FOUNDATION REPORT:

ADVANCES IN COMMERCIAL AND GENERAL SPACE DEVELOPMENTS

SPACE INDUSTRIALIZATION STUDY RESULTS RELEASED

Rockwell, Science Applications, Offer Space Use Strategy to NASA

Two eighteen-month studies on space industrialization have been completed for NASA by Rockwell International and Science Applications, Inc. Addressing both the "why" and "how" questions, these studies highlight world requirements and options concerning space for the next several decades.

Both studies believe that there is a major role for NASA in space industrialization, as well as for other governmental and international agencies. While industrial participation seems to be encouraged, and extensive use is made of cost/benefit analysis, it does not seem that the powerful role which can be played in space by private firms has been fully realized.

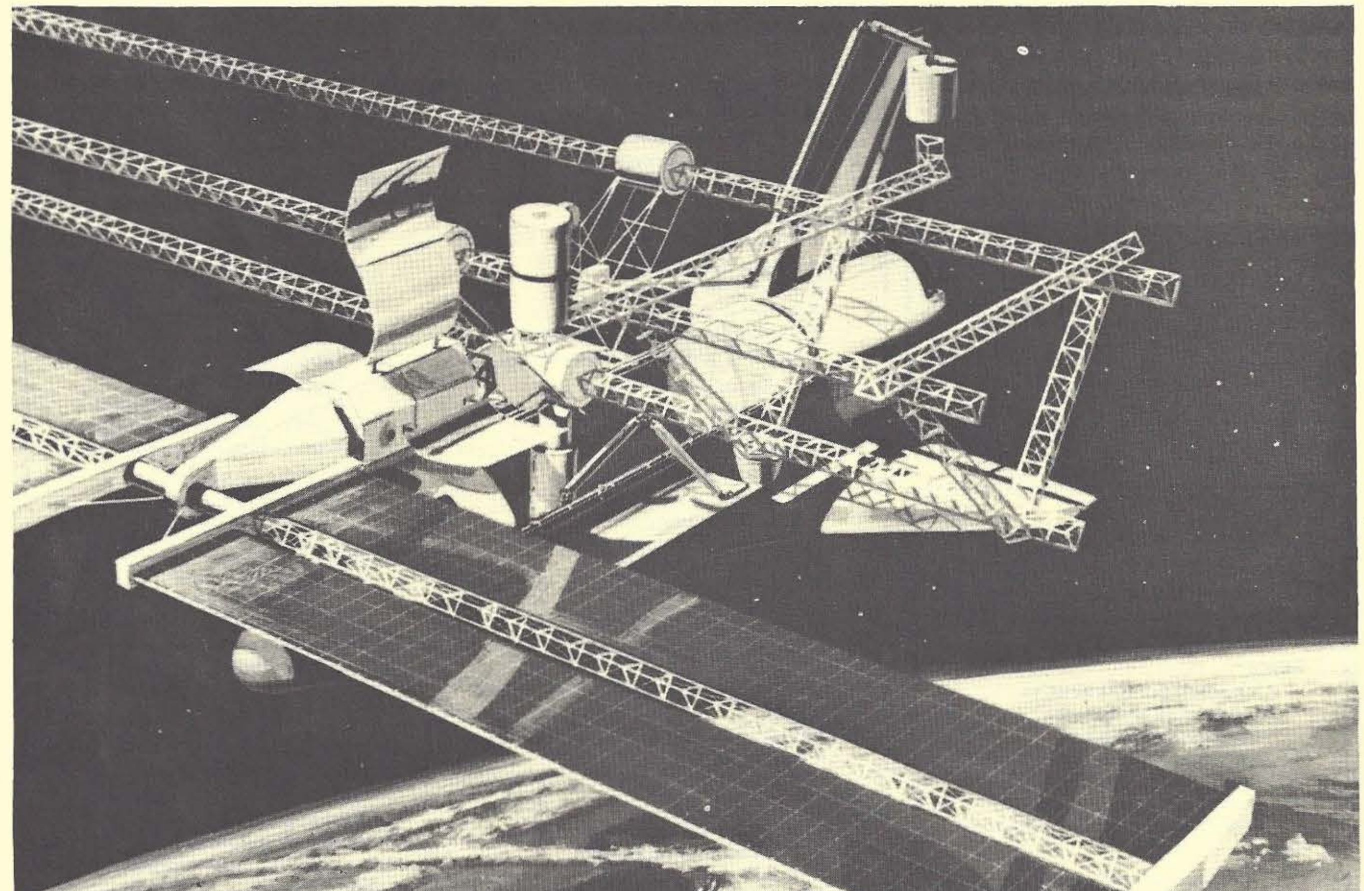
However, even with this shortcoming, the studies are very useful adjuncts to the already extensive literature on space industrialization potentials. They can be used to help convince investors that there is possibility for realistic returns from space industry.

This month in the *Report* we are profiling the Rockwell study, with the Science Applications investigation left for next month.

According to Charles L. Gould, Project Manager for the Rockwell Space Division study, the study "... highlights important future world needs and trends in which space can potentially play a part, and identifies the specific recommendations for the evolutionary industrialization of space." The problem, as he sees it is "... as we look toward the turn of the century, many people see an increasingly bleak future ..." while the Rockwell team asked itself: "Does space offer at least a partial solution, and if so, what is it?"

Krafft Ehricke, former chief scientist at

(Below) This Rockwell illustration shows an "add-on" power supply and space manufacturing module attached to the Space Shuttle Orbiter. This manufacturing module could be used in demonstrations of beam-building for large space structures or for materials processing in space activity.



the Space Division, believes space offers the major solution in the long run, while Gould feels that space is exceeded only by food and energy in long-range importance to mankind.

As a practical matter, however, long range solutions to overall world problems do not have easy access to the marketplace or a large constituency. The Rockwell study was funded by the taxpayer, Gould points out, who has a primary interest in the here and now. The taxpayer is interested in jobs—his—and his standard of living. Those people which satisfy those interests, like government officials, tend to get elected. Thus there seems to be a powerful negative force against long-range planning.

However, viability in the marketplace generally depends on long range planning, along with access to low-cost energy and high productivity. The marketplace is of vital importance in our consideration of space

Table 1. Attractive Opportunities in the Services Area

Communications

Information Relay
- Direct TV broadcast
- Electronic mail
- Education broadcast
- Rural TV
- Meteorological information dissemination
- Interagency data exchange
- Electronic cottage industries
- World medical advice center
- Centralized "distributed" printing systems
- Environmental information distribution
- Time and frequency distribution

Personal Communications
- National information services
- Personal communications wrist radio
- Voting/polling wrist set
- Diplomatic U.N. hot lines
- 3-D holographic teleconferencing
- Mobile communications relay
- Amateur radio relay
- "Telegraphing" personal communications systems
- Worldwide electronic ping pong tournaments
- Central computer service (for transmitting hand-held calculators)
- Urban/police wrist radio

Disaster Warning
- Disaster warning relay
- Pre-disaster data base (earthquake)
- Earthquake fault measurements
- Disaster communication set

Navigation, Tracking, and Control

Navigation
- Public navigation system
- Global position determination
- Coastal navigation control
- Global search and rescue locator

Tracking and Location
- Implanted sensor data collection
- Wild animal/waterfowl surveillance
- Marine animal migrations
- Vehicular speed limit control
- Rail anti-collision system
- Nuclear fuel locator
- Vehicle/package locator

Traffic Control
- Multinational air traffic control radar
- Surface ship tracking

Border Surveillance
- U.N. truce observation satellite
- Border surveillance
- Coastal anti-collision passive radar

Land Data

Agricultural Measurements
- Soil type classification
- Crop measurement
- Crop damage assessment
- Global wheat survey
- Crop identification/survey
- Agricultural land use patterns
- Crop harvest monitor
- Range land evaluation
- Crop stress detection
- Soil erosion measurement
- Agricultural acreage survey
- Soil moisture measurement
- Soil temperature monitor

Forest Management
- Timber site monitoring
- Logging residue inventory
- Forest stress detection
- Forest fire detection
- Rural/forest environment hazards
- Lightning contact prediction/detection

Hydrological Information System
- Snow moisture data collector
- Wet lands monitor
- Tidal patterns/flushing
- Water management surveillance
- Irrigation flow return
- Run-off forecasting
- Inland water/ice cover
- Subsurface water monitor
- Water resource mapping
- Soil moisture data collector
- Irrigation acreage measurement
- Aquatic vegetation monitoring
- Underwater vegetation survey
- Lake/river suspended solids
- Sediment measurements (rivers)
- Flooded area monitoring

Land Management
- Land capability inventory
- Land use mapping
- Wild land classification
- Range vegetation mapping
- Rangeland utilization/population
- Flood damage assessment
- Beach erosion

Pollution Data
- Advanced resources/pollution observatory
- Salt accumulations (irrigation)
- Agricultural pollutant monitoring
- Lake eutrophication monitor
- Great Lakes thermal mapping
- Effluent discharge patterns
- Toxic spill detector
- Air quality profilometer
- Air pollutant chemistry (Freon)
- Pollution detection and distribution
- Mosquito control (wetlands flooding)

Resource Measurements
- Oil/mineral location
- Drilling/mining operations monitor

Geographic Mapping
- Urban/suburban density
- Recreation site planning
- High-resolution earth mapping radar
- Wildland vegetation mapping
- Offshore structure mapping

Weather Data
- Atmospheric temperature profile sounder
- Rain monitor

Ocean Data
- Ocean resources and dynamics system
- Marine environment monitor
- Oil spill
- Shoreline ocean current monitor
- Algae bloom measurement
- Saline intrusion

Global Environment
- Glacier movement
- Ozone layer replenishment/protection
- Highway/roadway environment impact
- Radiation budget observations
- Atmospheric composition
- Energy monitor, solar terrestrial observatory
- Tectonic plate observation

Table 2. Attractive Opportunities in the Products Area

Organic
- Isozymes
- Genetic engineering of hybrid plants
- Urokinase
- Insulin
- New antibiotics via rapid mutation

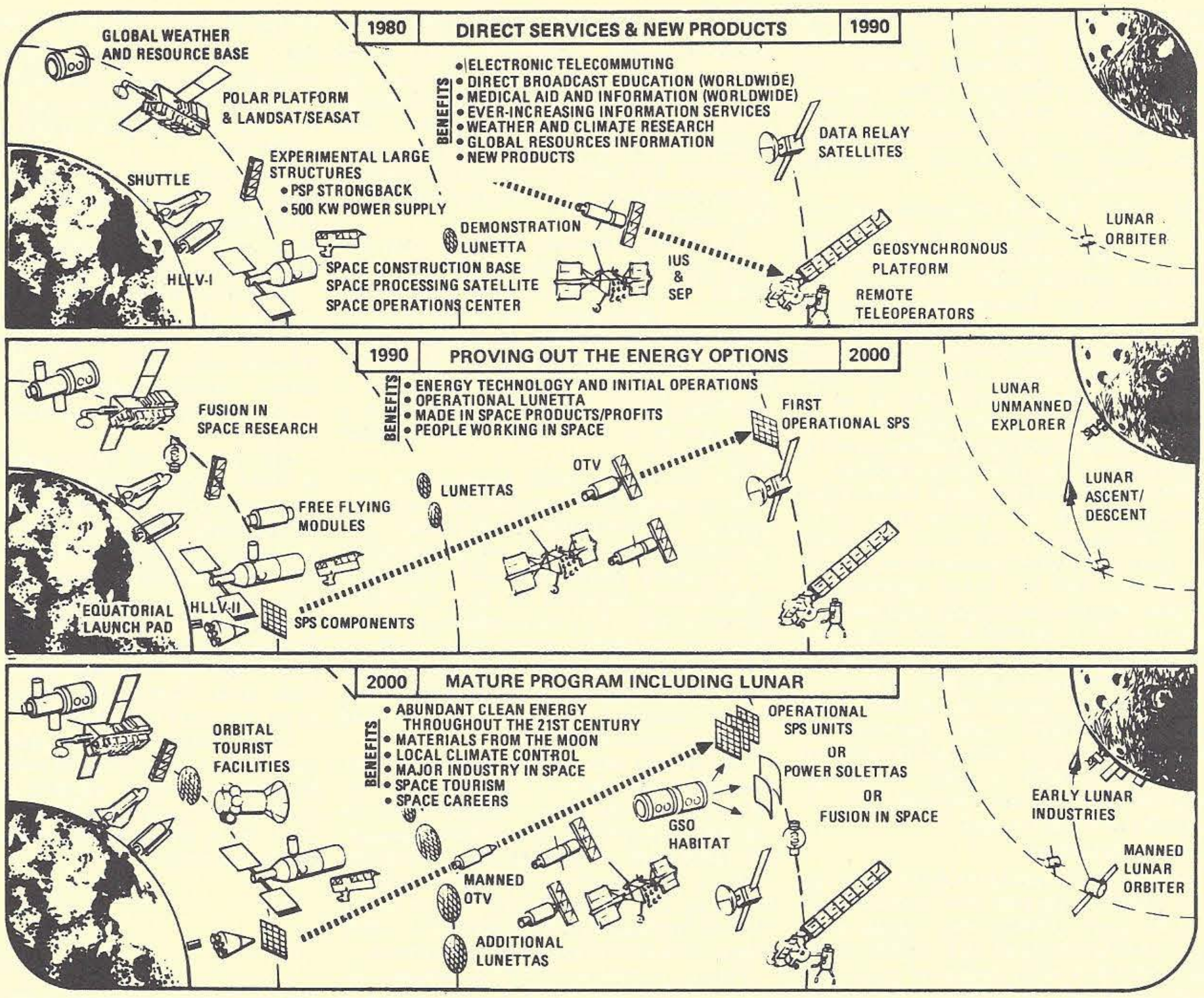
Inorganic
- Large crystals
- Super-large-scale integrated circuits
- Transparent oxide materials
- Surface acoustic wave devices
- New glasses (including fiber optics)
- Tungsten X-ray target material
- Hollow ball bearings
- High-temperature turbine blades
- Separation of radioisotopes
- High strength permanent magnets
- Magnetic bubble memory crystal film
- Thin film electronic devices
- Filaments for high-intensity lamps
- Aluminum-lead lubricated alloys
- Continuous ribbon crystal growth
- Cutting tools
- Fusion targets
- Microspheres

Table 3. Attractive Opportunities in the Energy Area

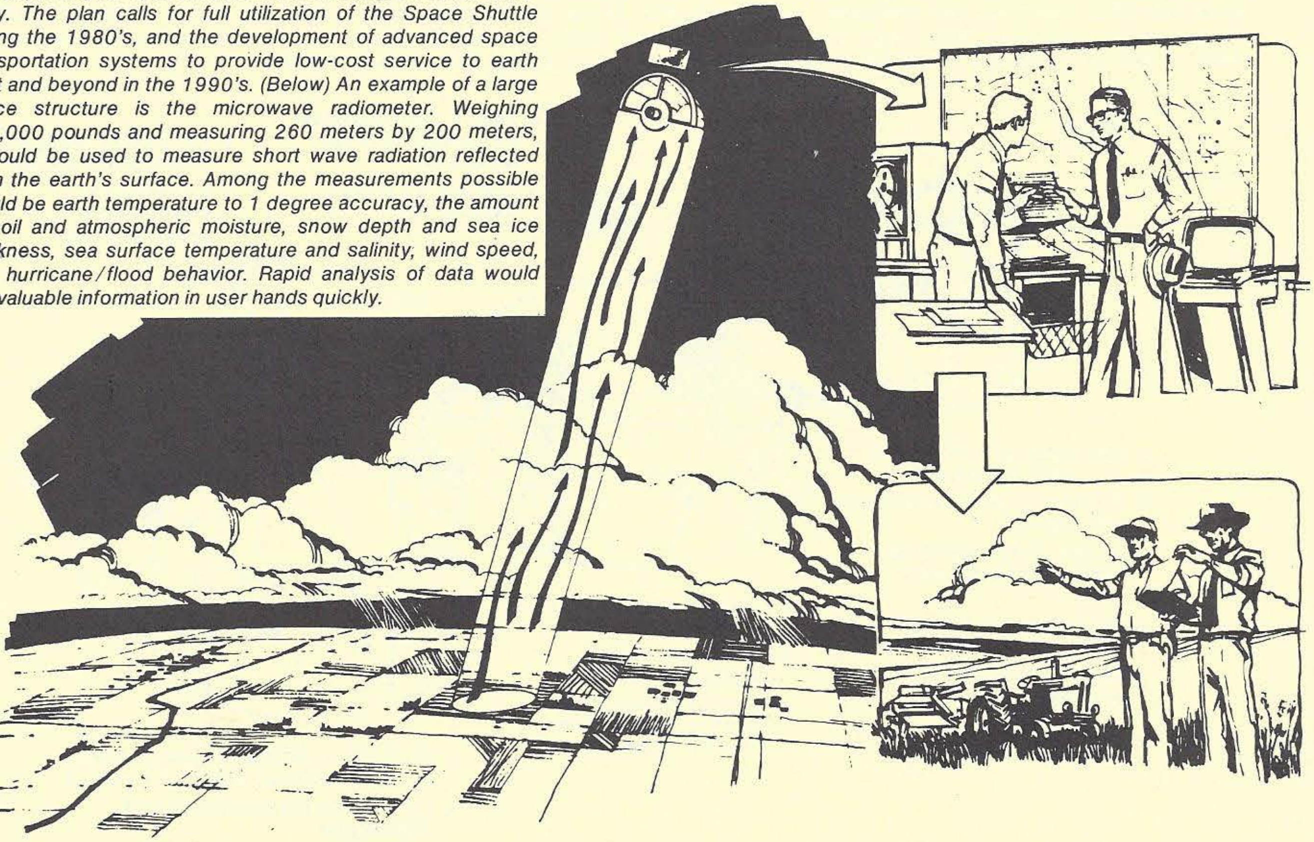
Lunetta
- Night illumination for urban areas
- Night illumination for argiculture and industrial operations
- Night illumination for disaster relief operations

Soletta
- Night frost damage protection
- Local climate manipulation
- Reflected light for ground electricity conversion
- Ocean cell warning for climate control
- Controlled snow-pack melting
- Stimulation of photosynthesis process

Other
- Satellite power system (solar)
- Fusion in space
- Nuclear waste disposal



(Above) Multiyear space industrialization program option summary. The plan calls for full utilization of the Space Shuttle during the 1980's, and the development of advanced space transportation systems to provide low-cost service to earth orbit and beyond in the 1990's. (Below) An example of a large space structure is the microwave radiometer. Weighing 500,000 pounds and measuring 260 meters by 200 meters, it would be used to measure short wave radiation reflected from the earth's surface. Among the measurements possible would be earth temperature to 1 degree accuracy, the amount of soil and atmospheric moisture, snow depth and sea ice thickness, sea surface temperature and salinity, wind speed, and hurricane/flood behavior. Rapid analysis of data would put valuable information in user hands quickly.



industrialization and its ramifications. The marketplace first serves as a source of requirements and investment capital, and later, of course, is the place where a product is sold. The world marketplace was of fundamental importance to the Rockwell investigators, along with the balance of payments between nations.

The export of high technology services and products which space can provide can help the United States relieve future balance of payment deficits, while at the same time expanding the world marketplace. The study notes that world poverty deprives us of a market of two billion people (at least three billion by the end of the century). This means that United States investments in space should be aimed at providing economic growth and increased purchasing power to as many developing countries as possible.

With these thoughts in mind, the Rockwell study began with two parallel paths. First, one path looked into the future for trends and needs of the world marketplace, and the second searched for space opportunities that technological forecasting could foresee. Ultimately, this resulted in six major program options, driven by use of the Space Shuttle, technology, and program cost.

The program options range from crisis reaction to a "play-it-safe" approach. All the programs include space industrialization activities like services, products, energy, human activities and lunar industry.

Overall Conclusions and Recommendations

While the study points out that forecasting as far ahead as the year 2010 is always suspect, Rockwell investigators believe some trends are fundamental. One of these is the predictability of some degree of population growth and where the people will be located. Barring major catastrophies, the vast majority of the people of the world will be in developing countries. The relationship between the industrialized countries and developing countries is of paramount importance, because of the vast numbers of people and their major raw material resources. The evolution of this relationship is one of the major determinants shaping national as well as global futures. The industrial utilization of space is important to the nation, and facilitates the advancement of developing countries. It is both technologically feasible and economically rewarding on a need/market oriented basis.

The most immediate rewards and the most favorable investment conditions in the 1980's are in the service area, both for information transmission and acquisition. In both cases the number of market opportunities is particularly large, while the capacity to realize them can be met by a relatively small number of systems due to a high degree of commonality made possible by the Shuttle.

The Shuttle/Spacelab combination provides an early first step toward a general-purpose manufacturing R&D facility. The prospects for meaningful production levels of promising biochemical and directional solidification products by the mid-1980's are promising. Their development should be pursued vigorously, since these products are needed, contribute to U.S. pharmaceutical and technological leadership (and, hence, enhance U.S. export capability) and are profitable to produce.

The energy area offers three near-term benefits (1984-1990): (1) products for use on earth that help either conservation or the identification/exploitation of new deposits; (2) generation of solar-electric power for in-space use, especially services and manufacturing (25-250 kwe); and (3) use of reflectors for night lighting (Lunetta) of urban areas, agricultural and other applications.

Energy, of course, is the key to many aspects of the creation of wealth. Potential shortages in many things, including materials, can be related in the long run to the cost of energy. Space has enormous long-range benefits. These are in three categories: reflected light, intercepted light converted to microwave energy, and nuclear energy in space. The largest benefit potential is long-range (1990's). There is a strong competing terrestrial potential in the form of "clean" breeder reactors and fusion reactors which can mature in the same period of 1995-2010.

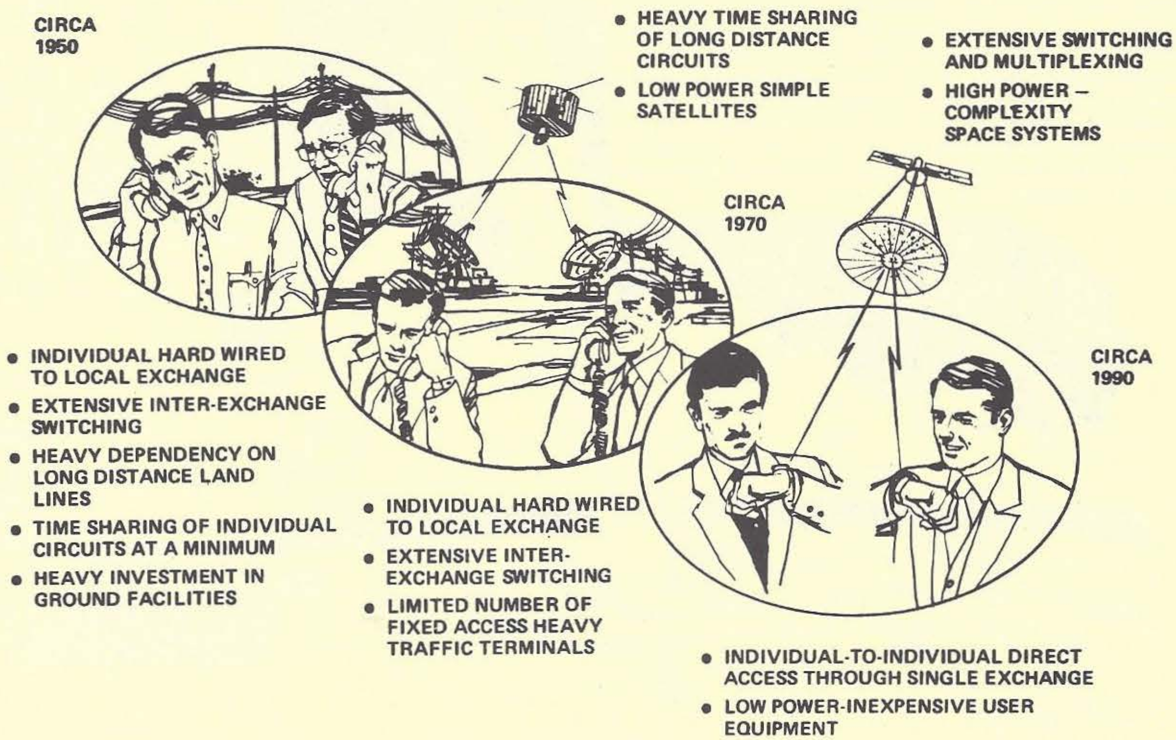
The development of operational techniques in orbit for assembly, handling, and maintenance of large structures (beyond sizes needed for large antennas) should be undertaken early in the 1980's.

Because of its great potential for advancing and economizing space industrialization, plasma research in orbit should be initiated early with the objective of generating controlled fusion power in orbit and on the moon and/or aiding terrestrial fusion research.

The initiation of lunar industrialization is likely to spring from needs associated with large space projects where advantage can be taken of the weak lunar gravity field. The largest potentials in this context are the SPS and Soletta structures. Associated with these are significant transportation requirements. If oxygen/hydrogen propulsion is used from near-earth space on out, large amounts of oxygen must be delivered from earth. In this case, lunar oxygen can be an attractive substitute.

Space industrialization should not be viewed as a competitor to science and exploration; rather, a vigorous space industrialization program can be the main impetus upon which an expanding science program can be carried. □

(Below) Complexity inversion concept as applied to personal communications. Use of the complexity inversion concept means relative freedom of choice in geographical location of user; easy access to data, computation capability and other people; and larger world markets.



CONCEPTUAL COMMUNICATION SERVICES SATELLITE

As one of the hardware initiatives of the Space Industrialization Study conducted by the Space Division of Rockwell International, a conceptual communication/information services satellite was proposed. Such a multimission platform has had other proponents, most notably Edelson and Morgan of COMSAT laboratories (*Report,* October, 1977). Using the principle of complexity inversion (see facing page), the platform would both provide new services and relieve crowding of select, high value orbital positions at geosynchronous locations.

The platform would provide five new services:

1) Direct-Broadcast TV. (Five nationwide channels, 16 hours per day.) In effect, such a system would add five new networks of broadcast capability, probably of educational and specialized programming. The consumer would need a one-meter rooftop antenna and a converter costing about $100 to receive the satellite transmissions.

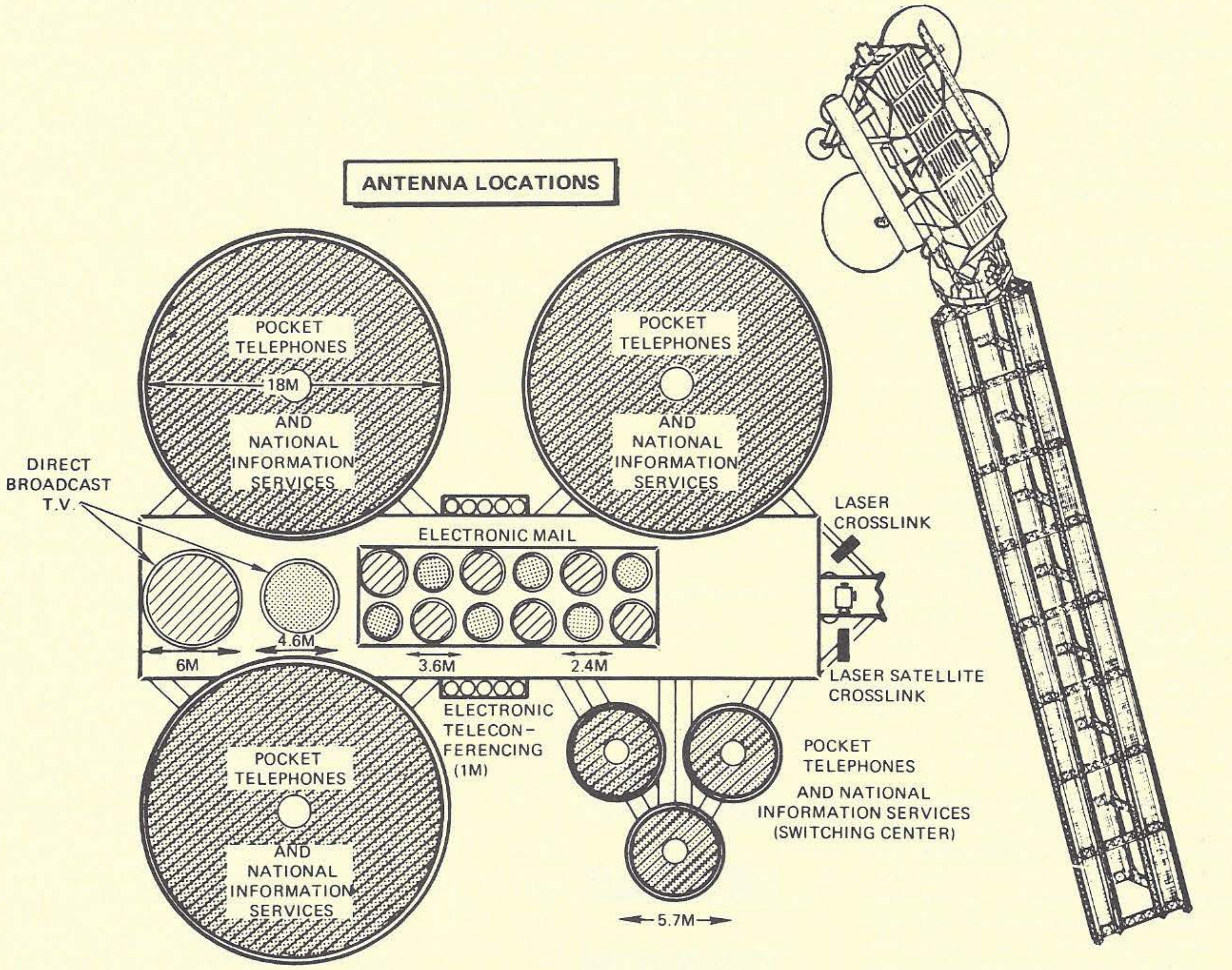
2) Pocket Telephones. (45,000 private channels linked to the present phone system.) The user sets would be the size and cost of a good pocket calculator and would allow direct communications with any person in the continental US who owned a similar set, even if the exact location of the receiver was unknown. Calls could be made to and from conventional telephones, and would cost 20 cents each.

3) National Information Services. (This system would use the pocket phones hardware.) With the cost of nationwide calls reduced to an affordable level, each subscriber would have access to national, rather than local data, people, calculating power, etc. Many small businesses would supply specialized national data banks and other imaginative services.

4) Electronic Teleconferencing. (150 two-way voice, video and facsimile channels.) This system would allow for as many as 150 color video teleconferences between anyone in the country. Multiple teleconferences from several locations at one time would also be possible. Such a service has already been demonstrated by the Canadian-US CTS communication satellite.

5) Electronic Mail. (40 million pages transferred among 800 sorting centers overnight.) The mail would be sorted by zip code or even internal mail codes of industries. Large companies would have fiber optic or microwave relays connected to the nearest sorting center.

The satellite would weigh 60,000 pounds and would have to be specially constructed in earth orbit. □



FIRST PIONEER VENUS LAUNCHED, SECOND PROBE TO FOLLOW

First Dual Planetary Probe Mission to Study Venus' "Weather Machine"

NASA has launched the first of two spacecraft toward Venus this month for a detailed scientific study of that cloud-shrouded planet.

Pioneer Venus 1, an orbiter, will reach Venus on December 4, 1978, and Pioneer atop an Atlas Centaur rocket. All systems are operating as planned.

The second spacecraft, Pioneer Venus 2, will be launched toward the planet in three months, about August 7.

Pioneer Venus 1, an orbiter, will reach Venus on December 4, 1978, and Pioneer Venus 2, a multiprobe spacecraft, will arrive five days later after splitting into a bus and four atmospheric entry probes, 13 million kilometers (8 million miles) and 20 days out from the planet.

The flights may shed new light on some of the most puzzling questions in planetary science, such as the following:

- Why do two planets with about the same mass, probably formed out of similar materials and situated at comparable distances from the Sun, have atmospheres that have evolved so differently?
- Why is the surface of Venus baked by a searing heat, while Earth luxuriates in a climate friendly to life?

The answers to both of these questions depend on an understanding of the factors that govern the evolution of a planet's atmosphere.

Information gathered by the two instrument-laden Pioneers at Venus may also help us learn more about the forces that drive the weather on our own planet.

The flights are the first ones devoted primarily to a study of the atmosphere and weather of another planet on a global scale. They will employ the largest number of vehicles ever used in such studies, and make measurements at the greatest number of locations.

The flights also will seek to learn more about the characteristics of Venus's upper atmosphere and ionosphere, as well as the lower atmosphere. They will study the interactions of these regions with the solar wind—the continuous stream of ions and electrons flowing outward from the Sun—and the solar magnetic and electric fields.

Circling the planet for at least eight months, the Pioneer Venus Orbiter will make the longest observations yet of Venus. It will be the first U.S. spacecraft to orbit the planet.

To reach Venus, the Orbiter will fly more than half way around the Sun on its seven-month journey, some 300 million miles, traveling outside the Earth's orbit for the first three months, and inside it for the last four months. This wide-swinging flight path will allow a slower approach to the planet, permitting a smaller orbital insertion motor and more spacecraft weight.

At Venus, the Orbiter will follow a highly-inclined (75-degree), 24-hour orbit planned so that spacecraft events are timed with those on Earth. At periapsis (orbital low point), the spacecraft will dip as low as 90 miles altitude, entering Venus' thin upper atmosphere. Its orbital high point or apoapsis will be 41,000 miles from the planet.

The Orbiter will make daily pictures in ultraviolet light of Venus' clouds for studies of their four-day rotation.

Experimenters will use precise orbit measurements to chart Venus' gravity field for calculation of planetary shape and density variations. The 12 Orbiter scientific instruments will make a variety of other remote-sensing and direct measurements of the planet's atmosphere and surrounding environment.

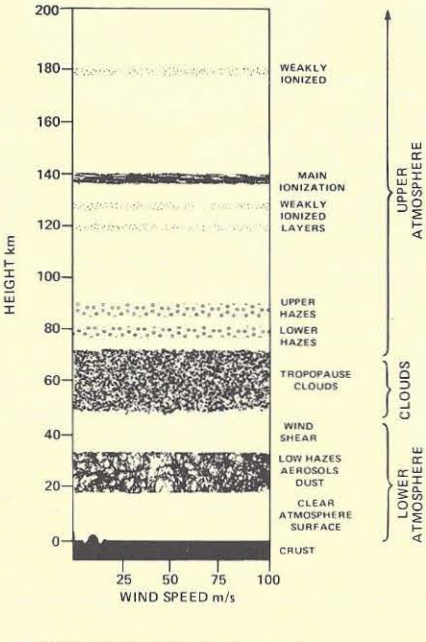
The Orbiter's primary mission of eight months in Venus orbit will cover one complete rotation of Venus on its axis—243 Earth days. It circles the Sun in 225 days.

The Orbiter's companion spacecraft, the Multiprobe, is made up of a transporter Bus, a Large Probe and three identical smaller probes.

These spacecraft, including the Bus, will enter at points spread over Venus' entire Earth-facing hemisphere, about 6,000 miles apart. The Bus will obtain data on the composition of the upper atmosphere before burning up. The other four probes will measure the atmosphere from top to bottom as they fly down to Venus' searing surface. The probes are not designed to survive after impact.

Scientists believe that these coordinated atmospheric missions combined with similar ones to Mars, Jupiter and other planets, will lead to a better understanding of atmospheric mechanisms in general. Studies of the interactions of temperatures, pressures, composition, clouds and atmospheric dynamics different from Earth's should provide insights into important mechanisms which are often prominent on just one planet. Such findings may help us better understand the Earth atmosphere and its complex weather machine.

VENUS ATMOSPHERE



Scientists think Venus may be an unusually good place to study the mechanics of atmospheres because the planet rotates slowly and there are no oceans. The atmosphere appears to be a relatively "simple" weather machine, and the important atmospheric circulation motions appear to be global. Hence, continuous measurements from orbit, combined with those of the probes from many points in the atmosphere, could provide at least a rough picture of Venusian weather processes.

The Orbiter spacecraft, like the Multiprobe bus, consists principally of a spin-stabilized, 8-foot-diameter, flat cylinder containing most spacecraft systems.

Above the cylinder, on a 10-ft. mast aligned with the spin axis, is the despun, narrow-beam, parabolic dish antenna. The dish is used for high-speed data transmission and faces toward the Earth throughout the mission, while the spacecraft spins beneath it.

Within the cylinder is a thermally-controlled equipment compartment, which houses the 12 Orbiter scientific instruments, a million-bit data memory and the communications and data-handling systems. Other Orbiter systems are the Sun and star sensors for spacecraft orientation; thrusters to make spin-rate, orientation and course corrections; the solid-fuel orbital insertion motor; and the battery and power system. The exterior of the cylinder is coated with power-generating solar cells. A 15-ft. boom extends radially outward to place two magnetometer sensors beyond spacecraft magnetic fields.

The Orbiter's launch weight is about 1,280 pounds with 100 pounds of scientific instruments. Weight in orbit after motor burn will be 820 pounds.

The Orbiter's destination, Venus, is the second planet from the Sun, and the closest one to Earth. Because of its highly reflective cloud cover, Venus is the brightest object in the sky after the Sun and the Moon. Its year is 225 Earth days. Its mean distance from the Sun is 67.2 million miles. This is nearly three-quarters of Earth's distance from the Sun.

When Venus is closest to Earth, directly between Earth and Sun, the planet is only 26 million miles away. While Earth and Venus are almost twins in size and mass, they are extremely different in other ways. Earth is a water-rich planet on which life thrives. Venus is a dry and desolate world, apparently without life. Scientists want to know how two similar planets can evolve so differently and if there is any chance of Earth becoming like Venus.

Available evidence suggests that Venus has a dramatically rugged surface, but it is less mountainous than Earth and Mars. Its surface temperature is hotter than the melting points of lead and zinc, about 900 degrees F., and the atmospheric pressure is about 100 times that of Earth. Surface features on Venus can never be seen because of its permanent cloud cover. The atmosphere of Venus appears to be predominately carbon dioxide—about 97 percent. Only minute amounts of water vapor have been detected in it.

Venus has no significant magnetic field. So the planet's upper atmosphere interacts directly with the solar wind. Venus is one of the three planets in our solar system which has no moons, the others being Mercury and Pluto.

The mass, diameter and mean density of Earth and Venus are almost identical. Venus' high overall density suggests a dense core something like Earth's nickel-iron core.

Venus receives almost twice as much solar radiation as Earth. But without the trapping of solar heat by its atmosphere, the planet's polar regions would have habitable temperatures. This trapping is called a greenhouse effect, which means that Venus' atmosphere allows passage of incoming solar radiation, but restricts radiation of heat outward.

The temperature at the poles of Venus is only about 18 degrees F. less than that at the equator. Both its day and night hemispheres have the same temperature. Hence, Venus' massive atmosphere contains circulation mechanisms which distribute solar heat evenly over the whole planet.

In addition to carbon dioxide and water traces, Venus' atmosphere also has some carbon monoxide, hydrochloric acid and hydrogen fluoride.

Venus' permanent clouds are very tenuous, something like terrestrial smog. They are almost twice as deep as Earth's cloud layer, about 11 miles thick and are believed to be composed mainly of sulfuric acid droplets.

Somewhere below the bottom of the main cloud layers, the temperature becomes great enough for the sulfuric acid droplets to evaporate into water vapor and sulfuric acid vapor. A clear atmosphere results. Enough sunlight gets through the clouds so that the surface appears as bright as on an overcast day on Earth.

From the Mariner cloud photographs in ultraviolet light, it appears that the stratosphere of Venus is in continuous high-speed motion. The clouds seem to move about 220 mph, circling the planet in four Earth days. However, the Soviet Venera landers showed that wind speeds in the deep atmosphere are extremely slow. In the region between atmosphere top and bottom, an abrupt change in wind velocity appears to take place. This seems to occur at about 36 miles above the surface, between the base of the clouds and the clear atmosphere below them.

Some major questions relating to Earth and Venus are these:

• Like Venus, the Earth has a "greenhouse effect" which appears to be growing due to increases in carbon dioxide in our atmosphere. These increases come from large-scale burning of fossil fuels since 1850. Could the Earth's greenhouse effect become strong enough to cause serious, permanent rises in temperature?

• Since Venus presumably formed as close to Earth as it is today, we might expect Venusian oceans like our own. Yet there is almost no water on Venus. Where did the water go, if it ever existed?

One theory is that greater solar heating vaporized any oceans, and forced water vapor into the stratosphere. There it would have split into hydrogen and oxygen by solar

continued on page 38.

news notes...

SPECIAL SPACE AD SECTION...New York...Business Week magazine, a McGraw-Hill publication with 780,000 subscribers, will run a special advertising section in it's September 25th, 1978 issue on the topic of Space Industrialization. The special section will contain text written by the world's leading authorities on space, as well as advertising from companies affiliated with the building and use of the Space Shuttle. According to Business Week, the section will illustrate the values of industrialization in space with 24 pages of display ads and 12 pages of text. The objectives of the section are: 1) to reach potential new users of space to inform them of the availability of the Shuttle and the potential benefits from the application of space industrialization to the development of new products, processes and services for business; 2) to provide a description of existing space technology from the businesses that contributed to the building of the Space Shuttle, from the businesses which will use the Shuttle to launch satellites, and from the businesses that build satellites; 3) to develop qualified sales leads for companies that advertise in this section; and 4) to inform Business Week's readers of the potentials of space industry. Among the contributors to the article will be John F. Yardley, Associate Administrator of the Office of Space Flight, NASA (writing on the Space Transportation System - A Public Investment), Congressman Don Fuqua (D-Florida) (writing on NASA's Scientific, Research and Development Role in Business Uses of Space), and Gary C. Hudson, Foundation, (writing on National Security and Space: The Business Implications). Additional topics will include the Commercial Uses of Space, A Forecast of State and Local Government Uses of Space - New Business, and Advanced Materials Processing Technology - New Products from Space. Business Week has already published a seven-page article on space industry as a cover story in the August 22, 1977 issue.

ROCKWELL FUTURES...The May 29 issue of Business Week magazine reported on Rockwell International's corporate strategy, concentrating on Rockwell's consumer business ventures but noting "One place Al Rockwell is sure his company will continue to go is into space...Rockwell has plans to capitalize on its orbiter and satellite experience through the eventual industrialization of space - manufacturing in a weightless, sterile environment, for example. And Al Rockwell sees the space shuttle program providing profits for Rockwell until at least the end of this century."

OTRAG DEVELOPMENTS...Zaire...It is not known if the recent invasion of Shaba province by rebels opposed to the rule of President Mobutu of Zaire will affect the planned second flight of the OTRAG modular launch vehicle. This flight, which is to test the staging theory of the booster, was scheduled for June. The fighting in Shaba was some 250 miles south of the OTRAG launch site.

NEWS NOTES continued...

NEWS NOTES continued...

FOUNDATION ARTICLE PUBLISHED...Boston...An article titled "The Commerce of the Solar System" has been published by Galileo magazine as "Beyond Earth" in the May, 1978 (#8) issue. The article, condensed from an essay in the forthcoming book "Beyond Earth" by Gary C. Hudson, is a discussion of the need for advanced transportation systems for the large scale industrialization of space. It includes a discussion of Solar System Spaceships similar to the article which appeared in the Report in the April 1st, 1978 issue.

CORRECTION...The Report has been advised by the Earthport Project that their press release titled "Astronaut to Lead Site Visit Group" (Report, May, 1978) was in error. The sixth paragraph should read: "Chapman became a scientist-astronaut in 1967 and helped prepare for the Apollo 14 mission in 1970. His responsibility included crew training and coordination experimentation."

FOUNDATION CONTRACT...St. Paul...Foundation has been awarded a contract to prepare educational material for the NASA Marshall Space Flight Center in Huntsville, Alabama. The material will assist NASA staff in their attempts to educate the U.S. business community concerning the progress and potentials of Space Processing of Materials.

PAPER TO BE PRESENTED...St. Paul...A paper titled: "Advanced Propulsion Systems and Solar System Spaceships" will be presented at the Propulsion II symposium of the International Astronautical Federation meeting in Dubrovnik, Yugoslavia by Gary C. Hudson. The eight day meeting, beginning October 1st, 1978, is an annual international space conference reporting progress in astronautics from all countries and future plans.

SPACE, EARTH PHOTOS...California...Pilot Rock, Inc., a California based firm, is offering more than 30,000 images from earth sensing and other NASA observational programs for sale to the general public. Covering topics from oceanography to urban land use, the photos can be purchased individually or in sets with handbooks for educational purposes. A catalog is available from Pilot Rock, Inc., P.O. Box ZZ, 934 H St., Arcata, CA 95521, or call (707) 822-4851.

NASA COMMERCIAL BROCHURE...Huntsville...A brochure is available from the Commercial Processing in Space Development Task Team at the Marshall Space Flight Center titled: "Commercial Materials Processing in Space...A New Horizon for Industry." The brochure answers the questions: What makes the space environment unique?; What are some of the applications of the observed phenomena in space?; What is NASA doing to facilitate commercial use of space for materials processing?; and, What avenues are open to commercial firms interested in space processing? Information about the NASA program and a copy of the brochure can be obtained from Commercial Space Processing Development, Mail Code PF 12, Marshall Space Flight Center, AL 35812. Telephone: (205) 453-4880.

SHUTTLE COSTS SCARE EUROPEANS...Washington...The Director of West Germany's Dept. of Space and Transportation testified before a House committee that costs for the Shuttle/SpaceLab combination are ruling out participation by private German firms in early space processing activities.

PIONEER VENUS

continued from page 37.

ultra-violet radiation. The light-weight hydrogen would then have escaped to space leaving the oxygen behind. But there seems to be so little free oxygen left, that scientists wonder where it all went.

NASA's Office of Space Science has assigned project management of the two Pioneer Venus spacecraft to Ames Research Center, Mountain View, Calif., and the spacecraft will be controlled continuously from the Mission Operations Center at Ames. The spacecraft were built by Hughes Aircraft Co., El Segundo, Calif., and the scientific instruments were supplied by NASA centers, other government organizations, universities and private industry. □

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