66.625 seconds: A bright, sustained glow is photographed on the side of the righthand rocket booster that is facing the Shuttle.

67.650 seconds: Abnormal plumes on bottom and top of booster appear to merge into one.

67.684 seconds: Telemetry indicates falling pressure in the liquid oxygen propellant lines feeding the main engines.

68.000 seconds: Mission Control tells the crew that the main engines are operating at 104% power and all systems look good.

69.000 seconds: Commander Dick Scobee calmly responds: "Challenger at throttle up." That is last transmission from crew.

72.141 seconds: Data show a lateral acceleration of .227 times normal gravity.

72.201 seconds: Nozzles of two solid rocket boosters change position.

72.400 seconds: Last data received by the Shuttle tracking satellite.

72.661 seconds: The Shuttle experiences another small but detectable jolt, in the opposite direction from the first one.

72.884 seconds: Main engine liquid hydrogen and liquid oxygen propellant pressures drop.

73.044 seconds: Internal pressure in the righthand rocket booster is recorded as below that of its counterpart.

73.175 seconds: Ground cameras show a sudden cloud, apparently rocket fuel, appearing along the side of the external tank.

73.200 seconds: A sudden brilliant flash is photographed between the Shuttle and the external tank.

73.226 seconds: An explosion occurs near the forward part of the tank, where solid rocket boosters are attached.

73.326 seconds: Explosion intensifies and begins consuming the external fuel tank.

73.339 seconds: Data indicate that the main engines are approaching redline limits on their powerful fuel pumps.

73.473 seconds: Pressure fluctuates in the Shuttle's onboard rocket fuel supplies

73.534 seconds: Main Engine no. 1 shuts down because of high temperatures.

73.605 seconds: Last valid data from the Shuttle are recorded.

73.621 seconds: Telemetry stops.

This, of course, is merely a phenomenology of the accident. We will know more when the right booster is recovered, which is expected soon. There has been a good deal of speculation as to why the accident occurred.

Aviation Week magazine has advanced the plausible hypothesis that at 72 seconds, the righthand booster became unmoored and rotated so that its nose penetrated the main fuel tank, causing the final explosion. Speculation sells newspapers, but it will no doubt be some time before the true explanation emerges.

The space program

by Marsha Freeman

During February and March, the U.S. Congress will be making budgetary and policy decisions that will define the future of the U.S. space program. In response to the loss of the Space Shuttle orbiter Challenger and its crew, President Reagan has recommitted the nation to continue with the shuttle program, and to build a permanently manned space station in Earth orbit. Meeting these goals, plus the longer-term objectives of returning to the Moon and going on to a manned expedition to Mars, require scrapping not only the budget proposal the Reagan administration has submitted to the Congress to cut the funding for the space program, but also the irrational approach to economics, which for 15 years has dictated that space technology must be "cost effective."

One of the obvious questions facing the Congress is, what needs to be done to ensure that the nation has the launch capabilities needed to meet scientific, commercial, and defense requirements for the next decade? The National Aeronautics and Space Administration (NASA) had planned its original program with a fleet of five orbiters. The fifth orbiter has never been authorized, funded, or built. With the loss of Challenger, only three orbiters remain.

Though there are some simple commercial and defense payloads that could theoretically be launched on tried and true unmanned expendable rockets, the satellites that have been designed and built for Shuttle launching cannot be reconfigured as expendables without great cost and delay. The payloads planned for the Shuttle that are the most interesting and important, can only be deployed on a manned spaceship. These include the testing of new sensing, tracking, and other technologies required for the Strategic Defense Initiative (SDI), the scientific experiments in Spacelab, the construction missions to work out procedures for building a space station, the launch of very large reconnaissance satellites for the Department of Defense, and the repair and maintenance of free-flying scientific telescopes and spacecraft. While we need to continue to have expendable rockets, especially for military back-up, they cannot replace the manned Space Shuttle.

The anti-science mob in the press, which led the rallying call to destroy the space program before we even landed on the Moon, and which is now ready to ditch the Space Shuttle program, has claimed that one of the reasons for the Chal-

the nation needs

lenger's explosion was that that NASA's flight schedule was too ambitious. One resolution to that problem, overlooked by these gentlemen, is for a full fleet of five orbiters to be available, so that NASA could meet its flight commitments with a longer turnaround time for each vehicle.

Congressman Robert Torricelli (D-N.J.) has introduced a bill into the House to add $400 million in supplemental funds to NASA's 1986 budget, to begin replacing the Challenger. This will take over three years and about $1.7 billion, making use of the inventory of spare parts that has been accumulated during the Shuttle program.

We have allowed the orbiter fleet to be determined by money, rather than scientific requirements, over the past decade. It is past time to build a full fleet, to allow the system to become fully operational.

The fallacy of 'cost-accounting'

The past six years of the space program have amply proven, contrary to tightly held beliefs about the "magic of the marketplace" or the responsibility of private enterprise to finance research and development efforts, that only the federal government, representing both the resources and interests of all of the people of the nation, can push foward the frontiers of basic science, and create the capabilities for their commercial application in industry.

There is no reason why the Shuttle system itself has to be "cost-effective" at all. It is a national capability which will open up whole new industries, like any infrastructure program. Without the Space Shuttle, many scientific experiments could not be carried out. The materials, medicines, and manufacturing processes of the future are created, by spending a week or 10 days in the microgravity conditions of the Shuttle.

The obsession that Shuttle missions should "pay for themselves" has led to a situation where increases in the price NASA charges commercial customers have made it more difficult for the United States to compete with the government-subsidized European Ariane reusable rocket. This has put pressure on NASA to fill its payload with as many paying customers as possible, to bring more money into the federal Treasury.

The frequency of Shuttle launches largely determines the cost of each launch. According to NASA, the cost of each Shuttle mission, if four are flown per year, is $350 million per flight. Doubling the flight rate to eight per year brings the cost down to $197 million each. At the projected future NASA rate of 24 launches annually, each mission will cost $91 million.

The pressure to bring the cost per launch down, has been too much of a factor in determining what the number of missions per year should be. Ironically, the same media and spokesmen who criticize NASA for having a too ambitious launch schedule, which they try to claim led to the Challenger loss, are equally critical of the "uneconomical" cost of the system, which is largely determined by launch frequency!

The most radical free-enterprise ideologues, represented by the Washington, D.C.-based Heritage Foundation, have tried to destroy the Shuttle program from the outset. After the successful maiden flight of the Shuttle Columbia in April 1981, Heritage Foundation spokesman Richard Speier stated that the government should "not make decisions" on how to get anywhere in the space program, but should "purchase the results" of what private enterprise funds for space development.

After the second Shuttle flight the following November, Speier declared in an interview to the *New York Times,* that it is "very likely the program is not a good buy," and recommended considering whether or not it should be scrapped. It is likely that he would have made a similar recommendation regarding President Lincoln's program to link the transcontinental railroads.

For its part, the *Times* warned the nation not to be too "euphoric" about the first Shuttle missions.

Following the Jan. 28 Challenger loss, Heritage spokesman Milton Copolous stated categorically on television that the "private sector" should build a Shuttle orbiter, provided it were determined to be a good investment. This policy, which may appear on the surface to be in the "American tradition" of industrial investment, is actually just a cover story to cut the NASA budget with impunity.

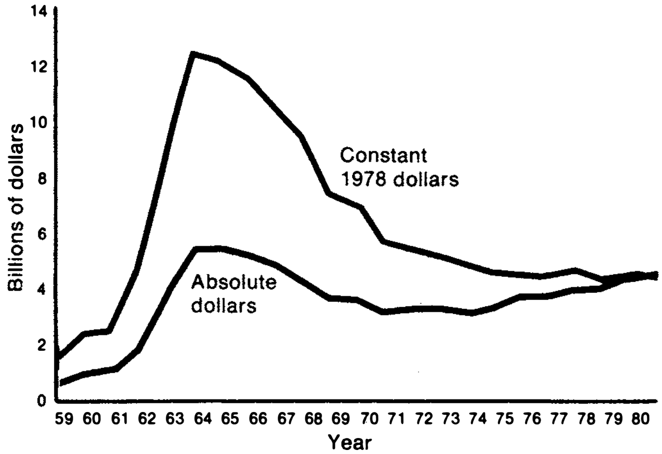
The damage done through the reckless abandonment of government-funded research and development programs, under the guise of "free market" economics, has already pushed U.S. technology behind that of other nations. In 1973, NASA was pulled out of advanced communications-satellite research, after the free-market budget office during the Nixon administration decided that the satellite builders in industry, who benefit from the research, should pay for it.

In 1979, NASA got back into communications R&D, after both France and Japan had pulled ahead.

The same scenario took place in the development of new aeronautics technology. Why shouldn't Boeing and Lockheed pay? the government reasoned. After the United States began to fall behind foreign competitors, NASA got back into advanced aeronautical research.

In the NASA budget request just submitted to the Congress, incredible as it may seem, the advanced communica-

FIGURE 1
The NASA budget



The budget declined in constant dollars from 1965 until the beginning of the Reagan administration.

Source: Fusion

tions satellite technology program has been zeroed out of the budget—again. Further, the $28 million that had been allocated for the Advanced Communications Technology Satellite (ACTS) this year, will be rescinded.

From 1965 up to the beginning of the Reagan administration, funding for NASA had been falling, in constant dollars (see **Figure 1**). President Reagan made the space program a centerpiece, along with the SDI, of his optimistic commitment to advanced technology and scientific exploration. Two years ago, he mandated that the space agency build an operational space station within a decade. This was the first initiative in the manned space program since the 1972 decision to build the Space Shuttle.

NASA administrator James Beggs, coming to head the agency from industry, was able to secure the President's promise that the NASA budget would increase by at least 1% each year in real dollars, above strenuous objections from the Office of Management and Budget (OMB). While an increasingly untenable overall economic situation gave the OMB the axe with which to slash other R&D programs, NASA remained protected. Until this year.

The passage of the Gramm-Rudman balanced budget act in December followed close on the heels of an indictment handed down against Beggs in a General Dynamics fraud case, which forced him to take a leave of absence from the agency.

Under the first round of Gramm-Rudman cuts, NASA lost over $200 million from this year's budget. At the same time that the agency has to cope with this cut, the loss of a crew and orbiter, and whatever required changes in the total Shuttle program will come out of the Presidential Commission's investigation, the budget that has been submitted to Congress for FY87 has a $38 million increase—or a 3.5% cut, in constant dollars.

The funding request made by NASA for next year's work on the space station was about $580 million. The agency is now budgeted at a level of $410 million, though the OMB had proposed a grand total of $100 million for the program next year.

According to NASA General Manager Phil Culbertson, who has led the space station effort at NASA headquarters since the beginning of the Reagan administration, the funding cut reduces the margin in the program; any further cuts would mean giving up President Reagan's goal of initial operation of the station by 1994.

The space station program has been defined by the same irrational parameters that ham-strung the Shuttle program throughout its development. It has not been defined by its projected necessary capabilities, but primarily by considerations of cost-accounting. NASA has been given $8 billion as the ball-park estimate of what it can spend on the station. Within that constraint, the design and operational decisions will have to be made.

Western Europe, Japan, and Canada have been invited to participate by contributing major modules to be added to the basic structure—not so much out of concern for international cooperation, as to more closely approximate the station that NASA will not get the money to build.

When the Space Shuttle program was begun, the major concern of many in both the Nixon administration and the Congress, was what it would cost. NASA was forced to make many kinds of design and technology decisions based on that criterion. Compromises had to be made in the original engineering designs, on what was originally to be a fully reusable shuttle system.

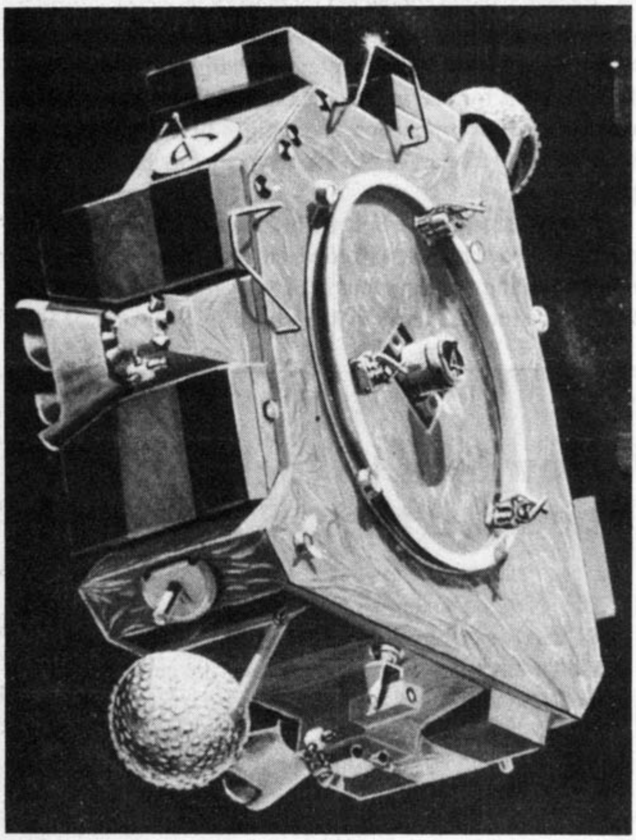
When the Apollo program was at its height in the mid-1960s, 37,000 scientists and engineers worked for NASA to build the nation's lunar program. By 1980, that precious skilled workforce had shrunk back to about 21,000. Hiring freezes and losses through attrition have reduced the manpower that the nation has to plan and implement its future in space.

If cuts in the budget continue, it is less and less likely that the station will be built, no matter how much money our foreign partners are willing to spend.

Regardless of what the President may tell the American public on TV, without a reappraisal of this nation's priorities, as well as its constitutional responsibilities for economic development and defense, there will be no Shuttle program, and no space station.

To get rid of the budget deficit, the U.S. economy desperately needs a rapid infusion of new technologies that can radically increase industrial productivity. As is often stated, but rarely taken seriously, the military and civilian space programs have been the most powerful engine for real economic growth in the postwar period.

FIGURE 2



The Orbital Maneuvering Vehicle is a reusable, free-flying space vehicle designed to enhance the Shuttle orbiter's payload delivery and retrieval capabilities. It can inspect satellites and retrieve them to a space station or the Shuttle orbiter, and can perform a variety of on-orbit tasks.

Source: Martin Marietta

There is nothing that the nation can better invest its resources in than the space program, which returns at least $10 dollars to the economy, for each dollar invested.

A 'momentous year'

NASA administrator Beggs was present when the Shuttle Atlantis blasted off for its mission in space at the end of November 1985. At that time, he described 1986 as the most "momentous year" for the space program. "I think from the point of view of what NASA is charged with doing, which is to fly for the purpose of exploring, this is probably the most important year since the halcyon days of Apollo." Among the projects reaching a crucial phase of implementation are the following:

In May, NASA had planned the first use of its modified liquid hydrogen Centaur upper stage, to send two separate scientific satellites toward Jupiter. One, the U.S. Galileo spacecraft, will orbit the planet for a full Jupiter year, and will also release a small probe which will descend through the great gaseous atmosphere of the planet.

The Ulysses probe, built by the European Space Agency, will use the huge gravitational force of the planet to swing it outside of the plane of the ecliptic, to become the first spacecraft to examine the Sun by orbiting, not around it equator, but around its poles.

In the fall of 1986, the enormous Hubble Space Telescope had been scheduled for launch, to become the first long-term space observatory in Earth orbit. Designed to be refurbished and repaired by Space Shuttle crews, the Space Telescope will allow astronomers to view the planets, stars, and new parts of the universe that could never be seen in such detail before.

Key missions were planned for the Defense Department to test new sensing technologies for the SDI, and to launch strategic satellites for reconnaisance. The second Space Shuttle launch facility at Vandenberg Air Force Base was scheduled to become operational this summer.

The schedule of the planned 1986 launches will be determined by when the Shuttle fleet is ready to fly. The planetary missions may have to be delayed until June 1987, when the relative positions of the Earth and Jupiter again make the trips possible. Other missions will also be rescheduled.

Adding to the Shuttle's capabilities

The impact of any months-long delays in NASA's Shuttle launch schedule points out the importance of doing whatever is necessary to keep the system in top shape, at all times. This means securing the needed number of orbiters, the manpower to have the fleet able to meet all contingencies, and the vision and resources to aggressively plan and implement the next steps in the scientific exploration of space.

Not only do we have to rebuild the orbiter fleet; we should be giving our Space Transportation System the auxiliary capabilities for its next range of missions. The Space Shuttle will be the construction platform for building the station, in the first half of the next decade. During the Shuttle Atlantis 61-B mission at the end of November, astronauts Sherwood Spring and Jerry Ross practiced putting together pieces of structures, simulating space construction techniques that NASA plans to use to connect station modules to a central structure.

Even before the space station is operational, Shuttle crews will need a small unmanned maneuvering vehicle to go further away from the Shuttle orbiter than they can go themselves, with the Manned Maneuvering Units (back-packs) currently in use. Using these MMUs, astronauts have been able to fix scientific satellites, but the commander has had to bring the Shuttle orbiter very close to the satellite.

Current designs for an Orbital Maneuvering Vehicle (OMV—see **Figure 2**) would allow it to take satellites from the Shuttle, which can only reach an altitude of 350 miles above the Earth, up to about 1,000 miles. It would also be able to be deployed from the Shuttle to retrieve satellites and bring them to the orbiter for repair and maintenance. The OMV would then place the repaired spacecraft back into their operational orbits.

The OMV could reboost satellites as their orbits gradually decay, extending the lives of many different kinds of space assets. The OMV would be remotely piloted from the Shuttle orbiter. It would measure about 15 feet in diameter, but only 3 feet in length, so as not to take up very much room in the payload bay. NASA hopes to have the vehicle ready for flight in 1990.

When a satellite is launched from the Space Shuttle today, it carries with it its own one-time-use upper stage, to propel it from low-Earth orbit to geosynchronous orbit (22,300 miles), or out of Earth orbit to the Sun or planets. NASA is planning to develop an Orbital Transfer Vehicle (OTV) which could be reused, perhaps 30 times.

Referred to as a space "tug," the OTV could be based on the ground, and carried inside the payload bay of the Shuttle each mission. It could pick up its payload in space and bring it back to Earth, for another Shuttle ride.

However, this would require that it have a thermal protection system like that of the Shuttle, to go back and forth through the Earth's atmosphere. The more effective use of the system would be to have it "parked" at the space station, never going back to Earth.

The most immediately efficient fuel for this reusable tug would be liquid hydrogen. The OTV could be refueled at the station after each trip. NASA is planning to do tests aboard the Shuttle soon, to experiment with the transfer of liquid fuels, to see how these liquids behave in micro-gravity.

It is very likely that a manned version will be the kind of vehicle that will carry people and supplies back to the Moon at the end of this century, to begin the exploration and industrial development left undone at the end of the Apollo program. Such next-generation OTVs should be nuclear-fueled.

The next frontiers

The space station will provide the necessary infrastructure to assemble spacecraft larger than the Shuttle, for trips to such places as Mars. New propulsion technology must be developed, using the most advanced fission, fusion, and directed-energy concepts. For these systems to be ready for the beginning of the next millennium, development must begin now.

The driver for revolutionary new propulsion technologies will be the manned mission to Mars. To get there with today's chemical propulsion, a trip of at least two years is required. NASA had already tested a nuclear-powered rocket engine by the end of the 1960s, in readiness for the Mars mission.

With the economic crisis at the end of the first Nixon administration, the plans to go to Mars were scrapped, along with the planned space station. With it went the shutdown of the advanced propulsion research and development already under way.

With an operational Earth-orbital space station, the possibility of returning to the Moon and the manned mission to Mars are once again on the agenda.

Research being conducted for the SDI program—in high-powered laser development, new plasma and particle-beam techmologies, and nuclear systems for large power sources—lays the basis for making that manned Mars mission with the next-generation propulsion capabilities. These areas of research should be part of NASA's space propulsion research program.

In between today's Space Shuttle, and nuclear- or plasma-propelled vehicles, will come advanced transonic planes, now beginning development in a joint program with the Defense Department. President Reagan, in his State of the Union

How NASA's technology boosted the U.S. economy

The National Aeronautics and Space Administration (NASA) spent billions of dollars to put a man on the Moon, but it did not cost the nation a net penny. In fact, it made money.

A study of the impact of NASA spending on the U.S. civilian economy was conducted by Chase Econometrics, which found that for every dollar spent in space-program research and development, $14 was generated in the private sector as a "multiplier effect," through capital-goods purchases, technological improvements, and so forth.

NASA, at its height during the Apollo Moon-shot gearup, was introducing *6,000 new technologies per month to private industry and agriculture*. The result was the only period of real industrial growth and productivity increase the United States has experienced since World War II. The productivity increases resulting from industry's assimilation of spin-off technology more than offset the cost of the original research and development.

Among the new technologies developed during the period of increases in NASA funding, which peaked in 1965, are these:

- **Computers and electronics:** One of the best known technology spin-offs of NASA was the cheapening and improvement of computers and electronics. Between 1968 and 1971, U.S. textile weaving mills were able to increase productivity 2-3% by introducing a multiplexer circuit which connects a computer to remove terminals, developed by NASA's Marshall Space Flight Center for the Saturn rocket.

- **Diagnostics:** An ultrasonic testing technique, developed by NASA to test delicate materials without destructive effect, is being used in the production of steel, speech on Feb. 4, referred to technologies of this sort which will make possible "a new Orient Express," that could fly passengers from Washington, D.C. to Tokyo in two hours.

The NASA budget for fiscal 1987 calls for a $45 million budget line for the Aerospace Plane, which could operate as an airplane at hypersonic velocities (4,000-8,000 miles per hour) in the upper atmosphere, or as a space vehicle accelerating directly into orbit.

The current lead concept is for a hydrogen-powered aircraft taking off horizontally like a commercial jet, and landing the same way. This would be a "global flight vehicle," which could be used for long-range air defense interception, and as a civilian transport. The government will spend about $600 million for technology development for the Aerospace Plane in the next three years, to provide the data which will allow a decision on whether or not to proceed with flight research in the early 1990s.

The initial design for the plane calls for carrying a crew of two and a payload of 2,500 pounds. A future vehicle could carry as much as 65,000 pounds into orbit, which is the capacity of the current Shuttle orbiters.

Clearly we cannot afford to waste time with a phony national debate on whether or not we need the Shuttle. The question before us is how to maximize the resources available, to turn a temporary setback into a resounding impulse forward.

rails, aircraft, nuclear reactors, and automobiles. The original $2 million NASA investment created a $50 million per year private industry.

- **Materials:** High-temperature resistant alloys needed for high-temperature energy and industrial processing were created for spaceships, and dozens of new materials were otherwise developed by private industry using the knowledge NASA's basic research produced. The new materials increased the efficiency of already existing industrial processes, for example, by allowing them to be operated at higher temperatures or in more hostile environments.
- **Energy:** The extreme environment of space required NASA to work with compact, high-density energy sources, which greatly spurred development potential in advanced on-Earth energy sources. NASA's ROVER nuclear space reactor program, and the NERVA nuclear rocket effort, contributed to civilian nuclear technology.
- **Agriculture:** Food production, processing, and treatment are among the greatest beneficiaries of NASA research. Remote sensing satellites developed, launched, and operated by NASA have saved farmers billions by preventing the spread of plant disease and providing early warning of floods by estimating spring run-off from snowfalls, impending hurricanes, and so forth.
- **Medicine:** The artificial heart is a spin-off of research and development conducted by NASA. Most of the materials used in artificial hearts are polymer plastics, whose quality and durability were improved by NASA, which also pioneered the automatic, computer-controlled technique for sensing biological parameters such as blood pressure. The telemetry technology used to monitor astronauts is now also used to monitor the life functions of infants in incubators. Infrared scanner devices developed by NASA are used in cancer diagnosis, as well as in industry. Artificial limbs are now created by applying the remote handling devices developed by NASA and the nuclear industry.

FIGURE 3

NASA R&D spending in the U.S. economy

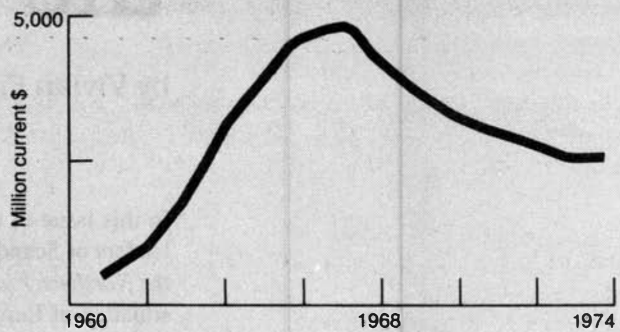
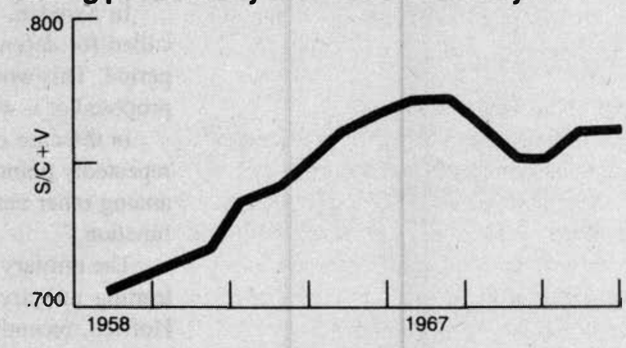


FIGURE 4

Rising productivity in the U.S. economy



In December 1982, EIR's LaRouche-Riemann Economic Model conducted a computerized study which compared NASA spending and rises in productivity in the economy as a whole. As NASA spending peaked and began to decline in real terms, productivity dropped. Productivity is measured as S/C + V, where S = the total volume of goods production available for investment the following year; V = the volume of tangible production required to employ the goods-producing workforce; and C = the cost of maintaining productive facilities plus the cost of raw materials.