

## Space Aff

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## Earth On The Brink

### **Action is needed now.**

**National Space Society.** Space Exploration, Opposing Viewpoints. **1992**, pg. 65.

It is past time to start pursuing our objectives in a serious way. We have seen numerous studies on how to get into space, and what should be done, and inadequate progress on implementing them. The National Space Society has declared that the 1990s should be a “decade of doing.” For this reason, we hope that the Committee’s report will largely be adopted, but with a real sense of the ultimate reasons why the space program is important to begin with. We look toward solutions and approaches that will bode well for our future, on this world and the worlds yet to come. The time for study is past; the time for action is now.

### **EARTH IS ON THE BRINK OF A COMMUNAL SUICIDE.**

(Danne w. **Polk**- Ph.D Environmental Ethics Summer **1994**, p.174)

Marcel’s philosophy exemplifies his personal experience, not only of the devastating effects of two world wars, but on the large-scale environmental destruction that spurred the beginning of the ecological movement in the 1960’s. He is convinced that the combined effect of such world events prove with glaring evidence that today we are on the very brink of communal suicide.

## Colonies lead to knowledge about space

### Space research leads to new technologies which benefit all of the Earth

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Space exploration has encouraged the development of new technologies that have translated into industrial and consumer products that enrich our lives on Earth. These are the so-called spin-offs of the space program. According to Paul S. Hardesen, by the mid-1990s NASA claimed over thirty thousand of them.

Some of the better-known products include Velcro; thin, lightweight blankets with amazing insulation properties; and a ballpoint pen that writes upside down, on grease, and irrespective of atmospheric pressure. Other spin-offs are "invisible" in that their origin is not widely known. For example, the requirement for onboard computers for navigation and automatic piloting moved us away from mainframe computers and helped make pocket calculators and personal computers available to us. The clunky but reliable onboard computers so essential to Apollo were the forerunners of the minicomputers that control automobile engines and serve as the nervous system for hundreds of products, including "smart" toys. Some already existing products such as Teflon and Tang (a powdered orange drink) became famous due to their association with the space program.

Lightweight, transportable; medical packs developed in space are useful in other hard-to-reach locations, such as Antarctica. Other medical spin-offs include implantable medication systems and sensors; automatic defibrillators; intensive care telemetry; computer-enhanced angiography; and synthetic, portable speech prosthetics.<sup>14</sup> Research intended to help spacefarers grow crops with minimal amounts of water could help us conserve water on Earth, and studies of waste management in space could help us clean up some of the world's greatest cities.

### Underwater colonies lead to knowledge about space

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Although conditions varied depending on the specific habitat and mission, it was difficult to achieve good temperature and humidity control in such environments, and in some cases, the sanitary, sleeping, and eating arrangements were not very good. Aquanauts took turns donning their underwater gear and going outside to conduct scientific research, salvage sunken equipment, or do other work. The cylindrical shapes and tubular configurations of these underwater stations, coupled with conditions where some people worked or relaxed in the habitat while others wore special life support equipment and worked "outside," are highly evocative of a space station. These underwater stations are gone now, but fortunately for us, useful behavioral research was conducted during their time.

## Space Technology Exists/Possible

### The technology needed for space colonies is nearly developed.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, 1992, pg. 26, 27.

Much progress is being made in technologies essential for the construction of space colonies. For example, prototype mass-driver electromagnetic launchers have been developed at the Massachusetts Institute of Technology and Princeton University. Accelerations have gone from 33 gravities to more than 1,800 gravities. This means that the length of the accelerator on the moon can be reduced from 8,900 meters (about 5 miles) to 160 meters (about 500 feet). Physical- and chemical-processing techniques to obtain propellants and construction materials from lunar soil have been demonstrated at laboratory scale. Studies by General Dynamics and SSI have shown that most of the mass of solar-power satellites can come from lunar materials. SSI's work shows that the cost of a lunar-sourced power satellite is only 3 percent of the cost of the same satellite built from Earth-launched materials. In 1988, NASA conducted what it called the Lunar Energy Enterprise Study in cooperation with representatives of electric- power utilities and other industries.

### Research has proven space colonies are feasible.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, 1992, pg. 25, 26.

Research groups in the United States and the former Soviet Union are advancing the state of the art in Closed Environmental Life Support Systems (CELSS). For many years, the Soviets were the undisputed leaders in CELSS research, with humans involved in systems experiments in large-scale facilities such as the Bios-3 experimental chamber in Krasnoyarsk, Russia. A privately funded US organization called Space Biospheres Ventures has surpassed the scale of the Soviet experiments by constructing a facility in the desert out side Tucson, Ariz. This facility is supporting eight people in near-complete material closure for a planned two-year period. This large facility, called Biosphere II, encloses about three acres and contains several different climate zones, including a tropical rain forest and an intensive agricultural area. These projects and work underway at the Kennedy Space Center, the Disney Epcot Centers land pavilion, and the Environmental Research Laboratory of the University of Arizona indicate that it will be feasible to sustain relatively complex closed-cycle ecological systems beyond Earth's atmosphere.

### Although difficult, space stations can be constructed in the status quo

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To some observers, the flame billowing forth from the mighty Proton rocket had an orange tinge, suggesting that something was awry. But apprehensions were laid to rest that day in November 1998, when the Proton placed Zarya, the first module of the ISS, into orbit. Zarya serves as a fuel depot and control module. In early December, the space shuttle Endeavour carried the second module, Unity, into orbit and successfully connected it to Zarya. This required incredible skill and determination on the part of the astronauts. Over the next few years, completion of the 520-ton space station would require 12 Russian and 33 U.S. launches. Assembly would require 166 space walks and over 1,000 hours of extravehicular activity.

After noting that routine shuttle launches are about as exciting as watching an 18-wheeler cruise Interstate 80," Newsweek reporters extolled the dangers of space station construction. "It's not going to be pretty," said the NASA administrator Dan Goldin. "We're going to see some unbelievably tough problems." A NASA study estimated a 74 percent chance that one of the 45 launches could be lost. Fluctuations in temperature could cause Zarya or Unity to contract, expand, and burst apart. A nickel-size micrometeorite could rip a hole in a space suit, causing decompression so violent that the wearer's eyeballs would pop out. But the prospects of death seemed to breathe new life into America's space program.

## Space Technology Exists/Possible

### Large-scale space colonies are possible.

Gerard K. **O'Neill**, NQA, The World & I. Space Exploration, Opposing Viewpoints. January **1992**, pg. 24.

Space has strong advantages over the surface of moons or of other planets as the site for location of human habitats. (colonies.) In space we can build habitats that are large in scale—far larger than could be built on a planet, because those structures will not have to withstand gravity. But they can rotate, to provide for their inhabitants internal gravity equal to Earth's norm, for which we have evolved over millennia. A space habitat will be a spherical shell of metal and glass, enclosing a normal, breathable atmosphere—something that does not exist on any planet other than Earth.

### Self sufficiency and independence for space colonies is possible.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, **1992**, pg. 24.

In addition to the workers and their families, space colonies would contain many of the professions found in any small terrestrial town. Space settlements would also address human needs beyond the physical and economic. By its very nature, each habitat would have a high degree of self-sufficiency and in dependence. Independence in space colonies need not, however, mean isolation. Communications between Earth and space colonies, or from one colony to another, would be a relatively simple matter with thousands of communities within a few light-seconds of each other. Although transport from Earth's surface to a colony or colony group is likely to remain relatively expensive, the cost of travel from one free-space habitat to another can be very small.

## Space Solves All

### All challenges on Earth can be solved with space exploration.

**National Space Council**, Report to the President. **1990**. Space Exploration, Opposing Viewpoints, 1992, pg. 53.

Today, America is faced with tremendous, all-pervasive challenges—in medicine, in energy, in industrial competitiveness, in national security, in the environment, and elsewhere. How well we meet these challenges will determine how we and all citizens of the world live in the future. The real questions that confront us are whether we appreciate their urgency, whether we understand the potential of space in meeting them, and, under standing that potential, whether we as a nation are willing to make the major commitments necessary to engage in the exploration of space with the dedication and seriousness that these challenges demand.

### The space program has multiple objectives and benefits.

**National Space Council**, Report to the President. **1990**. Space Exploration, Opposing Viewpoints, 1992, pg. 49, 50.

The Space Councils approach for implementing U.S. national space policy divides all space activities into five areas, each of which may encompass civil, national security, and commercial activities conducted by NASA, DOD, DOE, DOT, other government agencies, or the private sector. The space program serves multiple objectives: preserving the nation's security; creating economic opportunity; developing new and better technologies; attracting good students to engineering, math, and science; and exploring space for the benefit of mankind. The Council's approach is designed to achieve these objectives as an integrated national effort cutting across traditional lines of civil, national security, and commercial programs. The five key elements of U.S. National Space Strategy are: 1. To develop U.S. space launch capability—our transportation to and from space—as a national resource; the space transportation infrastructure will be to the 21st century what the great highway and dam projects were to the 20th. We will ensure that this infrastructure provides assured access to space, sufficient to achieve all U.S. space goals. 2. To open the frontiers of space through both manned and unmanned exploration: we will build on the successes of Viking and Voyager and proceed to comprehensively explore the solar system with Magellan, Hubble, Ulysses, and other ambitious unmanned programs. The President's call to complete Space Station Freedom, return to the Moon to stay, and the journey to Mars has finally given a much needed focus to our manned efforts. New ideas will be synthesized into varied approaches to undertake these premier space flight missions of the future. 3. To intensify our use of space in solving problems here on Earth: we already use space systems to verify arms control treaties and to provide our defense forces with warning, communications, navigation, meteorology, and other functions vital to our national security. Satellite communication networks link peoples around the globe and contribute to the increasingly successful fight against repression and totalitarianism. Remote sensing from space contributes to a variety of land and ocean use applications and helps us understand, and potentially mitigate, the process of global climatic change. 4. To foster our economic well-being: we will capitalize on the unique environment of space to investigate and produce new materials and medicines and develop clean and abundant energy for all. The resulting private investment will create jobs; boost the economy; and strengthen our science, engineering, and industrial base. Along the way, new commercial space markets will be created and existing industries will become stronger and more competitive in the world marketplace. 5. To ensure the freedom of space for exploration and development: there are currently numerous space faring nations, with many others on the way. Space will become to the future what oceans have always been—highways to discovery and commerce. But the sea lanes must be open to be usable, and as we know from past conflicts, they are subject to disruption. Thus, we must ensure the freedom to use space for exploration, development, and security for ourselves and all nations. . . .

## Space Solves All

### The key to solving Earth's problems is space.

Sally K. **Ride**, Masters of Science. Space Exploration, Opposing Viewpoints, **1992**, pg. 45.

The planet we live on is much more fragile than we thought it was. Not that it's going to break apart, but it's very sensitive to the changes that take place on its surface and even in the interior. And we can affect those changes; in fact, we're the cause of some of them. So it's important to understand the earth's ecosystem on a global scale and how it's changing. The only way we can effectively do that is from space, because that's the only place where we can get a view of the entire planet.

### Space exploration is an investment in our future.

**National Space Council**, Report to the President. **1990**. Space Exploration, Opposing Viewpoints, 1992, pg. 50.

The Space Exploration Initiative is the ultimate investment in America's future. By responding to the human imperative to explore, we will reap benefits for ourselves and future generations akin to those of the voyages by Columbus and Magellan. We will increase our storehouse of knowledge about the planets, including our own, and about the nature of life itself. We will develop new technologies, many of which will have applications that will improve our lives on Earth. We will stimulate science and engineering education in this country by inspiring and motivating our young people. And we will be setting the stage for eventual permanent human habitats on other planets. More over, the Space Exploration Initiative will improve our competitive technological position in the world while enhancing our national pride and international prestige. But most importantly, the technological capabilities we develop, the new resources we discover, and the new industries we find in pursuit of these ambitious space-exploration goals will power American economic preeminence throughout the 21st century.

## Space Solves Humanity's Problems

### Space unites humanity and reduces international tensions

Albert **Harrison 2001** Spacefaring Professor of Psychology at the University of California, Davis.

Space exploration began as a form of competition between the two superpowers, the United States and the Soviet Union, then slowly evolved into a collaborative international venture. Over the years, and in cooperation with the U.S. Department of Space, NASA has negotiated hundreds of collaborative agreements with scores of foreign countries. Canada invested \$100 million in developing the remote manipulator arm for the shuttle, and the European, Space Agency (ESA) invested \$1 billion in Spacelab, a laboratory facility that fits within the shuttle's bay. In addition to the United States and Russia, fourteen other nations are taking an active part in developing the International Space Station. There is also a long and rich tradition of international collaboration in automated missions, such as the Cassini mission to Saturn, launched in 1997.

International cooperation serves many purposes. It cuts costs by eliminating the duplication of effort that would occur if, for example, two or three competing nations each built its own spaceport. It reduces the financial burden placed upon any individual nation by spreading the total cost across many nations. A balky president or the US Congress might be willing to move forward with a new space program if other nations were willing to pick up part of the tab. International cooperation allows nations that could not afford space exploration on their own to enter the spacefaring arena. The involvement of many different nations can lend stability to a program: although a nation might be tempted to quit, it is under moral and diplomatic pressure not to do so. However, this is not always enough to ensure that all parties follow through on their commitments.

Perhaps the most important reason for collaborating in space is to reduce international tensions. A common justification for a joint United States-Russian mission throughout the history of the space program was to underscore cooperation rather than competition between the two countries and reduce East-West tensions.<sup>46</sup> As senator and then future US. President Lyndon Baines Johnson remarked to the UN General Assembly in 1958, "Men who have worked together to reach the stars are not likely to descend together into the depths of war and desolation."

### Space colonies would be self-sufficient and house one million people.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, **1992**, pg. 23.

Building the structures in space would allow the inhabitants to select whatever gravity level they desired by controlling the rate of rotation of the habitat. O'Neill showed that even if relatively simple materials such as steel cables were used in colony construction, habitat cylinders of up to 20 miles (32 kilometers) in length and 4 miles (6.4 kilometers in diameter) could be built to house up to 1 million people under comfortable conditions. Early habitats would be much smaller, with populations of hundreds or thousands. Each habitat would have provisions for agriculture and closed-cycle life support so that once a colony is established, very little outside material would be required to sustain it. To obtain construction materials for these settlements from Earth would obviously not be economical. Instead, O'Neill proposed using materials already in space. The first source of raw materials would be the surface of the moon. Thanks to the Apollo missions and the Soviet sample return probes, we know that the required elements are present in abundance. Because the moon has no atmosphere and only one-sixth Earth's gravity, it is possible to use an electromagnetic catapult (called a mass driver) to launch raw materials to a point in space without incurring the costs of chemical-rocket transport.

### Space colonies will decrease the possibility of the destruction of humans.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, **1992**, pg. 24, 25.

Ultimately, space colonies could be built anywhere in the solar system. By increasing the size of the mirrors used to direct sunlight into the living and agricultural sections, it would be possible to support habitats beyond the orbit of Pluto if we so desire. Given the known resources of the asteroids, there is sufficient material to construct habitats capable of supporting populations thousands of times larger than that of Earth. By increasing our ecological niche to include the solar system, the human species would become much less likely to be destroyed by a single natural or man-made catastrophe.

## Space Solves Humanity's Problems

**Space exploration is good for humanity.**

**Association of Space Explorers**, The SPACEExplorer, November **1991**. Space Exploration, Opposing Viewpoints, 1992, pg. 64.

Human exploration of the solar system is a challenging and inspiring initiative that can promote global understanding, peaceful cooperation, scientific progress, technology development, and educational excellence. This massive effort will clearly include opportunities for participation by many countries. It will provide a focus for space science and technology programs in all of the space faring nations and enhance new initiatives in emerging nations.

## Space Solves Extinction

**Space exploration solves extinction, scarcity, and environmental degradation.**

**National Space Society.** Space Exploration, Opposing Viewpoints. **1992**, pg. 63.

The National Space Society's vision is of a space faring civilization- With humanity residing throughout the solar system, we will no longer be at risk of extinction because of a single event, whether it is a nuclear war or a cometary impact like that believed to have wiped out the dinosaurs. With access to cheap solar energy and the material wealth of the solar system, many problems of scarcity and environmental degradation will be solved. And, during that expansion, we will be carrying on the frontier spirit that made America great.

## Space is key to America's Future

### Space exploration is key to America's future.

**National Space Council**, Report to the President. 1990. Space Exploration, Opposing Viewpoints, 1992, pg. 52, 23.

Our efforts are guided by several specific principles. First, the United States plans to develop and pursue its opportunities in space. Space exploration and the application of space technologies is as much an imperative for the continued development of the nation as was exploration of the continent by our forefathers. America's future is inevitably and irrevocably linked to our efforts in space. This reality underlies the Council's sense of urgency in approaching its tasks. Second, one of the greatest strengths of this nation is its ability to meld the efforts of its technological, industrial, academic, and governmental institutions toward a common cause. The Council's policies and plans for space capitalize on this strength by seeking to map a course that harnesses the innovative, creative and analytic prowess of all American institutions. Consequently, the Council treats each goal, each objective, and each initiative as a joint undertaking. Finally, the Council's actions recognize that what is needed is not leadership in space per se, but leadership in using space to address important human concerns. Space offers unlimited potential for improvement in almost every area of human endeavor; such as in medicine, where microgravity may offer new and undreamed of pharmaceuticals and cures; in industry, where productivity may be increased and made more affordable; and in national security, where space capabilities allow us to verify arms treaty provisions and counter threats to the nation's well-being. Space also offers tremendous potential for new sources of needed materials and clean, unlimited energy.

## Space Is Key To Hegemony

### Space exploration is key to maintaining world leadership.

Thomas P. **Stafford**, NQA, *America at the Threshold*, **1991**. Space Exploration, Opposing Viewpoints, 1992, pg. 52.

Ours is a rapidly changing world. To remain competitive and maintain world leadership in the 21st century, America will need the best trained and educated work force, the most advanced technology and the strongest leadership. We now have goals that challenge our abilities far beyond what we've experienced before. The Space Exploration Initiative is a vision for the 21st century. It is a vision of America reaching beyond itself, and onward, beyond the very bounds of this planet to an entirely new world. On the way there, we will reap the real, tangible benefits of space exploration.

### The U.S. must explore space to increase national strength and superiority.

John F. **Kennedy**, U.S. President, quoted in the *Twenty-First Century*, **1989**. Space Exploration, Opposing Viewpoints, 1992, pg. 49.

We have regained the initiative in the exploration of outer space ... making it clear to all that the United States of America has no intention of finishing second in space. This effort is expensive, but it pays for its own way, for freedom and for America. ... There is no longer any doubt about the strength and skill of American science, American industry, American education, and the American free enterprise system. In short, our national space effort represents a great gain in, and great resource of, our national strength.

## Space Solves Resources

### **Space exploration is beneficial in resource availability and land for settlement.**

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, **1992**, pg. 27.

In 1991, a workshop conducted by the International Astronautical Federation at a conference on solar-power satellites suggested a vigorous program of international experimentation on the use of space resources to provide energy to Earth. Although we have general information about the composition of the moon and asteroids, one of the largest opportunities in the development of space is the search for specific resource sites. Today there is a growing realization that the world's space programs must generate real value for their constituents. Providing clean energy for Earth and new lands for settlement and exploration can take space exploration and development beyond the "flags and footprints" missions of the 1960s. In undertaking space colonization, we can provide genuine hope for both our people and our planet.

## Space Has Positive Psychological Impacts

**Space exploration would have positive psychological impacts for humanity.**

**National Space Society.** Space Exploration, Opposing Viewpoints. 1992, pg. 64.

The National Space Society believes that this expansion of humanity is the most important project at hand today. Furthermore, we believe that it is not only important in itself, but that it will create enormous benefits even for those of us who remain at home. Most people nowadays are familiar with the many economic and technical spin-offs” from the space pro gram. But these are not the only ones. In a society, like ours, that seems to lack direction and goals itself, the opening of a new frontier in space could have enormous—and positive—psychological impact. Such was the effect of Columbus’ voyage, and the ensuing settlement of the Americas by Europe. As Samuel Eliot Morison recounts in his classic biography, Admiral of the Ocean Sea: At the end of the year 1492 most men in Western Europe felt exceedingly gloomy about the future, Christian civilization appeared to be shrinking in area and dividing into hostile units as its sphere contracted. For over a century there had been no important advance in natural science, and registration in the Universities dwindled as the instruction they offered became increasingly jejune and lifeless. Institutions were decaying, well-meaning people were growing cynical or desperate, and many intelligent men, for want of something better to do, were endeavoring to escape the present through studying the pagan past. Yet even as the chroniclers of Nuremberg were correcting their proofs from Koberger’s press, a Spanish caravel named Nina scudded before a winter gale into Lisbon, with news of a discovery that was to give old Europe another chance. In a few years we find the mental picture completely changed. Strong monarchs are stamping out privy conspiracy and rebellion; the Church, purged and chastened by the Protestant Reformation, puts her house in order; new ideas flare up throughout Italy, France, Germany, and the northern nations; faith in God revives and the human spirit is renewed. The change is complete and astounding. “A new envisagement of the world has begun, and men are no longer sighing after the imaginary golden age that lay in the distant past, but speculating as to the golden age that might possibly lie in the oncoming future.’ Christopher Columbus belonged to an age that was past, but he became the sign and symbol of this new age of hope, glory, and accomplishment. His medieval faith impelled him to a modern solution: expansion. This experience, it seems to us, is a good enough answer to those who say that we should solve our problems at home before we go into space. Where would we be today if the Europe of Columbus’ time had felt the same way?

## Space Leads To New Energies

### Space colonization can supply new energy sources and a new world.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, **1992**, pg. 23.

Space colonization means much more than Antarctic-style research habitats on the moon or other planets for an elite group of astronauts. Space can be colonized and provide Earth with the equivalent of the New World that Columbus “discovered” in the 15th century. Space colonies can supply clean energy necessary for human survival in the 21st century. In addition, they can provide new homelands and an expanded ecological niche for our species. For many people, the term “space colony” brings to mind visions of domed cities on the moon or the surface of a hostile planet. Since September 1974, however, the words have had a very different meaning. That month’s issue of Physics Today contained an article by Princeton University professor and nuclear physicist Gerard K. O’Neill entitled, “The Colonization of Space.” Dr. O’Neill proposed construction of large-scale habitats built in free space rather than on the surface of planets;

### Space colonization could lead to new, efficient energy sources.

Gregg **Maryniak**, NQA. Space Exploration, Opposing Viewpoints, **1992**, pg. 23, 24.

The initial economic reason for the colonization of space would be to use the resources of space to provide for the needs of our home planet. O’Neill proposed that the space colonists use low-cost space resources to construct large solar platforms to collect the sun’s energy and convert it into electricity. This electrical power would be transmitted to Earth’s surface in the form of a high-frequency radio beam. The beam would be received by a special antenna and rectifier array, which would convert it back into electricity with an efficiency of about 90 percent.

### Space colonies would have a cheap source of energy.

Gerald K. **O’Neill**, NQA. The Christian Science Monitor. Space Exploration, Opposing January 2, **1992**, pg. 26.

In our society, materials are relatively cheap and energy is relatively expensive. However, a space colony would be quite the reverse. Their energy would be very cheap and abundant—and to tally reliable, coming from the sun.

## Space Leads To An Economic Benefit

**Even if there isn't an economic profit in space the processes needed to get to space benefit the economy**

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All aspects of space exploration-whether it be constructing or operating telecommunications satellites, conducting cutting-edge astronomy with the Hubble space telescope, or establishing a strip mining operation on the Moon-have immediate economic benefits. So far, not one dollar has been spent in space-all money spent on space exploration has been spent right here on Earth. According to some analyses, every dollar spent on the Apollo Moon Program translated into seven to eight dollars returned to the economy in new goods and services. Space-related activities create high-level jobs: for scientists, engineers, and technicians, for analysts and accountants -for the people who will fly in space and the people whose work on Earth supports them. Scott Sacknoff and Leonard David estimate that parts of the space industry are growing at rates surpassing 20 percent annually, thus creating forty thousand new jobs each 1 year.

**Space exploration profits U.S. technology and the private sector.**

Charles P. **Cozic**, Book Editor. Space Exploration, Opposing Viewpoints, **1992**, pg. 9.

Twentieth century space exploration has helped humans learn more about the universe than ever before. For example, American unmanned spacecraft, Voyager I and 2, discovered new moons surrounding Neptune and helped scientists determine the composition of Saturn's rings. Also, radar images of Venus from the Magellan probe in 1991 revealed evidence of earthquakes and a 4,200-mile dry riverbed, the longest known to exist in the solar system. These discoveries can help scientists better understand the nature of the galaxy and the origins of the universe. Proponents argue that these dramatic discoveries are proof that space exploration is a profitable and worthy endeavor that benefits everyone. In addition, they cite numerous technological spin-offs from space-related research that have become everyday products and services. For example Apollo mission technology spawned laser surgery and a more effective heart pacemaker, innovations which have improved the health of thousands of Americans. Satellite photograph technology is used in medicine to diagnose cancer and other diseases. These and other accomplishments cause many people to praise the space program, including Utah Senator Jake Garn, who once flew aboard the space shuttle Discovery: "For every dollar spent on space research, the private sector receives eight or nine dollars in return. What other federal program can promise that kind of return on your investment?" he asks. Garn and others believe that the rewards of space exploration far exceed its costs.