.S. Space program, both to capture the benefits of space in earth orbit and to explore the solar system.

In 1969, when we landed on the moon, we were clearly and unquestionably the leader in space exploration. Like Columbus, we had gone beyond our world in search of the unknown. We were first. We were the best. And, we were proud to be Americans. Our advancements in space technology spurred advancements in education, commerce and industry. Our ability, our vision, and our expertise were the envy of the world.

Today, we are not the same America, but we can be. Soon, the Shuttle will resume flight and the next President will determine the strength of our commitment to space by deciding to move ahead with Space Station development or allowing other, more ambitious countries to proceed without us. The Space Station has been international from its inception with Europe, Canada, and Japan playing major roles. It will provide a centerpiece for international cooperation in space, enhancing U.S. space leadership.

Our generation has worked hard to leave a legacy for our children, for humanity. The Space Station is a continuation of that legacy. NASA has defined a Space Station program which will provide the stepping stone to further space exploration and will assure free world leadership in space during the 21st century. The configuration selected by NASA has been independently reviewed and endorsed by the National Research Council. If we step back now, others will pass us by.

We hope you continue your visible support for NASA and the permanently manned Space Station during your campaign, and especially during your presidency.

Sincerely,

John Glenn
Mercury-Friendship 7

Walter Shirra
Mercury-Sigma 7,
Gemini 6, Apollo 7

Gordon Cooper
Mercury-Faith 7,
Gemini 5

Charles Conrad
Gemini 5, Gemini 11,
Apollo 12, Skylab 2

James Lovell
Gemini 7, Gemini 12,
Apollo 8, Apollo 13

Neil Armstrong
Gemini 8, Apollo 11

— perm. pressure in space

Richard Gordon
Gemini 11, Apollo 12

Alan Bean
Apollo 12, Skylab 3

James McDivitt
Gemini 4, Apollo 9

Frank Borman
Gemini 7, Apollo 8

Thomas Stafford
Gemini 6, Gemini 9,
Apollo 10, Apollo 18

Eugene Cernan
Gemini 9, Apollo 10,
Apollo 17

Walter Cunningham
Apollo 7

Fred Haise
Apollo 13

Stuart Roosa
Apollo 14

Charles Duke
Apollo 16

Harrison Schmitt
Apollo 17

Owen Garriott
Skylab 3, STS 9

Gerald Carr
Skylab 4

William Pogue
Skylab 4

James Irwin
Apollo 15

Ronald Evans
Apollo 17

Joseph Kerwin
Skylab 2

Jack Lousma
Skylab 3, STS 3

Edward Gibson
Skylab 4

Donald Slayton
Apollo 18

I coordinated this letter last year and have the Telephone # and Address of each Astronaut, should the White House want to enlist their support.

either side of the acceleration shaft, which would be several miles (kilometers) in length. With free sunlight for power and inexpensive reaction material for the mass driver, asteroids weighing millions of tons, with diameters of thousands of feet (hundreds of meters), can be moved closer to the earth-moon system for mining operations that could provide an abundance of new resources to replace the dwindling supplies on planet Earth.

Fusion Spaceships

The era of chemical rocketry will be replaced by nuclear forms of propulsion in the first decades of the twenty-first century. Many experts agree that it will be some form of fusion spaceship that will dominate the next century, enabling rockets to travel to Mars in a few weeks and eventually head out of the solar system as humankind's first starships on missions to neighboring stars. The dream of reaching the stars is alive and well, although the starships that may someday travel the trillions of miles (kilometers) between the stars represent formidable challenges to the most brilliant engineering and scientific minds today.

Even the United States government pursued development of nuclear rockets for seventeen years and spent $1.7 billion on the programs. The idea of a fusion-propelled spacecraft was first described by scientists at Los Alamos in 1955. Referred to as a pulsed nuclear rocket or a pulsed fusion system, it depends on the continuous detonation of low-yield hydrogen bombs behind the vehicle. The extremely hot plasma jet and shock waves from these many microexplosions would hit a huge pusher plate to which giant shock absorbers would be attached, and together they would smooth out the separate detonations and provide constant thrust. This was the work of the famous Project Orion, which struggled along from 1958 to 1965, until it became a victim of the *Sputnik* response and the profound institutional changes that took place in the United States, including the formation of NASA and a new list of national priorities. Under the leadership of the von Braun team, chemical rocketry, not nuclear, would take men to the moon.

Freeman Dyson, the well-known American physicist, was involved in Project Orion almost from the beginning, and he developed several nuclear-pulse designs, which included the giant pusher-plate concept. Once such design called for thousands of microhydrogen "bomb" explosions every few seconds, which would give the spaceship its thrust. Dyson estimated that this starship could reach 3 percent the speed of light, have a payload of 45,000 tons, and reach the nearest star to the sun, Alpha Centauri, in about 130 years. That the *Star Wars* films have given many of us false expectations about interstellar travel times is undeniable. Real space travel between the stars is still a tremendous challenge for some of the best minds the world has so far produced. The distances to be traveled are difficult to comprehend. Only one part in one hundred million of the volume of the universe is filled with stars, and if we represented our sun by a basketball atop the Pan Am Building in New York City, the next star would be another basketball some 5,000 miles (8,000 kilometers) away in Hawaii. On the same scale, the earth would be a tiny pea-size object just over 100 feet (30 meters) up Park Avenue from the Pan Am Building.

After Project Orion

In 1978 the British Interplanetary Society published *Project Daedalus*, a detailed feasibility study, including the mathematical calculations, of an unmanned, robot-monitored interstellar mission, based on available technology, that would fly to Barnard's Star in forty-seven years at 14 percent the speed of light. The Daedalus star probe study used a variation of the nuclear-pulse propulsion system, and the mission fuel requirements would be 20,000 tons of deuterium and 30,000 tons of helium-3. The deuterium would be obtained on earth from the oceans, but the all-important helium-3 would have to be mined from the atmosphere of Jupiter. From the time the starship started to be built to the time earth received data from its flyby of Barnard's Star, it would take some eighty years.

Without question, *Project Daedalus* was a seminal study in the pursuit of interstellar travel. Its tens of thousands of words, and hundreds of diagrams and calculations leave no doubt that dozens of brilliant people are seriously studying the problems of journeys to the stars.

But will *Daedalus* ever fly? Probably conceptual parts of it will, but the explosive rate of technological advances is likely to drastically alter the design, including the propulsion system, of any unmanned starship that leaves our solar system in the last half of the twenty-first century. But as an example of the nuclear-pulse propulsion system that has been integrated with all other necessary starship systems, it is an important first effort. And it has motivated some brilliant minds to pursue their drawing-board dreams of the first starship. (See Chapter 12, "Extraterrestrials and Star Trips" for more information.)

The Laser Fusion Rocket

An advanced propulsion system that will power a starship or a fast interplanetary spaceship needs to be at least one thousand times more powerful than today's state-of-the-art chemical rockets, and research done at the Lawrence Livermore National Laboratory in the 1970s produced one on paper that may become the rocket of the twenty-first century: a laser fusion rocketship powered by thousands of microexplosions. Instead of hitting a giant pusher plate as they did in the *Project Orion* concept, microexplosions would be contained and directed by a magnetic field that would act as a rocket nozzle. As the plasma fireball expanded from the explosion, the magnetic field would blow it out the back as rocket exhaust.

For the explosions, a high-energy laser would first create an implosion system that would compress hydrogen to more than ten thousand times its liquid density. This would make possible the efficient thermonuclear burn of small pellets of heavy hydrogen isotopes. A rotating mechanical accelerator in the rocket engine would inject five hundred of these pellets into the thrust chamber each second. As each pellet reached the fusion point, it would be struck by a laser pulse that would last for less than a billionth of a second. Optical mirrors would focus the laser pulses on the pellets.

When the fusion occurred, a fraction of the fuel mass would contain the same power that keeps the stars burning throughout the universe. Two-thirds of this fusion energy would then be converted into a moving stream of charged particles that would give the spaceship momentum and would be dispersed as exhaust. Such an advanced propulsion system could drive spaceships at a velocity that is 1/100th the speed of light, perhaps faster. But even at 1/10th the speed of light, the vast distances to the nearest moving stars would take fifty to one hundred years for a one-way trip. If the earth's polar diameter of 7,900 miles (12,700 kilometers) represents 1 inch (2.54 centimeters), then at the same scale, the nearest star from our solar system is some 50,000 miles (80,450 kilometers) away. Such distances challenge the ingenuity and creative genius of our species.

A fusion spaceship may set out from our solar system late in the twenty-first century, but if the technology is available in the middle of the next century, fast fusion spaceships will be traveling the trade routes between the planets first. With their speed, they will help to rein in the solar system and bring it closer to human scale. Commercial and scientific missions within the solar system will always have priority over a starship mission. Any spaceship capable of journeying to the planet Mars in a few weeks will be in high demand among the spacefaring nations and corporations of planet Earth. And if the laser fusion spaceship is built, it will owe its existence to the intensive fusion research of the last few decades of this century, especially to the top-secret work now being conducted on high-technology defensive space weapons. It seems appropriate that what may be the key to reaching the stars involves human ingenuity recreating billions of tiny stars inside the spaceships that may carry us to them across the vast interstellar void.

The Ultimate Fusion Rocket

If a temperature of 2 billion degrees can ever be achieved and sustained, the ultimate fusion rocket engine driven by hydrogen and boron becomes possible. Boron-11 is commonly found in nature, and whatever amounts were needed could be routinely extracted from seawater.

Such a hydrogen-boron reaction would produce only charged particles and practically no side reactions. It could eventually offer direct conversion of energy and would produce no neutrons or radioactivity. Such a boron-hydrogen fueled fusion spaceship would be so powerful that its design would not have to compromise with gravity. But its nuclear-pulse engine would have to withstand the incredible 2-billion-degree temperatures, and today's technology does not even begin to have the engineering solutions to produce materials that can withstand such temperatures, which are more than one hundred times hotter than the center of our sun and can be found nowhere in our solar system.

The Alpha Centauri Express?

Beyond a perfected fusion rocket sometime in the next century, what theoretical propulsion systems could help earth folk break out to the stars and open up the age of interstellar flight?

The matter-antimatter propelled spaceship (M-AM for short) is the one most often considered, but no expert is willing to predict when such a spaceship could be built—if one can ever be built. It must be emphasized that such a propulsion system remains highly theoretical in the last decades of the twentieth century.

In 1932 Paul Dirac, an English physicist, discovered the positron, which verified the existence in nature of a particle-antiparticle symmetry. All known particles have antiparticles, and when particles of matter and antimatter come together, their energy is released. The mass of both these particles is then converted into 100 percent energy. In theory, such a mass annihilation rocket would convert all—not just a fraction—of its fuel mass into energy.

If such a M-AM rocket system could be built to fully convert a pound or kilogram of fuel into an exhaust beam and reaction force, it would be *five billion* times the energy release from the equivalent fuel mass in the most advanced chemical rockets.

Although some two hundred to three hundred antiprotons have been stored for several days at the European Center for Nuclear Research, storage for any practical length of time is beyond the reach of present technology.

The challenges of producing practical quantities of antimatter, storing it, and directing its energy release are formidable. But if earthling minds and their creative technology ever solve these subatomic perplexities, this far-in-the-future rocketship may use the most common element in the universe—hydrogen—to speed it to new planets around distant stars. Pit antihydrogen, composed of antielectrons and antiprotons, against ordinary hydrogen's electrons and protons, and the reaction would in theory produce a 100-percent conversion to energy (mass annihilation) and an unimaginable performance billions of times more efficient than those baby rockets of the early Space Age—the ones we fly today.

Such a superrocket would harness the elemental forces of the universe to penetrate its time and distance. Humankind could begin its migration to other stellar neighborhoods in the Milky Way galaxy.

Another Way-Out, Exotic Rocket

If no scientist alive today has the slightest idea of how to design and build a photon rocket, why even consider it as a possibility for the far future? The only justification for thinking that a photon rocket may exist someday is that the idea of one exists, created by the human mind, and the historic record is filled with tens of thousands of ideas that have become reality.

What would a photon rocket be? It would be another form of mass-annihilation propulsion, like the matter-antimatter fueled rocket. Theoretically this rocket's exhaust beam of photons could thrust the spaceship to the speed of light, but the on-paper mathematical dreams indicate that the best designs would be limited to 60 percent the speed of light. The power requirements of such a rocket appear impossible today, however. Each *pound* of thrust would require 668 megawatts of energy, more than 2,200 times the energy produced by a small power plant. But if such speeds could ever be realized, they would put one-way trips to some of the nearest stars such as Alpha Centauri and Barnard's Star a decade away. People could travel to the stars and return within their own lifetimes; it would not be a journey requiring several generations. And the cosmic prize might be a "new" planet for humankind after Mars gets crowded.

Seeding the Earth

Francis Crick's concept of panspermia is one such theory—that life was seeded on earth by an extraterrestrial civilization many aeons ago, when primordial earth had the conditions favorable for the development of life. The idea of panspermia was first put forward by Lord Kelvin; he suggested that life came to planet Earth on the back of a meteorite. Crick's version, presented in his book *Life Itself*, was formed in collaboration with Leslie Orgel, a biochemist at the Salk Institute, and was in large part an intellectual exercise that grew out of an international meeting on the topic of communication with extraterrestrial intelligence held in the Armenian Republic in 1971.

Many people believed that Crick had cracked the scientific limb he had been out on when he seriously presented his panspermia ideas, but this winner of the Nobel Prize felt the concept should be fully explored as an alternative to life evolving from the primordial chemistry of ancient earth—an explanation that Crick seriously doubted and considered improbable because of the numerous conditions and complex sequence of events that had to be met before it could happen.

Cyril Ponnamperuma, director of the Laboratory of Chemical Evolution at the University of Maryland, has wondered why Crick presented the improbable explanation of an extraterrestrial civilization seeding planet Earth at just the right time in geological history as an alternative to what the scientist considered another improbable history—life on earth from scratch, from the primordial soup.

"There's no way of disproving Crick's idea," Ponnamperuma told *Omni* magazine, "but I feel uncomfortable with it . . . . Sometimes I wonder whether he really believes what he wrote."

Francis Crick is not alone in presenting some unusual and controversial ideas about extraterrestrial life and the origins of life on earth. The famous astronomer Fred Hoyle has also gone out on what many peers consider to be a scientific limb by arguing that life originally evolved (and continues to evolve) in the same vast molecular clouds from which stars are born, once the condensed gas and dust builds up pressure and temperature until the fusion process begins. At some point in the evolution of these great interstellar clouds, they become biologically active.

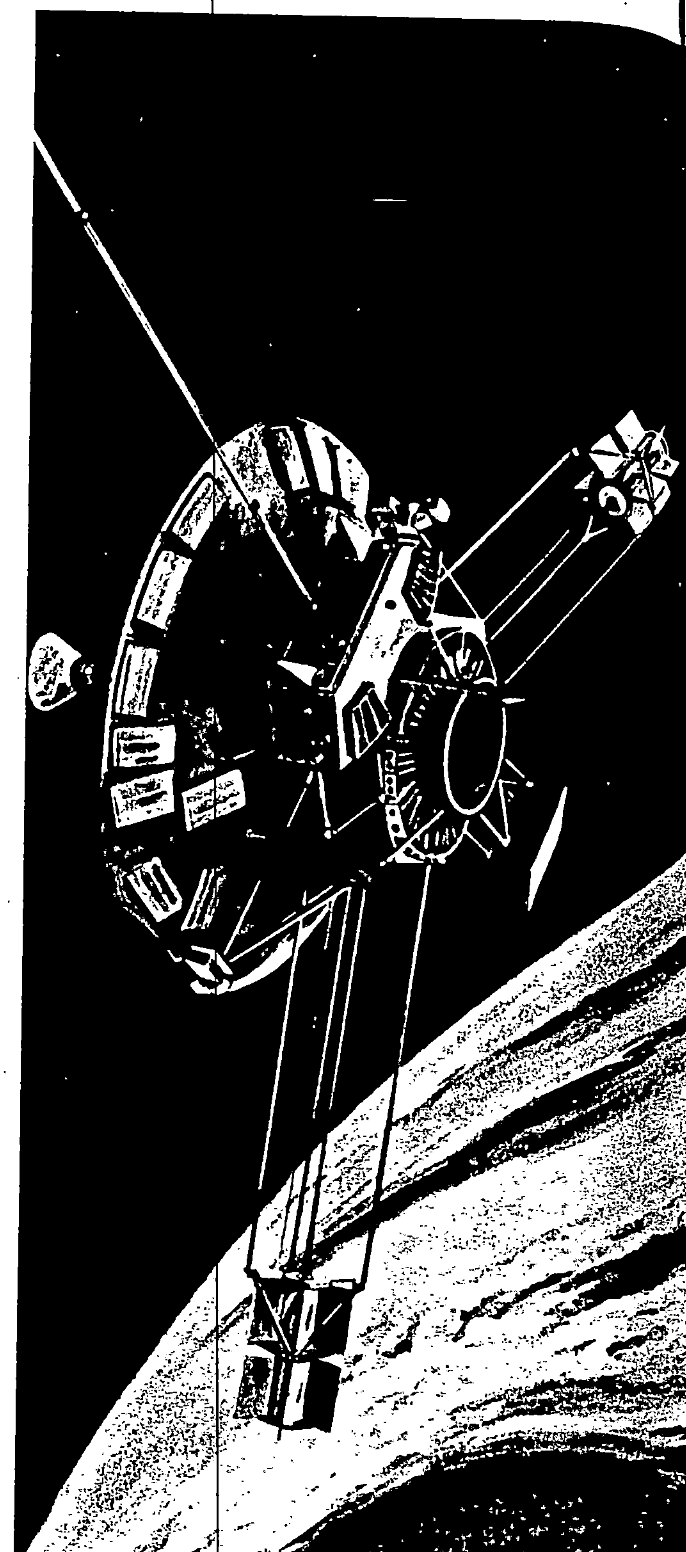
Hoyle has also presented a theory that diseases on earth have come via comets from space. While Ponnamperuma goes so far as to admit that organic molecules can exist on comets and that, under special conditions, some type of cometary life could evolve, he dismisses Hoyle's theory as "bizarre": "To get a virus, specific to a human, evolved completely away from the earth is very, very hard to accept," says Ponnamperuma. "You've got to throw away all of modern biology."

As skeptical as Ponnamperuma is about such Johnny Appleseed ideas of spreading life about the galaxy, he is a believer in extraterrestrial life and even gives the intelligent type a chance of existing. He refuses to accept the idea that we are alone in the universe. The SETI searches, he contends, have just begun to scratch the surface. "In order to detect a signal, you probably have to look for at least thirty years."

If humankind ever makes contact with ET life, there will be a whole shift in consciousness. We will, Ponnamperuma believes, "feel less freakish, part of a magnificent cosmic plan." Even if contact is not made in the next few thousand years, this expert on chemical evolution believes, we humans will be leaving the solar system and inhabiting other worlds orbiting other stars in our vast Milky Way galaxy. Humankind will evolve from terrestrial to extraterrestrial life. We will become the extraterrestrials, the members of the galactic club, perhaps its founding members. What, after all, is a few thousand years on the cosmic calendar? Approximately 1/5,000,000th the age of the universe.

To the Stars?

Given enough time, so the speculation goes, even the stars can be reached by earthlings and their interstellar ships. But is this so? Certainly it would be somewhat easier for humankind to



Pioneer 10, *which flew by Jupiter in December 1973, became the first human artifact to leave our solar system. It is heading toward a point in the sky near the constellations Taurus and Orion and may come "close" to another star (a few light-years or tens of trillions of miles) once every one to two million years! An average distance between two stars equals about 228 million times around the earth's equator.* Courtesy TRW, Inc.

send automated starships to the nearby stars than a peopled starship whose descendants would reach a star, perhaps at the expense of their descendants never seeing their home solar system again. Whether such far-future starships are piloted and tended by humans or robots is a small question resting on the shoulders of a giant one: Why travel to the stars at all, especially knowing the staggering quantities of energy and resources needed to cross such deserted interstellar voids? On the basis of what we know, or even imagine, today, why would our technological civilization want to weigh anchor from earth and set off toward the stars, a journey of decades and centuries across trillions of miles (kilometers) of interstellar space? There is plenty, after all, to keep us busy right here in our own solar system.

The distances between the stars, based on today's spacecraft speeds, appear impossible to cross. An Apollo spacecraft at its average earth-moon and return speed, would take some 850,000 years to reach the nearest star to our sun, Proxima Centauri, one of the three stars of the Alpha Centauri system, 4.3 light-years away. *Pioneer 10* was the first man-made object to leave the solar system, in June 1983, and it carried the first cosmic postcard in the form of the famous gold-plated aluminum plaque with its naked man and woman and other engraved message elements designed and drawn by Frank Drake and Carl and Linda Sagan. The spacecraft left the solar system at a speed of about 25,000 miles (40,000 kilometers) an hour, heading toward a point in the sky near the constellations Taurus and Orion. Astronomers estimated that this human artifact might come "close" (a few light-years or tens of trillions of miles or kilometers) to another star once every one or two million years. For it to enter the planetary system of a distant sun, it was estimated, ten billion (one thousand million) years would have to pass!

If we scale down the average-size star to a diameter of 1 inch (2.5 centimeters), about half the size of a golf ball, then the next star would be 100 miles (161 kilometers) away. Our sun's real diameter is 109 times that of the earth's, or some 865,000 miles (1,391,785 kilometers), equal to about 36 times around the planet Earth. An average distance between two stars, then, is equal to some 228 million times around the earth's equator. Expressed in a more personal way, this distance between the stars would be like having your next-door neighbor in the suburbs living about 40,000 miles (64,000 kilometers) away!

Talking about the nearest star to our sun is one thing, but when galactic distances are described, the human scale of space and time is swallowed up in one great cosmic gulp. Both the Voyager spacecraft will leave the solar system by the end of the century. But at their average speed relative to the sun, it would take them six hundred million years to travel to the center of the Milky Way galaxy. The nearest stars, perhaps, may be within our reach given enough time, say a century or two, but what about starship highways around the Milky Way, perhaps through black holes, at the hyperspace speeds of Hollywood film fantasies? Forget it. That's as close to "never happen" as anyone can reasonably predict for the next few thousand years.

Across the Light-Years

Why would humankind ever travel across the light-years to other planetary systems? Even assuming that technology can solve the tremendous problems of interstellar flight and that the international community approves the expenditure of huge resources, we still need a reason to go. Human curiosity or sense of adventure alone cannot justify such an immense human undertaking. Because they, the stars, are there is not the answer as it was for Mount Everest and the mountaineers who conquered its summit. The human spirit has proved itself over and over again, and it does not have to challenge the light-years to prove that it continues to endure.

There are two reasons earth folk would build their starships in the next few hundred years and point them in the direction of the nearby stars. If an intelligent signal is received from extraterrestrial life within about ten light-years (the odds are against this occurrence), then there would be a powerful motivation to travel to them for an encounter, or at least to meet them halfway. The other reason for such a migration would be survival of our species, a threat to our solar system or our sun that would be known for a long time in advance. It is conceivable, for example, that new knowledge about the sun could predict a shortened solar life span and make interstellar human migration essential for survival of the species. Assuming that there are no such cosmic upheavals in our corner of the cosmos, it would then seem that only a communication with ET life within just a few light-years would provide the impetus for starships setting off across the interstellar gulfs. We would have to know that intelligent beings were within our reach, even it if was a long reach of several decades. Interesting planetary systems that might, after careful study with state-of-the-art astronomical instruments, give every indication of harboring life would not be enough to make a commitment to such a human endeavor. From what we can imagine today, the will to build and pilot starships would come from ET life calling planet Earth. Instead of having "ET phone home," one of ET's fellow creatures would phone earth over the light-years and create a cosmic bond that would draw us starward.

Interstellar Speed Limits

The year in which the extraterrestrial call is received—if it ever is—will in large part determine how long it will take to build and launch an interstellar expedition, and how far and how fast such a starship can travel. The technological level in any given century beyond 2000, as well as the degree to which solar system resources are utilized, will be the key to attempting a voyage to nearby stars. Whether the starship is guided by artificial intelligence alone or whether it is supplemented by star-bound people from planet Earth—this does not matter much. The biggest factor is: When? If the cosmic call came in tomorrow, there would be some real problems in putting together an expedition in a few decades. The decision might be to wait for an advanced technology and make up the time in flight.

Freeman Dyson tinkered with several starship designs during Project Orion and got one, on paper, to fly at 3 percent the speed of light—somewhat over 20 million miles (32 million kilometers) an hour. While this speed is 33 times slower than the speed of light, it is 5,760 times faster than Apollo's average round-trip speed to the moon. It would take such a "slow" starship about 130 years to make a one-way trip to the nearby Alpha Centauri system. At 10 percent the speed of light, it would take about 43 years; and at 40 percent, about 11 years to travel the 4.3 light-years—one way. Any consideration of speeds beyond 40 percent the speed of light is taking freewheeling speculation into the twilight zone, which was already visited in Chapter 7 with reference to the photon rocket.

For a spaceship to get 25 light-years out from earth at 10 percent the speed of light, the one-way travel time jumps to 250 years. It quickly becomes clear that at 10 percent the speed of light (more than 66 million miles, 106 million kilometers, per hour), almost all interstellar travel becomes a journey of several human generations—whether we actually fly the starships or send sophisticated robots and wait for the information to return to earth. If the extremely long cosmic odds were with us, of course, and the ET life with which we made contact was on a similar technological level of spacefaring skills, then perhaps we could exchange cultures at some midway point by sending cosmic arks, interstellar cultural exhibits, that could have living crews or sophisticated artificial intelligence to run the missions and conduct the diplomacy. Two galactic civilizations traveling toward a common island (star or navigational point) of interstellar space at 10 percent the speed of light would double the speed and cut the journey time in half.

One fully robotized starship has already been worked out in amazing detail by the British Interplanetary Society, which published the seminal work *Project Daedalus* in 1978.

Humankind's First Starship

The project to design a *practical* starship, unmanned and controlled by advanced robotics, began in 1972. The captain of the first starship design team on planet Earth was Dr. Alan Bond, a propulsion engineer and former scientist at the rocket division of Rolls Royce. It was Bond who suggested in that year that members of the British Interplanetary Society form a working group and do a detailed feasibility study of a one-way, unmanned starship that would fly by Barnard's Star, which is some 5.9 light-years from our sun and solar system. The members enthusiastically supported the concept, and it was decided to proceed in January 1973—the same year that the United States launched Skylab, its first space station.

Propulsion. The design was based on state-of-the-art, available technology, and the group decided to use the nuclear pulse rocket as their propulsion concept. The engine would expel small spheres of frozen deuterium and helium-3, about half the size of a Ping-Pong ball, which would then be exploded by electron beams behind the ship. These spheres would explode at the amazing rate of 250 each second, each one releasing energy equal to about 90 tons of TNT. The grand total of energy released each second would therefore equal 22,500 tons of TNT. The expanding gases from these explosions would eventually propel the starship to a top velocity of about 13 percent the speed of light, some 86 million miles (138 million kilometers) per hour, which would fly it past Barnard's Star about fifty years after launch.

The Daedalus starship would use some 30,000 tons of helium-3 and 20,000 tons of deuterium to fuel its nuclear pulse engine. But because helium-3 is almost nonexistent on earth, it would have to be extracted from Jupiter's atmosphere, which is perhaps one of the most difficult logistical features of the Daedalus project. A base on one of Jupiter's moons such as Callisto or a large orbiting space station would have to be established for the helium-3 mining operations. Alan Bond did suggest an alternative way of obtaining the helium-3: artificially breed it on the surface of the moon. This too has its problems; the waste heat generated by the breeding process would be equal to the world's energy consumption, at today's rate, for some seven hundred years.

Size and Weight. After several design revisions, the unmanned starship had an on-paper launch mass of 104.8 million pounds (47.5 million kilograms). Its combined two stages and payload were to have a total length of some 650 feet (200 meters) and a total weight of 68,000 tons, including fuel, with a modest 400 tons (about equal to the total weight of five Skylab space stations) devoted to the payload star probes that would be activated during the flyby of Barnard's Star. The primary engine reaction chamber was designed to be 330 feet (100 meters) in diameter, but very thin, like a huge foil dish.

Thrust and Rocket Stages. Each small fuel sphere would be injected by a magnetic piston at about 27,000 miles (43,000 kilometers) per hour into the combustion chamber, where it would be bombarded by high-energy electron beams and exploded, creating a magnetic spring reaction in the magnetic field to give the starship constant acceleration.

Some eight and a third months after launch from an orbit around either Jupiter or the moon, two of the first-stage fuel tanks would separate, and the other four would separate during the first two years of the mission, at which time the entire first stage would fall away and the second stage would ignite. The second stage would burn for 1.76 years, at which time it would cease firing and the probe would coast the rest of the way to its destination star at 12.8 percent the speed of light—almost 86 million miles (138 million kilometers) an hour!

Star Ahoy! Some fifty years after launch from our solar system, this first starship conceived by earthlings would release an armada of seventeen targeted scientific probes of all sizes and containing different sensors as the sophisticated artificial intelligence center came alive in the mother ship and used all of its computing power, which had remained dormant during the journey. Each probe would transmit its information back to the starship for relay to earth. The data stream for a single image frame would take some three and a half hours to transmit, and the data for as many as one thousand images could be stored on the starship.

Perhaps for the first time in human history, close-ups of another star's planets, some of them actually showing surface features, would be seen after the data-bit signals traveled for another 5.9 years at the speed of light back to planet Earth.

Interstellar Ports of Call

While Barnard's Star is not as close to our solar system as is the Alpha Centauri system (5.9 light-years versus 4.3 light-years), it was chosen by the British Interplanetary Society study group as the target star for the unmanned Daedalus starship. It is easy to forget, when tossing around light-years as if they were miles or kilometers, how much farther Barnard's Star is than Alpha Centauri: the 1.6 extra light-years are equal to forty million times the earth-moon distance of about 240,000 miles (386,000 kilometers). The Daedalus study team believed that if they designed their unmanned starship to travel the almost six light-years to Barnard's Star, their design work would be more adaptable to other interstellar journeys and could probably make journeys out to about nine light-years from our solar system. This would include the closer Alpha Centauri duo as well as stars such as Luyten 726-8 A/B, Wolf 359, and Lalande 21185.

Barnard's Star, named for astronomer Edward Emerson Barnard, who discovered it in 1916, is a faint red dwarf, which has the fastest motion across the sky of any star. It is, in fact, moving toward the sun and solar system at about 24,000 miles (39,000 kilometers) an hour. Over the next ten thousand years, it will have moved some two light-years closer to earth and will replace the Alpha Centauri system as the closest star to earth. If the first starship is launched in the next two centuries, however, this star's motion toward the sun will not in any way lessen the tremendous challenge of designing, building, and launching it.

Another reason that Barnard's Star holds such interest as a target star for an interstellar voyage is that several studies, in particular Peter Van de Kamp's work at Sproul Observatory, have strongly indicated that this red dwarf has planetary companions orbiting it. The Hubble Space Telescope will study this and other neighboring stars and accumulate definite observational evidence of planetary systems around them. Any one of several stars could eventually replace Barnard's Star as the destination sun for humankind's first interstellar voyage.

Project Daedalus Star Ranking

Star	*Distance (l.-y.)*	*Rank*
Proxima	4.25	6
Alpha Centauri A/B	4.3	1
Barnard's Star	5.9	3
Wolf 359	7.6	8
Lalande 21185	8.1	11
Sirius A/B	8.6	10
Luyten 726-8 A/B	8.9	7
Ross 154	9.4	12
Ross 248	10.3	13
Epsilon Eridani	10.7	4
61 Cygni A/B	11.2	2
Epsilon Indi	11.2	9
Tau Ceti	11.9	5

Star Search

As other sophisticated astronomical instruments follow the Hubble Space Telescope into orbit above the earth in the next few decades, the ranking of neighboring stars as targets for interstellar voyages will change. It is, nevertheless, all but certain that the destination star for the first starship voyage will be among the list that was published by the British Interplanetary Society in 1978 as part of their *Project Daedalus*. Even though Barnard's Star was chosen for the study, it had a ranking of third on the target star list. The group considered it important to design their robot starship for the extra distance. The star list, by distance from the sun, is shown below. One of the three stars, Proxima Centauri, in the Alpha Centauri system, is listed separately because it is separated from the Alpha Centauri A/B by some 930 billion miles (1.5 trillion kilometers)—almost fifty-eight light-days.

The rankings of these nearby stars were determined by considering many factors, including the type of star, its temperature and life span, and the probability of planetary systems and the evolution of life forms on the planets. All known stars up to a distance of 10.7 light-years (Epsilon Eridani) were included, and the three stars beyond that distance were similar in type to our Sun or had a high ranking. One of these thirteen stars will probably be scrutinized in the next few centuries by the far-flung technological neophytes *Homo sapiens*.

Peopled or Roboted Starships?

One of the more attractive destination stars defined by the Daedalus study is Epsilon Eridani, a sunlike star some 10.7 light-years away. Assuming that the next few decades of advanced in-space telescopes tell us that this star has the most earthlike planets around it, will we send a robotized starship toward it or a space ark with a human crew? In this hypothetical instance, when there is actually no extraterrestrial communication taking place, either a new generation of in-space sensing technology would be designed and built or a robotized starship would weigh anchor and head toward interstellar space. A peopled space ark would depart the solar system only if ET communications had been established, and even then a starship with advanced artificial intelligence might be chosen to navigate the interstellar gulf. Why send people to Epsilon Eridani, after all, when it would take about 110 years to make a one-way trip at one-tenth the speed of light, a technological possibility in the next century? This is the big question: Why send people to do an advanced robot's work? Eye-to-eye contact may be a positive force here on earth, but if the ETs we communicate with have no eyes as we define them, what is the point of a creature-to-creature meeting when computer enhanced data will create as many detailed images as we care to see?

There are alternatives to physically sending a starship, peopled or not, to Epsilon Eridani or any other star that proves attractive in the twenty-first century. If it is only habitable planets around another nearby star that create the motivation, advanced above-earth or above-moon instruments may satisfy our curiosity and sufficiently increase our knowledge. A so-called ultimate telescope, proposed by Princeton University physicist Eric Hannah, could in theory use the entire sun as a gravitational lens to focus a distant star's image on a large, flat array of photodetectors in space. If ever built, such an ultimate telescope could amplify the light from a faraway star two hundred billionfold. It could show detail one hundred million times finer than the Hubble Space Telescope can, and it could even show features the size of houses on the planets that orbit Barnard's Star almost six light-years (36 million million miles, 58 million million kilometers) away.

The more ambitious plan would be to send an unmanned Daedalus-like (Daedalus in Greek, by the way, means "cunningly wrought") starship to explore such a planetary system, which could harbor evolving life forms that had not become spacefaring, interstellar-communicating species. An advanced on-board artificial intelligence could probably do as much or more than a trained human crew. Still, at only 10 percent the speed of light, the travel time to and information return from Epsilon Eridani would be some two hundred years—about the time it took two industrial nations to acquire the rudimentary means of leaving their cradle, planet Earth.

Without an ET message in hand, it is doubtful that a peopled starship will ever fly and deliver its crew or their descendants to a new world orbiting a distant star. Our answer may be: Let us let the robots take those interstellar risks.

An ET Message to Earth

If our sophisticated, computer signal analyzers do make contact with extraterrestrial intelligence, the response could eventually be a space ark filled with earth people and their fellow creatures. Such a response, however, would take several decades if such ET contact were made in the year 2019, and it would be the most improbable response.

After confirmation of the initial contact (an exacting, scientific procedure that could take weeks), communication with the ET intelligence could be initiated through a transmission program and then dramatically increased over the next few years. Or earth could decide not to respond for some reason. If thorough analysis leads experts to the conclusion that there is no danger in responding to the message, transmission will begin. The data stream from earth would include whatever information is both scientifically valid and internationally approved and screened for transmission by a multinational forum such as the United Nations.

Our ability to understand and interpret the first extraterrestrial message will in large part determine earth's response. And assuming that such an analysis is fruitful, then the location and distance from earth of the ET intelligence is also tremendously important. If the signal comes from a planet near a star one hundred light-years away, humankind's answer in the next century will be limited to radio or other electromagnetic radiation traveling at the speed of light—the speed limit of the universe. If, however, an intelligent signal comes from a star such as Epsilon Eridani (10.7 light-years from the sun), then an entire range of responses from earth may be possible in the next few hundred years: radio contact only; radio silence or censorship (if the contact message implies malevolence); launching a roboted starship; or launching a peopled space ark.

Radio contact. Radio contact with ET intelligence is astronomically more probable than physical contact. If the ET civilization is any more than twenty light-years from earth (the distance many experts believe to be the limit of possible exploration), it is doubtful that a starship will be launched to such a faraway celestial island because a one-way journey would take about two hundred years at 10 percent the speed of light. But with various wavelengths of the electromagnetic spectrum, humankind can communicate a tremendous amount of information *at the speed of light* and can do so over a distance of a few hundred light-years in fewer than a dozen human generations, which represents a short period of time when compared to the sixty-six thousand human generations that took us from the trees of the jungle to the surface of the moon.

That we or other galactic civilizations can send our messages via electromagnetic waves at the speed of light is luck of a cosmic order; but just as important as this is the fact that almost any kind of information can be sent in the message—including the genetic codes of the human species and its fellow earth creatures, which could be recreated by intelligent ETs somewhere in their solar systems far, far away. With DNA technology going through a revolution, the time is near when complete instructions on how to build a human being could be sent at the speed of light to intelligent creatures among the distance stars. In this way, the cybernetic seed of humankind could be broadcast throughout the galaxy. If advanced life forms on distant worlds catch our molecular DNA secrets, humankind could become a new species on those distant planets. Of course, such ETs may not want to have anything to do with us; they may consider us too low on the evolutionary spiral to bother with. If such galactic life receives a DNA message from us several decades after it was transmitted from earth, they may accurately predict on the basis of analysis that we no longer exist—just another of the millions of galactic species that die out each year.

Broadcasting humanity's seeds indiscriminately throughout the Milky Way galaxy does have its own risks, however. Some would argue that we would be forsaking our long evolutionary heritage by almost nonchalantly giving away the secrets of our species. How do we know that some evil ET alien would not recreate us and commit atrocities against our fellow creatures? We must practice caution in deciding what we broadcast into the universe. Perhaps our application for membership in the galactic club has already been turned down on the basis of ET life having heard some of our earlier radio broadcasts, such as "I Love Lucy" or "The Shadow," that were not intended for ET ears.

Radio Silence and Censorship. An immediate transmission after receiving a radio message from ET life could turn out to be a grave error. Painstaking analysis should be completed, and a profile of the ET life should be projected based on its message. Planet Earth's and our species' survival could be at stake. Scientists as well as dozens of science fiction writers have speculated on various outcomes of our species coming into contact with malevolent aliens. Common themes include earthlings being made slaves, harvested as food, used as pets, or put in zoos. Even the theory that, unknown to us, the earth and humankind are part of an ET zoo has been proposed. Our zookeepers want to preserve our natural habitat, and, therefore, do not reveal themselves.

A Robotized Starship. The Daedalus project, as already summarized, was the first detailed feasibility study of the design of a starship and an interstellar voyage. Because the life spans of advanced robots will be much longer than the natural lifespans of humans, and because future robots will have the ability to reproduce themselves, our first interstellar voyage probably will be fully controlled by a high order of artificial intelligence. Even Gerard O'Neill's concepts of large colonies in space could be adapted to interstellar travel and populated with a robot crew. Such an extraterrestrial starship was the focus of Arthur C. Clarke's 1973 novel, *Rendezvous with Rama*. In it, the solar system is visited by a huge spaceship, some 31 miles (50 kilometers) long, populated by biological robots. It turns out that this spaceship from a mysterious galactic civilization was only passing through to fill up with energy from our sun. They were not interested in earth or its creatures.

A Peopled Space Ark. J. Desmond Bernal, the British physicist, wrote his prophetic book *The World, the Flesh and the Devil* in 1929. Often quoted by such visionaries as Arthur C. Clarke, Freeman Dyson, Gerard O'Neill, and Olaf Stapledon, the book describes the expansion of life into space and includes a space ark in which generations of people live and die, never knowing the earth from which they came, nor the destination planet on which their descendants will land and live. In 1929, the concept of a space ark seemed the only way of transporting people across the vast distances of interstellar space and time.

The fact that several human generations would be required to journey at a fraction of the speed of light from star to star was not encouraging. This is why space arks are usually envisioned as large vessels able to accommodate attractive earthlike environments to keep the interstellar void at bay and out of the spacefarers' psyches. But the size of the space ark was directly interrelated to its propulsion and speed. If an O'Neill-type space colony were adapted to an interstellar ark and left the solar system traveling at 1 percent the speed of light (about 6.7 million miles, 10.8 million kilometers, per hour), it would take more than 13 human generations—about 430 years—to reach the nearby Alpha Centauri star system. Would such a long voyage attract enough volunteers? Who would want to go and why?

There is always that extraterrestrial rub: Why travel to the stars? What would be humankind's motivation? Beyond the survival of the species or a physical encounter with extraterrestrial intelligence, such motivations are secrets held by the future. Assuming for the moment that there is an important reason for earthlings to physically meet ET intelligence at a distance of between ten and twenty light-years and at a velocity of no more than 20 percent the speed of light, what are the alternatives to a voyage requiring several human generations? A deep and almost dreamless sleep.

As the Silent Stars Go By

An imaginative science fiction genre has often supplied a method of reaching the stars within a human lifespan: Suspended animation has been a way of slowing down human biological time to better match the cosmic time scale of interstellar journeys. Some type of human hibernation, in which the human body and brain are frozen in time, may become a real alternative in another one hundred or two hundred years for spacefarers journeying between the stars. A California research team has recently discovered, for example, that many organisms are able to survive dehydration and exist in a dormant state by producing a sugar called trehalose. This and other such discoveries may eventually lead to safe techniques that will suspend human biological processes over long periods of time.

In the film *Alien*, the crew members were held in suspended animation while their spaceship crossed the light-years. Although artificial hibernation or hypothermia for the human body is beyond present capabilities, human embryos have been frozen, thawed, implanted in the female uterus, and brought to a successful birth. It is conceivable that a nursery of frozen human life forms, shielded from radiation at the center of a starship (let us name it *Earthark*) could survive an interstellar journey of hundreds or thousands of years, and then complete their gestation and formative years under the guidance of programmed robot nannies before reaching their destination star and planetary system, in which they will meet the ET life or colonize a habitable planet.

If we can suspend the human biological clock in some way, and at the same time cut down tremendously on on-board consumables, physical travel to the stars becomes more realistic. If this cannot be done, be it with the embryonic human seeds ready for gestation or fully grown earthlings ready for the challenges of new worlds, then a one-hundred member crew on board the starship *Earthark* would need the following consumables for a twenty-year journey:

- Water: 7.9 million pounds (3.6 million kilograms)
- Food: 3.3 million pounds (1.5 million kilograms)
- Oxygen: 1.1 million pounds (0.5 million kilograms)

These three life-sustaining consumables add up to some 12.3 million pounds (5.6 million kilograms), a total weight that would greatly influence the starship's size, propulsion design, and flight time to the stars.

If our descendants board the starships and set sail on the interstellar oceans, they will probably choose, at some early point in the journey to chemically suspend their lives in time with future life-suspension techniques. Perhaps these deep-sleeping adults will be accompanied by an embryonic nursery of frozen fertilized eggs from various earth species on this first great voyage—an ark from planet Earth. As they fly to the stars, suspended in a deep and dreamless sleep, their robot friends will stand watch and tend to them during the cosmic journey spanning decades. For these star-bound humans, this will be a dreamless road to the stars, but a road built by the persistent dreams of humankind over thousands of years. Images of new and distant worlds may lie dormant during this cosmic slumber, but in essence they are what power this starship into the future. Such images will form again when the cosmic sleepers awaken to complete their lives and explore new worlds.

Is any of this possible? Will this happen to our descendants born on planet Earth? Will they become true extraterrestrials journeying from star to star? Human dreams tell us yes, this is the distant future of the Space Age.

The Book of QUOTES

Barbara Rowes

BALLANTINE BOOKS • NEW YORK

That's one small step for man, one giant leap for mankind.
—**Neil Armstrong,** the first man to set foot on the moon, July 20, 1969

This is the greatest week in the history of the world since the Creation.
—**Richard Nixon,** July 20, 1969

We're Number One on the runway.
—**Neil Armstrong,** preparing to take off from the moon to return to earth

Good-by, good night. Merry Christmas. God bless all of you, all of you on the good earth.
—**Frank Borman,** Christmas Eve telecast from Apollo VIII, December 24, 1968

I'm the link between Ham the Space Chimp and Man.
—**Alan Shepard,** first American in space, after his May 5, 1961 flight

We're on top of the world. I'll tell you, you can't believe it . . . utterly fantastic. The world is round.
—**Charles (Pete) Conrad,** from Gemini XI

I don't know what you could say about a day in which you have seen four beautiful sunsets.
—**John Glenn,** the first American to orbit the earth, February 20, 1962

Beautiful, beautiful, beautiful. A magnificent desolation.
—**Edwin (Buzz) Aldrin,** the second man to set foot on the moon

There seems to be a lot of traffic up here. Call a policeman.
—**Walter (Wally) Schirra,** in Gemini VII while docking with Gemini VI, August 1, 1969

Four days vacation with pay and see the world.
—**James Lovell,** commenting on his Gemini XII mission

Sputnik doesn't worry me one iota. Apparently from what they say, they have put one small ball in the air.
—**Dwight D. Eisenhower,** 1957

I have never believed that a spectacular dash to the moon, vastly deepening our debt, is worth the added tax burden it will eventually impose upon our citizens.
—**Dwight D. Eisenhower,** 1963

There is just one thing I can promise you about the outer-space program: Your tax dollar will go farther.
—**Wernher von Braun**

I can't understand what's holding up our missile program. It's the first time the government ever had trouble making the taxpayer's money go up in smoke.
—**Bob Hope**

This nation has tossed its cap over the wall of space, and we have no choice but to follow it.
—**John F. Kennedy**

There is something more important than any ultimate weapon. That is the ultimate position—the position of total control over Earth that lies somewhere out in space.
—**Lyndon Baines Johnson**

For years, politicians have promised the moon. I'm the first one to be able to deliver it.
—**Richard Nixon**

In the nuclear age, by the time a threat has become unambiguous it may be too late to resist it.
—**Henry Kissinger**

The view of the moon is spectacular. Well worth the price.
—**Neil Armstrong,** from Apollo XI

Science cannot bear the thought that there is an important natural phenomenon which it cannot hope to explain even with unlimited time and money.
—**Robert Jastrow**

This nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to earth.
—John F. Kennedy, May 25, 1961

According to information received from Cape Canaveral, a rocket with a man on board was launched. After fifteen minutes the capsule with the pilot, Alan Shepard, fell in the Atlantic Ocean.
—Soviet news release of the first United States manned flight

The Roman Empire controlled the world because it could build roads. . . . The British Empire was dominant because it had ships. In the air age, we were powerful because we had airplanes. Now the Communists have established a foothold in outer space. It is not very reassuring to be told that next year we will put a better satellite into the air. Perhaps it will even have chrome trim and automatic windshield wipers.
—Lyndon Baines Johnson

What we will have attained when Neil Armstrong steps down upon the moon is a completely new step in the evolution of man.
—Wernher von Braun

One of our problems is trying to figure out which way is up and which way is down.
—John Young, from Apollo X

Boy, this is beautiful. Boy oh boy. It looks that pretty. Boy oh boy.
—Gordon Cooper, the first astronaut to orbit in space, Mercury-Atlas IX

Let them eat moon-shots!
—Isaac Asimov, updating Marie Antoinette

It suddenly struck me that that tiny pea, pretty and blue, was the earth. I put up my thumb and shut one eye, and my thumb blotted out the planet Earth. I didn't feel like a giant. I felt very, very small.
—Neil Armstrong, on the Apollo XI return trip

The only way to define the limits of the possible is by going beyond them into the impossible.
—Arthur C. Clarke

No. No. I won't go! You can't make me!
—**Gordon Cooper,** showing newsmen what astronauts go through before entering the capsule

I was a rotten S.O.B. before I left. Now I'm just an S.O.B.
—**Alan Shepard,** after becoming America's first astronaut

There is a single light of science, and to brighten it anywhere is to brighten it everywhere.
—**Isaac Asimov**

The moon is a different thing to each one of us. It looks like a vast, lonely, forbidding place, an expanse of nothing.
—**Frank Borman,** from Apollo VIII while orbiting the moon

The great tragedy of Science—the slaying of a beautiful hypothesis by an ugly fact.
—**Aldous Huxley**

If we die, we want people to accept it. We are in a risky business, and we hope that if anything happens to us it will not delay the program. The conquest of space is worth the risk of life.
—**Virgil (Gus) Grissom,** astronaut killed in action on January 27, 1967

I'm like an orchestra conductor. I don't write the music, I just make sure it comes out right.
—**Christopher Kraft,** flight operation director of the Apollo missions

This has been far more than three men on a voyage to the moon. More even than the efforts of one nation. . . . This stands as a symbol of the insatiable curiosity of all mankind to explore the unknown.
—**Edwin (Buzz) Aldrin,** from Apollo XI shortly before splashdown

We are all on a spaceship and that spaceship is Earth. Four billion passengers—and no skippers.
—**Wernher von Braun**

I think Isaac Newton is doing most of the driving right now.
—William A. Anders, aboard Apollo VIII

I just don't think the moon is going to be an adequate substitute for the fact that we haven't addressed ourselves to clearing up the slums.
—Kenneth B. Clark

Basic research is what I am doing when I don't know what I am doing.
—Wernher von Braun

Any sufficiently advanced technology is indistinguishable from magic.
—Arthur C. Clarke

May the Force be with you.
—Benediction of the good guys in the film *Star Wars*

Somewhere, something incredible is waiting to be known.
—Carl Sagan

Respectfully Quoted

A Dictionary of Quotations
Requested from the
Congressional Research Service

edited by **Suzy Platt**
Congressional Reference Division

LIBRARY OF CONGRESS · WASHINGTON · 1989

Space exploration

1742 To see the earth as we now see it, small and blue and beautiful in that eternal silence where it floats, is to see ourselves as riders on the earth together, brothers on that bright loveliness in the unending night—brothers who *see* now they are truly brothers.

ARCHIBALD MACLEISH, "Bubble of Blue Air," *Riders on the Earth; Essays and Recollections by Archibald MacLeish*, epigraph, p. xiv (1978).

This was written by MacLeish for *The New York Times* "after the Appollo mission of 1968 returned from space with a photograph of what earth looked like as seen from beyond the moon: the photograph which gave mankind its first understanding of its actual situation; riders on the earth together, brothers on that bright loveliness in the unending night—brothers who *see* now they are truly brothers" (p. ix).

The article has slightly different wording and reads as follows: "To see the earth as it truly is, small and blue and beautiful in that eternal silence where it floats, is to see ourselves as riders on the earth together, brothers on that bright loveliness in the eternal cold—brothers who know now they are truly brothers."—*The New York Times*, December 25, 1968, p. 1.

1743 Some say God is living there [in space]. I was looking around very attentively, but I did not see anyone there. I did not detect either angels or gods. . . . I don't believe in God. I believe in man—his strength, his possibilities, his reason.

GHERMAN TITOV, Soviet cosmonaut, comments at world's fair, Seattle, Washington, May 6, 1962, as reported by *The Seattle Daily Times*, May 7, 1962, p. 2.

1744 Yet I do seriously and on good grounds affirm it possible to make a flying chariot in which a man may sit and give such a motion unto it as shall convey him through the air. And this perhaps might be made large enough to carry divers men at the same time, together with food for their viaticum and commodities for traffic. It is not the bigness of anything in this kind that can hinder its motion, if the motive faculty be answerable thereunto. We see a great ship swims as well as a small cork, and an eagle flies in the air as well as a little gnat. . . . 'Tis likely enough that there may be means invented of journeying to the moon; and how happy they shall be that are first successful in this attempt.

JOHN WILKINS, *A Discourse Concerning a New World and Another Planet*, book 1, chapter 14, pp. 238–39 (1640). Spelling modernized.

Speaking out

1745 Try to raise a voice that shall be heard from here to Albany and watch what it is that comes forward to shut off the sound. It is not a German sergeant, nor a Russian officer of the precinct. It is a note from a friend of your father's offering you a place in his office. This is your warning from the secret police. Why, if any of you young gentlemen have a mind to get heard a mile off, you must make a bonfire of your reputation, and a close enemy of most men who wish you well.

And what will you get in return? Well, if I must for the benefit of the economists, charge you up with some selfish gain, I will say that you get the satisfaction of having been heard, and that this is the whole possible scope of human ambition.

JOHN JAY CHAPMAN, "The Unity of Human Nature," address delivered before the Hobart Chapter of Phi Beta Kappa, Hobart College, Geneva, New York, on commencement day, June 20, 1900.—Chapman, *Learning and Other Essays*, p. 185 (1910, reprinted 1968).

1746 Laws can embody standards; governments can enforce laws—but the final task is not a task for government. It is a task for each and every one of us. Every time we turn our

FAX MESSAGE

Radio 104

104,1 MHZ/FM

Stéréo

B.P.4 Mondercange

L-3901 Tél:55.18.12

FAX 440201 LUXEMBOURG-EUROPE
TLX 1244 travin lu

Mondercange le 19 juillet 1989

Dear ms WATSON Linda

many thanks for your faxsimile send on june 18, 89

we enjoy your co-operation and please leave following message

to the president MR BUSH Georges

"Dear president of the united states of amerika

All our congratulations, from the team on RADIO 104
Luxembourg-Europe to you and especialy to MR Neil Armstrong, Mr Edwin Aldrin and Mr Michael Collins concerning the first landing on the moon twenty years ago.
Our special radiotransmission SPACE 20 years ago was a big succes.

We hope the USA will remain leader on the universe.

Sincerly your's

KRIER Edi
the president
RADIO 104

p.m a few letters from the white house will be apreciated

First Floor Galleries

100 Milestones of Flight: from the Wright brothers' Flyer and the Spirit of St. Louis to Apollo 11 and the Viking Lander

101 Museum Shop

102 Air Transportation: air transportation of people, mail and cargo

103 Vertical Flight: helicopters, autogiros and special vehicles

104 Special Aircraft Exhibits: rotating exhibition of recently-restored aircraft

105 Golden Age of Flight: history of aviation between the two world wars (1919–1939)

106 Jet Aviation: traces the evolution of military and commercial jet aircraft

107 Early Flight: a 1913 indoor air show

108 South Lobby (Independence Avenue Lobby): aeronautical and astronautical trophies flanked by two large murals—Eric Sloane's "Earthflight Environment" and Robert McCall's "The Space Mural—A Cosmic View"

109 Flight Testing: the history of flight research—research aircraft, flight testing and ground testing

110 Looking at Earth: Practical uses of aerial photography—from early kite and balloon observations to sophisticated spacecraft and satellite imagery

111 Stars: a tour of the known universe—from ancient times to the present

112 Lunar Exploration Vehicles: the Apollo Lunar Module, Lunar Orbiter, Surveyor and Ranger

113 Rocketry and Space Flight: history of flight from the thirteenth century to the present; rocket engines and space suits

114 Space Hall: space launch vehicles, manned spacecraft such as the Skylab Orbital Workshop, Apollo-Soyuz and Space Shuttle

115 Theater: large-screen motion picture presentations

Second Floor Galleries

201 Albert Einstein Planetarium: multi-media presentations

203 Sea-Air Operations: a history of flight over water, featuring naval aircraft and simulations of an aircraft-carrier hangar deck

205 World War II Aviation: fighter aircraft from five countries

206 Balloons and Airships: the history of lighter-than-air flight, including the Double Eagle II

207 Exploring the Planets: a look at the planets, the tools of exploration and individual space missions. Includes a Voyager spacecraft

208 Pioneers of Flight: aircraft used on famous first flights and an exhibit on blacks in aviation

209 World War I Aviation: several significant WWI planes are displayed, including a Spad XIII and a Fokker D-VIII

210 Apollo to the Moon: the triumph of manned space flight, from project Mercury through the moon landings of the Apollo program

211 Flight and the Arts: works by leading artists that encompass the theme of flight

213 Beyond the Limits: Flight Enters the Computer Age: how computers have revolutionized the aerospace industry

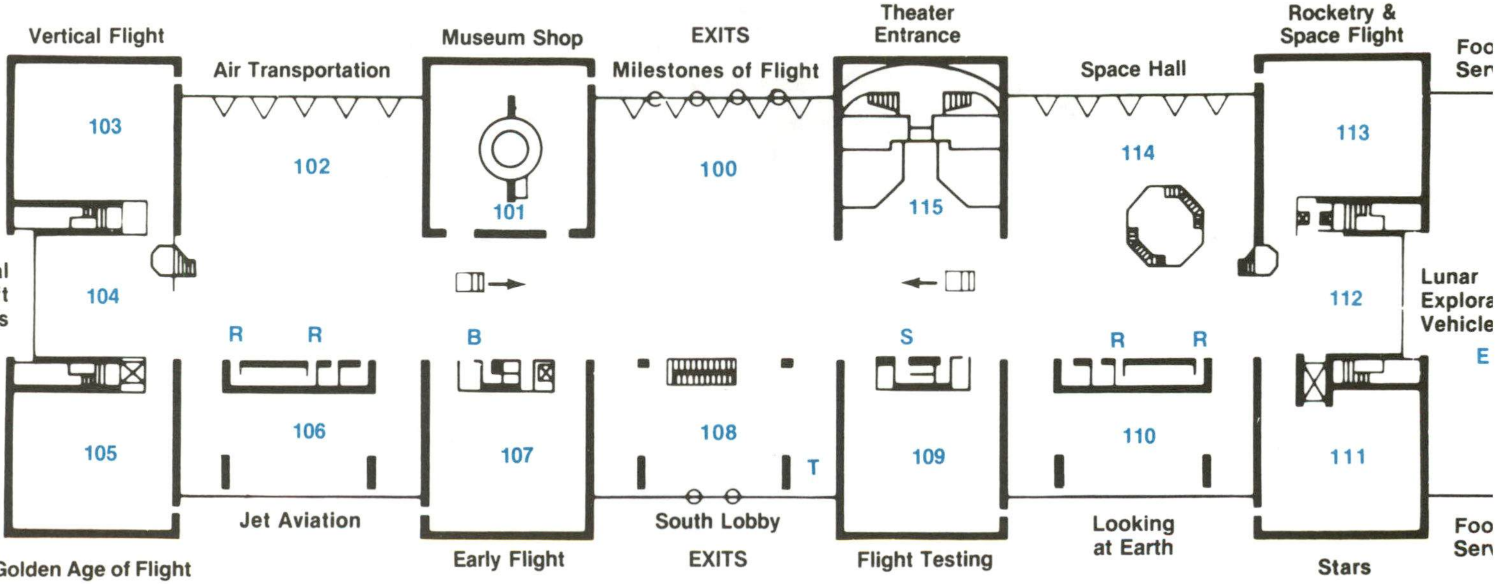
Smithsonian Institution

NATIONAL AIR AND SPACE MUSEUM

Museum Information and Floor Plan

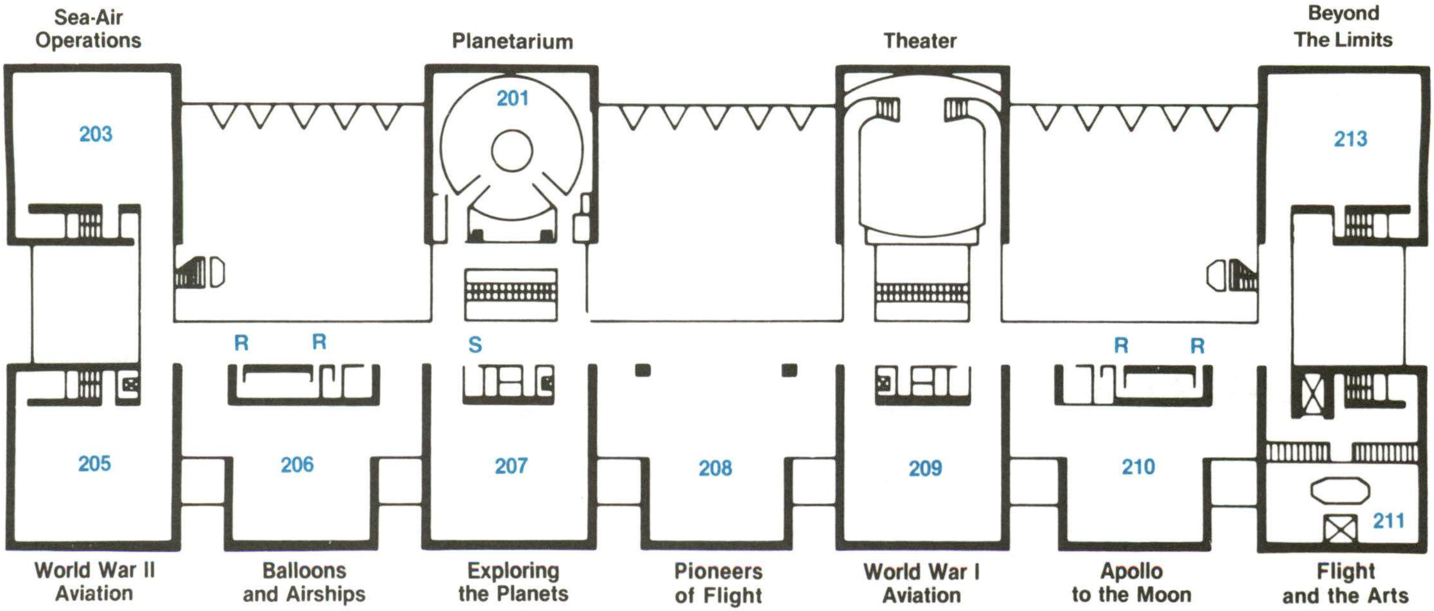
5/89

irst loor



R Rest Rooms B Baby Service Station T Public Telephones S Gift Shop E Entrance to Food Service

econd loor



R Rest Rooms S Gift Shop

The National Air and Space Museum

The Smithsonian's National Air and Space Museum, opened in 1976, offers its visitors a dazzling array of flying machines and spacecraft never before assembled in one place. An average of 9 million people visit the Museum each year.

Twenty-three exhibit areas house artifacts ranging from the Wright brothers' original 1903 Flyer and Lindbergh's "Spirit of St. Louis" to a touchable moon rock and a Skylab Orbital Workshop which visitors may enter.

Also included are dozens of airplanes and spacecraft, missiles and rockets, engines, propellers, models, uniforms, instruments, flight equipment, medals and insignia. These items document most of the major achievements—both historical and technological—of air and space flight.

The Smithsonian's interest in aeronautics dates back to its early years. In 1861, the first Secretary of the Smithsonian, Joseph Henry, recommended to President Lincoln that balloonist Thaddeus Lowe be permitted to demonstrate the potential of the balloon for military observation.

The third Secretary of the Smithsonian, Samuel P. Langley, constructed and tested a number of heavier-than-air craft from 1887–1903. Two of these unmanned models succeeded in flying under steam power over the Potomac River for more than a half-mile (1 km).

Interest in rocket research was prompted by Charles Abbot, later the fifth Secretary of the Institution, when he supported the early work of the American rocket pioneer Robert H. Goddard. Goddard was one of the first to recognize the potential of the rocket for propelling vehicles through space.

The building was designed by the architectural firm of Hellmuth, Obata & Kassabaum. The exterior of the 680 ft. (280m) long, 90 ft. (27.7m) tall Museum is constructed of Tennessee marble of a pinkish hue. All the aircraft and spacecraft displayed were actually flown or were used as backup vehicles, unless the label specifically notes an exception.

Feature Attractions

Albert Einstein Planetarium

Is anybody out there? "Calling All Stars," the museum's new planetarium show, explores that question.

Join the search for extraterrestial life and learn where we are likely to find it—and where we aren't. Visit the seething planet Venus, the snowy Saturnian moon Titan and the ice-bound oceans of Jupiter's moon Europa. Trace the evolution of life back to a stellar nursery and tune in to hear some of the messages we've been sending to the stars.

"Calling All Stars" will be shown every 40 minutes, seven days a week.

There is a nominal admission charge.

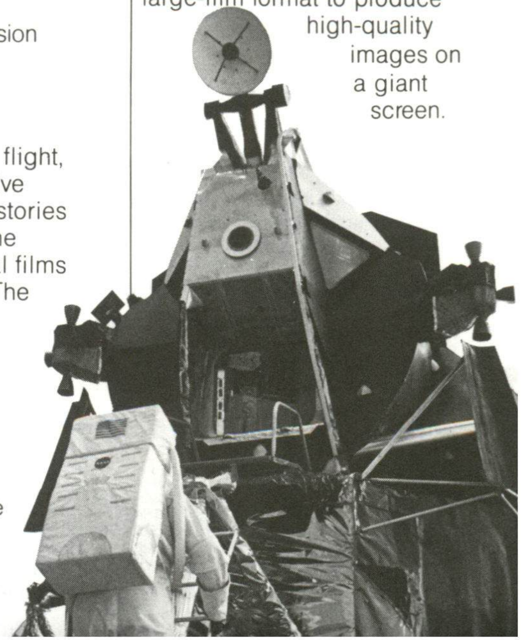
Langley Theater

Special films related to flight, projected on a screen five stories high and seven stories wide, may be seen in the Langley Theater. Several films are offered each day: "The Dream Is Alive," an inside look at America's space shuttle program; "To Fly!," a bird's eye view of America and "On The Wing," a depiction of flight in all its forms—from birds and insects to kites and aircraft. Also featured are "Flyers," the exploits of a fictional American aviator, and "Living Planet," an aerial travelog that takes the viewer across five continents.

Double features of selected films will also be shown in the evening after the museum has closed.

There is a nominal admission charge. For schedule information call (202) 357-1686.

The Langley Theater is one of the few in the world with an IMAX motion picture projection system. This system uses a large-film format to produce high-quality images on a giant screen.



General Museum Information

Membership

Recorded Tours

Recorded highlights tours are available in English and six foreign languages and may be rented from the Recorded Tour Desk in Gallery 100.

Checkroom

Museum Shops

The Museum's three gift shops have books, slides, postcards, posters, models and souvenirs

Associate and begin an adventure that will take you to the outer reaches of the universe. For more information on benefits, visit the membership desk located under the "Spirit of St. Louis" in Gallery 100.

Smoking Areas

Smoking is permitted in the dining area.

Lost and Found

Please report or return lost items to the Security Desk located in the South Lobby.

Public Tours

Free tours are offered daily to the general public at 10:15 a.m. and 1 p.m. Departure is from the Tour Desk in Gallery 100.

Parking

Street parking is available on Jefferson Drive, Independence Avenue and other surrounding side streets. Metro station: L'Enfant Plaza (Md. Ave. & 7th St. exit)

facilities are next to the Langley Theater on the first floor.

Food Service

The Museum's dining facilities, located on the first floor, east end, include both a seated dining area and a cafeteria-style food service.

Public Telephones

Public telephones are located in the South Lobby.

Library and Information Management

The Museum's research library has more than 24,000 books and journals, a rare book room, many original documents and an extensive photographic collection, much of which is available on videodisc.

Located on the third floor, it is open Monday–Friday, 10 a.m.–4 p.m. Please check in at the Information Desk on the first floor of the Museum. Telephone (202) 357-3133.

Group Reservations

Theater, planetarium and tour reservations are available for groups of 25 or more. Activities must be scheduled 2-8 weeks in advance. Write Tour Scheduler, NASM, Washington, D.C. 20560.

First Aid

A health unit is located on the Museum's parking level. See a security officer for directions or assistance.

Services for Disabled Visitors

Tours for the mentally retarded, visually, hearing, and physically impaired may be arranged on request. Call (202) 357-1400. Materials to enhance the Museum visit in braille, large print and recorded form are available at the Information Desk in the South Lobby, as are adapted scripts of most audiovisuals. Wheelchairs may be obtained free of charge in Gallery 100. See checkroom attendant.

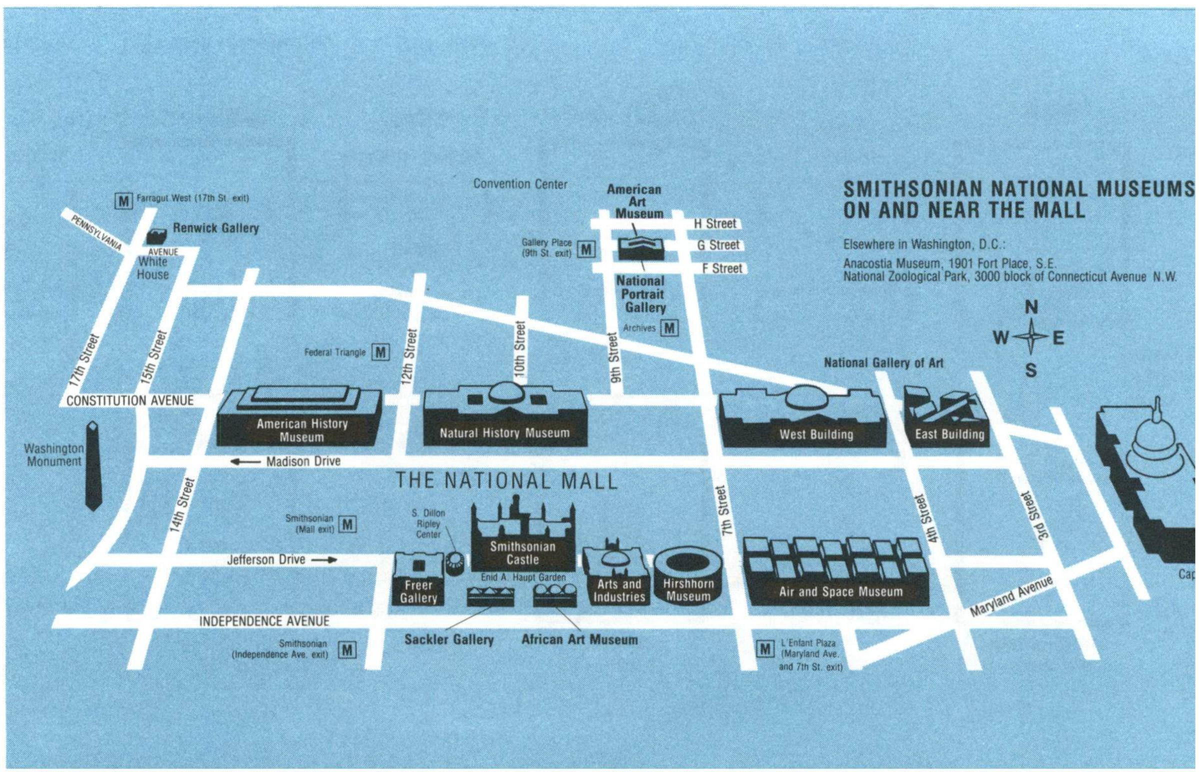
What's Happening . . .

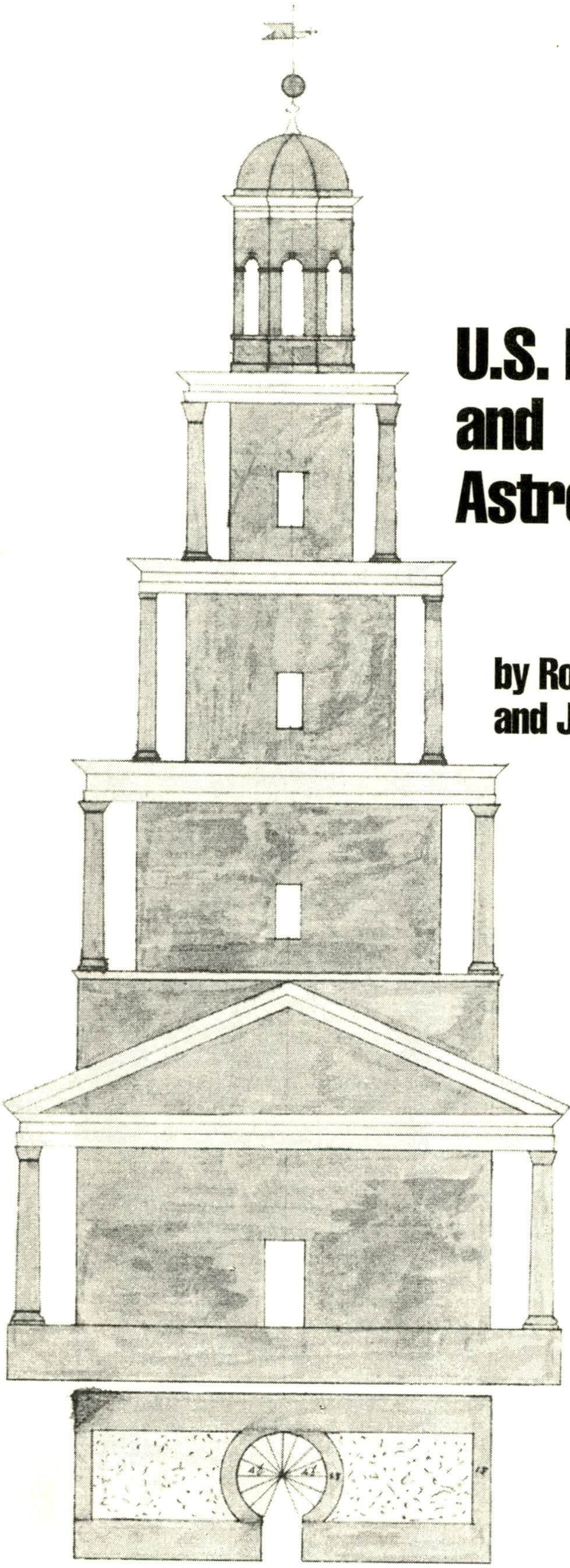
For information on the Museum and its programs, check in the South Lobby at the Information Desk or on the Information Kiosk. Or call: (202) 357-2700 TDD 357-1729

Hours:
10 a.m. to 5:30 p.m.
(Closed Dec. 25)
Extended Summer Hours
(June 16-Sept. 4, 1989):
9:30 a.m. to 7:30 p.m.

Location of the National Air and Space Museum

Independence Avenue between 4th and 7th Streets, SW
Washington, D.C. 20560





U.S. Presidents and Astronomical Discovery

by Robert A. Brown
and Jeanette C. Ishee

**"Towering genius disdains a beaten path.
It seeks regions hitherto unexplored."**

Abraham Lincoln (1838)

Cover: Thomas Jefferson's architectural drawing of an observatory tower for Montalto. Ink and wash, c. 1771.
Courtesy of the Massachusetts Historical Society

U.S. Presidents and Astronomical Discovery

by Robert A. Brown and Jeanette C. Isbee

This essay examines the intersection of three spheres of American thought: scientific exploration, "frontier" concepts, and public policy. It is a story of ideas, not a history of science. Here, presidents voice policy and speak for America. Astronomy is the focus because it is today both the least applied and most exploratory science. Also, astronomy is ancient, and both the nature of astronomical inquiry and the public policy challenge it poses have remained remarkably unchanged from the founding of the Republic to the present day. Finally, the object of this study is insight—in the same realm of ideas—that may be useful in conducting the federal science program, astronomy in particular.

From its earliest history, America has placed supreme value on exploration and discovery as the embodiment, the purest expression, and the due consequence of freedom. This concept has been fundamental in defining the individual and collective personalities of Americans. The U.S. presidents, in turn, have been the important national caretakers of the idea. From George Washington to George Bush, the presidents have sought federal support to open various wildernesses for American pioneers in pursuit of expanding geographical, technological, and intellectual frontiers. By variously asserting and promoting the diverse benefits of freedom manifested in exploration, they have inspired and supported voyages into the unknown, beginning with the American exploration of the West. Today, space and the realm of science are the most prominent objects of exploration being pursued with public funds.

Each frontier has distinctive challenges and rewards, and every president has interpreted the exploratory needs of America in terms of his perception of those opportunities. The frontier of astronomy in particular has held the imagination of presidents from the youngest days of the Republic. Early presidents connected the importance of astronomical exploration and discovery variously with teleological speculation, national prestige, and the centrality of learning to a successful democracy. (And, of course, astronomy has had practical applications for geography and determining civil time, which we will not consider here.) In the most recent four decades, the presidents have viewed astronomy as a distinctive discipline entwined with federal science as a whole.

Government sponsorship of astronomy as an open research discipline is a recent experiment in public policy, covering a period somewhat less than one-fifth of our Republic's age. As a policy experiment, it bears evaluation. This essay tracks the course of presidential ideas about astronomical exploration and federal support for it from the American Revolution to the present day. It shows how presidential support has helped to frame today's billion dollar per year national astronomy program through an oft-asserted historical analogy between our current conduct of science research and America's 19th century expansion west—an analogy based primarily on the idea of exploration. We will argue that, to ensure American society's return from the metaphorical frontier of astronomy, and to re-validate the analogy that sustains its special place in the American experience, new programs for education are needed within the existing federal astronomy program.

Early Presidential Interest in Astronomy

The American fascination with astronomical exploration and the U.S. presidents' role in promoting it can be traced to the origins of the American attitude toward government itself. This attitude originated in the ideas of the Enlightenment, which themselves had been greatly influenced by earlier developments in astronomy. The Copernican Revolution, Kepler's laws, and Newton's law of gravity had resolved an ancient debate on planetary motion and replaced the view of a hierarchical universe with one explained by free particles equal under the laws of nature moving according to a balance of forces. In the 18th century, this scientific triumph resonated with an analogous view of human nature and the role of government and civil law. The Founding Fathers saw a link between an understanding of the natural world and the moral improvement of mankind through new and more rational forms of government.

The Founding Fathers were knowledgeable of, took a personal interest in, and, in some cases, practiced astronomy. As a surveyor, George Washington was competent in making accurate astronomical readings and understood the practical benefits of the science both personally and for the fledgling democracy. While in England, John Adams visited Herschel at the Royal Observatory at Windsor Castle. His journals reveal intense curiosity about the possibility of life on other planets and wonder at the harmony of the solar system and what he termed its "stupendous plan of operation."[1] Thomas Jefferson once confessed in a personal letter that he felt Nature had intended him "for the tranquil pursuits of science, by rendering them my supreme delight. [It is] the enormities of the times in which I have lived," he wrote, that "have forced me to take a part in resisting them, and to commit myself on the boisterous ocean of political passions."[2] Nonetheless, he still managed to make frequent astronomical observations, and insisted that Lewis and Clark do so as well on their expedition to the Pacific. Later in his life, Jefferson planned an observatory for his beloved Central College (soon the University of Virginia), and designed the dome room of the Rotunda there as a teaching planetarium, complete with movable stars and a carefully-engineered elevated chair from which an astronomy professor could lecture while manipulating the planets. Presidents James Monroe, James Madison, and John Quincy Adams all argued forcefully in Congress and elsewhere for the establishment of a national observatory.

Indeed, no one has allied astronomy with American ideas more than John Quincy Adams. "The express purpose of an observatory," he wrote, "is the increase of knowledge by new discovery."[3] Such new knowledge, he felt, spurred "progress in the march of the human mind."[4] His first annual address to the nation as president was a manifesto for federal investment to improve and stimulate America. The concept of a national observatory—a "lighthouse of the skies"—was prominent among his proposals:

> It is with no feeling of pride, as an American, that the remark may be made that, on the comparatively small territorial surface of Europe, there are existing upward of one hundred and thirty of these light-houses of the skies; while throughout the whole American hemisphere there is not one. If we reflect a moment upon the discoveries which, in the last four centuries, have been made in the physical constitution of the universe by the means of these buildings, and of observers stationed in them, shall we doubt of their usefulness to every nation? And while scarcely a year passes over our heads without bringing some new astronomical discovery to light, which we must fain receive at second-hand from Europe, are we not cutting ourselves off from the means of returning light for light, while we have neither observatory nor observer upon our half of the globe, and the earth revolves in perpetual darkness to our unsearching eyes?[5]

As U.S. president, as overseer and benefactor of Harvard University, as "The Old Man Eloquent" in the Congress, and as a tireless public speaker, John Quincy Adams sought to turn "the science of astronomy…into a permanent and perservering national pursuit, which may extend the bounds of human knowledge and make my country instrumental in elevating the character and improving the conditions of man on earth."[6]

Early Presidential Valuation of New Knowledge

The interest in astronomy evinced by early American leaders indicates their appreciation for the vast importance of learning to the welfare and dynamism of the nation. This belief in the value of learning, exemplified by the acquisition and diffusion of new astronomical knowledge, was reflected in the efforts of each of the first six presidents to promote knowledge and understanding as the very basis of democratic decisionmaking. "Knowledge," said Washington, "is in every country the surest basis of public happiness. In one in which the measures of Government receive their impression so immediately from the sense of the Community as in ours it is proportionably essential."[7] John Adams claimed it was "the duty of legislators and magistrates, in all future periods of this Commonwealth, to cherish the interests of literature and the sciences, and all seminaries of them."[8] Jefferson declared that "knowledge is power…knowledge is safety, and…knowledge is happiness,"[9] and Madison believed that "a diffusion of knowledge is the only guardian of true liberty."[10] Monroe was a proponent of formal education and, while Governor of Virginia, argued that "in a government founded on the sovereignty of the people…knowledge should be diffused throughout the whole society, and for that purpose the means of acquiring it made not only practicable, but easy to every citizen."[11] Later, he joined Jefferson and Madison in planning the University of Virginia, and served as a member of its first Board of Visitors. In a report to Congress in which he lobbied for Congressional acceptance of the Smithson bequest, John Quincy Adams wrote:

> The attainment of knowledge…is the high and exclusive attribute of man, among the numberless myriads of animated beings, inhabitants of the terrestrial globe…It is by this attribute that man discovers his own nature as the link between earth and heaven; as the partaker of an immortal spirit; as created for a higher and more durable end…To furnish the means of acquiring knowledge is therefore the greatest benefit that can be conferred upon mankind.[12]

Clearly, the early presidents saw learning and new knowledge as keys to the future.

Early Public Policy Context of Astronomical Exploration

The first presidents' unanimity of outlook on learning was countered, though, by their differing philosophies on the federal government's role in supporting it. Early efforts to promote "internal improvements," *i.e.*, the establishment of a national university, a national observatory, and a national transportation infrastructure, proceeded only fitfully in early administrations, and were finally extinguished in the administration of the seventh president, Andrew Jackson. Resentment of the growing political and economic disparity between the diverse regions of the young nation surfaced repeatedly in the debate over the issue of internal improvements. The disagreement centered on the correctness of the federal government's use of public funds to finance improvements that might result in economic benefit to one state over another or increase the authority of the national government over the states.

Since the earliest days of the nation, the Federalists, led by Alexander Hamilton, had argued for a strong central government, and sought broad authority to finance large federal programs of internal improvement. Such improvements, they believed, would play an important role in preserving the union of the states and in promoting commerce and trade. For example, they proposed, but failed to enact, a broad federal system of roads and canals.

The Republicans, led by Thomas Jefferson, supported many of the philosophical goals of those who sought funding for internal improvements, but staunchly rejected the additional implied authority of the federal government over the states. They therefore insisted that internal improvements by the federal government first be mandated by a Constitutional amendment—despite the general agreement that such an amendment was not likely to garner the necessary approval of the states.

Andrew Jackson's campaign against federal involvement in internal improvements included denying funding for a national road and dissolving the Second National Bank of the United States. His opposition to such involvements was firm. In his first year in office he told Congress: "This was intended to be a government of limited and specific, and not general, powers...and it is our duty to preserve for it the character intended by its framers."[13] The next year, he reminded them "the successful operation of the federal system can only be preserved by confining it to the few and simple, but yet important, objects for which it was designed."[14] By the end of his second term in office, the issue of internal improvements was settled in favor of the so-called states' rights viewpoint, largely through the diligence and aggressive political maneuverings of Jackson. Although specific conflicts and pressures still arose, the broad issue itself ceased to dominate ensuing Congressional debates.[15]

After Jackson, federal funding of scientific research as pure exploration was in eclipse for more than a century. Although various succeeding presidents showed interest in astronomy—including Lincoln, Garfield, and Taft—none sought to promote pure astronomical research with federal funds with anything matching the verve of the pre-Jackson presidents. This is not to say that appropriated funds were not used to support astronomical observations directed at practical purposes. The U.S. Naval Observatory, for example, was built in 1844 to aid the coastal survey and improve the distribution of civil time. An observatory was built at West Point, which trained officers of the Corps of Topographical Engineers for land surveys of the West. But, until the 1950s, only private, state, or local funds were used to build astronomical observatories for pure scientific research and exploration akin to the vision of John Quincy Adams.

The President as "Voice of the People"

A second direct effect of the power struggle that took place during the Jackson administration was the transformation that occurred in the public view of the presidency. During the administrations of the first six presidents, the Executive Branch had been viewed primarily as the agent of Congress: it was to execute the laws that the Congress enacted. Jackson sought a stronger and more proactive role for the presidency and found the means in the issue of internal improvements. Jackson appealed to a sense of fairness among the masses when he vowed to represent the rights of all states in contrast to partisan political efforts in Congress seeking favor for certain individual states or regions. He came to be viewed as spokesman for all citizens and thus to be, in effect, the "voice of the people." He inspired a popular emotional reaction, which historian Leonard White describes as follows:

> Masses of people believed he was their friend—the "monstrous crowd of people" that Webster observed at the inauguration ceremonies on March 4, 1829, seemed really to think that the country had been rescued from dreadful danger. When, eight years later, Jackson stood on the rear platform of the railroad car on his way again to the Hermitage, no sound came from the multitude that bade him farewell. Emotions were too deep for expression.[18]

The Jacksonian mystique deeply affected American attitudes towards the U.S. presidency. The American public came to expect the president to be the representative of *all* the people and not merely of a region or party. Abraham Lincoln thus remarked that "as the President in the administration of the government, I hope to be man enough not to know one citizen of the United States from another, nor one section from another."[17] Theodore Roosevelt declared that "no man is fit to hold the position of President of the United States at all unless as President he feels that he represents no party but the people as a whole."[18] And, as Harry Truman explained, "it is only the President who is responsible to all the people. He alone has no sectional, no occupational, no economic ties. If anyone is to speak for the people, it has to be the President."[19] The newly strengthened ties of the president to the people aided Jackson and later presidents in their ability to influence and often to command federal policy by voicing American ideas.

Science as an American Frontier

In the 1920s, Herbert Hoover reconnected the American ideas of exploration and discovery with pure scientific research. In an essay on American individualism, he named science an eternal frontier for American pioneers. "Our American individualism," he wrote,

> has received much of its character from our contacts with the forces of nature on a new continent...[but t]he days of the pioneer are not over. The great continent of science is as yet explored only on its borders, and it is only the pioneer who will penetrate the frontier in the quest for new worlds to conquer. The very genius of our institutions has been given to them by the pioneer spirit.[20]

Hoover thus affirmed a revolution in American historical research precipitated in 1893 by Frederick Jackson Turner, who postulated a central role for the American frontier in the development of the American character. "To the frontier the American intellect owes its striking characteristics," Turner wrote, arguing that the American character is largely made up of "traits of the frontier, *or traits called out elsewhere because of the existence of the frontier.*"[21] According to Turner, the will to venture forth lies at the very heart of what it is to be American. "He would be a rash prophet," Turner maintained, "who should assert that the expansive character of American life has now entirely ceased. Movement has been its dominant fact, and, unless this training has no effect upon a people, the American energy will continually demand a wider field for its exercise."[22] Turner concluded that Americanism had long flourished on the frontier and would continue to thrive best there—if and where a new frontier might be found after the West was won. Hoover's assertion was that science is just such a frontier. He did not suggest, however, that the frontier of science be explored with public funds.

Franklin Roosevelt, on the other hand, supported federal financing of pure science research, and forged a transition in public policy using Hoover's theme of science as a frontier in combination with a revised "frontier policy." Wishing to know the "lessons learned" from science's role in winning World War II, he established a panel toward the end of the war to study and recommend a possible role for the federal government in the support of basic scientific research in peacetime. In his letter charging the panel's chairman, Dr. Vannevar Bush (who had headed the wartime science effort), Roosevelt made reference to "new frontiers of the mind" and wondered how they might be "pioneered with the same vision, boldness, and drive with which we [had] waged [the] war."[23] Vannevar Bush's response was a report entitled *Science, The Endless Frontier.* The report cited prior policy with respect to geographical frontiers as precedent for an expanded role of the federal government as patron of the sciences:

> It has been basic United States policy that Government should foster the opening of new frontiers. It opened the seas to clipper ships and furnished land for pioneers. Although these frontiers have more or less disappeared, the frontier of science remains. It is in keeping with the American tradition—one which has made the United States great—that new frontiers shall be made accessible for development by all American citizens.[24]

The report promoted the idea that science is a frontier that, if energetically explored with federal funds, will produce social benefits.

The linkage of these ideas—science with frontiers, exploration, and discovery—has been invoked by all succeeding presidents. Eisenhower, for instance, declared in 1954 that the United States had become "strong through its diligence in expanding the frontiers of scientific knowledge."[25] Gerald Ford, in an inspirational speech during the U.S. Bicentennial, claimed that

> The hallmark of the American adventure has been a willingness—even an eagerness—to reach for the unknown. For three and a half centuries, Americans and their ancestors have been explorers and inventors, pilgrims and pioneers, always searching for something new—across the oceans, across the continent, across the solar system, across the frontiers of science, beyond the boundaries of the human mind... Our country must never cease to be a place where men and women try the untried, test the impossible, and take uncertain paths into the unknown.[26]

In more recent years, Ronald Reagan asserted that: "The conquest of new frontiers for the betterment of our homes and families is a crucial part of our national character...The pioneer spirit still flourishes in America. In the future, as in the past, our freedom, independence, and national well-being will be tied to new achievements, new discoveries, and pushing back new frontiers..."[27] Calling the Hubble Space Telescope a "metaphor for a renewed spirit of basic exploration,"[28] the current administration has linked pure astronomical research with the American exploration idea.

The American people have thus far been willing to support this approach with tax dollars, believing in the implied promise that basic scientific exploration will bring about social benefits. They have supported the formation of such governmental "exploration" agencies as the National Aeronautics and Space Administration and the National Science Foundation. Federal funding for pure science research has grown to more than $12 billion per year.[29] Federal support for astronomy research has increased to about $1 billion per year, including all costs. In consequence, the federal government is now the principal patron of basic scientific research, including astronomical research, in the United States.

The Issue for Astronomical Exploration Today

The value of exploration for its own sake, then, has been a prominent theme in the rhetoric of U.S. presidents from the earliest days of the Republic, and since World War II, it has been used to rationalize—in part—increased funding of basic scientific research. This motive has been particularly significant for astronomical research, the least applied of all scientific endeavors. However, while the exploration metaphor still strikes a vibrant chord in the American imagination, its effectiveness in the current implementation of federal science programs is questionable. This is because those programs have not obviously led to the social and economic results expected of a "frontier," as is indicated by America's crisis in education, the declining technical skills of her workforce, and the dearth of new products and processes she brings to the international marketplace.

The authors believe the social benefits of exploration have so far failed to materialize because of two related factors. First, scientists and program administrators do not appreciate the latent power of federally-funded science exploration *as exploration.* A specific example is the potential of research astronomy to respond to the national education problem. Second, there exists little programmatic coupling between federally-funded science exploration and the public interest it is meant to serve. Consequently, the social benefits of astronomical exploration, for example, are largely serendipitous.

We assert that astronomical research can provide qualitatively increased social benefits if these factors are addressed analytically and the consequences pursued. We see astronomy's untapped "frontier" potential in its dynamic ideas, not in its established facts. If it were not so, then the value of old knowledge would dwarf that of new knowledge, and the teaching of astronomy—rather than astronomy research—would have paramount importance. Relatively few Americans know what Copernicus, Kepler, and Newton knew about the cosmos, which is elementary knowledge, and far fewer know enough to understand the astronomical questions the Hubble Space Telescope was launched to answer. Yet, the Hubble mission has captured the public imagination. Find the American who does not want to know if there are planets like Earth around other stars, or that a brown dwarf or black hole exists! And find one who does not wish to make it an American discovery rather than "fain receive at second hand."

This distinction between facts and ideas is critical to exploration's contribution to "the American energy." A fact is merely data; an idea is a mental process that, once planted in the mind, creates new opportunity. Withal, it can spark a sense of progress and optimism far beyond its immediate reference. Turner's great insight was that America's frontier experience could be generalized *on the basis of ideas* from the literal to a metaphorical plane after the geographical frontiers were gone. It is at this point that America's western horizon and science "horizons of the mind" coincide.

We see that the historical analogy and thematic resonances between science and the West break down precisely when the role of the federal government is examined. In opening the West, the government's role was to create opportunity for private activity that would benefit all the citizens. It acquired the land, surveyed it, built roads through it, and assured civil order. By contrast, federally-funded science exploration now affects the intellectual experience of an elite few. The fact that there is little programmatic effort to bring the stimulus of scientific exploration and discovery to bear beneficially on the spirit of America is a failure to follow through with a great idea. What effort there is lacks focus, coherence, and coordination, and is trivial compared with expenditure on the activity itself. Without extending and enhancing the ramifications of scientific exploration, it will be as if the government commissioned Lewis and Clark to explore new territories, but then never surveyed the land for settlement, never built roads, and never allowed the pioneering families to move in.

Fulfilling the Social Promise of Astronomical Exploration

The bounty waiting on "the endless frontier" is the magic of ideas. The federal astronomy program must open opportunities for citizens to extract, utilize, and profit from that magic on much wider and deeper levels than is currently attempted. This is a revolutionary suggestion—indeed shocking to astronomers inured to a sense of academic isolation and entitlement—yet it could be accomplished at little or no risk to the research itself. It is a matter of cleverly assuring everyone access to the magic of ideas and the excitement of exploration and discovery.

The best way for this to happen is for the federal astronomy program to address the nation's most significant need today: education. (Perhaps "learning" is a better word because it extends, as does the problem, far beyond the classroom.) Recognizing this opportunity, a group of educators and astronomers have recently proposed "an education initiative in astronomy".[30] This new program would exploit the glory of astronomical exploration to inspire learning widely in America. Today, no program with that purpose exists.

The primary objective of the proposed education initiative is to utilize astronomy—its lore, methods, history, and discoveries—to acquaint elementary and high school students with the basic concepts of science. Attitudes toward science are formed in the early school years, and astronomy's accessibility and attractiveness can enhance a child's first impressions. Other objectives of the initiative include increasing the science literacy of the public and the involvement in science of minorities and women. Astronomy has a proven potential to achieve all these objectives.

The broad resources of a federal research program can be engaged only through the program structure itself. Thus, the existing astronomy research offices would be responsible for the proposed education initiative, but would coordinate closely with outside educational, commercial, government, and private interests. Because of the vast scale of educational activity, and because education is not primarily a responsibility of the federal government, the initiative would seek to engage the spirit of free enterprise by encouraging entrepreneurship. Also, national astronomical facilities, the storefronts of federally-funded astronomy research, would be adapted to provide high-impact learning contacts, especially for science teachers, museum and planetarium professionals, and the media.

The towering genius of America, as Abraham Lincoln maintained, is that it has ever disdained the beaten path and sought regions hitherto unexplored. Our task today is to create, through federal support, opportunities for all Americans to share in these new horizons of the mind. The proposed education initiative in astronomy exemplifies how the federal government can open a frontier of science in the way it opened the West to the American people over a century ago.

Notes

1 Page Smith, *John Adams*, Vol. 1, 1735-1784 (New York: Doubleday & Company, Inc., 1962) 30.

2 Dumas Malone, *Jefferson and His Time*, Vol. 5 (Boston: Little, Brown & Co., 1974) 668.

3 *Report of the Select Committee on the Smithson Request*, John Quincy Adams Chairman, House of Representatives, March 5, 1840, in *The Smithsonian Institution: Documents Relative to Its Origin and History*, William J. Rhees, ed. (Washington, D.C.: The Smithsonian Institution, 1879) 202-36.

4 Ibid.

5 Fred L. Israel, ed., *The State of the Union Messages of the Presidents of the United States*, Vol. 1 (New York: Chelsea House, 1966) 246.

6 Charles Francis Adams, *Memoirs of John Quincy Adams, Comprising Portions of His Diary from 1795-1848*, Vol. XI (Philadelphia: J.P. Lippincott and Co., 1874-7), 409.

7 Israel, 3.

8 Smith, 443.

9 Caroline T. Harnsberger, ed., *Treasury of Presidential Quotations* (Chicago: Follett Publishing Company, 1964) 150.

10 Saul K. Padover, ed., *The Complete Madison—His Basic Writings* (New York: Harper & Bros, 1953) 337.

11 Harry Ammon, *James Monroe: The Quest for National Identity* (New York: McGraw Hill, 1971) 177.

12 Samuel Flagg Bemis, *John Quincy Adams and the Union* (New York: Alfred A. Knopf, 1956) 505.

13 Israel, 303.

14 Israel, 323-4.

15 An ironic inverse consequence was the Philadelphia High School Observatory—one of the first few observatories in the country—started in 1836 with funds that devolved to the municipality after the Second National Bank of the United States was dissolved.

16 Leonard D. White, *The Jacksonians* (New York: The MacMillan Co., 1963) 5.

17 Arthur Bernon Tourtellot, *The Presidents on the Presidency* (New York: Doubleday & Company, Inc., 1964) 42.

18 Tourtellot, 54.

19 Tourtellot, 67.

20 Herbert Hoover, "American Individualism" in *Essays on Current Themes*, C. Alphonso Smith, ed. (Boston: Ginn & Company, 1923) 393.

21 Emphasis added. See Frederick Jackson Turner, "The Significance of the Frontier in American History" in *The Frontier in American History* (New York: Holt, Rinehart and Winston, New York, 1962) 37-38.

22 Ibid.

23 Letter from Franklin D. Roosevelt to Vannevar Bush, in Vannevar Bush, *Science, The Endless Frontier: Report to the President on a Program for Postwar Scientific Research* (Washington, D.C.: U.S. Government Printing Office, 1945) viii.

24 Bush, 6.

25 *Department of State Bulletin*, Vol. 31, July 5, 1954 (Washington, D.C.: U.S. Government Printing Office, 1954) 20.

26 *Weekly Compilation of Presidential Documents: Gerald Ford, 1976*, Vol. 12, No. 27 (Washington, D.C.: U.S. Government Printing Office, 1977) 1105-06.

27 *Public Papers of the Presidents of the United States: Ronald Reagan, 1982*, Bk II (Washington, D.C.: U.S. Government Printing Office, 1983) 892.

28 Richard Darman, "Keeping America First: American Romanticism and the Global Economy." Text of remarks delivered at Harvard University on May 1, 1990, Cambridge, MA.

29 Intersociety Working Group, *AAS Report XV: Research and Development FY 1991* (Washington, D.C.: American Association for the Advancement of Science, 1990) 55.

30 Robert A. Brown, ed., *An Education Initiative in Astronomy* (Baltimore: Space Telescope Science Institute, 1990).

Support for this research was provided by NASA under Contract NAS5-26555 through the Space Telescope Science Institute, which is operated by the Association of Universities for Research in Astronomy. Production assistance was provided by Foxglove Communications.

Space Telescope Science Institute
3700 San Martin Drive
Baltimore, Maryland 21218

January 1991