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SPACE ISSUES
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After more than 25 years in space, the United States has come to a turning point in its space program. As a result of the accident of the space shuttle Challenger, the United States faces many decisions about space policy including getting the space shuttle operational again, management of the National Aeronautics and Space Administration, the proper roles of expendable launch vehicles versus shuttles, the issue of civilian vs. military payloads, the commercial potential of space, and the building of a permanently-occupied space station. This Info Pack addresses the pros and cons of these issues.

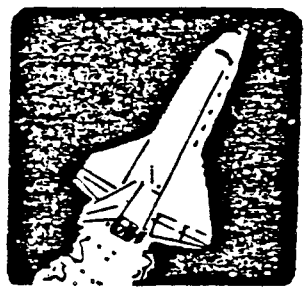
Members of Congress who want additional information on this topic can call CRS at 287-5700. Other CRS reports can be identified in the Guide to CRS Products (for congressional use only) under "Space policy" and in Update under "Science and technology."

Constituents may find additional information on this subject, primarily in periodicals and newspapers, at a local library through the use of indexes such as the Readers' Guide to Periodical Literature, Public Affairs Information Service Bulletin (PAIS), General Science Index, and the New York Times Index.

We hope this information is useful.

Congressional Reference
Division

NASA has shaped up since Challenger was lost. But it's not standing tall yet. Some say US space programs still lack long-range purpose. Others wonder about foreign competition. Today, the Monitor looks at projects affected by the explosion; tomorrow, the people.



The year since Challenger

US spreading the space load

By Marshall Ingwerson
Staff writer of The Christian Science Monitor

Miami

A year after Challenger's tragic 73-second flight, the National Aeronautics and Space Administration has picked itself up and dusted itself off.

After an excruciating season of public hearings last spring revealing a trail of NASA misjudgments and weaknesses that led up to the Jan. 28 accident, the agency that planted an American flag on the moon is moving forward again.

The shuttle hardware is being revamped for greater safety, NASA management has been reorganized, Challenger is being replaced with a new orbiter, and the shuttle Discovery will likely be flying again in early 1988 – even if not by NASA's Feb. 18 target date.

Ultimately, it was planning solely around the space shuttle that left the United States with no access to space at all for a time last

Please see NASA back page

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NASA from front page

year. This happened when both the Titan and Delta rocket launchers failed.

But the revived shuttles will not be the nation's one-size-fits-all space truck fleet of the pre-Challenger era. The nation no longer wants all its eggs in one basket. As a result, the shuttles and NASA itself will have somewhat diminished roles.

Even though the military will use about two-thirds of the shuttle payloads for a decade, the Air Force is fast developing its own unmanned space launch fleet.

Most commercial satellite companies are going to have to look to private launch companies, here or abroad, to reach orbit. The US currently has no private launch capacity, but the shuttle will no longer have room for most commercial cargo.

NASA administrator James Fletcher announced last week that the agency's own plans will once again include unmanned, expendable rockets.

Suffering most perhaps are space science and exploration projects. Two-thirds of them have been canceled. The rest are running at least a decade behind schedule.

"It has just been a catastrophe," says Bruce Murray, a California Institute of Technology professor of planetary sciences. Mr. Murray is also the former director of the Jet Propulsion Laboratory in Pasadena, Calif. "We had been forced to put all of our eggs in that [shuttle] basket," when most missions could be launched more cheaply and easily on unmanned rockets, he says.

But the legacy of the Challenger disaster has improved the agency, many NASA-watchers think.

"I think it has changed [NASA] quite dramatically, says a former NASA head, Robert Seamans of the Massachusetts Institute of Technology. "I think it has changed it for the better."

NASA administrator Fletcher, who returned to the agency last spring after running it in the early 1970s, is getting high marks for vigorously pursuing the recommendations of the presidential commission that investigated the accident.

The commission, run by former Secretary of State William Rogers, found that the flawed hardware that caused the accident grew out of deeper flaws in the NASA organization, saying the organization succumbed to flight schedule pressures.

Dr. Fletcher has shifted the shuttle management from Johnson Space Center in Houston to NASA headquarters, opened a new safety office, and given astronauts more control and visibility in the program – "like it used to be," says Mr. Seamans.

The directors of all three major space centers have been replaced since the accident. So have all the managers directly involved with the ill-advised decision to launch the Challenger on an unusually cold morning last January, including Lawrence Mulloy. He headed the booster rocket program at Marshall Space Flight Center in Hunstville, Ala., and took much of the heat for the decision.

The thrust of Fletcher's moves is to open up cleaner lines of authority and communication so that critical safety concerns are not again lost between space centers and management layers.

The effort to redesign the shuttle hardware is traveling a rockier course. Some outside experts still question whether the rejigging planned for the booster joints goes far enough. But the new joints – with an inside lip added to keep them from twisting slightly apart under pressure – will have to survive four full-scale test firings before NASA will fly them.

NASA has also decided to equip the shuttle orbiter with a limited bailout capability. The system may not be in place in time for the Discovery's first launch in 1988. It would not have saved the Challenger crew, who were lost during the highly stressed first two minutes after launch. But future shuttle crews will have parachutes, and blow-off hatches will be installed in the crew cabins. The agency is still considering whether to use extraction rockets to pull crew members clear of the shuttle.

For all of NASA's progress in finding its feet again, observers still voice strong concerns about the future of the space program.

Many even see the space station, NASA's next big project, as subject to the same pitfalls that ensnared the shuttle program. NASA tried to justify the shuttle through its commercial potential and found itself pressed into setting unrealistic flight schedules and underestimating costs.

Like the shuttle program before Challenger, says John Logsdon, a George Washington University space policy expert, the space station "is still promising to be all things to all people."

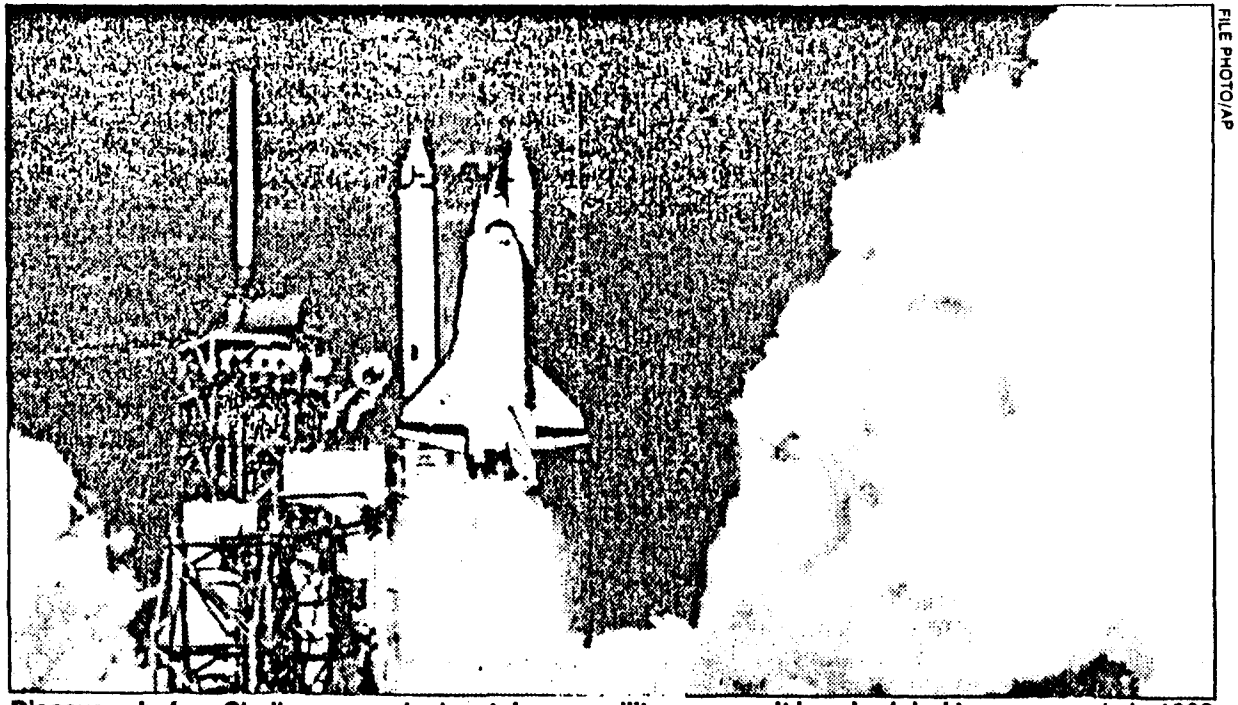
Most outside analysts believe the space program lacks a vision or long-range purpose to make sense out of its more immediate decisions.

"We drifted into the fourth orbiter decision [replacing Challenger] without knowing exactly why," says Lou Friedman, director of the Planetary Society in Pasadena, Calif. "The space station is the big driving activity now, yet we don't know what it's for."

Dr. Friedman believes the nation should decide to land a human on Mars in the next century and build its space program around that goal. That could be achieved, he insists, at NASA's current budget levels.

Alex Roland, a Duke University historian of the space program, believes that NASA's concentration on manned projects like the shuttle and the space station bleeds money away from more useful endeavors, such as finding cheaper ways to launch unmanned vehicles.

NASA's problem is still that it has to scrape for its budget every year on an increasingly skeptical Capitol Hill. Although support there has held up through the crises of the past year, says former associate administrator Jack Kerrebrock, "The agency's budget is still stretched tight as a drum."



FILE PHOTO/AP

Discovery, before Challenger explosion, takes up military cargo. It is scheduled to go up again in 1988

SHUTTLE PAYLOAD MANIFEST

New Manifest for Space Shuttle Generates Payload Sponsor Debate

By Craig Covault

Washington—A new space shuttle payload manifest forcing fundamental changes in shuttle flight operations is being criticized by U. S. and international payload sponsors, and questions are being raised about whether the flight rate will be able to keep up with even the constrained payload plan.

As a result of the new manifest, communications satellite operators are threatening lawsuits against NASA, and foreign governments are bringing diplomatic pressure on the U. S.

By 1993, according to the manifest, the space shuttle program will become almost entirely devoted to space station assembly and Defense Dept. space missions. Major science payloads important to U. S. space leadership, such as Hubble Space Telescope, are set for launch early in the new manifest.

First launch of the space shuttle following the Challenger accident has been set for Feb. 18, 1988. Experienced space managers and astronauts said, however, that the shuttle recovery momentum does not exist to achieve that target, and the first launch is unlikely until mid-1988 or early 1989.

Navy Rear Adm. Richard H. Truly, who heads the shuttle program, told AVIATION WEEK & SPACE TECHNOLOGY he also is concerned about the current momentum, but disagrees that it already has affected schedule.

Truly said, however, that if he is unable to implement some changes in the way the recovery effort is proceeding, the shuttle will not be able to make the February, 1988, target. He said one of the problems is that elements of the organization remain out of step.

"I'm not sure everybody is working to the same music," Truly said. The astronaut office, program office and NASA centers were cited by Truly as elements that need closer coordination.

Truly agreed that the shuttle recovery effort remains too broad, rather than being narrowly focused on returning the program to flight. He said a particular concern is ensuring progress is made in receiving and implementing decisions from the multiple committees, both inside and outside of NASA, looking at all aspects of the shuttle program. "I am not satisfied we are doing that well enough right now," he said.

Annual Flight Rate

The manifest is based on an annual flight rate starting with five missions, increasing to 10 in the second year and gradually building to 16 per year.

A National Research Council report to the House Appropriations subcommittee overseeing NASA, just released, said however, that even with a fourth orbiter, an annual flight rate of 11-13 missions is the maximum that should be expected from NASA, except for short surge periods.

Defense Dept. payloads including numerous Navstar satellites are a significant element in 18 of the 30 missions on the new manifest through mid-1991. Eleven of those flights are entirely devoted to military payloads.

Several of the Defense missions in the new manifest will be USAF/Central Intelligence Agency imaging reconnaissance satellites launched into relatively high inclination orbits from Kennedy Space Center, a factor affecting the outlook for use of Vandenberg AFB, Calif., as a shuttle launch site.

In light of the Kennedy Space Center's capability, and the ability of the Titan 4 booster to launch heavier payloads from Vandenberg into polar orbit than is possible with the shuttle, the U. S. Air Force is now likely to abandon launch of space shuttle altogether from Vandenberg, many space managers believe.

Other elements of the new manifest are:

- **International pressure**—West Germany and Japan are concerned that a three-year delay (to 1991) in the launch of the German D2 and Japanese Spacelab missions seriously will inhibit their preparations for participation in the space station project. Both countries have voiced concern to NASA and the State Dept. In West Germany's case, that effort resulted in a somewhat earlier launch for D2. The European Space Agency has been equally frank in expressing its concern on delays to the Ulysses mission to Jupiter and the Sun.
- **Small payloads**—NASA will ask Defense Dept. to carry some smaller civilian middeck, Getaway Special and Hitchhiker payloads on shuttle flights primarily dedicated to military space operations.

Manifest Development

"Since the accident, the development of the shuttle manifest has been one of the most complex and difficult things we have had to cope with," Truly said. Truly and other managers said none of the payload sponsors are pleased, but that delays in launch dates were dealt out fairly. Major international missions such as the West German and Japanese Spacelab flights

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maintained their chronological relationship when slipped, he said.

The manifest would have been ready about July but was held up by the White House Economic Policy Council, which decided to make key decisions on communications satellite aspects of the document. The Administration group included members unfamiliar with significant spaceflight issues. NASA space program personnel believe the process introduced political concerns, complexity and delays into decisions that many NASA managers said should have been left for space program officials.

Shuttle missions now planned into 1994 are:

- 1988—The first flight in February will launch a tracking and data relay satellite. It will be followed in May, 1988, by a geosynchronous orbit Defense mission and by a second military mission in July expected to be a large imaging reconnaissance satellite. The TDRS-D satellite is set for a late September, 1988, launch and the Hubble Space Telescope will be the fifth mission of the year set for launch Nov. 17, 1988.
- 1989—The Astro-1 ultraviolet telescope attached payload mission is set for launch in mid-January, 1989, followed by a military geosynchronous payload in March. The Magellan Venus radar mapper is set for a late April, 1989, launch, followed by a Strategic Defense Initiative Spacelab mission in early June, 1989. The fifth flight in late June, 1989, also will be defense-oriented, carrying two USAF Navstar satellites, but also a NASA materials science pallet. Two dedicated military missions will be flown in July and early September, followed by another defense-oriented mission in late September, 1989, again carrying two Navstars and the materials pallet. Either Galileo or Ulysses could be launched toward Jupiter during a November, 1989, slot while a December, 1989, launch is set for NASA's first Spacelab Life Sciences mission.
- 1990—The Gamma Ray Observatory is set for launch in January, 1990, followed by a Defense mission in February and the International Materials Science Spacelab flight in April, 1990. A multidisciplinary mission including a USAF Navstar, McDonnell Douglas electrophoresis processor and space station heat pipe test is set for May, 1990, followed in late May and early July, 1990, by dedicated Defense Dept. flights.

The British Skynet-4 military payload, which was commercially booked, is set for launch in late July, 1990, followed by a Defense mission in late August, 1990, and another Galileo or Ulysses launch opportunity in October, 1990. The joint U. S./ Italian tethered satellite will receive its first test in October, 1990, on a flight that will also deploy India's Insat and USAF Navstar payloads. The last flight in 1990 is set to launch a Syncom-4 payload and finally retrieve the long-duration exposure facility, with the majority of its payloads ruined by spending nearly five years longer in space than desired.

The flight schedule in 1991 opens with a Spacelab pallet mission, focusing on atmospheric data and a large structures control experiment. It is followed in February, 1991, by a Navstar/materials pallet flight, a Defense mission in March and then launch of the European Eureca unmanned space platform in April, 1991.

In 1991 the manifest stops assigning flights, simply naming the highest-priority payloads and establishing which quarter they are scheduled for launch. Specific flight rates are not assigned during this period.

The Japanese Spacelab mission is set for the second quarter of 1991, while the West German Spacelab D2 mission is set for the third quarter of 1991, along with shuttle's first revisit to the Space Telescope for refurbishment. Retrieval of the European Eureca is set for the fourth quarter of 1991.

Commercial missions such as Intelsat and Inmarsat do not begin to show up on the manifest in force until about 1992. In 1993, the first five space station construction flights are planned.

In 1994, the manifest is composed almost entirely by Defense missions along with seven space station assembly flights. □

Developing the US commercial space launch industry

by Ramon L. Lopez

In deciding to fund construction of a replacement Space Shuttle orbiter, the Reagan Administration also cleared the way for development of a new US commercial expendable launch vehicle (ELV) industry.

Stated, US President Reagan: "It has been determined... that NASA will no longer be in the business of launching private satellites.... NASA and our Shuttles can't be committing their scarce resources to things which can be done better and cheaper by the private sector.... NASA will keep America on the leading edge of change; the private sector will take over from there. Together, they will ensure that our country has a robust, balanced, safe space program."

Despite the August go-ahead for development of new, non-reuseable space launchers, the US aerospace industry has hardly created a 'stampede' to the doorsteps of the nation's ELV manufacturers for bookings. Indeed, the response by Shuttle users has been restrained and it appears that they are awaiting pending decisions by the Reagan Administration as to how many strictly commercial payloads will in fact remain on the Space Shuttle manifest.

But it is a fact that a large number of payloads will be taken away from NASA as a result of the Space Shuttle grounding. And most new commercial customers will be turned away.

On 15 August, Reagan gave NASA the authority to build a replacement for the Challenger Space Shuttle orbiter that was destroyed last January. In doing so, the White House ordered NASA out of the commercial launch business, the point being to permit NASA to concentrate on Shuttle launches of national security, foreign policy and scientific applications.

For the nation's aerospace industry, the long waiting game ended. Ever since the Challenger tragedy, the nation's ELV industry had been expecting a clear signal from the Reagan Administration as to whether NASA would continue to be a major competitor for private-sector rocket launch operations.

The much awaited decision to build a new Shuttle orbiter almost seems insignificant when compared with the implications of the new space launch policy. This decision, coupled with the Pentagon's desire for additional heavy boosters and medium launch vehicles (MLVs), should create new opportunties for the US aerospace industry for years to come. Also to benefit are Arianespace's Ariane ELV and new launchers being developed by Japan and the People's Republic of China.

The Reagan Administration, in effect, has moved to encourage development of a private rocket industry. But the White House made it clear that no company should expect to be subsidised by the US Government except as a recipient of government contracts for launch services.

White House spokesman Larry Speakes said a fourth Shuttle orbiter is required if NASA is to accomplish planned missions, such as Space Station construction. He remarked that the space launch policy decision "eliminates the major roadblock, or the major fear that the private sector has."

It was noted that NASA was committed to launch 44 commercial payloads via the Shuttle fleet. An inter-agency working group is developing a 'priority list' among the 44 commercial customers because only 15 commercial spacecraft can be launched by the Shuttle fleet between now and the end of 1992.

In all, 29 commercial spacecraft will be taken off the Shuttle manifest, said Speakes. According to the White House, commercial payloads that can expect Shuttle launch will be those which (1) are Shuttle-unique and (2) have significant national security or foreign policy implications. In this category would be foreign broadcast spacecraft, such as Indonesia's Palapa satellite series.

The White House decision was greeted with less than enthusiastic acclaim by NASA administrator James C. Fletcher, who said that NASA was "pleased" with the decision to build a new orbiter. But Fletcher did not laud Reagan's decision to yield the bulk of its commercial launch base to the private sector. He said simply that the President's decision "accurately reflects the attitude of the majority of Americans."

Later, Fletcher indicated that NASA might be able to launch a larger number of commercial satellites than the 15 mentioned by Speakes. "We plan to accommodate most of the commercial satellites that we are committed for," he said.

Richard H. Truly, NASA's associate administrator for space flight, said he was "delighted" with the orbiter decision but declined to express disappointment at the prospect of losing space launch fees from the commercial satellite industry.

Others, however, were beside themselves in applauding the White House space launch decision. DoT Secretary Elizabeth Dole predicted that US ELV manufacturers will begin launching commercial satellites by 1989 as a result of Reagan's decision.

It is Dole's government agency which is in charge of developing a private-sector space transportation agency. DoT's Office of Commercial Space Transportation has issued interim regulations that outline the policies and procedures for licensing commercial launches.

Dole said the greatest barrier to development of a commercial launch vehicle industry has been "the highly subsidised Shuttle system". She added: "By eliminating the government monopoly in space transportation, we can expand America's fleet of launchers at no cost to the taxpayer."

The DoT said that, by the early 1990s, US firms could have about 50 per cent of the anticipated worldwide market of 15 to 20 commercial satellite launches per year, with the rest going to Ariane and other foreign competition.

◀ The US launch industry began its recovery this summer with the successful orbiting of the NOAA-10 polar-orbiting weather satellite on 17 September, following numerous 'play-safe' delays. The launch vehicle was an Atlas E, made by General Dynamics. This picture shows the more powerful Atlas G version, topped with a Centaur cryogenic upper stage.

According to Dole, Martin Marietta (maker of the Titan ELV series) has had "about 21" formal requests for commercial launch services, while General Dynamics (the Atlas Centaur manufacturer) has had 14 requests for launch proposals. She added that Transpace Carriers, responsible for marketing the McDonnell Douglas Delta ELV, has already signed contracts to launch two commercial satellites.

Understandably, both Martin Marietta, which is offering the Titan III, and General Dynamics, aiming to enlarge Atlas Centaur production, have been less than forthcoming in describing the level of interest by satellite manufacturers and users in their launch services.

Both companies are seeking formal negotiations for launches, and both have been contacted by several firms concerning pricing and schedules. A Martin Marietta spokesman said his company has talked to a half-dozen firms concerning a launch total of between 21 and 25 spacecraft. A General Dynamics official said his firm has contacted about seven companies regarding Atlas Centaur launch of 25 commercial satellites, probably as from 1989.

In September, Martin Marietta disclosed that it had signed a contract to launch a commercial satellite for Federal Express. It said that the express mail company paid a $100,000 down-payment for a Titan III launch in 1989. (The Titan III is a commercial version of the Titan 34D.) At press time, the full cost of the launch services was not finalised, but Federal Express expects to pay Martin Marietta around $40-50 million.

The Federal Express deal represents the first firm reservation to be placed with a US ELV company. The spacecraft to be launched via the Titan III, to be called Expresstar, will be used to relay voice, data and video messages. Federal Express holds an option for a second Expresstar spacecraft launch that could take place the following year. A Federal Express official is quoted as saying that his company turned to Martin Marietta after failing to win a launch commitment from Arianespace. However, another spokesman said his company still held an option for Ariane.

Transpace Carriers, meanwhile, says that two customers have indeed signed launch reservation contracts for the McDonnell Douglas Delta, the launch vehicle it has long planned to operate commercially. In addition, Transpace Carriers' Rick Endres says that the customers are US companies that do not wish to reveal their identities until NASA's role in future commercial launch operations is finalised.

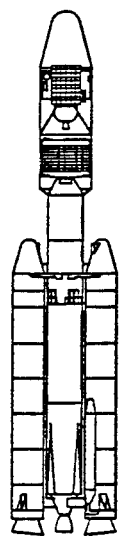
"We are currently looking at the fourth quarter of 1988 for both launches, if all goes well," said Endres. However, firm launch dates will depend on whether Transpace Carriers can gain access to long-lead Delta parts. Launches would be from Cape Canaveral aboard the first and second commercial flights of the Delta 3920, according to Endres. Although Transpace Carriers says that its pricing policy is currently under review, the company has previously quoted figures in the mid-$30 million range for a dedicated launch, plus payload assist module (PAM) booster.

The decisions of the nation's ELV manufacturers to enter the commercial space launcher sweepstakes were not taken without consideration of the emerging US military market. For, equally affected by the Challenger loss is the Pentagon, which, as it turns out, made the right decision in not relying 100 per cent on the reuseable Space Shuttle for placing military payloads in orbit.

Aside from procurement of the Titan IV (previously called Titan 34D7), the USAF is in the process of selecting the manufacturer of the MLV which will be used to launch Navstar/GPS spacecraft.

With start-up and production costs paid for by Uncle Sam, the MLV winner would be well positioned to move into commercial production. Whether a second or third space launch company can also find business remains to be seen.

"These actions by the USAF will provide the essential, on-going production base from which commercial launchers can be drawn," according to one senior US aerospace official. Prior to the White House announcement, the USAF said it "could not afford to rely on a single launch system." It revealed a space launch recovery plan which places heavy reliance on ELVs.



Martin Marietta's Titan III (formerly the 34D) is competing for the US Air Force medium launch vehicle contract and (in a slightly modified version) has secured a reservation to fly a Federal Express Expresstar satellite in 1989. Martin Marietta is offering two launch deals: a conventional launch into geostationary transfer orbit or, for former Shuttle customers stuck with a payload assist module which they cannot resell, a flight to low orbit only. The Titan III can put payloads with a total weight (including PAMs) of 31,900lb (14,470kg) into low orbit or of 12,500lb (5,670kg) into transfer orbit. Alternatively, it can inject 4,200lb (1,905kg) directly into circular geosynchronous orbit. Martin Marietta intends to stay in the commercial launcher market even if it does not win the USAF MLV contract.

The USAF is buying at least 23 Martin Marietta Titan IVs, which incorporate the seven-segment United Technologies UA 1207 solid strap-on boosters (replacing the 5.5-segment boosters used on the Titan 34D). The current Titan's liquid-fuelled core first and second stages remain unchanged.The USAF will also buy at least 12 MLVs which will be used, beginning in 1989, to launch Navstar/GPS spacecraft and other military satellites in the same weight class.

Consequently, the USAF plans to increase the rate of Titan IV launches from the Kennedy Space Center from about two per year to four per year. It will also convert the Titan launch pad at Vandenberg AFB for Titan IV launches at the rate of two per year as from 1989. (The USAF is delaying activation of the Vandenberg AFB Space Shuttle launch complex until 1992.)

The USAF said the MLV will be smaller than the Titan IV and more capable than the existing Titan II. In early August, the USAF awarded initial MLV R&D contracts to McDonnell Douglas, Martin Marietta, General Dynamics and Hughes/Boeing. The initial $5 million six-month contracts will fund design work on existing or modified launch vehicle configuration.

Candidate MLV boosters include a version of the Martin Marietta Titan using just the 34B core vehicle, with upgraded General Dynamics Atlas Centaur and McDonnell Douglas Delta rockets. The MLV must be capable of lifting a 2,100lb (950kg) payload to a 10,000nmi orbit. For example, Hughes Aircraft, teamed with Boeing Aerospace, is proposing an MLV design that combines Saturn launch vehicle propulsion systems with structures and electronics derived from the Space Shuttle.

According to a USAF official: "The established MLV production base should facilitate US industry entry into the space launch arena. The additional commercial production will in turn benefit DoD by expanding the production base and lower the unit cost of the launch vehicles to the Government and industry." A long-term MLV production rate of about four rockets per year is expected.

In addition to this, while Navstar/GPS launches are currently the only firm requirement for the MLV program, the majority of commercial payloads also fall within the MLV payload and orbital launch capability. It was noted that MLV bidders are being required to outline adaptability of the MLV for commercial usage and to consider future growth versions.

Aside from a build-up in Titan IV production and MLV procurement, the Pentagon plans to begin work on a heavy-lift ELV to be available in the late 1990s. It would be used to launch payloads of 150,000-300,000lb (68,040-136,080kg) into low Earth orbit.

The Reagan Administration's plan for ELV usage into the next century comes as welcome news to the US aerospace industry. But equally important have been recent ELV launch successes after a series of catastrophes earlier in the year.

In April, a USAF Titan 34D exploded shortly after launch from Vandenberg AFB; aboard was a secret DoD satellite. And in May, the Delta 178 rocket launched from KSC was destroyed after it veered off course; it was carrying a NOAA GOES-G weather satellite. Officials later ordered minor modifications to both rockets and declared them operational.

In early September, a Delta booster carrying a classified SDI experiment was successfully launched from Cape Canaveral. Later in that month, NASA succeeded in launching the NOAA-G weather satellite with an Atlas ELV from Vandenberg AFB.

Dole has stated that the US ELV industry faces "a market as vast as space itself". She says that the new space launch policy will allow for "a bold leap into the heavens"

But so far, little has transpired in the way of commercial ELV bookings since the August announcement. And the US aerospace industry appears content – for now – to take a 'wait and see' attitude. ◆◆

NASA's Next Stop in Space

Is the agency building a laboratory, factory, diner—or Trojan horse?

The NASA engineers who dreamed up the space shuttle wanted a truck that would ferry astronauts and cargo to a permanent, manned station in space. Twenty years later, their vision of a U.S. colony in the heavens has been blurred by budget cutters, political infighting—and the Challenger disaster last January. Hurting, NASA will finally take its first steps toward building the space station next month. The project may cost at least $12 billion as currently proposed. This plan calls for a giant orbiting station built like a galactic Tinkertoy. As long as one football field, it will be assembled by outer-space construction workers. Ultimately a crew of six to eight astronauts will man its duty posts.

Will NASA repeat the design mistakes that seared the U.S. space program after the explosion of Challenger a year ago? "The big question about the space station is whether there will be a demand or whether they will just sit up there playing cards and measuring each other's heartbeats," says space expert John Pike, of the Federation of American Scientists. So far, much of the thinking behind the space station mirrors early decisions leading to the shuttle.

NASA's strategy is uncomfortably familiar. In 1972 the agency chose a design that made it cheaper to build the shuttle but far more expensive—and arguably more dangerous—to operate. To win funding from Congress, NASA downplayed the risks and costs and promised that the shuttle would reliably serve many competing customers, hauling military payloads and commercial satellites into orbit and serving as a lab for short-term scientific experiments. The agency's leadership is the same. NASA Administrator James C. Fletcher shepherded the shuttle through Congress in the early '70s—and now has returned to take over an organization still in shock from the Challenger disaster. Facing similar budget pressures, NASA is taking the same Swiss Army knife approach to the space station. It promises that the station will be an orbiting observatory and a scientific laboratory for experiments in life sciences, physics and materials research. *And* a factory in space for commercial customers. *And* a forum for international cooperation—NASA is negotiating with the European Space Agency (ESA), Japan and Canada to be partners in the venture. If the United States ever flies manned missions to the moon again or to Mars, the space station will serve as a diner on the interplanetary highway as well as an assembly station and launch pad. In December the Pentagon said it wanted to use the space station as well. The interest led doubters to fear that the station might also become a space-age Trojan horse, a military outpost in civilian disguise.

Under NASA's current plan, astronauts will haul the space-station components into orbit aboard the space shuttle. A construction crew will stay in space, building the structure in orbit. NASA officials estimate that it will require at least 17 shuttle flights to launch the components. Floating in space, the astronauts will assemble two long trusses built of interlocking lightweight materials that will form the twin backbones of the structure. Crew quarters and laboratory modules will be attached to the keel. The space station will mostly use large parabolic mirrors for power. Unmanned platforms in other orbits will accompany the manned station: one will carry an X-ray telescope, another will carry instruments for gathering data to study climate and weather patterns on earth.

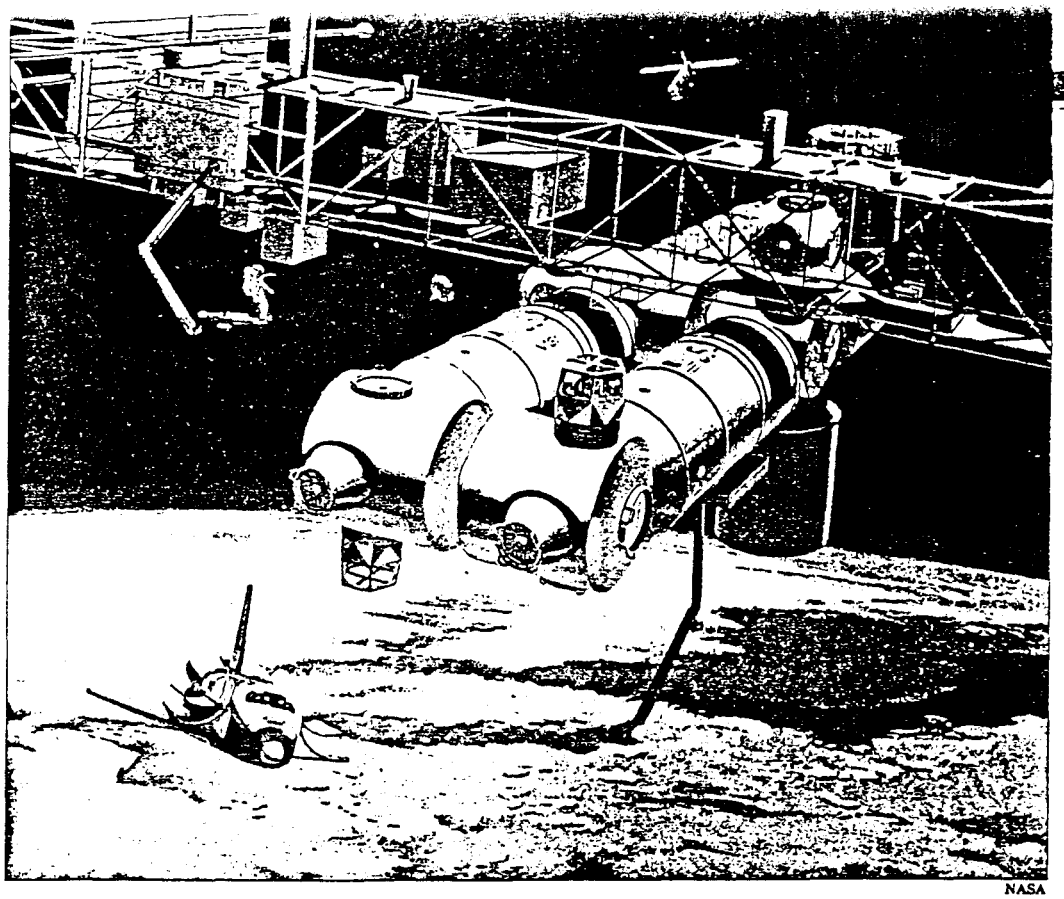
JAMES L. LONG ASSOCIATES

Getting ready to fly again: *The Discovery*

Veteran crew: Before the Challenger blew up, NASA had hoped to have the station in orbit by 1992, in time to celebrate the 500th anniversary of Columbus's voyage to the New World. No more. Last week NASA began to bury the Challenger wreckage in an old missile silo at Cape Canaveral. It also announced a veteran five-man crew to fly the next mission, now scheduled for February 1988, aboard the *Discovery*. After that, NASA wants to return gradually to a regular program of shuttle flights and to launch the parts for the space station in the mid-1990s.

The evidence demonstrates how risky the technology of space shuttles has become. Even so, NASA still plans to rely on the tiny U.S. fleet of shuttles to build the new project. It has yet to rule out entirely the possibilities in backing the shuttle up with one-shot, expendable rockets. "The questions are whether we are building the right station and whether we're confident enough in the shuttle capabilities to build a shuttle-dependent station," says John Logsdon, a space-policy expert at George Washington University. "There's the possibility of compounding the error if the shuttle isn't fixed properly and the station isn't properly conceived."

NASA altered the design of the station last summer after some astronauts and space experts objected to it. Originally NASA planned to use relay teams of space-walking astronauts from the shuttle to build the structure. The teams would have had about 48 hours to work during each shuttle flight. Then they would return to



NASA

'Will they just sit up there playing cards?' *An artist's rendering of the space station*

JIM JUDKIS—PICTURE GROUP

Blueprint for a megaproject: *NASA's Fletcher*

earth while another shuttle took off with more cargo and a fresh work crew. After the astronauts complained that the scheme was impractical, NASA changed the design. The new plan allows work crews to live in space for months at a time while doing construction in one of the station's orbiting modules. NASA also revised the design to enclose more of the space station's equipment, thereby cutting down the time astronauts will have to spend spacewalking to fix and maintain the gear.

NASA's plans to proceed with the space station have sharpened a question that has divided scientists from the earliest days of the space program: are manned flights even necessary? Some top space scientists, like physicist James Van Allen, don't think they are. This school of thought believes that scarce funds could be better used on unmanned flights. The equipment to protect human crews in spaceflight greatly magnifies the cost of an expedition. And on a practical level, astronauts may inadvertently interfere with the delicate optical or microgravity experiments. Indeed, many of the greatest scientific accomplishments of the space age have been made on robotic spacecraft such as the interplanetary Viking mission to Mars and Voyager missions to the outer planets.

Advocates of the space station argue that a manned laboratory in outer space will open a new scientific frontier. David Black, NASA's chief space-station scientist, believes basic research in life sciences and materials research will be important, especially research into basic phenomena involving gravity. He envisions growing large, pure crystals and returning them to earth for analysis or studying why the body loses calcium in the near-weightless conditions of space in hopes of finding ways to prevent osteoporosis. Like any pioneering scientific effort, the results may not always be predictable. "The real benefits come not from what you knew would happen but from the discoveries and capabilities you run into when you open the new horizon," says Black. "If we do our job well and attract the right people, a Nobel Prize should come from working in this environment." Black is more skeptical about the immediate prospect for manufacturing in space: "It is too early to say with any certainty what the commercial opportunities might be."

Next month NASA will solicit final proposals and bids from contractors. Ronald Reagan's new budget includes $767 million in development money for the space station, and the project has the support of some key players in Congress. "We need to proceed because it is a natural frontier from which important national gains can be achieved," says Sen. Donald Riegle, the chairman of the Senate subcommittee that oversees NASA.

Overseas flak: But the space station's future on Capitol Hill is by no means assured. And NASA has run into flak abroad: its negotiations with the European Space Agency, Japan and Canada were put on hold when the Pentagon showed renewed interest in the project. A Defense Department spokesman said that the military wanted to protect its option "to conduct scientific research on national-security options." The Pentagon won't be more specific, but such research might include work with advanced electronics, lasers and optics. "This is a civilian program for peaceful purposes," says NASA's Black. "That means the space station won't be used for operational military activities, but if they want to do basic research, that's OK."

In fact, with Reagan's commitment to Star Wars, the Pentagon's space budget is twice as large as NASA's. The Soviets have already launched the core of their third-generation Mir space station. "The notion that space is the next military frontier is a view held by the president and those of high rank around him," says Riegle. "That puts the civilian space program in great jeopardy." If it doesn't fall of its own weight. Bringing off this extraterrestrial triple play—Star Wars, a retooled shuttle and the space station—may be too much for any American outside of Hollywood.

WILLIAM D. MARBACH *with* MARY HAGER *in Washington*