

**Moon methods**

A new Advanced Programs Office report provides details on Moon base requirements. Part 1 on Page 3.



**'Bedstead' back**

The "flying bedstead" used to train Apollo crews for lunar landings makes its return to JSC. Photo on Page 4.

# Space News Roundup

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## Bush charts course to Moon, Mars, beyond

By Kelly Humphries

On the 20th anniversary of the first manned lunar landing, President George Bush announced Thursday a multiple-decade plan to make Space Station *Freedom* operational, establish a lunar base, send humans to Mars and eventually go to other stars.

"A dream to be realized by future generations must begin with this generation," Bush said. "We cannot take the next giant leap for mankind tomorrow unless we take a single step today."

The president, speaking to a rain-weary crowd outside the National Air and Space Museum, invoked the

memory of American astronauts who have died for the space program and tasked Vice President Dan Quayle to lead the National Space Council in determining specifically what is needed for the next round of space exploration.

He directed the space council to provide recommendations on the money, manpower and materiel necessary, the feasibility of international cooperation and a realistic timetable as soon as possible.

"The time has come to look beyond brief encounters," Bush said. "We must commit ourselves anew to a

sustained program of manned exploration of the solar system and, yes, the permanent settlement of space. We must commit ourselves to a future where Americans and citizens of all nations will live and work in space," he said. "Our goal is nothing less than to establish the United States as the pre-eminent spacefaring nation."

"I'm not proposing a 10-year plan like Apollo," he continued. "I'm planning a long-range continuing commitment. First, for the coming decade—for the 1990s—Space Station *Freedom*, our critical step in all our space endeavors. Next, for the new

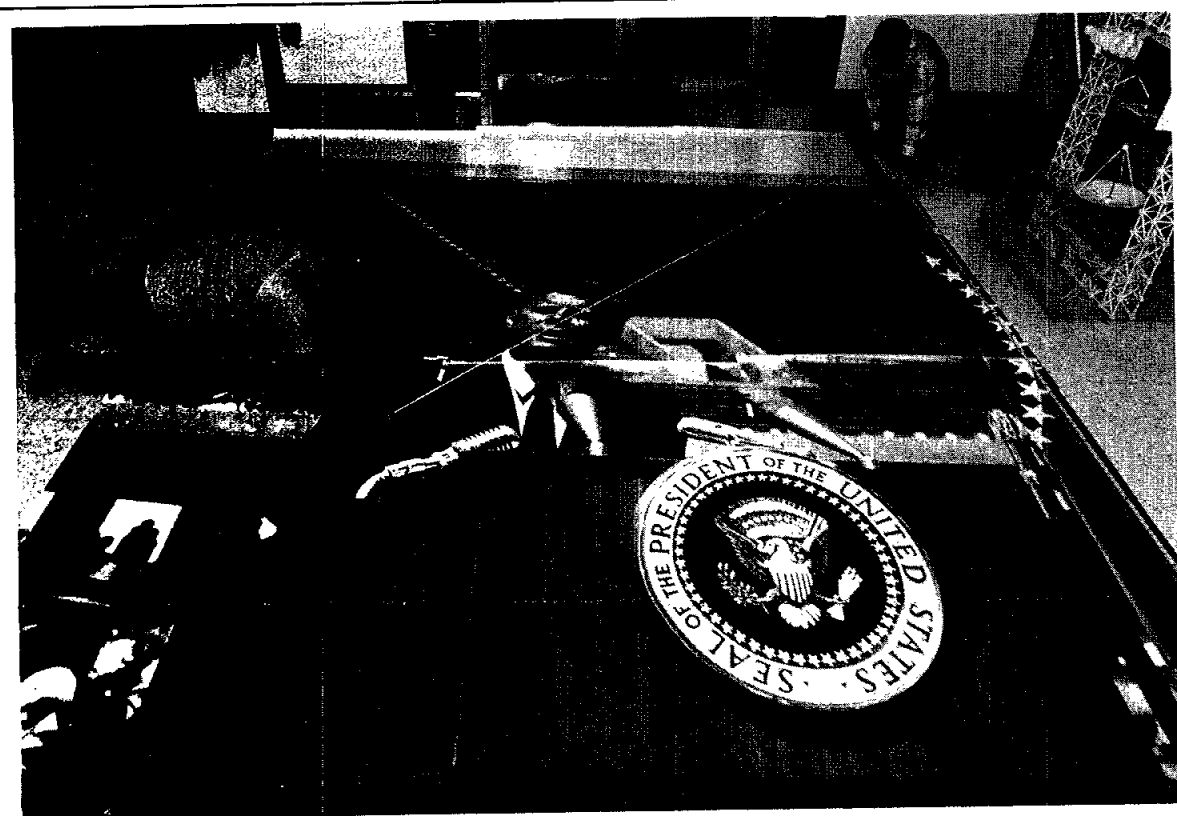
century, back to the Moon, back to the future and this time, back to stay. And then a journey into tomorrow, a journey to another planet, a manned mission to Mars. Each mission should and will lay the groundwork to the next."

Bush acknowledged that Congress is now deciding the future of the space station in its budget deliberations, and said he believes the country is at a crossroads and that hard decisions must be made.

"To this day, the only footprints on the Moon are American footprints. The only flag on the Moon is an

American flag. And the know-how that accomplished these feats is American know-how. What Americans dream, Americans can do," he said.

"And 10 years from now, on the 30th anniversary of this extraordinary and astonishing flight, the way to honor the Apollo astronauts is not by calling them back to Washington for another round of tribute. It is to have Space Station *Freedom* up there, operational and underway, a new bridge between the worlds and an investment in the growth, prosperity and technological superiority of our nation."



JSC Photo by Mark Sowa

Technician Ron Carron, left, and Jim Hoffman, contractor TGS Technology supervisor in JSC's Photographic Branch's Metric Lab, put the finishing touches on one of the visual displays to be used at the Thursday night Apollo Anniversary gala at the Hyatt Regency in downtown Houston.

## JSC gears up for Apollo weekend

Gala, parade, speakers, parties honor anniversary

Former Apollo workers, public visitors and the news media descended on JSC this week for the start of the Apollo 20th Anniversary celebration that promised a "wow" finish this weekend.

The revelry was expected to reach fever pitch Thursday night at the re-creation of an Apollo "splashdown party" at the Gilrueth Recreation Center. Attendance at the party was expected to reach 8,000, said coordinator Cathey Lamb.

As for supplies, the party was expected to consume about 700 pounds of potato chips, peanuts, corn chips and pretzels, more than 100 kegs of beer, 32 tanks of soda pop and 24 18-liter boxes of wine, said Robin

Fenneberg, catering director.

After that party was over, many of the celebrants were expected to move to the shores of Clear Lake for the Eagle Twenty Group's "A Thousand Points of Light" pageant of boats and fireworks display.

Final preparations for tonight's black-tie gala at the Hyatt Regency Hotel in downtown Houston continue today. Rehearsal for the gala program, which

will feature news commentator Walter Cronkite and the members of the Apollo 11 crew, was Wednesday evening.

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## Columbia rolls to pad; readiness review nears

By Kyle Herring

Shuttle program managers will conduct a two-day meeting next week to discuss the readiness of the Space Shuttle *Columbia* for its return to flight early next month.

The traditional flight readiness review meeting at Kennedy Space Center for the STS-28 mission will take place Tuesday and Wednesday with an expected official target launch date announcement planned for the afternoon of July 26.

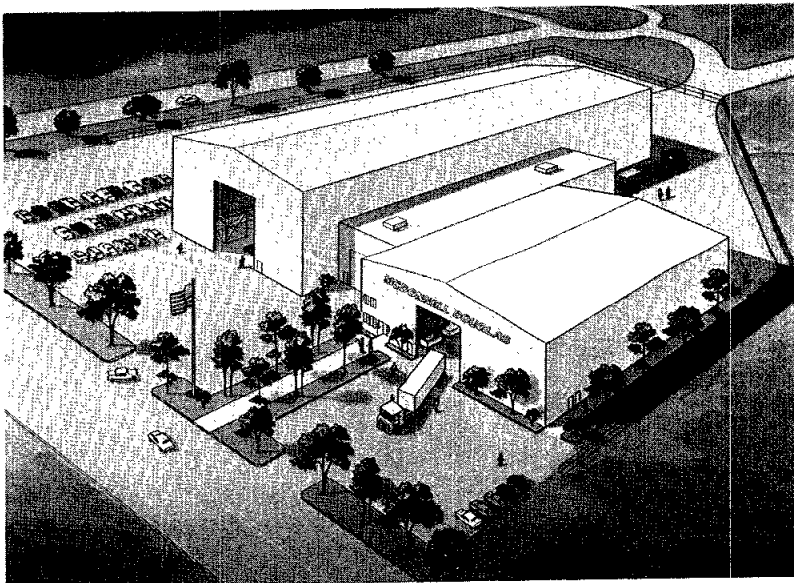
Preparations for the 30th shuttle mission, a Department of Defense

flight, are proceeding with launch expected in early August.

*Columbia*, easily distinguishable from the other two orbiters because of unique markings on the wings and fuselage, and the lack of its name on the upper wing surface, along with its solid rocket booster and external tank stack, was transferred to the launch pad a week ago for final preparations for its first flight since January 1986.

Earlier this week at launch complex 39B, the crew for the mission, along

Please see **STS-28**, Page 4



McDonnell Douglas Space Systems Co. plans to begin building light manufacturing facilities adjacent to Ellington Field within 90 days.

## McDonnell Douglas to build assembly plant near Ellington

In a few months, McDonnell Douglas Space Systems Co. (MDSSC) will begin building a 35,000-square-foot light manufacturing facility for space station near Ellington Field, the company announced recently.

The Clear Lake Development Facility, expected to bring about 250 new jobs to the Clear Lake area, will be the first tenant in Friendswood Development Co.'s new 1,000-acre Clearpoint industrial park. The \$1.3 billion industrial park is expected to house work places for an estimated 8,500 new area employees.

Robert F. Thompson, vice president and general manager of MDSSC's Space Station Division, said the facility

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## Truly's primary concern battle for '90 budget

Today's NASA is not ready to handle a major new initiative such as a lunar base or manned visit to Mars, but given adequate resources the agency can meet any challenge, Administrator Richard H. Truly said last week.

"Given the adequate resources, I think NASA is very strong," he said. "I think we have a NASA that can be built upon to take on major new challenges. But I can tell you this, today's NASA cannot do it. We have been through several years of very marginal funding. We have a lot on our plate. And to take on new challenges would require buttressing up the facilities and the people to do the job."

Truly and Deputy Administrator J.R. Thompson, in their first news conference as the agency's top leaders, said July 13 that their main concern today, is "watching, working, arguing and fighting for" the fiscal 1990 budget now being reviewed by Congress.

Truly said he appreciates the difficult decisions the president and Congress must make this year, but that he feels NASA's budget is a logical one, worth fighting for.

"You can't argue against the homeless, you can't argue against housing and you can't argue against jobs for people that need them," he said. "But the space program provides housing and homes and jobs for the next decade and the decade after that... the jobs that the space program pays for are the kinds of jobs that create communities. I think the country can well afford a viable and important space program and I don't think we

can afford not to have one."

Truly complained about recent decisions regarding salaries and ethics laws that have driven some top government managers out of their agencies, including NASA, and Thompson warned about the consequences for the future.

"We've got good people in place and I think we're very proud of the people we've got," Thompson said. "I would be crazy to tell you that we haven't also lost some very good talent. Just since the first of this year it's about 8 or 9 percent of the senior executive work force. That is significant. We are fortunate to be in a position to backfill with people of very good experience. But we can't continue down this trail in this way for the next several years."

"It's not so much the numbers," Truly said, "but the quality and experience of these people. Ten senior executive service people that leave you take with them 250-300 years of government leadership and experience when they walk out the door. It's an unhealthy situation for our country to have a public service that people can't afford to continue to be in because they've got four kids in college and they can't pay for them, or other people don't admire them for what they do, or they can't understand the rules."

Asked what he thought NASA's goals for the future should be, Truly said he thinks that such goals should be decided by the nation's elected officials after a detailed debate, but that whatever the goal is it should be

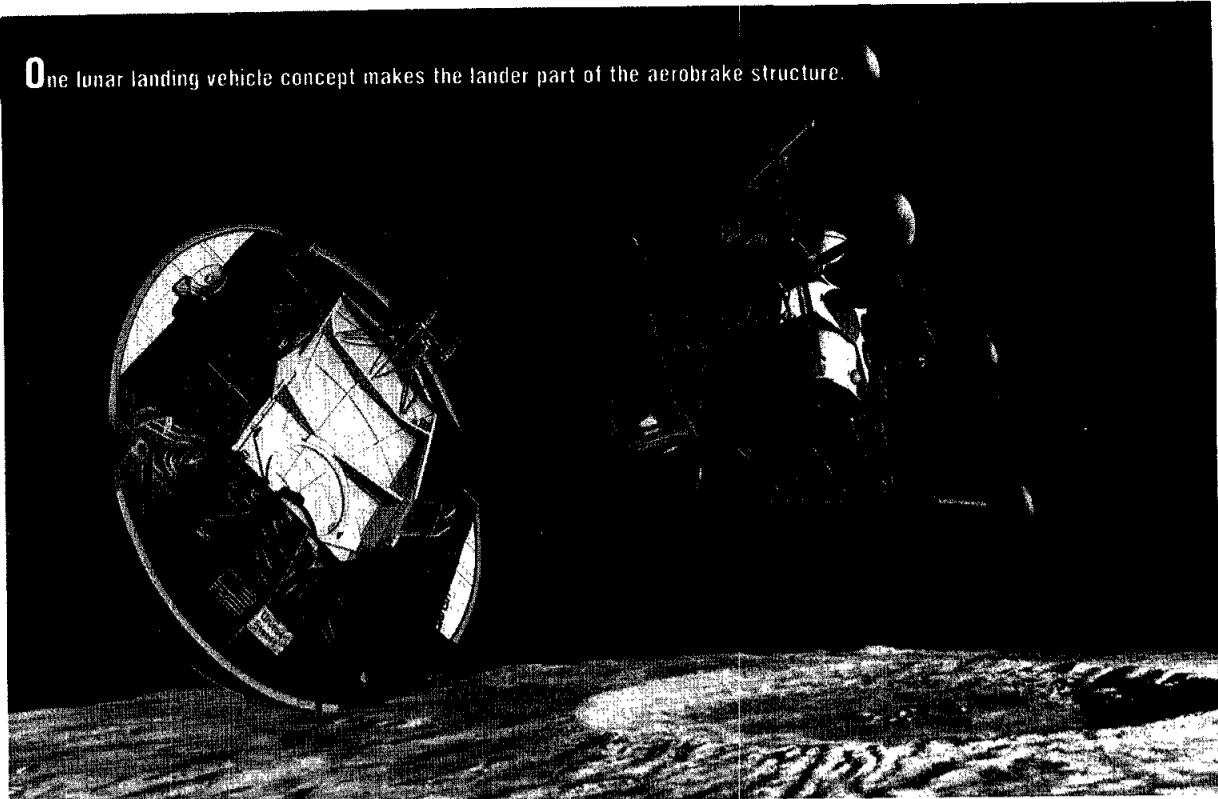
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# LUNAR OUTPOST

P • A • R • T • 1

## THE INFRASTRUCTURE



One lunar landing vehicle concept makes the lander part of the aerobrake structure.

## BASE WOULD NEED TRANSPORTATION NODE, TRANSFER VEHICLES

[Editor's note: This is the first in a two-part series of excerpts from "Lunar Outpost," a new document published by JSC's Advanced Programs Office, Systems Definition Branch in Engineering. Part 1 will focus on The space infrastructure needed to support a lunar base. Part 2, in two weeks, will deal with site selection and establishment of a base. Principal authors are John Alred, Ph.D., Ann Bulkin, Kriss J. Kennedy, Andrew Petro, Michael Roberts, Jonette Stecklein and James Sturm.]

The human race began its exploration of the solar system in earnest with the July 1969 lunar landing of Neil Armstrong and Edwin Aldrin. Six additional Apollo missions followed this historic endeavor. Twenty years later, a group of scientists and engineers at the Lyndon B. Johnson Space Center (JSC) are considering the return to the Moon, not just to explore, but to learn to live and work on another planetary surface. The Moon becomes another stepping stone in the human path from the oceans to the stars, from home to the unknown.

In the past two years, a number of concepts for going to the Moon, living on its surface, and adapting to its unique environment have been developed at JSC by designers who drew on experience reaching many years into the past. Though the study is completed, the work is not.

The spacecraft concepts presented here may not be the ones that will eventually fly; habitation systems and stay times may be different than described; some of the elements described here may not even be built. The actual scenarios and elements will be based on long-term strategies of the civilian space program, technological advances, and finally, public and Congressional support. The purpose of this overview is not to present a preferred path or "road map" to the Moon, but to enlighten the reader on the needs of lunar exploration and development, and to challenge the reader to formulate new ideas and concepts.

### Precursors

Before a lunar outpost can be constructed, topological and cartographic data on the Moon must be obtained. Such data can be collected from lunar orbit using imaging satellites in the same manner that the U.S. Landsat and French SPOT collect data on the Earth. In addition, sample collection missions may be desirable to assure the proper location and design of the outpost . . . .

Piloted missions back to the Moon before the beginning of construction of a lunar outpost will be useful. Their findings will significantly influence the outpost. For example, some lunar scientists feel that water in the form of ice may be located at the south pole of the Moon. Gamma-ray and neutron spectrometers on a lunar polar orbiter could search for ice that might be present in permanently shadowed craters in that region. Since water, a basic human commodity, was absent in samples of the previously explored lunar sites, such a find would greatly enhance the ability of the outpost to reduce its imports from Earth . . . .

### Transportation Node

The lunar transportation vehicles are assembled and serviced at a space platform in low-Earth orbit: the transportation node (TN). This platform acts as the connecting link between Earth transportation vehicles and the lunar transportation vehicles. The mission to the Moon is an ongoing operation with four to eight flights to the Moon and back each year using reusable vehicles. A facility is needed to store and service the lunar spacecraft between flights.

The TN is assumed to be separate from, although possibly co-orbiting, Space Station

Freedom. A TN supporting the lunar Base Program must store large quantities of propellant and handle frequent vehicle interactions . . . docking of vehicles, transfer of propellant, mating of payloads and vehicle elements, and deployment of lunar transfer vehicles. The intensive servicing operations and frequent spacecraft traffic . . . would disturb Space Station Freedom functions and experiments, increasing the microgravity environment and contaminating the near-station vacuum . . . .

Three configurations are presented. The first was designed with an emphasis on spacecraft processing inside the TN . . . The other two configurations have as their primary goal the overall operation and maintenance of the TN itself, including its attitude control and stability . . . .

**Drive-Thru Configuration** is designed to support mission stack buildup, refurbishment, and propellant loading within one large unpressurized hangar . . . Initially, the lunar spacecraft pieces are delivered from Earth and enter the hangar through the back door. Each stack is docked to a fixture that provides 360-degree rotation and allows pressurized access to the lunar crew module (or payload) from the TN interior . . . .

The assembly operations control module, extending vertically into the hangar, serves as a viewing platform from which the TN crew directs the activities within the hangar. Two habitation modules house a total of 13 crew: six permanent TN crew, three visiting Shuttle orbiter crew, and four visiting lunar crew . . . .

**Atrium Configuration** . . . Six storage hangars surround an assembly area in this concept. Each of the two OTV hangars can accommodate a two-stage OTV. The Atrium TN was designed to accommodate the linked lunar stack arrangement . . . Two hangars are reserved for the storage and maintenance of the lunar ascent/descent vehicles. The fifth hangar holds the lunar cargo and crew modules, and the sixth is used

to store and service the orbital maneuvering vehicles . . .

The pressurized volume is contained within a habitation module, a command operations module, two interconnect modules, two air locks, a logistics module, and a remote operations node. One habitation module is able to provide facilities for six permanent and seven temporary crew . . . .

The Atrium configuration includes a mobile transfer boom with a detachable operations node and manipulator system. The transfer boom moves on a "tracked rail" inside the dual keels to transfer crew and payload from modules to the assembly and departure areas . . . .

**Platform configuration.** The Platform configuration represents an evolution of Phase 1 Space Station Freedom. The vertical keel, assembly platform, and hangars have been added to facilitate transportation-related activities . . . Designed to be gravity-gradient stable, the Platform configuration has its storage hangars and fuel tanks located at the bottom of the keel. This arrangement allows the TN to take advantage of the stabilizing torque provided by Earth's gravitational field . . . Facilities are provided to prepare two complete mission stacks. Four hangars provide 25,000 cubic meters of volume to store the stacks; the 364 metric tons of fuel provide enough propellant for two lunar missions . . . .

### Space Transportation

Several concepts for the spacecraft which will transport people and cargo to the lunar outpost are described here within the framework of mission scenarios.

**Transport Missions.** The transportation system elements, such as the orbital transfer vehicle (OTV), aerobrake, and landing craft, are assembled in low Earth orbit.

After a crew or cargo module is attached, propellant is loaded into the OTV and landing

craft tanks. Finally, any passengers board and the vehicle departs.

After leaving the transportation node, the OTV fires its engines for the trans-lunar injection maneuver, which swings the vehicle out of low Earth orbit into a path to intercept the Moon. Near the Moon, the OTV engines fire again to insert the vehicle into lunar orbit.

Once in lunar orbit, the OTV and landing craft separate. The landing craft engines fire briefly to begin the descent. Then, while approaching the surface, the engines fire continuously to accomplish a soft landing. After completing its mission on the surface, the landing craft ascends to meet the OTV waiting in orbit.

On many missions, when the OTV reaches lunar orbit, it will meet a reusable landing craft based on the lunar surface. Payloads and passengers can be transferred in lunar orbit, and the landing craft can be refueled.

The return to Earth orbit begins when the OTV fires its engines for the trans-Earth injection maneuver. The spacecraft coasts back on a path which is targeted to skim through the upper atmosphere of the Earth. During this aerobraking phase, the OTV, which must be protected by a heat shield, slows down due to air friction and is captured in an elliptical orbit. The aerobraking maneuver conserves enough propellant to make the extra mass of the heat shield worthwhile. After aerobraking, the OTV fires its engines briefly to circularize its orbit and begins a rendezvous sequence which eventually returns it to the transportation node, where the journey began.

**Lunar Spacecraft.** The lunar vehicle generally consists of an OTV with an aerobrake and a landing craft, all reusable elements with many common components. The OTV and the landing craft each has four engines which use liquid oxygen and liquid hydrogen propellants. The vehicle can carry a variety of payload exploration missions with four people on the lunar surface for about one week. These missions could be designed for a variety of locations, including potential outpost sites. Once a permanent outpost is established, landing craft might be used for suborbital flights to explore remote locations.

When used for routine crew rotation, the landing craft and crew module will be able to deliver six people to the outpost . . . .

(In an alternative concept) the OTV is part of the aerobrake structure and the landing craft is returned to Earth orbit at the end of each mission. The landing craft fits behind the aerobrake, between the OTV propellant tanks. When connected the landing craft engines can be used to propel the entire vehicle using propellant from the OTV tanks . . . .

In another alternative concept, the landing craft is also returned to Earth orbit. However, the landing craft and OTV each has its own aerobrake; a configuration which provides greater flexibility in arranging the vehicle elements and payloads . . . .

**Crew Module.** The crew module is a self-sufficient payload which supports people in transit and for short durations on the lunar surface. It is a cylinder with a diameter of 4.5 meters (15 feet), a height of six meters, and a mass of six metric tons (11,000 pounds). The same basic module would be used on the OTV and the landing craft.

### In two weeks: THE OUTPOST

**A** space shuttle is docked to a Drive-Thru Configuration transportation node (TN). A lunar stack, complete with aerobrakes, is departing at top right, as a heavy-lift propellant tanker arrives at top left.

NASA Illustrations by Mark Dowman and Pat Rawlings



# Voyager scientists discover new moon orbiting Neptune

Voyager Project scientists at NASA's Jet Propulsion Laboratory (JPL) have announced the discovery of a new moon orbiting the planet Neptune.

The moon's discovery was confirmed July 5, when it was located in images returned from the Voyager 2 spacecraft en route to Neptune. Temporarily designated 1989 N1, the new moon was initially seen in

Voyager 2 images transmitted to Earth in mid-June. Later images showing the small body in its predicted orbit confirmed its existence.

Dr. Stephen P. Synnott, a Voyager imaging team scientist at JPL, found the small, bright smudge in Voyager pictures that led to the moon's discovery. According to Synnott, the new Neptunian satellite could range in diameter from about 125 miles to 400

miles and is in a very nearly circular, equatorial orbit about 57,600 miles from the planet's cloud tops or 73,000 miles from the planet's center.

The moon is too indistinct to appear in photographic prints made from the Voyager images at this time. Pictures taken in coming weeks will show the moon more clearly.

1989 N1 cannot be seen from Earth because it is so close to Neptune that

the brightness of the planet itself masks the tiny point of light. Voyager 2 will continue to study the moon and conduct searches for others as it approaches the planet.

Neptune has two other known moons: Triton discovered in 1846 and Nereid discovered in 1949. Triton is between 1,500 to 2,500 miles in diameter. Nereid probably is between 200 miles to 700 miles in diameter.

Voyager 2 is now 43 million miles away from Neptune and will make its closest pass of the planet on Aug. 24, 1989. The spacecraft was launched in 1977 and flew past Jupiter in 1979, Saturn in 1981 and Uranus in 1986. The Neptune encounter will be the final planetary flyby of the Voyager mission, which also included Jupiter and Saturn flybys conducted by twin spacecraft Voyager 1.

## Apollo festivities build up to finale

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The week-long speakers program series in Teague Auditorium received good attendance as experts relived the scientific speculation that preceded America's lunar visits, the planning that went into the missions, and the experiences of the flight directors and controllers during the lunar missions.

The final program in the series, featuring astronauts from each Apollo crew, is scheduled to begin at noon today in Teague Auditorium. Jim McDivitt will moderate a panel comprised of Frank Borman, Gene Cernan, Mike Collins, Al Bean, Jim Lovell, Al Shepard and John Young.

And a JSC Homecoming Parade and Rally will kick off the weekend open house. Apollo 11 Astronaut Buzz Aldrin will be grand marshal and 13 other Apollo astronauts will participate. The parade, which begins at 9:30 a.m. at the Gilruth and culminates in a rally at Rocket Park.

As part of the open house, a Northrop T-38 astronaut training aircraft will be on display in the flag yard in front of Bldg. 1.

"We're gearing up for a heavy weekend," said Omniplan Corp.'s Bonnie Scurlock, supervisor for visitor services. She said the staff of tour guides will be doubled for the weekend in anticipation of heavy attendance by members of the general public.

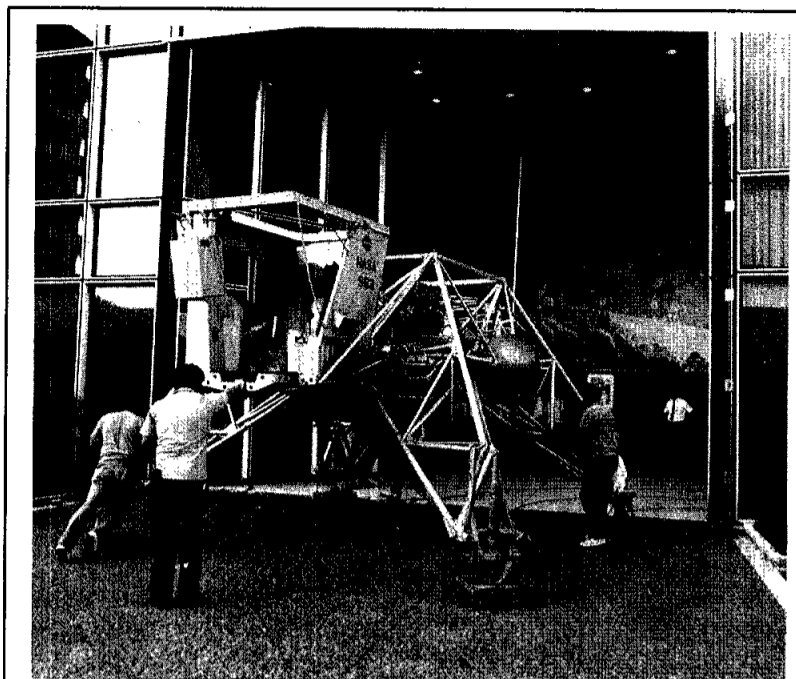
## Truly picks Lee to head Marshall

NASA Administrator Richard H. Truly has announced the appointment of Thomas J. (Jack) Lee to be director of the Marshall Space Flight Center.

Lee, 54, succeeds James R. Thompson, Jr., who was selected by President Bush to be the NASA deputy administrator.

Lee has been Marshall's deputy director since December 1980, after seven years as manager of the Spacelab program at the center. From July to September 1986, he served as acting director of the center.

In addition to his responsibilities as deputy director, Lee has served as manager of the Heavy Lift Launch Vehicle Definition Office, which is leading NASA's efforts to define and develop a heavy lift launch vehicle capable of meeting national requirements.



JSC Photo by Benny Benavides

**NEW EXHIBIT—Publis Services Branch Deputy Chief Louis Parker looks on as workers from JSC's Transportation Branch move Lunar Landing Training Vehicle No. 952 into the Bldg. 2 Visitors Center in preparation for this week's Apollo 20th Anniversary celebration. The LLTV will remain on display in JSC's permanent collection.**

## McDonnell Douglas plans two-stage project near Ellington Field

(Continued from Page 1)

will support current operations and supply Space Station *Freedom* flight hardware under the JSC-managed Work Package 2.

"McDonnell Douglas is committed to a long-term presence in Houston and this is another important step in that direction," Thompson said.

Construction of the initial phase is expected to be completed by mid 1990, Thompson said. In that building, McDonnell Douglas will help

develop the Crew Health Care Systems prototype and space station development mock-ups and hardware modifications.

The company plans a second, 68,000-square-foot Integrated Truss Assembly, Development and Verification Facility to house assembly of the 508-foot space station structure that will be built at various locations around the country. Between those two buildings will be an Avionics Development Facility and Clean Room.

The facility will be built east of Ellington Field and north of FM 2351 on a proposed extension of Space Center Blvd. MDSSC initially will lease 12 acres with the option to lease an additional eight for possible future expansion beyond Phases I and II.

"The action McDonnell Douglas is taking today is a major step forward in making the space station a reality," JSC Director Aaron Cohen said at a July 12 news conference announcing the MDSSC development project.

Houston Economic Development Council and Greater Houston Chamber of Commerce executives began the efforts to attract the space station hardware manufacturing facility two years ago.

Friendswood Development announced the founding of the industrial park on July 11. McDonnell Douglas announced plans for its new facility on July 12, and on July 13 announced that J.A. Billipp Co., a Houston-based developer, had been selected as builder.

## Budget Truly's main concern

(Continued from Page 1)

sustainable in the long term.

"A program of manned exploration is one that will never bubble up from the bottom," Truly said. "It'll never be the result of doing a whole series of cost-benefit analyses and then suddenly out pops the answer. It'll always bubble up from the top of our leadership, the president and the Congress."

"I think there are opportunities we have today that could and should and I hope will be debated. But my personal belief is that the NASA

administrator 100 years from now sitting at this table or wherever he'll be sitting talking to the media, will talk with pride about how we went to Mars and how we did return to the Moon."

Truly said any future goal assumes the continued safe, effective flight of the space shuttle and that right now that is NASA's primary task.

"There is still risk in flying in space. You can't take it all out and all the budgets in the world won't do it for you. I think the shuttle is in good shape, but it's going to be our job to keep it that way. It won't happen by itself."

## Space News Roundup

The Roundup is an official publication of NASA's Lyndon B. Johnson Space Center, Houston, Texas, and is published every Friday by the Public Affairs Office.

## STS-28 ready to begin final preparations

(Continued from page 1)

with flight controllers in Mission Control and the launch team in the firing room at KSC, went through an actual launch day countdown to exercise the readiness capability of the entire launch and flight control teams.

The terminal countdown demonstration test covered the final 24 hours of an actual count, including planned hold periods, and provided training for both the astronauts and the launch team. The rehearsal ended with the astronaut crew boarding the orbiter for the final two hours as on launch day.

While at KSC, the astronauts checked their space suit fits Monday and were briefed on emergency procedures at the launch pad.

The all-military crew is commanded by Air Force Col. Brewster Shaw and piloted by Navy Cmdr. Dick Richards. Remaining crew members serving as mission specialists are Navy Cmdr. David C. Leestma, Air Force Lt. Col. James Adamson and Air Force Maj. Mark Brown.

Also this week, the helium signature leak checks of *Columbia's* three main engines and the orbiter's main propulsion system were conducted.

The test, designed to find any leaks that need to be fixed before launch day, was completed late Wednesday night with only minor difficulties.

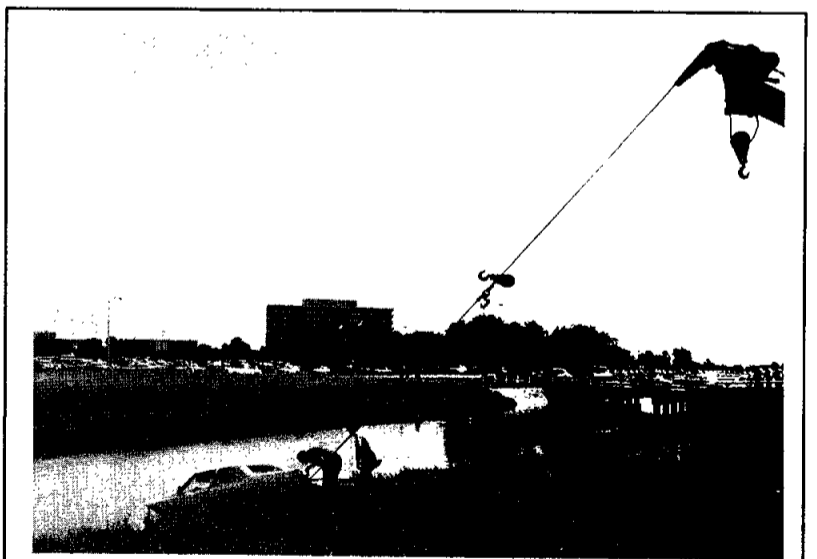
Preparation and loading of storable propellants took place this week. Reaction control propellant loading was to be completed today.

*Columbia* will be making its eighth flight since the start of the space shuttle program. The orbiter was commissioned in 1979 and delivered to NASA in March. *Columbia* flew the first five Shuttle flights (STS-1 through STS-5) in 1981 and 1982 and STS-9 in 1983 before flying STS-61C January 12-18, 1986.



JSC Photo by Jack Jacob

**GROUND BREAKING—Employees and well-wishers gathered near the intersection of Avenue B and Second at 2 p.m. on July 7 for the official ground breaking of the JSC Employee Child Care Facility. JSC Director Aaron Cohen, ceremonial shovel in hand, was joined by, from left, Facility Development Division Chief Dick Thompson, Director of Human Resources Jack Lister, Estella Gillette, employee development specialist; Mary Allen, chief, Employee Service Section; J.H. Morris, Alpha Construction; and Grady Owens, chief of technical operations. The scheduled completion date for the 62-child facility is May 1990.**



JSC Photo by Bob Walck

**BIG FISH—Wrecker service workers retrieve a stolen car that crashed through JSC's southern fence early July 7 and sank into a Houston Lighting and Power cooling water canal. No driver could be located. Damage to the fence was estimated at \$600.**