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THE NEW SPACE RACE: CHALLENGES FOR U.S. NATIONAL SECURITY AND FREE ENTERPRISE

BRYAN T. JOHNSON

Thirty years ago, when astronauts Neil Armstrong and Buzz Aldrin stepped on the moon, they broke the tethers binding mankind's feet to Earth and lofted the nation's aspirations and energies into space. Today, as the nation celebrates the 30th anniversary of the Apollo 11 mission, Congress is considering legislation that will chart the future course of America's space program. The reauthorization of the National Aeronautics and Space Administration (NASA) and other legislation proposing to solve some of the problems facing the U.S. space program offer Congress its first opportunity since 1992 to take a closer look at America's goals for space exploration and development.

Unfortunately, America's commanding lead in space technology and military capabilities is slipping. For example, despite the billions invested in the Space Shuttle, space exploration remains prohibitively expensive; military access to and control of space for surveillance and defense purposes are threatened by technological developments and proliferation of weapons around the world; and the U.S. commercial space industry, namely the providers of launch technology and equipment, is being encumbered by federal regulations, trade restraints, and poor contracting decisions.

The main reason the space program is floundering is that NASA began to de-emphasize space exploration in favor of politically motivated missions, such as studying the Earth's climate and financially supporting Russia's participation in the International Space Station (ISS). The result is that NASA is doing many things, but none of them well enough to maintain both the standards it set in the 1960s and America's dominance in space. Congress should re-evaluate NASA's objectives as well as the challenges and threats to America's space assets and then take specific steps to ensure that the space program gets back on course. To this end, Congress should:

- **Require NASA and the Defense Department to purchase the most cost-effective and reliable launch systems available.** The cost of launching payloads from the United States is

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prohibitive. Other nations have reduced costs significantly. Congress should require NASA and the Pentagon to identify ways to lower launch costs while increasing reliability and instruct the U.S. General Accounting Office to conduct feasibility studies on more cost-effective alternative launch vehicles.

- **Fully privatize space launch facilities.** The federal government is considering whether to partially privatize launch sites, such as Cape Canaveral in Florida and Vandenberg Air Force Base in California, and create a quasi-government organization, modeled on the U.S. Postal Service, to manage these sites. However, partial privatization is less effective than full privatization in reducing launch costs or upgrading these facilities.

- **Refocus NASA's priorities on manned space exploration and eliminate duplicative and wasteful projects.** NASA spends $1.5 billion annually to study global weather patterns and vegetation growth. The National Oceanographic and Atmospheric Administration has satellites to collect data on the Earth's climate as well. Such duplication does not promote space exploration and should be eliminated.

- **Establish a time line for privatizing the Space Shuttle fleet and for establishing commercial payloads on the International Space Station.** NASA demonstrated its support for Shuttle privatization when it established a joint venture in 1995 with U.S. aerospace companies to manage, maintain, and operate Shuttle payloads. But only NASA can approve how the Shuttle's space is used. Moreover, NASA's plan for commercializing the station would permit only one-third of the U.S.-operated section to be used by the private sector. Congress should require NASA to promote private-sector involvement in these projects and proceed with full privatization.

- **Ensure U.S. military access to and control of space to protect national security.** U.S. military and civilian assets in space are vulnerable to attack. This could compromise not only U.S. navigation systems, but also the military's access to reconnaissance, communication, and weather information. Congress should ensure that the U.S. military is capable of controlling and defending America's assets in space.

- **Seek an amendment to the International Space Station Agreement to prevent other countries from using the station to spy on America.** No agreement prohibits other countries from using the station to spy on the United States. The United States may give Russia up to $1 billion to subsidize its participation even though Russia maintains a "listening post" in Cuba and is working on programs that could undermine U.S. national security. Congress should require NASA to seek a new agreement that specifically prohibits countries from using the ISS for espionage.

- **Streamline the monitoring of technology transfers to protect national security.** The State Department should be encouraged to streamline its regulatory process or transfer its jurisdiction over export licensing to the Defense Department. Congress should consider guidelines for export licenses so that they do not unduly burden the commercial space industry when national security is not at risk.

- **Remove restrictions that limit U.S. commercial competitiveness in space.** Congress should review the space launch quota system to determine whether such quotas are warranted. It should require the President to certify that joint ventures with foreign companies do not facilitate the transfer of vital technology.

- **Extend space launch indemnification authority.** The indemnification authority Congress created in 1988 to protect commercial companies from third party liability will expire at the end of this year. Although the best approach is to allow the insurance industry to assume the risks and pass the costs on to commercial companies, Congress should extend indemnification authority to cover current contracts.

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Thirty years ago, when Apollo 11 astronauts Neil Armstrong and Buzz Aldrin stepped on the moon, they broke the tethers binding mankind's feet to Earth and lofted the nation's aspirations and energies into space. As the nation celebrates the 30th anniversary of the lunar landing, which occurred less than a decade after President John F. Kennedy challenged scientists to put a man on the moon, Congress is considering legislation that will chart the future course of America's space program. The reauthorization of the National Aeronautics and Space Administration (NASA)[1] and other legislation proposing to solve some of the problems facing the U.S. space program offer Congress its first opportunity since 1992 to take a closer look at America's goals for space exploration and development.[2]

Space is the high seas of tomorrow. As many of America's allies and adversaries understand, dominating this strategic environment for civilian and military purposes will help establish a nation's greatness in the 21st century. Unfortunately, there are signs that America's once commanding lead in space may be slipping. For example:

- **Space exploration** is prohibitively expensive, despite the billions in tax dollars invested in the Space Shuttle over the past 25 years to reduce launch costs;
- **Military access to and control of space** for surveillance and defense purposes are threatened by the pace of technological development and the proliferation of ballistic missiles and nuclear weapons around the world; and
- **The U.S. commercial space industry,** the providers of launch technology and equipment, has been encumbered by federal regula-

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1. H.R. 1654.
2. Congress is obligated to pass authorizing legislation providing the legal justifications for appropriations for NASA. Because Congress has not authorized it since 1992, NASA currently operates under outdated guidelines.

tions, trade restraints, and poor contracting decisions.

The euphoria surrounding the Apollo II moonshot in 1969 gave NASA the political and popular support it needed to try to achieve a permanent manned presence in space, such as orbiting space stations, missions to other planets, and colonies on the moon. This support was more than enough to ensure U.S. military control of space for the purposes of national security, the future expansion of the U.S. commercial space industry, and the development of new technologies and products.

Still, the goals are far from realized. The United States has not returned to the moon since Armstrong took his famous "giant leap for mankind." The International Space Station (ISS), a multibillion- dollar headache, has experienced many setbacks in recent years. The U.S. military, which relies heavily on such space-based assets, including imaging satellites and global positioning systems for security purposes, is suffering from poor launch vehicle reliability and from the high cost of using completely expendable vehicles to place classified systems in orbit. Moreover, other countries are now capable of interfering with or destroying U.S. satellites, and the commercial space industry is plagued by accusations that it allowed the transfer of sensitive missile technology to China.[3]

Clearly, the space program is adrift.

The reasons the space program is floundering are many. Like most government agencies established for a singular purpose, NASA needed new objectives after fulfilling its Apollo missions. Over the years, however, NASA de-emphasized space exploration in favor of more politically motivated missions, such as studying the Earth's climate, building advanced airplanes, and subsidizing Russia's activities on the ISS. This should not surprise anyone, since NASA, as well as the Defense Department, must work within the funding constraints mandated by Congress. As a result, NASA does many things, but none of them well enough either to maintain the standards it set in the 1960s or to preserve America's dominance in space.

NASA has been asked to do more, but with less. To be sure, NASA has been able to retool itself while reducing some waste. Nevertheless, Washington needs a more coherent space policy. To that end, Congress should re-evaluate America's goals in space and take specific steps to ensure that the space program gets back on course. In addition, Congress should use its oversight powers to refocus the space program on manned space exploration while promoting a stronger military presence in space and unleashing the entrepreneurial energies of the private sector. Such an approach would enable the United States to fulfill the dreams of many Americans who witnessed the first walk on the moon, as well as open opportunities in space that will benefit their offspring into the 21st century.

HOW THE SPACE PROGRAM VEERED OFF COURSE

For many, the race for space, which began in earnest after the Soviet Union successfully launched Sputnik in 1957, epitomizes the conflict between democracy and communism. During the 1950s and 1960s, the United States was engaged in a serious ideological war with a powerful enemy, and every scientific, economic, military, and political success was interpreted as proof that one system was superior to the other. Indeed, the Soviet Union touted Sputnik as a triumph over capitalism.[4]

The United States, in turn, set out to beat the Soviet Union to the moon and claim victory in a battle for ideological and technological supremacy. Washington sought a partnership with the private sector to facilitate the development and testing of rocket-propulsion systems. NASA, created by President Dwight D. Eisenhower in 1958 to oversee this effort,[5] realized its role in America's race against the Soviet Union with an exhilarating suc-

3. See Richard D. Fisher, Jr., "Commercial Space Cooperation Should Not Harm National Security," Heritage Foundation *Backgrounder* No. 1198, June 26, 1998.

cess on July 20, 1969, when Apollo 11 became the first manned spacecraft to reach the moon.

The conquest of space encouraged American scientists and policymakers to look to the moon for solutions to problems on Earth: for example, what to do once resources like water and fossil fuels were depleted and how to feed and house a burgeoning population. It is no surprise that NASA's plans included permanently manned colonies on the moon[6] and on Mars,[7] as well as space stations orbiting Earth. Space exploration was now NASA's broad mission.[8]

Space Exploration

To facilitate space exploration, NASA began searching for cheaper and less expendable methods of launching payloads into orbit and returning them to Earth. The Saturn V rocket, designed by Wernher von Braun for the Apollo missions, could be used only once, at a cost of $3,800 per pound.[9] The same was true for NASA's entire launch infrastructure, a byproduct of the military's throwaway ballistic missile technology. The space program could not sustain such costs. As a low-cost, "partially reusable" alternative to the expendable systems,[10] NASA developed the Space Shuttle. Since 1981, NASA's five orbiters—including the *Columbia*, which blasted off on July 23 with America's first female commander—have ventured into space 95 times.[11] The Shuttle will also be used to service the ISS.

The cost of launching a payload aboard the Shuttle today, at nearly $10,000 per pound, is almost three times higher than the cost of launching a payload during the Apollo program.[12] Unfortunately, the Shuttle has not succeeded in reducing space launch costs. To cut costs, the Nixon Administration nearly halved the Shuttle's budget, forcing NASA engineers to abandon many of their planned technological improvements that would have reduced launch costs.[13]

4. United State Information Agency, Office of Research and Intelligence, "World Opinion and the Soviet Satellite, A Preliminary Evaluation," Report No. P-94-57, October 17, 1957. One historian reported that shortly after a U.S. rocket launch failure, "members of the Soviet delegation to the United Nations asked American delegates if the United States would be interested in receiving aid under the USSR's program of technical assistance to backward nations." See Constance McLaughlin Green and Milton Lomask, *Vanguard: A History* (Washington, D.C.: National Aeronautics and Space Administration, 1970).
5. NASA was created by the National Aeronautics and Space Act of 1958 (P.L. 85-568).
6. According to Deke Slayton, former Mercury astronaut and director of NASA's Astronaut Office, von Braun designed the Saturn V so that it could deploy a military space station in orbit as well as carry a military base to the moon. See Donald K. Slayton, *Deke!* (New York: Tom Doherty Associates, 1994).
7. "Into the late 1960s, the space community had high hopes that Apollo would lead directly to the construction of a permanent base on the Moon and, sooner rather than later, to the first human voyages to Mars." See Eric M. Jones, "Apollo Lunar Surface Journal," National Aeronautics and Space Administration, 1995.
8. See NASA, "History," at *http://www.ksc.nasa.gov/history/apollo/apollo-goals.txt*.
9. "Runway to Space," *Popular Science*, June 1999, p. 74.
10. Public Affairs Office, John F. Kennedy Space Center, *The Kennedy Space Center Story* (Washington, D.C.: U.S. Government Printing Office, 1974), No. 1974-740-742.
11. See NASA, "Space Shuttle Mission Chronology," at *http://www-pao.ksc.nasa.gov/kscpao/chron/chrontoc.htm*, and including the *Columbia* mission on July 23, 1999.
12. "Runway to Space," *Popular Science,* June 1999, p. 74.
13. For example, in order to accommodate the large military payloads the Air Force wanted carried into space, NASA widened and lengthened the payload bay, nearly doubling the size of the Shuttle design. The Administration believed it was too expensive and ordered NASA to cut costs almost in half. Designs for "fly-back" boosters were replaced with a pair of solid rocket motors.

In the late 1970s, to bring down per-flight costs, NASA required all payloads, including commercial ones, to be carried on the Shuttle.[14] This reduced the market forces that could have driven down costs and stimulated the development of new technologies. The Air Force soon realized, however, that relying on one launch vehicle (the Shuttle) was unwise from a national security perspective. Eventually, the government rescinded this payload restriction to enable the burgeoning U.S. commercial launch industry—using a privatized version of the government's existing expendable launch systems—to compete for commercial payloads. The end result was that the commercial space industry and the military were forced to rely on fully expendable rockets technologically similar to the rockets that lifted Alan Shepard and John Glenn into space in the early 1960s. Many U.S. businesses now launch satellites from China or Russia, at a cost between $12 million and $70 million per launch—significantly less than the cost of launching payloads from the United States.[15]

Although NASA's fiscal year (FY) 2000 reauthorization bill proposes spending almost $3.2 billion on the Shuttle, NASA is working on plans for its replacement, which could involve a single-stage-to-orbit, fully reusable launch vehicle. NASA budgeted $370 million in FY 1999 for its Advanced Space Transportation program to develop the Shuttle's replacement.[16] To work, however, the proposed launch vehicle requires technology that as yet does not exist.

The ISS, first envisioned as an orbiting laboratory for studying, for example, the effects of weightlessness on living organisms, is also far more expensive than originally planned—or, for that matter, than it should be. NASA spends almost $2.5 billion annually on the Station. The reauthorization bill proposes spending $2.5 billion on the Station in FY 2000, $2.4 billion in FY 2001, and almost $2.1 billion in FY 2002.[17] Between 1999 and 2000, NASA plans to support Russia's participation on the Station with $448 million,[18] in addition to the $60 million the United States has contributed since Russia began falling behind on its obligations.

A recently introduced bill now before Congress (H.R. 1883) would withhold U.S. payments for the Space Station until the President can certify that Russia is no longer selling technology for weapons of mass destruction to Iran.[19] But Russia's participation in the ISS is causing other problems for the United States.

Currently, the only emergency egress (exit) vehicle for astronauts to use to vacate the station quickly is the Russian *Soyuz* capsule. However, the safety, reliability, and availability of the *Soyuz* capsule are all in doubt. In 1969, a cosmonaut returning to Earth aboard the *Soyuz* came close to death when a malfunction prevented the capsule from correctly separating from its boosters; it nearly burned up in Earth's atmosphere. In 1988, the separation procedure occurred prematurely, almost stranding another cosmonaut in orbit.[20] Although the Russian Space Agency claims these problems have been fixed, Russia tried to keep the incidents from NASA. Other safety problems with the *Soyuz* may also exist. Moreover, if Russia withdraws from the ISS project, no emergency exit vehicle would be available for American astro-

14. The practice ended shortly after 1986 when the Space Shuttle *Challenger* exploded, killing all on board. Military payloads eventually would be launched on fully expendable vehicles based on early U.S. ballistic missile technology.

15. See Brian Harvey, *The Chinese Space Program* (Chichester, U.K.: Praxis, 1998), p. 80, and Fisher, "Commercial Space Cooperation Should Not Harm National Security."

16. From NASA's Web site, at *http://www.nasa.gov/budget/FY99.html*.

17. H.R. 1654.

18. See NASA's budget at *http://ifmp.gsfc.nasa.gov/codeb/budget2000/HTML/ISS_FP.htm*.

19. "NASA Land Transfer, Penalties for Russia on Panel's Agenda," *CQ Daily Monitor*, July 29, 1999, pp. 13-14.

20. James Oberg, "Secrets of Soyuz," *LaunchSpace*, March/April 1999, p. 52.

nauts. NASA is working on plans to build its own exit vehicle, called a Crew Return Vehicle.

NASA is also working on plans to send a manned expedition to Mars, as well as several unmanned missions to study Mars' soil and atmosphere, to bring back rock samples to analyze for toxicity and to determine the suitability of long-term manned missions. Previous missions include the Viking mission in 1976 and the Pathfinder probe in 1997. NASA believes it could launch its first manned mission to Mars by 2014,[21] yet some private-sector entrepreneurs are pushing to get there sooner. A plan known as Mars Direct, for example, intends to initiate manned missions for exploration and settlement in the first decade of the 21st century, depending on the availability of modified Shuttle hardware for heavy lift capability.[22]

Private companies are clearly ready to invest in the race for space. Some have plans to send a robot surveyor to the moon to look for water and provide imagery and detailed maps of the moon's surface for companies that may be interested in sending their own probes in the future.[23] Other countries have space exploration programs in the works as well. China, for example, is planning to send an astronaut into orbit and, possibly, to the moon. Japanese companies even have plans for space and moon hotels.[24]

As demand for access to space increases, the need for domestic commercial "spaceports" from which to launch payloads will increase. Currently, there are no U.S. private-sector spaceports. Several facilities built in the 1950s to test long-range ballistic missiles and missile defense systems are being used to launch both military and commercial payloads. Two of the largest, Vandenberg Air Force Base and Patrick Air Force Base in Florida, suffer from outdated infrastructure, including equipment dating back to World War II. The Air Force, NASA, and the aerospace industry have indicated their support for turning control of these sites over to a quasi-private management firm like the U.S. Postal Service.[25] Under one plan, for example, the Air Force would relinquish control of Cape Canaveral and Vandenberg over 10 years. Such partial privatization, however, will be less effective than full privatization for reducing launch costs and for modernizing facilities.

Military Access to Space

America's armed services rely heavily on space-based assets, such as surveillance and communications satellites, to protect national security.[26] According to Air Force General Howell M. Estes III, former commander in chief of the North American Defense Command, "space is becoming a 'vital national interest,' and because it is a source of national power, like oil today, it will be challenged by those who choose to do our country harm."[27] Indeed, the U.S. military is facing many threats to its continued use of and access to space:

- Russia has admitted to developing an anti-satellite weapons system capable of destroying U.S. satellites.[28] There are indications that other countries have acquired or will soon acquire this capability as well.[29]

21. NASA is currently trying to determine whether this date can be moved forward.
22. See Robert Zubrin, *The Case for Mars: The Plan to Settle the Red Planet and Why We Must* (New York: Simon and Schuster, 1996).
23. See "Lunar Prospector Could Lead to Commercial Moon Exploration," *Aerospace Daily,* July 19, 1999.
24. See "Package Tours to the Moon," *South China Morning Post*, August 8, 1997.
25. Craig Covault, "Commercial Ops Urged at Cape, Vandenberg," *Aviation Week & Space Technology*, January 18, 1999, p. 32.
26. U.S. Air Force, *Space Operations Doctrine*, Air Force Doctrine Document 4, July 19, 1996.
27. General Howell M. Estes III, "Is America's Future at Risk?" *LaunchSpace*, March/April 1999, p. 6.
28. "Yeltsin Letter Reveals Anti-Satellite Weapons," *The Washington Times*, November 7, 1997.
29. Robert Wall, "Intelligence Lacking on Satellite Threats," *Aviation Week & Space Technology*, March 1, 1999, p. 54.

- Many of America's low-orbiting satellites are vulnerable to laser attacks, which could blind certain imagery satellites.[30] According to the Defense Department, "Given China's current level of interest in laser technology, it is reasonable to assume in the future Beijing will develop a weapon that could destroy U.S. satellites."[31]
- Certain types of electronic equipment are capable of jamming signals from U.S. satellites.[32] According to Air Force General Richard B. Myers, "We have already seen instances of jamming satellites by Indonesia, Turkey, and Iran."[33]
- Although Russia's military suffers from lack of pay and resources, it launches about 15 military satellites a year, including reconnaissance and communications satellites.[34] The United States launches about 10 such satellites each year.
- Not long after the Kosovo intervention began, European leaders announced that their continued dependence on the United States for space-based intelligence and reconnaissance information would not be tolerated. *Defense News* noted in May 1999 that Europeans have embarked on an ambitious agenda to challenge the United States' use of space.[35]
- China's long-term goals include designing advanced anti-satellite systems that can be deployed either in space or on the ground, establishing permanent bases on the moon and permanently manned stations in orbit.

The U.S. military demonstrated its reliance on space-based assets during the Persian Gulf War when it used precision munitions supported by the Global Positioning System (GPS), tactical warning systems, and satellites for communications, navigation, imagery, and surveillance to conduct nightly televised raids on Baghdad.[36] Perhaps because of the success of those missions, the U.S. Navy incorporated the environment of space in future naval operations in its *Space Operations Doctrine*, which it issued on July 19, 1996.[37] Dependence on space-based assets likely will increase, thanks to the recent enactment of H.R. 4, the National Missile Defense Act, establishing as U.S. policy the deployment of a national missile defense system, which many defense experts believe must include space-based sensors and interceptors.[38]

Specifically, the U.S. military relies on access to space for:

- **Communications.** During battle, uninterrupted communications are essential to victory. Indeed, *preventing* the enemy from communicating is a primary objective in warfare. Space-based communication assets enable the military to operate more efficiently. Current systems include the Defense Satellite Communications System (DSCS), used by the armed services and a number of government agen-

30. *Ibid.*
31. *Ibid.*
32. Allan Thomson, "Satellite Vulnerability: A Post-Cold War Issue?" Federation of American Scientists, at *http://www.fas.org*.
33. Wall, "Intelligence Lacking on Satellite Threats," *op. cit*.
34. "Satcom Market Buffeted by Economic Uncertainties," *Aviation Week & Space Technology*, January 11, 1999.
35. See "Europe Decries Reliance on U.S. Satellites," *Defense News,* May 17, 1999, p. 38.
36. As successful as these assets were in the Gulf War, there were shortfalls. A number of systems failed to operate together effectively, and dissemination of intelligence to commanders in the field was inadequate. Some progress has been made in these areas.
37. U.S. Department of the Navy, Office of the Secretary of the Navy, *Department of the Navy Space Policy* SECNAVINST 5400.39B, August 26, 1993.
38. President Clinton signed the National Missile Defense Act (H.R. 4) on July 23, 1999.

cies; the Navy's Fleet Satellite Communications (FLYSATCOM), Leased Satellite (LEASAT), and Ultra-High Frequency Follow-On (UFO) systems;[39] the Army's Military Strategic/Tactical Relay (MILSTAR) satellites; and the Air Force Satellite (AFSAT) system.[40]

- **Surveillance and intelligence.** Monitoring the activities of other nations and assessing their capabilities from space are far less risky than they otherwise would be, because human lives are not put at risk, satellites are always on duty, and the cost to deploy them decreases over time. Moreover, satellites cannot defect. An array of U.S. military surveillance satellites (in separate "constellations") provide constantly updated information to force commanders. Imagery intelligence (IMINT) satellites provide the Pentagon and commanders in the field, or at sea, with detailed data on targets, troop and fleet location and movement, armored units, airfields, air defenses, mine fields, beachhead defenses, and other data. As forward-deployed forces are being cut back, the military is becoming increasingly dependent on this form of intelligence.
- **Navigation and meteorology.** The Global Positioning System is a radio signal system of 24 satellites in six different orbits around the Earth that can quickly locate any object on Earth equipped with a GPS receiver.[41] It provides precise coordinates, speed, and time-related data to any number of military and civilian users. The Defense Department also fields a fleet of weather satellites to assess or predict weather conditions, vital information when planning military operations.

However, these space-based military assets are at risk, given Russia's claims that it possesses anti-satellite systems, as well as the Defense Department's confirmation that U.S. satellites have been subjected to jamming by foreign countries. There are also concerns that the International Space Station may be used to spy on the United States. The current agreement stipulates that only "peaceful" projects can be conducted on the Station; however, members do not agree on what qualifies as "peaceful." The United States and Russia believe that experiments vital to national security have "peaceful purposes," but Japan does not. And while agreements between the members prevent them from conducting certain experiments or activities in a particular country's space, no such agreement exists to restrict members from using their own space for reconnaissance and espionage activities. This loophole leaves wide open the door for spying on America.

Another major issue facing the Air Force and U.S. intelligence agencies is the exorbitant cost of building and launching ultra-sophisticated electronic imaging satellites. The Air Force is now investigating two stage systems to lower launch costs.

Commercial Space Enterprise

Many early space scientists believed America's investment in space would lead beyond manned moon bases and exploration of the solar system to a lucrative commercial space industry, just as the government's involvement in the development of military aircraft during World War I and World War II facilitated the rapid growth of the civil aeronautics industry. In fact, as soon as Charles Lindbergh crossed the Atlantic, the benefits of air transportation became clear. New aviation-related industries took off, such as airplane manufacturing, parts suppliers, travel agencies, and commercial air services. By the 1940s, similar benefits from access to space were the subjects of widespread speculation. In 1945, for example, science fiction writer Arthur C. Clarke predicted that satellites could be used for "wireless" communications.[42] Four decades later, wireless

39. U.S. Department of Defense, Office of the Under Secretary of Defense, Acquisition and Technology, *Space Program, An Executive Overview*, March 1997.

40. Federation of American Scientists, *Military Communications Satellites*, at *http://www.fas.org.*

41. U.S. Department of Defense, *Space Program, An Executive Overview.*

telecommunications is a multibillion-dollar industry.

The rapidly evolving and profitable telecommunications industry—which includes broadcast and satellite television, cellular telephony, and paging systems—has catapulted the demand for commercial access to space. Globally, commercial space activity generated some $51 billion in revenues in 1997,[43] including:

- Over $19 billion from satellite services;
- Over $13 billion from manufacturing of spacecraft;
- Over $11 billion in manufacturing ground-based equipment to launch, monitor, track, and manage spacecraft; and
- Over $7 billion from the space launch industry.[44]

Today, the market for global government and private-sector space activities is believed to be as high as $75 billion. By 2005, it is expected to reach more than $180 billion.[45] And the U.S. space industry is rapidly expanding, from generating more than $7 billion in 1995 to more than $10 billion today.[46] Commercial space activity includes:

- **Satellite remote sensing.** An imagery satellite system known as LANDSAT gathers meteorological and reconnaissance data and supports consumer services in the insurance, marketing, real estate, and farming sectors. Even the U.S. government uses LANDSAT data. Advances in technology allow private companies to launch and use their own imagery satellites or to buy imagery services from other companies with satellites already in orbit. By 2000, this industry should produce over $2 billion in revenue.[47]
- **Space transportation.** Space transportation involves putting cargo (or people) into space reliably at diminishing marginal costs. The vehicles used by the private sector to put commercial satellites in orbit are also used by the U.S. military to put advanced military satellites in orbit.
- **Positioning systems.** The GPS Industry Council projects that the greatest growth for GPS services will be in consumer-based services, such as automobile navigation, consumer/cellular telephone tracking, and mobile computer access.[48] GPS service is available for cars, boats, hikers, and even bikers.
- **Space-based manufacturing.** Manufacturing in space uses near-zero gravity to produce materials for commercial purposes. A market is developing for products such as metal alloys, plastics, glass, pharmaceuticals, and organic crystals produced in space.

Despite the commercial interest in space, many activities are limited or prohibited because of the costs involved. For example, launch costs are so high that it is not profitable, or even potentially profitable, to begin taking tourists into space. And launching commercial payloads like direct broad-

42. Arthur C. Clarke, in an article in the fall 1945 edition of *Wireless World*, described the use of satellites in orbits around the Earth to distribute television programs and other communications. He repeated this idea in his 1951 book, *The Exploration of Space*. Clarke is widely regarded as the first person to advocate this use of space. Moreover, *The Exploration of Space* traced the logical progression from satellite launchings to fully manned colonies on the moon.

43. Remarks by Clayton Mowry, Executive Director of the Satellite Industry Association, at *Space Technology and Business*, an Aerospace Expo in Washington, D.C., 1999.

44. *Ibid.*

45. *Aviation Week Online*, at *http://www.awgnet.com/conferences/spbizinf.htm*.

46. U.S. Department of Commerce, *Trends in Commercial Space*, 1996.

47. *Ibid.*

48. *Ibid.*

cast satellites (DBS) or telecommunications satellites is restrained by liabilities that the government and private enterprise could incur in a mishap. Finally, U.S. export restrictions—aimed at protecting national security by preventing technology transfers in joint ventures with other countries—may needlessly restrict legitimate commercial activities and even fail to prevent such transfers.

Indemnification. Obtaining insurance to cover a company's substantial investment in a space-related enterprise is problematic. Before 1988, few insurance firms were able or willing to cover the commercial space industry. Yet countries such as France were protecting their own space industries against lawsuits and litigation. To enable U.S. companies to compete with foreign space launch companies, such as France's Arianespace, Congress created an indemnification authority in 1988. It amended the Commercial Space Launch Act of 1984 to protect U.S. commercial space companies from third-party liability. Companies must be insured up to the "maximum probable loss" or $500 million, whichever is less. The government will cover liability above that amount to $1.5 billion.

In 1992, Congress extended this indemnification authority, but it is slated to expire at the end of 1999. The chairman of House Subcommittee on Space and Aeronautics, Representative Dana Rohrabacher (R–CA), recently introduced H.R. 2607 to extend the indemnification authority for another five years. Many policymakers would like to see the private sector take over liability protection for U.S. space launch companies. Until that happens, indemnification authority should be extended to cover the current contracts.

Export Restrictions. Foreign competition threatens to overtake America's superiority in some space launch activities. Now that NASA no longer prevents private launches of payloads, other barriers to space commerce—such as quota restrictions on foreign launches—limit cooperative ventures for U.S. companies.

For example, in 1992 Lockheed entered an agreement with Russian rocket manufacturer Khrunichev-Energia to launch U.S. commercial satellites on Russian rockets.[49] However, out of concern that Russia was proliferating nuclear weapons technology, the Administration imposed a quota system restricting joint launches to 15 per year. In July 1999, the Administration announced that it would permit four additional launches. The quota is set to expire by the end of 2000. After that, the joint space launch activities between the United States and Russia are expected to cease.

To date, there is no evidence that this particular venture led to the transfer of crucial U.S. technology to Russia. Moreover, such ventures are helping both U.S. businesses and Russia, which could use the income generated by these ventures to retool its space industry away from weapons production and toward more lucrative commercial activity. To be sure, Washington should ensure, through prudent use of U.S. law, that national security is not compromised in such ventures. But in the absence of any security violations, or when U.S. security is unlikely to be compromised, commercial ventures between U.S. companies and other countries should proceed.

PLAYING CATCH-UP IN SPACE LAUNCH TECHNOLOGY

NASA's cost of about $3,800 per pound to launch a payload into space during the Apollo program was a direct result of the fact that the Saturn V was designed to put a man on the moon *before* the Soviets were able to do so. The Saturn V rocket was big, quick, and fully expendable, but hardly economical. Because costs were too high to maintain over the long term, NASA was pressured to develop a replacement for the Saturn rocket. Its replacement, the Space Shuttle, was conceived and designed to be reused. However, a series of decisions at NASA and the Department of Defense—along with congressionally imposed budget restrictions and requests by the Nixon Administra-

49. A joint venture known as Lockheed-Khrunichev-Energia International (LKEI). Lockheed Martin also is engaged in other joint ventures with Russian companies for using Lockheed engines on Russian rockets and other projects.

tion to cut costs—forced engineers to design a compromise vehicle that was much larger and more expensive to operate than the vehicle in NASA's original concept.[50]

Forced to reduce front-end development costs, and knowing that this would mean sacrificing long-term low operating costs and evolutionary growth options, NASA engineers abandoned one of the original Shuttle's most cost-saving design features—reusable "fly-back" boosters.[51] The Shuttle currently uses an expendable external fuel tank and solid rocket boosters that fall into the ocean and require expensive recovery missions—sapping funds that could be spent on space exploration or science.

When *Challenger* exploded in 1986, NASA grounded the Shuttle program; then it and the Department of Defense resorted to using ballistic missile technology developed in the 1950s, with fully expendable vehicles—perhaps the most expensive way to put something into orbit—to launch their payloads. In fact, the Department of Defense continues to use this as its only method of launching payloads. When the improved Space Shuttle was returned to use in 1988, it still failed to offer inexpensive or routine access to space.

Alternative Launch Systems. Alternatives to today's costly launch vehicles are currently under development. These vehicles could use single-stage-to-orbit or two-stage-to-orbit reusable rockets. The single-stage-to-orbit platform is efficient and may hold the best promise for affordable space launches over the long term.

NASA's plans to replace the Space Shuttle with a single-stage-to-orbit vehicle involve an experimental aircraft known as the X-33 and a commercial follow-on known as the VentureStar. NASA's total budget for developing the system is some $941 million. Private plans for a single-stage-to-orbit system include the Roton,[52] which will take off vertically and carry two pilots and up to 7,000 pounds of cargo. The Roton is projected to enter service in 2001 at a cost of about $7 million per flight (about $1,000 per pound), significantly less than the cost of similar launches on most expendable launch vehicles today. The company developing the Roton has raised more than $30 million of the expected development costs of $150 million.

Many respected scientists and engineers, however, believe large-scale production of heavy lift, single-stage-to-orbit vehicles is decades away. Consequently, several companies are also working on two-stage-to-orbit vehicles. Private plans include using existing rockets like the *Atlas III* inside a winged vehicle to bring the rocket safely back to Earth. Such a configuration, which relies on existing technology, would lower space launch costs immediately. Others include a first stage that takes off from a runway like an airplane and travels to a high altitude before releasing a second stage orbiter to deliver its payloads into orbit. Both stages would return to Earth and land on a runway.[53] Another would lift off vertically like a conventional rocket; the first stage, powered by three Russian kerosene–liquid oxygen engines, would deploy parachutes and airbags to land near the launch site,[54] after which the second stage would put the payload into orbit. The manufacturer of

50. See Roger D. Launius, *NASA: A History of The U.S. Civil Space Program* (Malabar, Fla.: Krieger Publishing Company, 1994), p. 100.

51. Engineers at NASA's Marshal Space Flight Center had worked on designing fly-back boosters for the original Shuttle. These boosters would land on a runway, just like the orbiter. When they learned the fly-back boosters would not be part of the Shuttle, they encouraged NASA to adopt their design of recoverable solid rocket boosters that would parachute back to Earth. For more on fly-back boosters, see "Booster Club," *Lockheed Martin Today*, June 1997, and "Liquid Fly Back Booster," at *http://www.boeing.com/defense-space/space/lfbb/index.html*.

52. See "Sky's the Limit for Prototype Private Rocket," *Financial Times*, March 2, 1999.

53. See "Runway to Space," *Popular Science*, June 1999, pp. 70-75.

54. See Paul Proctor, "Kistler Foresees RLV Flight in 2000," *Aviation Week & Space Technology*, March 8, 1999, p. 38.

this vehicle has raised more than $450 million toward its $750 million development budget.

The Air Force is designing a Space Maneuver Vehicle (SMV), a two-stage-to-orbit vehicle that would be launched on an expendable booster rocket or a larger winged space plane to deploy a satellite into orbit. But this configuration would have no commercial applications.[55]

Unfortunately, private and government-sponsored U.S. space launch programs face heavy competition from foreign companies. Russia's *Proton* and *Soyuz* heavy booster rockets deliver payloads into space more cheaply than do their U.S. counterparts.[56] In April 1999, Ukraine successfully launched its Sea Launch system, the product of a joint private venture with a U.S. aerospace company.[57] France's *Ariane V*, which just emerged from its test flight stage, could outperform U.S. launch vehicles in the near future and recapture the bulk of the heavy launch commercial satellite market. China regularly launches U.S. satellites at much lower costs than can be done stateside.[58] Other countries like Japan also have ambitious programs in the works.

Certainly, competition in any industry is good. It leads to lower costs and greater innovation. But the U.S. space launch industry is being forced to play catch-up in some areas because of decisions made by NASA and the Department of Defense in the past, such as maintaining a monopoly on space launches and developing new fully expendable launch systems. U.S. manufacturers are now building space launch vehicles with larger lift capacities, but most of the plans involve larger, fully expendable vehicles known as "evolved expendable launch vehicles" (EELVs)—another type of "throwaway" rocket designed to deliver payloads and then burn up in the atmosphere. This approach has been criticized as extremely expensive to develop.[59] It certainly goes against the reason the Space Shuttle was funded in the first place: to develop a fully reusable vehicle that would reduce space launch costs.

The EELVs are building on the technology of the current launch vehicles, which recently have exhibited some problems:[60]

- On May 4, 1999, a $230 million communications satellite ended up in the wrong orbit when the second stage of a *Delta III* rocket misfired;
- On April 30, 1999, a *Titan IV* rocket misfired, sending an $800 million military communications satellite into the wrong orbit;
- On April 27, 1999, an *Athena II* rocket failed to place a multibillion-dollar commercial remote sensing satellite into orbit;
- On April 9, 1999, a $250 million early (missile) warning satellite was stranded in a useless orbit when a $432 million *Titan IV* upper-stage booster misfired;
- On August 26, 1998, a $255 million *Galaxy X* payload on the maiden flight of the *Delta III* was lost when a guidance computer failed, forcing the rocket to use all of its hydraulic fluid for steering (the rocket broke apart from wind shear); and
- On August 12, 1998, a $700 million reconnaissance satellite was destroyed when an electrical malfunction scrambled the guidance system on the $344 million *Titan IV* rocket.

55. Kristin Rountree, "The Space Maneuver Vehicle," *LaunchSpace*, March/April 1999, p. 40; see also various articles under "USAF in Space," *Aviation Week & Space Technology*, April 5, 1999, pp. 42–58.

56. "Commercial Proton, Soyuz Launch Surge Readied," *Aviation Week & Space Technology*, February 8, 1999, p. 68.

57. Bruce A. Smith, "Sea Launch Passes Demonstration Test," *Aviation Week & Space Technology*, April 5, 1999.

58. Fisher, "Commercial Space Cooperation Should Not Harm National Securuty."

59. William B. Scott, "EELV Funding: Is It Enough?" *Aviation Week & Space Technology*, March 1, 1999, p. 27.

60. See, for example, "Rocket Failures Shake Faith in Space Industry," *The Washington Post*, May 11, 1999, p. A1.

These incidents led retired North American Space commander General Estes to observe:

> I think this is probably one of the worst times in the launch history of the country…. Not only is it a critical national security issue, but it is critical for commercial space interests. If we can't do the launches here, [those who wish to place satellites in orbit] will go to foreign markets such as China and Russia.[61]

European Union (EU) members, especially France, have a significant lead in commercializing EELV-type services. According to *Aviation Week*, "As it is now, [France's] Araine 5 will have at least a 4 [to] 5- year lead on commercial EELV spin-offs."[62] Moreover, the EU is working to develop reusable launch vehicles (RLVs) to lower costs, thus helping to save the European space program.[63]

A Cost-Effective Alternative? Perhaps the most promising short-term solution to the high cost of U.S. space launches using fully expendable rockets will prove to be a rocket that uses a liquid fly-back booster (LFBB).[64] The LFBB (or, as NASA calls it, a "reusable first stage") would lift a payload into near space, release an upper stage with a payload bound for orbit, return to Earth, and land, ready for another flight. According to both major aerospace corporations, the LFBB technology is more reliable and less expensive than the expendable system employed by the Shuttle today. Boeing, on its Web site, states that LFBBs "offer increased safety, higher reliability, lower-cost, and improved performance, along with new growth options for America's space program."[65] As Lockheed Martin explains on its Web site:

> The [LFBB] booster will burn liquid fuel, which will improve safety over the solid rocket boosters currently used on the Shuttle. Also, the proposed booster's fly-back capability and the efficiencies of liquid booster design have the potential to save millions of dollars in program costs annually.[66]

However, both major aerospace companies are currently under contract with NASA to upgrade the existing expendable rocket rather than the LFBBs. NASA should promote the development of the lowest cost-to-orbit system that is technologically feasible and reliable. This would benefit the U.S. military's access to space and help U.S. companies stay competitive.

MAKING AMERICA MORE SECURE AND COMPETITIVE IN SPACE

The U.S. space program is on the verge of falling behind in space exploration as well as military and commercial access to space. Moreover, as many nations race to space, the risks to national security are likely to increase.

In 1997, the U.S. House of Representatives passed the Civilian Space Authorization Act to increase access to space,[67] but the Senate failed to pass its version of the bill. This year, both houses are considering NASA's reauthorization. It is the first time since 1992 that Congress has had an opportunity to reduce launch costs, reform NASA's mission and objectives, promote manned space exploration, improve the use of space to protect national security, and propel the U.S. commercial space industry to success.

61. *Ibid.*

62. Marco Antonio Caceres, "Launch Vehicles: Steady Growth," *Aviation Week & Space Technology*, January 11, 1999, p. 131.

63. "France Advocates RLV Demonstrators," *Aviation Week & Space Technology*, January 11, 1999, p. 31.

64. Indeed, this was the idea behind the Shuttle's boosters. It was rejected in favor the solid rocket booster now in use.

65. See "Liquid Fly Back Booster," at *http://www.boeing.com/defense-space/space/lfbb/index.html*.

66. See "Booster Club," *Lockheed Martin Today*, June 1997, at *http://www.lmco.com/files2/lmtoday/9706/booster.html*.

67. Civilian Space Authorization Act of 1998 (H.R. 1275).

To meet the challenges America will face in space during the next century, Congress should:

- **Require NASA and the Department of Defense to purchase the most cost-effective and reliable launch systems available.** The high cost of launching payloads aboard the Space Shuttle limits its use and hinders exploration of and military access to space. NASA and the Defense Department should seek the most reliable, lowest cost-to-orbit system possible. To determine the most cost-efficient system, Congress should instruct the U.S. General Accounting Office (GAO) to conduct feasibility studies on alternative launch vehicles, including single-stage and two-stage-to-orbit vehicles.[68]

  The short-term strategies of NASA and the Defense Department include "evolved expendable launch vehicles"; longer term strategies include a single-stage-to-orbit fully reusable vehicle that could launch vertically or from a runway, fly into orbit, deliver its payload, return to Earth, and be ready for another launch—with no expendable parts. But the technologies to achieve this capability are not likely to be available for some time unless Washington places a priority on their development.

  There is little incentive for the major U.S. aerospace companies to invest in less costly reusable launch systems (such as liquid flyback boosters) when the government continues to issue contracts for purely expendable ones. The lack of R&D in this area increases the likelihood that foreign companies will take the lead in reusable technology. In the near term, NASA and the Defense Department should pursue privately developed two-stage-to-orbit vehicles.

- **Privatize space launch sites.** The missile ranges built in the 1950s to test long-range ballistic missiles and missile defense systems are largely outdated. The commercial space launch industry is putting tremendous demands on these "spaceports." The federal government is considering plans to partially privatize them. For example, under one plan, Air Force control of Cape Canaveral and Vandenberg would be relinquished over 10 years.

  Washington is considering creating a quasi-government organization modeled on the U.S. Postal Service to manage these facilities.[69] Partial privatization, however, will be far less effective in reducing launch costs and modernizing such facilities. The priority should be full privatization.

- **Refocus NASA's priorities on manned space exploration and eliminate duplicative and wasteful projects.** Since 1969, NASA's missions have moved far beyond space exploration to such activities as studying weather patterns and funding Russia's participation in the ISS. NASA's priorities should be reoriented to permanently manned lunar bases, manned missions to Mars, and manned exploration of the solar system. Funding should be eliminated for projects that do not fulfill these missions or, alternatively, transferred to other agencies.

  For instance, NASA spends $1.5 billion a year in its Earth Science Enterprise project to study global weather patterns and vegetation growth.[70] Yet the National Oceanographic and Atmospheric Administration already has satellites and programs studying the Earth's climate. Such duplication is wasteful. Congress should require federal agencies to study the potential benefits of contracting with private firms for this information.

68. This would include analyzing (1) the X-33 and VentureStar program, to determine when they would be achievable and how much they would cost; (2) existing technologies that would make a two-stage-to-orbit vehicle possible in the short term; and (3) how much it would cost to develop a fully reusable single-stage-to-orbit vehicle in the long term.

69. Covault, "Commercial Ops Urged at Cape, Vandenberg," p. 32.

70. National Aeronautics and Space Administration, "Earth Science Strategic Enterprise Plan 1998-2002," 1998.

In addition, although NASA's Aero-Space Technology Enterprise serves both the U.S. military and the commercial aviation industry, military research is and should be funded by the Department of Defense. Moreover, NASA's Space Science Enterprise project involves many experiments, such as discovering how the universe, galaxies, stars, and planets evolved and whether life exists beyond Earth, that are also conducted by universities and other research organizations. NASA should use the research of private-sector organizations rather than duplicating their efforts.

- **Establish time lines to privatize the Space Shuttle fleet and U.S. space on the International Space Station.** In 1995, NASA established a joint venture among U.S. aerospace companies—the United Space Alliance (USA)—to privatize some of the Shuttle's operations. USA manages, maintains, and operates the Shuttle, although only NASA can approve the use of space on the Shuttle. Congress should instruct NASA to develop a time line for fully privatizing all orbiter operations, including the use of Shuttle space. The oldest orbiter, *Columbia*, may be the best candidate for initial privatization, but the immense cost of operating the older vehicles makes full privatization less likely in the short run. USA operation of the payload program is a step in the right direction, but Congress should ensure that USA controls the size of its workforce and that contracts for space on the Shuttle are open for bids from private-sector companies.

  NASA's plan for commercializing the ISS calls for providing up to one-third of U.S. space for private sector use.[71] NASA should establish a plan that allows private companies to rent or perhaps even purchase available U.S. space on the ISS.

  Transportation to and from the ISS currently occurs on the Space Shuttle or the *Soyuz* capsule. The ISS agreement precludes countries from paying cash for Shuttle services. Instead, the United States receives remuneration in services or equipment. Such a barter arrangement cannot assure that the United States is compensated adequately for the costs involved, and it makes the Shuttle a government-subsidized ferry. Congress should ensure that agreements to transport foreign astronauts to the ISS aboard the Shuttle allow for full recovery of the costs involved. And because the reliability and availability of the *Soyuz* capsule as an emergency egress vehicle are in doubt, Congress should consider diverting some of the U.S. subsidies for Russia's participation on the ISS to the NASA program that is developing a U.S. emergency exit vehicle.

- **Ensure U.S. military access to and control of space to protect and enhance national security.** U.S. military assets in space are vulnerable to jamming or attack. This vulnerability could compromise the military's surveillance and reconnaissance efforts as well as its ability to help forces navigate, communicate, and determine weather conditions. Congress should take steps to ensure that the U.S. military is capable of controlling space and defending military and civilian assets.

  The military must be able to operate freely in space to protect U.S. assets and lanes of communication, and to monitor all space vessels. It needs adequate command-control-communications-computers and intelligence (C4I) capabilities and systems for tactical warning, anti-satellite efforts, space-to-ground attack, and missile defense. Subsidies for Russian activities on the ISS that could be used to fund Russia's development of advanced anti-satellite systems should be diverted to the U.S. military. Alternatively, Congress should consider diverting funds from the U.S. foreign aid program, specifically development assistance. If the Administration can suggest offsetting an emergency supplemental foreign aid increase with funds

71. National Aeronautics and Space Administration, "Commercial Development Plan for the International Space Station," Washington, D.C., November 16, 1998.

that Congress considered appropriating for intelligence activities, as President Clinton did last winter, Congress can use the same approach to divert foreign aid funds to intelligence activities.

- **Seek an amendment to the International Space Station Agreement to prevent other countries from using the Station to spy on America.** NASA spends almost $2.5 billion annually on the Station. It could spend millions more to subsidize Russia's participation.[72] But continuing to support Russia in this endeavor has been heavily criticized, since cash-strapped Russia continues to maintain an intelligence-listening post in Cuba that could be used to spy on the United States, and since its activities on the Station may include projects that could be used against U.S. satellites. H.R. 1883 would limit U.S. payments to punish Russia for selling weapons technology to Iran. At the very least, Congress should withhold from future disbursements amounts equal to Russian subsidies of the listening post in Cuba and other activities that compromise U.S. national security.

  NASA should be required to renegotiate the ISS agreement with all members, especially Russia, to prevent the use of the Station for espionage or reconnaissance. The current agreement stipulates that only "peaceful" projects can be conducted on the Station, but members do not agree on what qualifies as "peaceful." No formal declarations about the use of the Space Station for experiments that might be classified as military in nature have been made, and no agreement restricts members' use of their own spaces for espionage. Congress should insist on an amendment to the ISS agreement that spells out such restrictions.

- **Streamline the monitoring of technology transfers to protect national security.** In 1996, China most likely gained access to sensitive U.S. missile technology when a Chinese rocket carrying a U.S. commercial communications satellite exploded on launch. As part of the subsequent investigation of the accident, the U.S. manufacturer may have revealed classified information inadvertently to the Chinese.[73] Congress responded to the news by moving authority for granting export licenses from the Department of Commerce to the State Department, which essentially shut down the licensing process. Congress should encourage the State Department to streamline the regulatory process or move this authority to the Defense Department. Guidelines should be established for the use of export licenses to prevent them from unduly burdening the U.S. commercial space industry when national security is not at risk.

- **Remove other restrictions that limit U.S. commercial competitiveness in space.** The U.S. commercial space industry would be far more vibrant had NASA not monopolized space launch activities until the mid-1980s. Current quota restrictions on joint ventures imposed by the Administration reduce U.S. commercial competitiveness. Congress should initiate a review of the quotas to determine whether they are warranted. It should require the President to certify that the transfer of vital technology is not occurring in joint ventures between U.S. and foreign companies, and that U.S. national security will not be compromised. If the President makes such a certification, commercial ventures should proceed.

- **Extend space launch indemnification authority.** Congress authorized indemnification authority in 1988 to protect U.S. commercial space companies from third-party liability. This authority is slated to expire at the end of this year. Although the best approach would be to allow the insurance industry to assume

72. NASA Fiscal Year 2000 Budget Request, at *http://ifmp.nasa.gov/codeb/budget2000/*.

73. See Fisher, "Commercial Space Cooperation Should Not Harm National Security." See also Jeff Gerth, "U.S. Business Role in Policy on China is Under Question," *The New York Times*, April 13, 1998.

the risks and pass the costs on to commercial companies, Congress should extend the indemnification authority for at least a short period. Many current contracts for commercial space activities that will not be completed for several more years would be put in jeopardy without this coverage.

CONCLUSION

During the Apollo program, there was an overriding political imperative to beat the Soviets to the moon. After achieving that objective, NASA, like many other agencies or groups established to meet a singular goal, needed to find another mission. Today, it is involved in many broad missions.

But the cost of space launches is significantly greater now than after the Apollo 11 moon landing. Space exploration is proceeding slowly, and the military's access to space is being threatened. Clearly, the space program must be reoriented. By taking a bold new approach, Congress could reinvigorate the race for space with a new sense of purpose that could fulfill the dreams of so many Americans who witnessed the first walk on the moon, as well as open opportunities in space to benefit their offspring into the 21st century.

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