

# FOUNDATION REPORT:

ADVANCES IN COMMERCIAL AND GENERAL SPACE DEVELOPMENTS

## SOVIETS TEST REUSABLE SPACE SHUTTLE

### Tests Underway for One Year; Manned Orbital Tug Undergoing Study

According to reliable sources of *Aviation Week and Space Technology* magazine, the Soviet Union has been testing a delta-winged reusable manned shuttle vehicle for the past year. In a story by Craig Covault, *AW&ST* Space Technology Editor, the magazine has reported the vehicle has undergone drop tests from a Tupolev Tu-95 "Bear" bomber.

The shuttle-like vehicle has apparently been based at a remote Soviet aeronautical test facility for more than one year. It has not been flown in space to the best knowledge of western sources, although the Soviets have tested a new type of manned orbital vehicle with space tug capabilities.

Without official Soviet photos to back up the story, *AW&ST* had to resort to a conceptualized vehicle design in a painting done for the March 20 issue. The illustration shows a delta-winged orbiter, but, interestingly enough, shows no empennage structure, control surfaces or reaction control motors. A small cockpit is indicated. Generally the projected lines of the shuttle resemble the U.S. Space Shuttle Orbiter and previous lifting body concepts, though it is noted that the Soviet vehicle is much smaller than the U.S. Shuttle.

The Soviets have been using their Soyuz-class spacecraft (first flown in April of 1967) for the past ten years. The Soyuz is flown by a two man crew since the loss in space of the three man crew of Soyuz 11. Soyuz spacecraft have been used primarily as passenger transporters, carrying crews and light cargo to the various Salyut orbital stations. A recent Soyuz-type vehicle, called Progress-1, was used to resupply the Salyut 6 space station with oxygen, fuel and food.

It is believed that the new Soviet Space Shuttle will be used to replace the Soyuz spacecraft as the primary passenger and light cargo transporter for space station resupply missions. There is every indication the Soviets plan a permanent space station within the next few years, and a shuttle vehicle with five to ten thousand pounds of cargo capability would be a valuable asset in such a program. From available indications, it does not appear that the Soviet shuttle has a cargo bay running the length of the orbiter as does the U.S. Space Shuttle. The mission requirements for the two vehicles seem quite different. While the U.S. Space Shuttle was originally conceived as a space station resupply transporter, political considerations forced a design change. Congressional opponents of the Shuttle warned in the early 1970's that Shuttle would have little economic justification without a multi-billion dollar space station program. In an attempt to defuse the argument, NASA separated the Shuttle program from the space station program. The space station program has since been allowed to die, and the Shuttle is now being justified on its merits as a transport vehicle alone.

The Soviets have apparently made no such distinction. While they continue to operate their Salyut-Soyuz configuration (two more manned missions are planned this year) they are no doubt planning to phase the new shuttle vehicle into

the cargo delivery role for a permanent space station rather than use it as an end in itself.

A possible exception to this observation is use of the new shuttle as a military reconnaissance spacecraft. Since it is manned, reusable and maneuverable, the Soviets could easily employ it as a surveillance device for "quick-look" observations. (See article on OTRAG, this issue.) The Soviets fly more than two dozen military observation missions each year. A reusable observation vehicle would be a wise economic investment for them. Also, the new shuttle vehicle could be considered for the manned antipodal bomber role, suggested by E. Sanger more than thirty years ago. Such a system would combine the speed of a ballistic missile with the recall capability and other advantages of a manned bomber.

While aerodynamic testing of the Soviet shuttle appear well underway, there is no indication that the vehicle has yet flown in space. Booster configuration is open to speculation. Foundation analysts believe that the vehicle is meant to be launched by the first stage cluster of either the Proton or SL-4 (Soyuz) booster. The shuttle would then serve as a second stage, placing itself into orbit without discarding any parts but the first stage booster. Alternately, the Proton booster could be used to place the fully loaded shuttle into earth orbit. Proton is now used to orbit the Salyut space station which masses around 42,000 pounds. The new space shuttle may not weigh more if its primary mission is crew transfer.

While *AW&ST* magazine implies that the development of a manned reusable shuttle system is a major engineering feat, this is not necessarily the case. The U.S. Shuttle is complex and expensive because of its multiple mission roles and oversize cargo capacity. Completely new boosters, tanks and an extremely advanced engine must be developed for the Space Shuttle. On the other hand, a vehicle with a small payload capacity and with a very limited range of missions, such as the Soviet shuttle, is much easier to develop.

According to *AW&ST*, the shuttle-like vehicle is not the only new manned spacecraft under development in the Soviet Union. It is possible that a prototype of a new manned orbital tug has already been tested in space. In July of 1977, Cosmos 929 was orbited by the USSR. It now appears from analysis of data concerning that mission, that it was an in-space test of the new tug in an unmanned operation. This possibility takes on special significance when seen in conjunction with the reported space shuttle development and the long-duration use of the Salyut space station. The tug would be used to aid the assembly of large space structures, including advanced large space stations. (The existing orbital vehicle, Soyuz, has been plagued by inadequate maneuvering propellant capacity, and limited orbital stay-time. The Soviets will be attempting to correct this by designing a vehicle which never has to be re-entered, thus avoiding the weight penalties and structural limitations set by atmospheric flight.)

Use of the new shuttle and tug combination would afford real economies for the Soviet manned space program. In six months they have used four manned Soyuz and one Progress-class tanker vehicles to occupy and resupply the Salyut 6. Informed sources have indicated to Foundation that it is apparent the Soviets will be operating extensively in near earth space for the next several years, and they may fly lunar missions with stay-times as long as a month by 1985.

# NEW MOONS

## Lunar Science Conference Proceedings Published

The Lunar and Planetary Institute has released the transcripts of presentations at the special session of the Eighth Lunar Science Conference titled "New Moons: Towing Asteroids into Earth Orbits for Exploration and Exploitation". The session, which was held on 16 March 1977, complements the recent special session on industrial exploitation of cis-lunar space just concluded at the Ninth Lunar Science Conference (see *News Notes*, this issue).

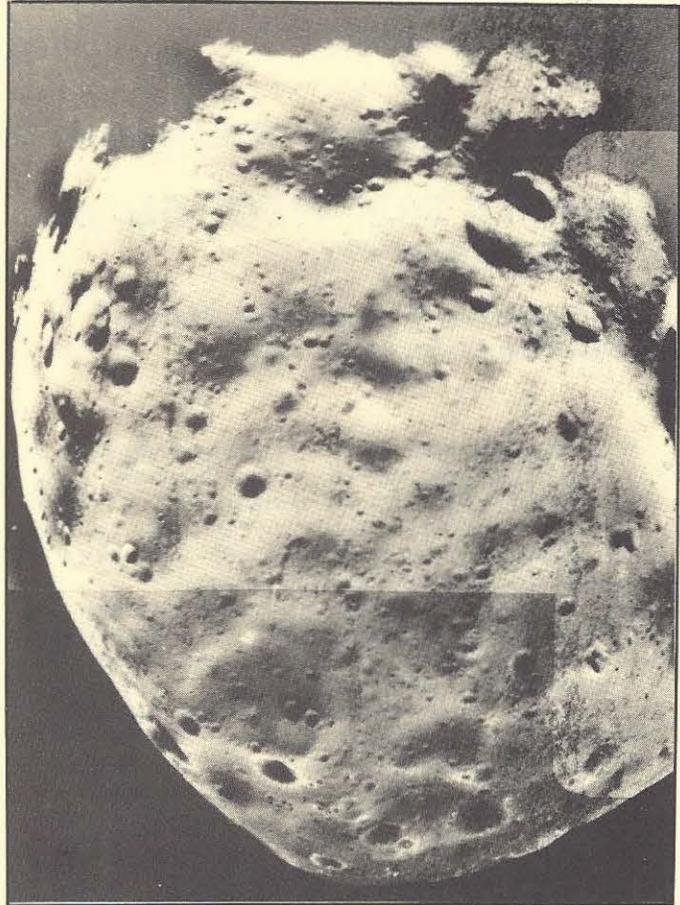
Organized by Dr. David Criswell, and co-sponsored by the Lunar and Planetary Institute and the Johnson Space Center, Houston, Texas, these sessions have been the unofficial highlights of the last two Lunar Science Conferences.

Using asteroids for industrial and habitation purposes has been explored in speculative literature for many years. However, this special session was prompted primarily by research conducted by the NASA/Ames Summer Study on Space Manufacturing (1977) as well as a paper by Brian O'Leary which indicated that asteroid retrieval might be accomplished in the near future using mass-driver solar electric engines. Three fundamental questions were explored at the session. First, could mass-drivers be utilized as a form of propulsion system? Next, could one actually make some use of asteroidal materials for industrial purposes? And finally, is there a large population of asteroids which is easily accessible? According to Criswell "there is a growing realization that with the Space Transportation System coming into operation in 1980, it is reasonable to envision large scale construction in space . . .". Asteroids could supply nearly all of the material feedstock for space industries (see *Report*, January, 1978).

Large emphasis was placed on the capability of and the requirement for a "mass-driver" rocket engine. The mass-driver is an electromagnetic accelerator which launches projectiles (in a gun-like fashion) out the tail. Operating on solar or nuclear energy, a two hundred meter long mass-driver, accelerating loads at 1000 gravities, could deliver a performance about equal to the engine in the historic V-2 rocket (about 200 seconds specific impulse). The advantage of the mass-driver lies in its ability to use almost any matter as "propellant", rather than requiring conventional rocket propellants. The disadvantage lies in the very low accelerations and total mission velocity capability of the mass-driver, leading to multi-year trips for even the lowest energy asteroid return missions. Such a long time delay would have serious consequences on the overall economic feasibility of the scheme. Brian O'Leary, Hugh Davis (Johnson Space Center) and Henry Kolm (MIT) each presented papers dealing with the overall mass-driver concept, technology challenges in deploying and using the mass-driver, and the theory of the engine, respectively.

Dr. James Arnold addressed the question of material usability. Arnold made the point that we know a great deal about the moon, which was the early choice for space manufacturing materials, but less so about the earth-orbit crossing asteroids. (Only asteroids which cross the orbit of earth were considered as likely candidates for retrieval at this meeting. Main belt asteroids severely tax the limits of the mass-driver.) Additionally, he pointed out, there is the advantage of location for the moon. It is already in high earth orbit . . . no moving is necessary. In what must have been a heretical statement for most O'Neill colony supporters, Arnold wondered if the moon was not a better place for space settlements and manufacturing than orbit. He remarked "The area of the moon is just equal to that of Columbus' new world, of

An example of the material resources available in space. One picture element from this Viking photo of Phobos is about two hundred meters (smallest sized object that we can make out). That is ten million tons, or the amount necessary to construct forty satellite solar power stations.



North and South America. That's a lot of territory. If one wants to build anything, if one wants to make anything, if one wants to grow anything, the importance of real estate which does not have to be built is an important advantage." On the other hand, if water cannot be found on the moon, Arnold notes we will have to seek it in carbonaceous chondrite asteroids.

According to O'Leary and others, it appears that many earth-orbit crossing bodies exist. In fact, the number has been estimated as high as one hundred thousand objects on the order of one hundred meters across. (If nickel-iron, such a body would be worth 1.5 billion dollars or more. See *Report*, January, 1978.) However, only a few asteroids have been observed at this time, and a search program is recommended to locate appropriate candidate bodies for retrieval.

In a summary statement, Criswell noted the following advantages for asteroid retrieval:

- Ten million tons of material for one-two billion dollars, versus five hundred billion dollars if brought from earth
- All material is useful
- High public visibility
- Uses the Space Shuttle intensively
- Reduces the cost of Space Solar Power Systems
- Little emotional or legal constraints regarding use, versus the moon

Asking the question, what might asteroid retrieval mean for the man on the street? Criswell notes that lunar materials returned to earth from the Apollo missions would have to be priced at \$500,000 per gram, while asteroids (which are pieces of the primordial solar condensate) could be sold for \$4.95 per thousand grams. Only half joking, he suggests that the return of half the mass of the first asteroid to earth for souvenirs could pay for the retrieval of the first of the "new moons".

# OTRAG, SOVIET MYSTERY DEEPENS

## USSR Plot, Penthouse and Writer Taken In

The March issue of *Penthouse* magazine published an article by Tad Szulc, a former *New York Times* reporter, allegedly exposing a top secret West German plot to build ballistic missiles and cruise missiles in Zaire, Africa. There were dark hints that the project involved nuclear weapons, the CIA, West German intelligence and the Stuttgart-based company Orbital Transport and Rockets, A.G. OTRAG is attempting to develop low-cost launch vehicles for commercial exploitation of near earth orbit space, and recently fired a suborbital test vehicle from its launch center in Zaire.

The problem with the *Penthouse* expose is that it is totally false. In fact, it appears that the whole story has been fabricated by Soviet intelligence to cast suspicion on the first private attempt to exploit outer space, and to embarrass the West Germans and the US in Africa. Proof that the USSR knew in advance of the publication of the *Penthouse* article that it was false has been offered by Andrew Wilson, investigative reporter for the *London Observer*, in a copyrighted article published in the *Boston Sunday Globe* February 26, 1978.

The OTRAG story has been reported in past issues of this newsletter, including September, October (1977) and January (1978). The company has raised about \$30 million from German investors to develop a low-cost nitric acid-kerosene expendable booster which would be able to compete with the Franco-German Ariane and the US Space Shuttle vehicles. Headed by rocket engineer Lutz T. Kayser, 40, and Dr. Kurt Debus (former head of the NASA Kennedy Space Center), the company has been under attack from both the German aerospace industry and the Soviet Union. The response of the German aerospace industry was predictable: if Kayser can successfully launch his vehicles for the very low price that he has promised it would tend to make the conventional aerospace industry in Germany look foolish. On the other hand, the motives of the Soviets are more complex. While they have long held antagonism toward the prospect of any private activity in space, they may have immediate political interests in Africa uppermost in their minds. Kayser, seeking an equatorial launch site for his chemical boosters, negotiated a contract-treaty with President Mobutu of Zaire. The agreement gives OTRAG virtual sovereignty over nearly 40,000 square miles of territory in Shaba province. (The province was invaded by Katangan troops financed and supported by Angola last spring.) It may be that the USSR is attempting to "score points" with the Marxist government of Angola, and other African states which dislike Mobutu's regime.

Wilson investigated the allegation of Tad Szulc that OTRAG was a front for the German government in Bonn. Wilson found that OTRAG signed the agreement with Zaire on March 26, 1977 and immediately went ahead with the establishment of an airfield and a launching site for the first of the OTRAG rockets—the OTRAG 200. Wilson reports, "At that time, OTRAG's team of 25 technicians caused surprisingly little comment, perhaps because public attention was fixed on the . . . war in . . . Angola". However, on August 8th, *Asie-Afrique* magazine published the text of the OTRAG/Zaire contract. The contract copy had been stolen from a safe in the Zaire Embassy in Bonn. The magazine often leaks information which originates from East Germany and other Eastern European sources. It is now believed the contract was stolen by East German agents operating in Bonn. According to the contract, the rental for use of the 40,000 square miles in Zaire by OTRAG amounts to \$70 million

a year, which is more than twice the amount of money raised by Kayser and his company up to now. Furthermore, the sum is to be "paid into an account to be determined by the office of the president (of Zaire)". Additionally, the contract gave OTRAG police powers over the site, and OTRAG offered to launch an experimental recon satellite for Mobutu.

Sources of information for the Szulc article in *Penthouse* should be called into question. Where did he get his information? Actually, the *Asie-Afrique* article about OTRAG bears close resemblance to the Szulc report. Furthermore, when Szulc discussed the involvement of the German firm Messerschmitt-Boelkow-Blohm he spelled the name of the company Messerschmidt-Belkov-Blaum. As pointed out by Soviet space expert James Oberg, who is associate editor for *Space World* magazine, this spelling is identical to the Cyrillic—the Russian—spelling. Szulc used direct Soviet propaganda in his article without verification.

Rocket experts have questioned whether the OTRAG rocket is sophisticated enough to serve as a missile. The unanimous agreement is that it is not. The Russians must know this fact also, which calls into question their motives. Given these observations, it appears questionable that the contract printed in *Asie-Afrique* was indeed genuine and unaltered.

Even before the Soviets began their propaganda attack on OTRAG, they had the chance to take a close look at the German firm's operations. Kayser has been quoted as saying that OTRAG staff observe Soviet recon aircraft over the test site often enough, but apparently for the USSR, the aircraft overflights (in violation of Zaire's sovereignty) were inadequate.

Two Soviet Cosmos spy satellites were launched to observe the OTRAG launch site during July of 1977. According to Dr. Bhupendra Jasani of the Stockholm Peace Research Institute, who did computer analysis of the flight of Cosmos 922 and 932, these satellite overflew the OTRAG facility first on July 20-24 and one week later on a lower altitude track. Jasani told the *Observer*, "On July 20, Cosmos 922 was launched into orbit. Between July 20-24 it made four passes over the area of Zaire during daylight with optimal conditions for photography. Only one week later the Soviets launched a second satellite—Cosmos 932—to fly along the same track, only this time at a much lower height to allow for high-precision photography. With present technology, reconnaissance satellites can take photographs that can be enlarged by computers to identify even the make of a small car."

Such overflights would have revealed that there were no provisions for testing a military rocket at the OTRAG base.

Why have the Soviets paid so much attention to the OTRAG company and its commercial plans? Besides the basic reason of discrediting West Germany and Mobutu, there may be an explanation in the planned launch policies of Kayser. OTRAG has committed itself to launching low-cost payloads, including reconnaissance satellites, for any customer who is willing to pay. One of those customers may be the Chinese government.

The Chinese space program has been very limited so far, though their eighth satellite, believed to be a spy platform, was tested in February. Jasani said, "After launching seven satellites between 1970-76, the Chinese suspended their experiments. Western experts believe they may have had difficulties with the weight of their space vehicles." The OTRAG vehicle would be an ideal booster for large, somewhat primitive spy satellites. When asked about this possibility, Kayser said he would have no problem with launching a spy satellite for the Chinese. "I do not see anything wrong about China doing the same thing as both the Americans and the Russians have been doing for years." The Soviets no doubt feel differently.

Additionally, the Soviets are in the process of attempting to modify the Outer Space Treaty of the United Nations, according to Wilson, to prevent other nations besides the US and the USSR from orbiting any form of spy platform. Since

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Kayser frankly looks toward the spysat business as a substantial market, it was inevitable that OTRAG and the Kremlin were on a collision course.

Now, however, the most interesting question is: what will be the US official view on OTRAG? The silence of the Administration and the State Department, while not altogether unexpected, is disquieting. By placing itself in the heart of Africa, OTRAG was courting trouble. It may be that to win Western approval of its plans will require a new base of operations outside the Third World.

## INTERNATIONAL SPACE PACE ACCELERATES

### Japanese, Europeans Making Aggressive Plans for 1980's

In the last month, both the European Space Agency and the Japanese Space Activities Commission have proposed ambitious plans for space exploration and exploitation in the next decade. The European Space Agency has suggested SpaceLab modifications which could extend the lifetime of the system, eventually allowing it to become a free-flying space station platform. The Japanese are proposing to spend more than \$14 billion on space activities over the next 15 years.

#### 80 Payloads, 76 Launches

Japan plans more than 80 individual spacecraft payloads during the next fifteen years, and has formed a subcommittee to investigate the possibility of Japanese astronauts flying aboard the US Space Shuttle. Plans are for the first scientist-astronauts to fly the Shuttle in 1983, with one to three going every year following that date.

An earth-resources payload is also scheduled, with the information to remain in Japanese hands, rather than being freely circulated. Along with this payload, two marine observation spacecraft and a three-axis stabilized weather satellite is planned.

Japan has scheduled its first lunar probe for 1984 (a lunar orbiter), and would fly Venus and Mars probes in the late 1980's and early 90's. One concept uses instrumented balloons in the Venusian atmosphere.

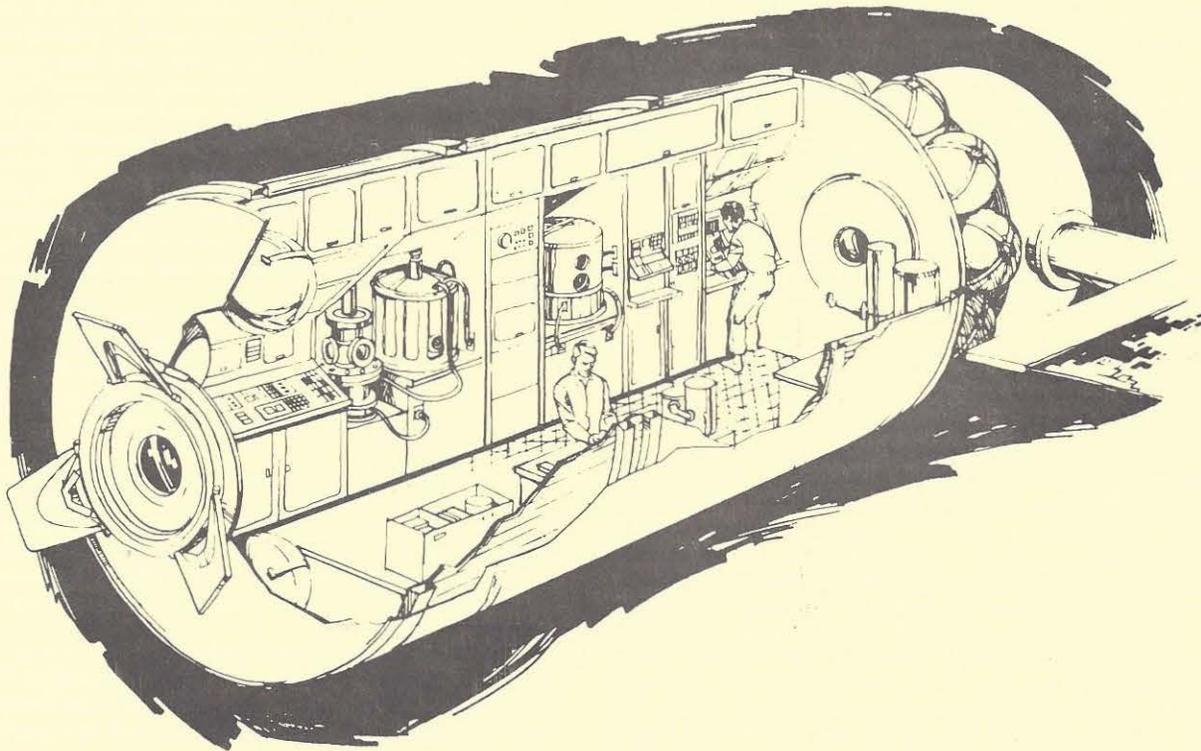
No mention of the advanced liquid hydrogen/liquid oxygen booster for manned missions (which was announced in Report, September, 1977) survives in the final version of the Space Commission's report. However, a smaller version of that booster has been designated the "H" vehicle, and should be developed by 1984, according to the Commission. This booster could launch 5000 kilograms to low orbits, and 800 kilograms to geosynchronous altitudes.

### SpaceLab to Space Station?

At the recent Goddard Memorial Symposium in Washington, D.C., Guenter Seibert, deputy head of the ESA Future Space Transportation Systems group, discussed ESA options for the SpaceLab module. Presently, SpaceLab is designed for short duration mission attached to the Shuttle Orbiter. A first step would be to extend the SpaceLab lifetime from the present seven days to two or three years. This done, 40 to 60 day missions could become possible with the use of the NASA 25-kilowatt power module now in the NASA budget. Ultimately, the SpaceLab could be manned continuously, and would no longer be attached to the Orbiter. At this point it will have become a free-flying space station.

This proposal is similar to the Manned Orbital Systems Concept (MOSC) of the McDonnell-Douglas Astronautics Company which was proposed to NASA several years ago and rejected for budgetary reasons. It has been referred to as "backing into a space station project" by some industry observers.

*An example of a free-flying space station module designed by McDonnell-Douglas Company using SpaceLab component parts. The ESA proposal to turn SpaceLab into a long duration system would ultimately lead to establishment of a space station similar to this.*



# SOLAR SYSTEM SPACESHIP UNDER STUDY AT FOUNDATION

A study project underway at Foundation has produced a preliminary conceptual design for an advanced, nuclear-powered solar system spaceship. While tentative, it offers insights to the type of ships which could be flying in the next few decades, provided that suitable engines or propulsion systems are developed. The propulsion systems are part of a separate study (*Foundation News, Report, September, 1977*).

Advanced nuclear engines are under consideration to provide motive power for the solar system spaceship. They include fission/fusion pulse engines, gaseous-core nuclear engines, and diluted antimatter/matter engines.

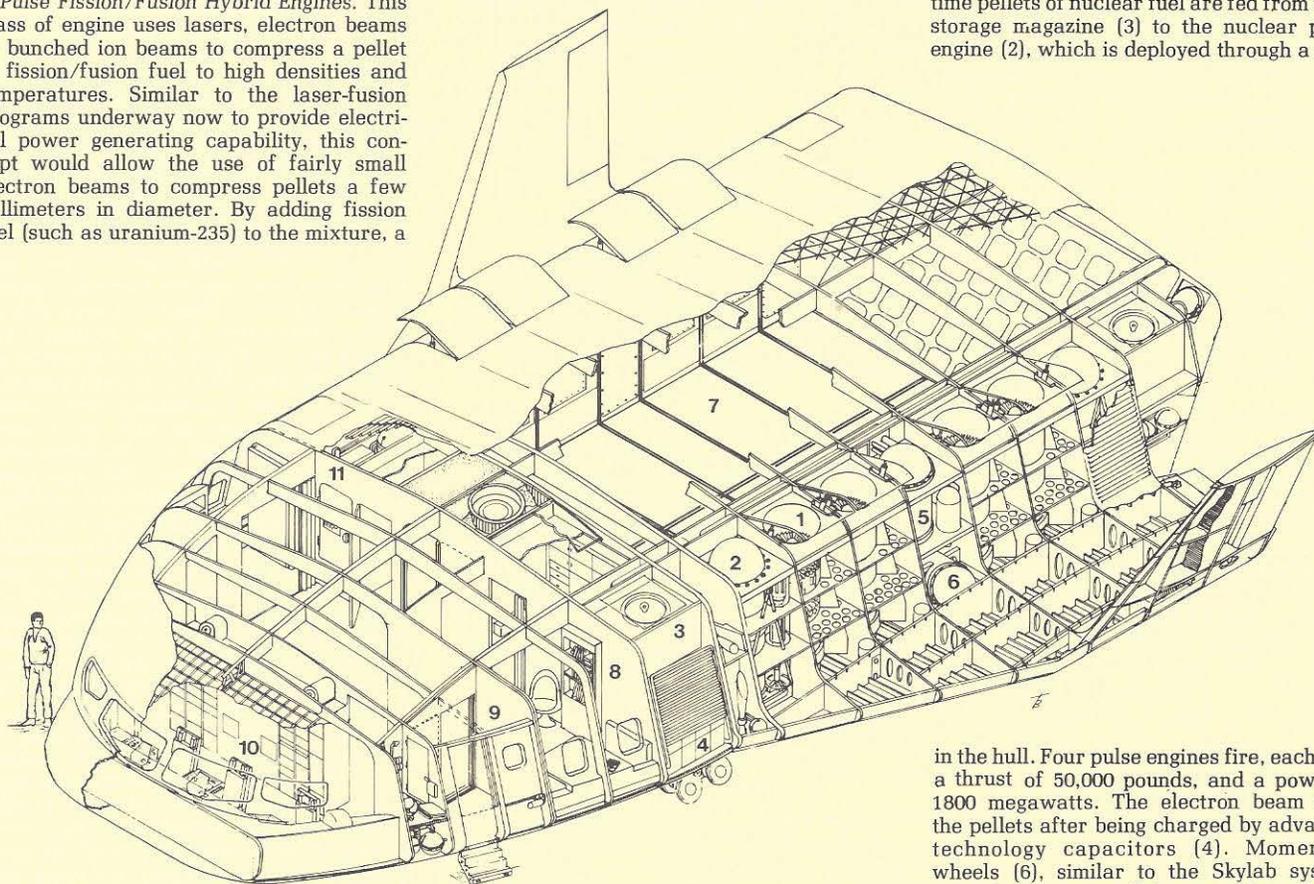
**Pulse Fission/Fusion Hybrid Engines.** This class of engine uses lasers, electron beams or bunched ion beams to compress a pellet of fission/fusion fuel to high densities and temperatures. Similar to the laser-fusion programs underway now to provide electrical power generating capability, this concept would allow the use of fairly small electron beams to compress pellets a few millimeters in diameter. By adding fission fuel (such as uranium-235) to the mixture, a

leading to total mission velocities of 500,000 feet per second in a single-stage configuration, without refueling. Fuel cost will be under a dollar per pound for payload delivered to the lunar surface. It appears to be the most promising engine design under study.

**Gaseous-Core Nuclear Engine.** First studied by NASA and the Air Force during the 1960's, this engine is a nuclear reactor which contains its fission fuel in a gaseous, or plasma state, rather than in conventional solid form. The advantage to this scheme is the temperature of the fissioning fuel can be much higher than solid fuel elements would allow. For example, the NERVA class nuclear rocket engine operated at less than 5000 degrees F., near the melting point of its solid core. A gaseous-core engine may have its fission fuel at 200,000 degrees F. The fuel must be separated from the engine walls, of course, and this is accomplished by clever container design, and a buffer flow of neon gas. Energy is transferred to the propellant (which can be hydrogen, ammonia or ordinary water) by radiation, rather than conduction or convection. In-

thought to be completely impractical. In 1975, however, Dr. Robert Forward of the Hughes Research Labs in Malibu, California, suggested in a paper on interstellar exploration that the antimatter need not be mixed with matter in equal proportions. By diluting the antimatter with 40 parts normal matter, it was possible to control the reaction, and make it usable in a rocket engine. Two primary problems need to be faced: 1) can we make antimatter in usable quantities?, and 2) can we store it safely? The answer to both questions appears to be a cautious affirmative, though much work will need to be done during the next few decades. However, the potential rewards are great: to carry the solar system spaceship in the illustration to the moon with 25,000 pounds of cargo would require less than 2 grams of antihydrogen.

The spaceship under study at Foundation masses 167,000 pounds at earth launch. Using 8 nuclear heated airbreathing engines (1), it can climb to nearly 30,000 feet. By employing a LIFTER style reactor (5), it can cruise or hover for long periods without fear of running out of fuel. At an appropriate time pellets of nuclear fuel are fed from their storage magazine (3) to the nuclear pulse engine (2), which is deployed through a door



bootstrapping effect makes the total energy input to the system less than that needed to trigger fusion in conventional fusion pellets. Neutrons from the fusion reaction trigger large-scale fissions in the uranium, which in turn liberates heat and high pressures which generate further fusions. It is believed that 1000 times more energy will be generated in the fuel burnup than is consumed starting the burn. The "microexplosion" which occurs is less than a ton-equivalent of TNT. By pulsing this explosion off the surface of a pusher plate, and absorbing the resulting shock with a momentum conditioner, it will be possible to impart a velocity to the ship. Performance of the engine is extremely high,

tense light from the fissioning fuel heats the propellant, which is then exhausted through a nozzle. Performance would be close to the pulsed fission engine, but the gaseous-core engine would be more complex, and would require large, very high temperature radiators.

**Diluted Antimatter/Matter Engines.** Most previous engine concepts which employed antimatter assumed that the antimatter and matter would be mixed in one-to-one ratios. The resultant products of the annihilation would be gamma rays. Since gamma rays are dangerous at nearly all energies, as well as exceedingly difficult to convert into thrust, the idea has long been

in the hull. Four pulse engines fire, each with a thrust of 50,000 pounds, and a power of 1800 megawatts. The electron beam fires the pellets after being charged by advanced technology capacitors (4). Momentum wheels (6), similar to the Skylab system, control orientation of the spaceship without fuel usage. Cargo is carried in a 28 foot long, 16 foot wide, 9 foot high bay (7), which the four man crew operates from the flight deck (10). Life support systems (11), a forward airlock (9) and a wardroom (8) round out the ship's facilities. Water propellant is carried in the wing and surrounding the engines. The vehicle is about 70 feet long and 50 feet wide.

While still conceptual, this advanced spaceship points the way to large scale commercial utilization of space. The Foundation study of engines, systems and economics will continue, with conclusions of the first year of study to be published as a Foundation Monograph this fall.

# news notes...

## POPULAR SCIENCE REPORTS OTRAG PLANS

CHAMBER OF COMMERCE AND SPACE...Washington...The February issue of *Nation's Business*, the official publication of the Chamber of Commerce, ran a ten page article on "Space: Industry's New Frontier". Timed to commemorate the launch of Explorer I, the first US earth satellite, the article was the second major cover story on space industry in a business publication over the last six months. (*Business Week* covered the story in nearly identical fashion on August 22, 1977.) The article emphasized near-term service aspects of space industry, like communications, but also dealt with space power stations, space manufacturing and space settlements. Copies of the article can be purchased from *Nation's Business*.

CISLUNAR SPACE INDUSTRY...Houston...The Ninth Lunar and Planetary Science Conference held a special session on the topic: "Industrial Development of Cislunar Space", on March 14 in Houston, Texas. Included were the following presentations: Refining Lunar Materials, Near Earth Resources, Resource Potential of the Central Highlands of the Moon, Electrostatic/Magnetic Separation of Lunar Materials, and An Environmental Impact Matrix of the Use of Extraterrestrial Resources. The full program will be published as a proceedings by the Lunar and Planetary Institute within the next year. Copies may be reserved by writing the Lunar and Planetary Institute, 3303 NASA Road #1, Houston, TX 77058.

SPACE UTILIZATION BIBLIOGRAPHY...Houston... A Selected Bibliography on Lunar and Space Colonies Space Utilization has been published as Lunar Science Institute Contribution No. 303. Compiled by Frances B. Waranius of the Library Data Center of the Lunar and Planetary Institute, it can be obtained by writing to the above address.

PEACESAT PROPOSAL...Santa Barbara...The Earthport Project is investigating the possibility of an international peace-keeping satellite system. Such an international space recon satellite would provide intelligence to all countries associated with the establishment of the system, but would be nongovernmental in nature. Besides its peacekeeping function, the satellite would have earth resources surveying equipment. While pictures from the peacekeeping portion of the satellite would be freely available, no definitive interpretations of the images would be offered. The Earthport Project is now studying ways that the system might be established. Other countries, including Switzerland, France and China, have proposed similar systems, and the OTRAG company has suggested surveillance satellites to potential Third World customers (see OTRAG article, this issue).

EARTHPORT GAINS MOMENTUM...Santa Barbara...Following the first phase of Earthport's approach to potential host countries for the establishment of the free trade zone/spaceport, several nations have responded encouragingly. Among the nations which have given positive responses or requests for further information are: Liberia, Nauru, Brazil, Indonesia, Rwanda, The Cook Islands, Panama, The Sudan, and Sierra Leone.

SHUTTLE TO HUNTSVILLE...The Shuttle Orbiter #101 (Enterprise) was delivered to the Marshall Space Flight Center by its 747 carrier aircraft last week. The Orbiter will undergo ground vibration testing through November of this year. Before being moved to the test site, the Orbiter was put on public display for two days, drawing a crowd of 85,000 observers. The Enterprise will not be the first Shuttle to fly in space, but will be refurbished for later space operations. Orbiter #102, now under construction, will be launched on an orbital mission in July, 1979.

The March, 1978 issue of Popular Science Magazine has done the most comprehensive article yet on Orbital Transport and Rockets, Inc. of West Germany. The OTRAG company has been attempting to develop low-cost private launch vehicles which would compete with existing expendable boosters and the Space Shuttle.

The six-page article is highly recommended for those who want a thorough overview of the OTRAG operation.

The Report is published monthly, and has a subscription price of \$20 per year (\$15 per year for students, \$25 per year for institutional and library subscriptions and \$25 per year for overseas airmail). Back issues are available at \$2 each from September, 1977. Xerographic copies may be substituted as stocks are depleted. Address all correspondence to Foundation, 85 East Geranium Avenue, St. Paul, MN 55117 or call (612) 489-4466. Editorial Direction: Gary C. Hudson; Special Assistance: Resident Fellows E. Anne Roebke and T.A. Brosz; Staff Artist: David Egge. The Foundation Report accepts VISA/BankAmericard and Master Charge. Please give us your full credit card number, expiration date, and the four digit Interbank number (Master Charge only). Your signature is also required on mail orders. Phone orders accepted at (612) 489-4466. No collect calls please.



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