MARSBUGS:

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HORIZON 2000 PLUS: A BOLD AND VISIONARY ESA SCIENTIFIC PROGRAMME RECOMMENDED BY EUROPEAN SCIENTISTS FOR THE NEXT CENTURY

ESA press release

At its ministerial meeting in Granada in 1992, the ESA Council asked for a plan to be drawn up setting out space science objectives once Horizon 2000 has been completed. Work on this plan culminated in a meeting in Rome from 29 September to 1 October 1994 bringing together the ESA Executive and a Survey Committee, composed of European scientists and chaired by Professor Lodewijk Woltjer. The plan finalized in Rome followed extensive preparatory effort involving scientists from throughout Europe, various ESA working groups and five "topical teams" covering the areas of solar system exploration, astronomy and fundamental physics. In June 1993, the

scientific community (more than 2500 European scientists) responded massively to a call for mission concepts, proposing some 110 new ideas illustrating trends in space science for the next century and representing that community's main areas of interest. Fourteen concepts were submitted by US scientists.

The program, called Horizon 2000 Plus, covers some ten years and is concerned with missions beyond 2006. It is designed as a rolling program, thereby ensuring continuity and coherence with the objectives of Horizon 2000. The program, drawn up by the Survey Committee, seeks to combine vision and realism. It identifies major scientific trends and makes full use of European space facilities and predicted progress in new technology applications. It addresses such exciting topics as:

- cosmology, the origin of the Universe;
- the nature of gravity, general relativity and the observation of gravitational waves;
- detection of planets around other stars;
- exploration of the solar system, with special emphasis on Mercury, Mars and the Sun.

To ensure that the missions achieve their ultimate goals and are conducted with maximum efficiency, the program will call for development of some very advanced technologies, in particular in the areas of spacecraft mass and power, pointing, data handling and communications. In solar system science, the Survey Committee recommends a major (cornerstone) mission to Mercury, the planet nearest the Sun, which is still largely unexplored. Both planetary and magnetospheric aspects should be addressed by this mission.

In view of the great international interest in the study of Mars, the Survey Committee recommends that ESA participate at the level of a medium- class mission in opportunities that may arise in the framework of the Mars exploration projects currently under discussion.

Given the exceptional research opportunities in solar physics offered by several ongoing and future missions, together with the keen interest expressed by the solar physics community, the Survey Committee recommends that ESA take advantage of openings as they arise and participate in future international solar missions. It should also draw on opportunities provided by the space station and by the small- and medium-class missions of Horizon 2000 Plus, taking full advantage of the very high resolution instruments that will be available, of the technique of stereoscopic observation and of future in situ probes. In astronomy, the Survey Committee recommends that ESA initiate a cornerstone-level program in interferometry, the first aim being to perform astrometric observations. An interferometric global astrometry mission to 10 micro-arcsec accuracy will enable searches to be carried out for Jupiter-like planets and brown dwarf companions around stars in our galaxy and detailed information to be acquired about them. It will ascertain the distances, motions and luminosities of tens of millions of stars in the Milky Way and will allow the mass distribution in nearby galaxies to be studied. The mission will also be a chance to test general relativity against alternative theories. In addition, the Survey Committee recommends studies using infrared interferometry, with the aim of detecting Earth-like planets around other stars.

To build on the great advances achieved by Europe in X-ray, gamma-ray and infrared astronomy, and given that the currently planned missions in these areas may extend until about 2010, the Survey Committee recommends that development of cornerstone-level missions to be undertaken soon after completion of Horizon 2000 Plus.

In the meantime, the case for developing a major high-energy astrophysics facility under the space station utilization program should be analyzed, and access to small- and medium-class missions should also be fully exploited.

A final recommendation from the Survey Committee is for ESA to engage in technological and system studies in preparation for a cornerstone program devoted to the observation of gravitational waves, in particular at low frequencies. Such a unique mission would make it possible to explore the very early phases of the Universe and to observe massive black holes and their coalescence, furthering our understanding of the nature of gravity and of general relativity.

The bulk of activity aimed at ensuring continuity from Horizon 2000, in areas in which Europe has achieved recognized international leadership, can be carried out at the present level of funding, even though the aims pursued are massively more ambitious. However, entry into the field of fundamental physics, which will be an entirely new departure for ESA, and in particular research into gravitational waves detection from space, together with the pressing need to engage in the development of new technologies, will call for an extra financial effort. But so compelling are these studies and so important for our understanding of the Universe and the force which binds it together that the Survey Committee is convinced the extra effort is worthwhile. The Committee is therefore proposing that the ESA science budget be held at its 1994 level until 2000 and then increased by 4% to 5% per year for the next 4 to 5 years. The content and financial projections of the Horizon 2000 Plus program will be fed into the ESA Long Term Plan, which will be presented to the ministerial meeting of the Agency's Council in the second half of 1995.

SIMULATION OF THE PHYSIOLOGICAL EFFECTS ON ASTRONAUTS OF THE ABSENCE OF GRAVITY
ESA/CNES press release

Among the environmental factors that can alter equilibria in living organisms on board spacecraft, the absence of gravity causes physiological changes that can affect astronauts' performance. Commissioned by the European Space Agency (ESA) and the French space agency (CNES), the MEDES Institute of Space Medicine and Physiology has recently completed a long-duration bedrest experiment.

When the human body is lying in the head-down tilt position, at an angle of -6 degrees to the horizontal, organic fluids shift towards the head and thorax in a manner similar to that observed in spacecraft in the absence of the influence of gravity, which in the terrestrial environment causes 1 to 2 litters of blood to remain in the lower body. In addition, the reduction in physical activity during the bedrest leads to changes in muscle and bones. This experiment took place between October and December 1994 at the Purpan Hospital, in an area of some 600 square meters with full medical back-up made available by the Toulouse health authority. It was conducted by MEDES, in accordance with the health regulations. The subjects were eight young and healthy male volunteers, who had been selected on the basis of stringent medical and psychological tests.

The experiment was divided into three phases:

- a two-week ambulatory period for measurements to gather basic data,
- a six-week period of bedrest as defined above,
- a two-week ambulatory recover period for observations and monitoring of the return to "normal".

This is being followed up by longitudinal monitoring over several months. The experiment was proposed by ESA and CNES on the recommendation of an expert group appointed by the two space agencies to evaluate physiological changes in astronauts during future long-duration missions. The experimental protocols of 13 European scientific teams selected by the expert group were carried out, studying the processes of adaptation to simulate weightlessness displayed by the following physiological systems:

- cardiovascular and renal systems (regulation of organic fluids, hormonal regulation, neurovegetative control of cardiac activity and arterial pressure),
- pulmonary function,
- muscular system (biomechanical, bioenergetic, reflexes, contractile properties, morphology and morphometry),
- bone metabolism,
- energy balance,
- immune system.

To make sure that the volunteers were comfortable and at no risk to their health, the MEDES team kept them under close medical and psychological monitoring on a full-time basis throughout the experiment.

Little is as yet known about the influence of gravity, which in the Earth's environment is a major factor affecting most physiological mechanisms. The results obtained in space and from simulations on Earth are bringing significant progress in the understanding of the adaptive processes of living organisms, such as bone structure remodeling or blood volume regulation. Initially, the results of this experiment should afford a better understanding of the adaptive physiological phenomena associated with simulations of weightlessness, providing a basis for more accurate definition of the preventive means (or countermeasures) to be developed in order to mitigate the physiological consequences of the absence of gravity on long-duration flights in space and for improving arrangements for readjustment on return to Earth. Subsequently, these countermeasures should be evaluated in the course of two further long-duration bedrest experiments.

TREES BENEATH THE CLOUDS
ESA press release

Approximately seven percent of the Earth's surface--almost a quarter of the continental landmass--is still covered by extensive forest area. Next to the oceans, these forests constitute the most important ecosystem of our planet: not only are they a source of commodities and food but they also have a regulating effect on the Earth's climate and its water and nutrient cycle; in addition, they offer a natural habitat for more animal and plant species than any other ecosystem. But within the last few decades, the Earth's natural forest cover has been decimated at an alarming rate. Deforestation is advancing particularly fast in the tropical rainforest of South America, Central Africa and Southeast Asia. A substantial part of the virgin forest in these areas has already been depleted by "slash and burn" cattle farmers, by large-scale logging and by gigantic technical projects. Each year, an additional 200,000 square kilometers of rainforest--an area the size of England--are devastated. This wholesale destruction is motivated by economic interests ranging from the development of new plantations and the cutting of firewood for new residents to the lucrative trade in the tropical hardwoods and the exploitation of mineral resources.

Every minute, deforestation programs worldwide destroy a forest area as big as 25 football fields. This loss affects the carbon dioxide content of the air we breathe because trees and plants are, in the medium term at least, major CO_2 reservoirs. Not only are these reservoirs destroyed by deforestation, but subsequent burning of the trees following their cutting also releases CO_2 into the atmosphere. But it appears that the carbon dioxide balance of the Earth's atmosphere does not fully reflect the effects of this process.

Since 1958, the CO_2 content of the atmosphere has been monitored on a regular basis, and scientists have recorded a steady increase of more than 13 percent--from an initial 315 ppm to over 350 ppm. That is slightly less than the total increase over the preceding 130 years since the beginning of the industrial revolution (for the pre-industrial area, an estimated CO_2 content of 275 ppm is assumed). But the truly surprising aspect of this rise is not so much its increasing speed but the fact that apparently only part of the carbon dioxide released by burning actually remains in the atmosphere. In the late eighties, global energy consumption was estimated at close to nine million tons of coal or other fossil fuels. Burning these fuels released approximately 5.4 million tons of carbon into the atmosphere, mostly in the form of carbon dioxide.

It is assumed that close to 40% of this amount is dissolved as carbon dioxide in the ocean. The rest should be sufficient to increase the CO_2 content of the atmosphere by approximately 2% per year. But the instrument at the extinct volcano Mauna Loa recently indicated an increase of one third less this volume. As long as there is no reliable information about where the carbon dioxide released into the atmosphere ends up, any forecast of future climate changes as a result of CO_2-related greenhouse effect are met with skepticism that effectively discredits the call for a reduction of the CO_2 output.

Against this background, an inventory of the Earth's existing forest area (at least the tropical rainforests) appears to be indispensable. But with a total surface of roughly 36 million square kilometers, the forest areas of our planet are far too large to be adequately explored by means of aircraft-based surveillance. Since the time is running out, the only solution is satellite-based global Earth observation. Scientists will only be able to estimate the compensating effect of forest areas and the thus far hidden contribution of deforestation to the increase of the carbon dioxide content of our atmosphere after they have compiled quantitative data about the biomass existing in these areas. Precise knowledge of these parameters is a vital prerequisite for the drive towards binding international agreements on the protection of rainforests and the preservation of our climate. Most scientists believe that an uncontrolled increase of the CO_2 content of the atmosphere will result in a gradual warming of the Earth, in turn causing the polar icecaps to melt and the sea level to rise. The effects of deforestation on the global climate go far beyond its contribution to the rise of the CO_2 content of the atmosphere: large-scale clearing leads to a local reduction of precipitation levels because the topsoil dries out leaving no soil moisture to be evaporated; this in turn results in a gradual warming of the ground and subsequently the atmosphere above it, which can eventually also affect large-scale circulation patterns. In addition, there are other undesirable side-effects; reduced precipitation can, for example, lead to lower ground water levels in the Amazon basin, shorten the flood periods and adversely affect fishing yields, while the dried out topsoil is washed away more easily destroying irrigation systems built with great effort. Some of the observations and measurements for this urgently needed inventory were made in a research program jointly sponsored by the European Union and the European Space Agency (ESA). Using funds provided by the European

Commission, the Institute for Remote Sensing at the Joint Research Centre (JRC) in Ispra in northern Italy launched the TREES project (Tropical Ecosystem Environment Observation by Satellite), which recently entered its second phase. The purpose of this program is to combine data provided by different satellite systems, and to jointly evaluate them. The basis for mapping and establishing a first inventory of the Earth's tropical forests were optical and IR images from the Advanced Very High Resolution Radiometer (AVHRR) on board NOAA satellites. However, large parts of the tropical rainforest are hidden under an almost permanent cloud cover, which makes comprehensive and continuous observations using these systems alone difficult and time consuming. A viable alternative is provided by the Synthetic Aperture Radar on board the ERS-1 satellite of the European Space Agency which works irrespective of cloud cover and lighting conditions and, in addition, supplies high-resolution views of the areas it covers. Before they could exploit the information provided by ERS-1, scientists had to learn to transform SAR data into usable information--in other words, they had to acquire the experience in the interpretation of satellite data which had been gathered in traditional optical satellite observation over many years. As Dr. J.P. Malingreau of the JRC explained, classical Earth observation satellites supply images in the optical and neighboring near-infrared spectrum, while the Synthetic Aperture Radar (SAR) is working in the microwave portion of the spectrum. This opens a new "window" for Earth observation, but at the same time requires a new type of viewing. SAR data indicate the microwave backscatter of the regions observed and that is influenced by the geometrical and electrical properties of the "target"; for land surfaces, the main factors are surface roughness and soil moisture." To enable reliable attribution of data, the TREES project included extensive "ground truth" campaigns, in which topographical information was gathered by conventional methods, generally with the participation of national organizations and research agencies. Projects of this type were conducted in Brazil, the Ivory Coast and Indonesia. In a test area in the Brazilian Rio Branco region, for instance, deforested patches were clearly visible because of their backscatter properties in comparison to neighboring undisturbed forest areas. By evaluating different images obtained during subsequent passages of the satellite it was not only possible to monitor deforestation activities but also to quantify the biomass growing in these clearings. Another ESA pilot project is the TRULI project (Tropical Rainforest and Use of Land Investigation) on the island of Borneo, which is funded by the German Space Agency (DARA) and supported in Indonesia by the German Society for Technical Cooperation (GTZ) and the National Land Planning and Mapping Board of Indonesia (Badan Pertanahan Nassional - BPN). Here, too, the aim was to interpret the radar backscatter signals, to develop a monitoring system which would make it possible to track the long-term changes in tropical rainforests due to human activities, and to assess the usefulness of these data for land use planning activities.

The ERS-1 SAR data of the test area in Borneo were acquired by a satellite receiving station in Thailand. This station, located 25 kilometers east of Bangkok began graphs taken by Russian cosmonauts with a KFA 1000 high-performance camera aboard the Mir space station in December 1991. These photographs have a ground resolution of 7 meters and show such details as single tree crowns. In addition, a five-week ground truth campaign was conducted during the time of ERS-1 data acquisition to obtain information about surface relief, forest types, intensity of selective logging, infrastructure, human settlements and agricultural activities in existing clearings.

The subsequent comparison between SAR images and the data sets extracted from ground truth campaigns and Mir photographs made it possible to clearly distinguish a number of different land-use classes, from undisturbed rainforests to selectively logged areas and secondary forests in cultivated areas; even minor human settlements can easily be detected because of the high backscatter of metal-roofed houses.

Measurements series such as these show that space-based imaging radar systems provide essential support for the mapping and surveillance of the tropical rainforests. "The ERS-1 SAR has undoubtedly supplied new information for the monitoring of tropical rainforests," Dr. J.P. Malingreau of the JRC pointed out. "For it optimal use, in particular for a global forest inventory, we now have to investigate its employment for various forest types, terrains and deforestation patterns. ERS-1 has already supplied us with a lot of data for these studies -- with ERS-2, we intend to continue even further."

SPACEHAB ENHANCEMENTS SAVE ASTRONAUTS TIME IN SPACE
SPACEHAB press release

February 2, 1995. Kennedy Space Center, Florida. The SPACEHAB Space Research Laboratory has been upgraded to improve the efficiency of the experiments' operations on the upcoming Space Shuttle mission, scheduled for launch on February 3, 1995, at approximately 12:22 a.m. The first two SPACEHAB missions (June 1993 and February 1994) have shown that the astronauts' time in space is a limited resource, so SPACEHAB, Inc. has developed improved equipment to automate many manual tasks. On the upcoming mission, the astronauts are scheduled to spend almost half of their time on SPACEHAB operations or 94 hours of the 198- hour mission. The astronauts' schedule includes about five hours of margin which are expected to be saved due to the system enhancements. The first new feature is a video switch to reduce the demand for crew time in video operations, and the second new feature is an experiment interface to the SPACEHAB telemetry system to reduce the demand for crew time in experiment data downlink.

The SPACEHAB video system uses camcorders that are tied to the Space Shuttle closed circuit television system and then downlinked through the Space Shuttle. On the first two SPACEHAB missions the astronauts set up the camcorders and manually switched from one camera scene to another, a time-consuming operational arrangement. For this upcoming SPACEHAB mission, SPACEHAB, Inc. installed a video switching unit allowing up to eight camcorders to be cabled into the SPACEHAB video switch. Then, by ground control, one of the camcorders can be switched into the Space Shuttle system for downlink. Also, another one of the camcorders can collect a digital image on a freeze frame and send it down through SPACEHAB's telemetry stream, independent of other Space Shuttle video downlink operations. This new video switch and digital television downlink capability will provide operational flexibility, saving about 30 minutes total during the mission. SPACEHAB, Inc. also enhanced the experiment data interface with the SPACEHAB telemetry system in the interest of on-orbit efficiency. A new Serial Converter Unit has been developed which saves about 45 minutes per day on the upcoming mission. The SPACEHAB telemetry system now allows an experimenter with a standard RS232 computer interface to tie directly into the system and send continuous information down to the ground, off-loading this task from the crew and enhancing ground controller monitoring of experiment status. SPACEHAB laboratories are pressurized, cylindrical

modules that measure 10 feet in length by 13.5 feet in diameter, with a truncated top and flat "end-caps," a patented design. During a typical flight in the Space Shuttle, the laboratory is located in the forward quarter of the Space Shuttle payload bay and connects to the astronaut compartment through the Space Shuttle airlock by a short tunnel. SPACEHAB doubles the available living and working space on the Shuttle for the astronauts and quadruples the available experimentation space.

SPACEHAB, Inc. is the first company engaged solely in the business of providing frequent, low-cost access to an astronaut- tended environment in space. SPACEHAB has pioneered the creation of the world's first privately-developed space R&D facility, the Space Research Laboratory, that can support humans in space. Research in SPACEHAB laboratories is generating revolutionary advances in biotechnology, advanced materials, and other technologies. Such product-oriented research on SPACEHAB is preparing U.S. industry for the advent of the International Space Station Alpha. For more information, contact: Rebecca B. Gray, SPACEHAB, Inc., 407/868-7400

SPACEHAB BEGINS THIRD MISSION WITH NASA
SPACEHAB press release

February 3, 1995. Kennedy Space Center, Florida. Space Shuttle Discovery lifted off from Earth at 12:22 a.m. today with a full complement of experiments inside the SPACEHAB Space Research Laboratory, destined for a rendezvous with the Russian Space Station Mir. The astronauts set to work as soon as they began orbiting the Earth, almost 200 miles overhead. Payload Commander Bernard Harris, and Russian Cosmonaut Vladimir Titov activated the SPACEHAB laboratory and many of the experiments inside. After activation, Dr. Harris said, "Everything is ready to go in the SPACEHAB." When asked how the Space Shuttle compared to the Russian Space Station Mir, Titov said that "... the SPACEHAB module is very close to our modules." The SPACEHAB experiments on this mission represent a wide range of product-oriented R&D, including biotechnology experiments for new pharmaceuticals, advanced materials development experiments for improved contact lens materials, and a demonstration of a revolutionary space robot called Charlottex.

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PLANTS SEEN GROWING IN THE SPACEHAB SPACE RESEARCH LABORATORY SPACEHAB press release.

February 4, 1995. Johnson Space Center, Houston, Texas. Downlinked video from the Space Shuttle Discovery has revealed flowering plants thriving in the SPACEHAB Space Research Laboratory. The plants are growing in the Astroculturex experiment unit, sponsored by the Wisconsin Center for Space Automation and Robotics, a NASA Center for the Commercial Development of Space. "We will continue to look for additional flowering throughout the remainder of the mission," said Dr. Robert Morrow of the University of Wisconsin-Madison. Russian Cosmonaut Vladimir Titov is the primary crew member for Astroculturex operations in space. This demonstration of successful plant growth in space using the Astroculturex unit represents a major advance in the ability to provide environmental control for plant growth in an inexpensive and reliable flight package. This Space Shuttle mission, STS-63, is the third flight of the Astroculturex unit in the SPACEHAB Space Research Laboratory.

Wheat seedlings and mustard plants are being grown in the Astroculturex unit. The mustard plants are special fast-growing plants with a rapid life cycle developed at the University of Wisconsin-Madison College of Agriculture and Life Sciences. This experiment is the fourth in a series of flights to validate the performance of plant growth technologies in the microgravity environment of space. The information from these flight experiments will become the basis for developing large scale plant growing units required in a space-based life support system. These technologies also will have extensive uses on Earth, such as in improved dehumidification/ humidification units, water-efficient irrigation systems, removal of hydrocarbons and other pollutants from indoor air, and energy- efficient lighting systems for plant growth. "These plants provide evidence of the progress being made by researchers in the SPACEHAB laboratory," said Richard Hora, President and CEO of SPACEHAB, Inc.

The SPACEHAB laboratory is a pressurized, cylindrical module that measures 10 feet in length by 13.5 feet in diameter, with a truncated top and flat "end-caps," a patented design. During this flight, the laboratory is located in the forward quarter of the Space Shuttle payload bay and connects to the astronaut compartment through the Space Shuttle airlock by a short tunnel. SPACEHAB doubles the available living and working space on the Shuttle for the astronauts and quadruples the available experimentation space. For more information, contact: Rebecca B. Gray, SPACEHAB, Inc., 713/483-5111

IMPROVED CONTACT LENSES TO BE TESTED IN SPACEHAB
SPACEHAB press release

Paragon Vision Sciences Corporation of Mesa, Arizona, one of the two leading oxygen permeable contact lens material manufacturers in the United States, is testing a new contact lens material in the SPACEHAB Space Research Laboratory. Paragon will be conducting its second space experiment in the SPACEHAB laboratory on the Space Shuttle Discovery, scheduled for launch on February 2, 1995. Paragon hopes to verify that its new material is more gas-permeable and dimensionally stronger than currently used materials, therefore making a more comfortable lens. Lenses made of this space-age material could be available to the public as early as 1998. The SPACEHAB Space Research Laboratory is the world's first privately-developed space R&D facility that can support humans in space. SPACEHAB, Inc. of Arlington, Virginia, owns and operates the laboratories.

The first test of Paragon's contact lens material was made in the SPACEHAB laboratory in June 1993 onboard the Space Shuttle Endeavour. The experiment mixed raw materials that are currently used for lenses and a new type of material which proved to have high permeability when tested on Earth. Both materials were polymerized in the near-zero gravity of space and examined upon the Space Shuttle's return to Earth.

Paragon scientists found that the composition of the new material was more permeable than current lens materials. They also found that the new material was stronger than current lens materials, allowing almost four times more lenses than before to be sliced apart from the same amount of material. Paragon forecasts that the new contact lenses will be introduced into the market when the manufacturing costs fall to about twice the cost of current lenses. If the regulatory agencies of the United States, Europe, and Japan approve the new lens, it will be introduced as early as 1998.

Paragon Vision Sciences Corporation is a progressive company dedicated to identifying clinical needs and developing products to fill them. Paragon enjoys a long tradition of innovation in the contact lens industry, having developed some of the industry's most valuable contact lens products. In 1986, Paragon introduced ParapermrEW, the first extended-wear oxygen permeable contact lens on the market. Paragon followed this innovation with the introduction of The FluoroPermr System in 1987, an important development allowing practitioners to fit lenses to meet individual patients' lens permeability needs. With the dawning of a new era in space-age lens technology, Paragon is uniquely positioned to continue in its role as the world leader in oxygen permeable contact lens technology.

SPACEHAB, Inc. is the first company in the world engaged solely in the business of providing frequent, low-cost access to an astronaut-tended environment in space. SPACEHAB has pioneered the creation of the world's first privately-developed space R&D facility, the Space Research Laboratory, that can support humans in space. Research in SPACEHAB laboratories is generating revolutionary advances in biotechnology, advanced materials, and other technologies. SPACEHAB is building on its successful core business franchise of providing human habitats in space and is seeking other space-related technologies to bring to the market, positioning the company on the leading edge of the space frontier.

For more information, contact: Rebecca B. Gray, SPACEHAB, Inc., 703/414-8100 or Krist Jani, Paragon Vision Sciences Corporation, 602/482-4591

MARS PATHFINDER MISSION DESIGN STATUS
by Richard Cook, Mars Pathfinder System Engineer

The Mission Design and Navigation Office in the Mars Pathfinder Project is responsible for designing the interplanetary trajectory from Earth to Mars, designing the Mars atmospheric entry trajectory, defining the high-level sequence of events performed during the mission, and developing the software and processes required to navigate the spacecraft to Mars. The detailed design of the interplanetary and Mars atmospheric entry trajectories is essentially complete. Mars Pathfinder plans to use a direct transfer from the Earth to Mars with a total flight time of 6-7 months. Launch is currently scheduled to occur sometime between December 5 and December 25, 1996 from Cape Canaveral. The launch vehicle is a three-stage Delta manufactured by McDonnell Douglas Aerospace. Recent trajectory analysis has assessed the possibility of launching earlier, potentially as early as December 2. The advantage of this earlier date is that it allows a longer launch window, which improves the overall odds of launch. As a note, the next available launch opportunity to Mars should Pathfinder miss the 1996 opportunity is in late 1998.

The spacecraft arrives at Mars on July 4, 1997 and enters the Martian atmosphere directly from the approach hyperbola. The speed at entry is approximately 7.6 km/s, or about 17,000 mph. The trajectory which the spacecraft follows through the atmosphere depends on this initial speed, plus the spacecraft mass and the entry angle. The entry angle is angle between local horizontal and the spacecraft's direction of travel at entry. If this angle is steep, the spacecraft descends very quickly through the atmosphere and experiences high heating and deceleration forces. If the angle is too shallow, the atmosphere will not slow down the spacecraft enough to keep it from flying back out of the atmosphere and escaping. The spacecraft must be carefully navigated to make sure that this entry angle is within an acceptable range. In the case of Mars Pathfinder, this means knowing where the spacecraft is to within 50 kilometers when it is more than 190 million kilometers from Earth. The navigation engineers on Mars Pathfinder use the observed Doppler shift in the communications signals coming from the spacecraft in order to determine where it is.

The Mission Design and Navigation Office, in conjunction with other project elements, is responsible for developing the overall mission plan summarizing the key activities performed during the mission. The mission is essentially divided into four major phases. The launch phase is relatively short, extending from launch through the point when the spacecraft separates from the upper stage. This 75-minute period is crucial, however, in that the launch vehicle must perform a specific series of activities to send the spacecraft to Mars. The cruise phase of the mission starts at separation and ends just before the spacecraft enters the Martian atmosphere. Cruise is a relatively quiet period, except for periodic maneuvers which target the spacecraft to the correct entry trajectory. The spacecraft also communicates to the Earth in this period to make sure that all components are still functioning correctly.

The entry, descent, and landing phase of the mission occurs when the spacecraft enters the Martian atmosphere. This is also a relatively short period, but it is definitely the most critical to successfully completing the mission. The spacecraft performs a series of activities to descend through the

atmosphere, land safely on the surface, and establish the correct surface configuration. The surface phase starts when the spacecraft is safely on the surface of Mars and continues indefinitely. The spacecraft is required to operate for 30 Martian days, but should operate for much longer. The surface phase is when most of the key science and technology objectives are accomplished. The microrover is deployed soon after landing and proceeds to explore the area around the lander. The science instruments gather data in order to provide scientists with a better understanding of the geologic and atmospheric characteristics of Mars.

MARS PATHFINDER SCIENCE STATUS: INVESTIGATING THE LANDING SITE
By Mat Golombek, Mars Pathfinder Project Scientist

At present most of the scientists associated with the Mars Pathfinder mission are busy building the three science instruments (Imager for Mars Pathfinder, Alpha Proton X-ray Spectrometer, and the Atmospheric Structure/Meteorology Package) for the spacecraft and rover. Over the next year the instruments will be built, tested and calibrated before and after integration on the spacecraft. The progress and status of the instruments will be reported in a future status report. However, in addition to building the instruments a smaller number of scientists are attempting to learn everything possible about the place we plan to land the spacecraft on the martian surface. This status report will focus on this topic.

As previously announced, the project has decided to land where Ares Vallis opens into Chryse Planitia on Mars (19.5 degrees North latitude, 32.8 degrees West longitude). The rationale for choosing this location is that it represents a place where there is the potential for sampling a wide variety of different rocks that make up the planet Mars in the small area accessible to the rover (a few tens of meters). One of the areas of greatest scientific return possible from the Pathfinder mission is in its ability to learn about the mineralogy and chemical composition of the various materials at the landing site. Imaging rocks and other materials at the landing site with a variety of spectral filters should allow discrimination of different pyroxene and iron oxide minerals. The rover would then be directed to different interesting rocks, where the alpha proton x-ray spectrometer would be used to determine their elemental composition. Close-up images of the rocks would also be taken by the color and monochrome cameras on board the rover, allowing discrimination of any millimeter-sized crystals present in the rock. Using all these data together, scientists will attempt to determine the mineralogy of the rock. If the mineralogy can be determined, then a tremendous amount of information can be inferred with regard to the processes and environment in which the rock formed. The greater the number of different rocks that can be studied at the landing site, the more that can be learned about the geologic history of the planet. Because the Ares Vallis floods drained from the ancient highlands, which include some of the planet's oldest rocks, Pathfinder may enable scientists to determine how the planet differentiated into a crust and mantle and whether early Mars was both warmer and wetter than at present (and thus more like the early Earth).

Images of the surface of Mars at the meter scale (of interest to a lander) currently exist only at the two Viking landing sites. The reason for this is that images of Mars taken from orbit are at a scale insufficient to resolve lander-sized objects. At the Ares site, for example, the highest-resolution Viking Orbiter images are at about 40 meters per picture element (pixel). That means that when Pathfinder lands on Mars, virtually all of its observations will be taken within a single pixel of the orbiter images. Predicting what the surface will look like at the meter scale is virtually impossible from such coarse-resolution images. For this reason, other remote sensing techniques must be used to attempt to understand the nature of the surface. Such techniques include Earth-based radar, which can give information about the roughness of the surface at a scale of 10-100 meters. In addition, Viking Infrared Thermal Mapper (IRTM) observations can be used to infer the relative abundance of rocks on the surface (as opposed to dust) and the albedo and color of the Viking images can be used to infer the relative amounts of bright martian dust and dark rocks. Scientists studying Mars are actively involved in using these data sets to learn as much as possible about the surface at the landing site. In addition, because Mars is presently near opposition with the Earth, additional Earth-based radar data are being acquired of areas of interest. Another way to learn about Ares Vallis is to study similar features here on Earth. Ares Vallis is one of the largest outflow channel on Mars, which form when enormous quantities of water flow over the surface during a short period of time. A well-known similar feature on the Earth can be found in the Channeled Scablands of Washington State. Large streamlined islands and channels were carved when ice that dammed a large glacial lake (Lake Missoula--about the size of Lake Ontario) ruptured and the water drained to the Pacific Ocean over a period of about two weeks. Ares Vallis flood involved substantially greater quantities of water (roughly the entire volume of all five Great Lakes) draining into the martian northern lowlands. Another group of scientists is using knowledge gained from studying the Channeled Scablands on Earth to better understand similar large-scale features visible in the orbiter images of Mars.

SEE-THROUGH, SMOKY-BLUE AEROGEL WILL HELP PROTECT MARS PATHFINDER ROVER
From the *JPL Universe*

When a small, six-wheeled rover, not much heavier than a bowling ball, rolls onto an ancient flood plain of Mars in 1997 to begin studying the parched and rocky landscape, its delicate electronics will be protected by a novel substance--not new--but never before used to keep a rover warm. This same material will also play the key role in collecting cometary particles from interstellar space in a Discovery mission called "Stardust," which was one of three such missions developed in cooperation with JPL and selected by NASA in February for Phase A study. The material is called "aerogel" and it was first developed in the 1930s for scientific experiments. But aerogel is making its true debut now, 60 years later, as a substance with practical applications in the space program and, potentially, in the commercial marketplace.

Dr. Peter Tsou, of the Asteroids, Comets and Satellites Research Element 3238, began working with aerogel several years ago and came up with a form that could be flown on space shuttles to capture cosmic dust--microscopically small particles present in outer space--which is the centerpiece of his research.

"The substance is incredibly resilient in the space environment and it has proven to be an effective temperature shield," he said. "Aerogel is able to protect against heat and cold, and it cannot be frozen, nor can it be destroyed by extremely hot temperatures. In fact, aerogel is not affected by temperatures of less than 1,400 degrees Celsius (2,550 degrees Fahrenheit)." This nearly weightless substance--made from silicon dioxide--is a form of sand and is now manufactured in Tsou's JPL laboratory. But by using the material for things

other than capturing cosmic dust, Tsou quickly discovered that he could accomplish great feats.

Almost coincidentally and at his colleagues' request, Tsou went to work this year on a brand new application: outfitting the Mars Pathfinder rover with aerogel to replace the standard thermal insulation that had been proposed. Tsou was able to significantly reduce the rover's mass by more than 2.6 kilograms--nearly six pounds or 20 percent of the rover's weight.

Donna Shirley, manager of JPL's Mars Exploration Program Office, said, "We saved the rover mission by using aerogel. If we'd had to use conventional insulation, the rover would freeze to death." The rover was previously designed with a paper honeycomb structure, which was filled with a powdered form of silica mixed with aluminum. In designing the rover structure, Dave Braun of Section 352 found the only powdered mixture that met his thermal requirements was a material with a density of 171 milligrams per cubic centimeter. He soon discovered, however, that it might be possible to reduce that by a factor of 10 by using a solid aerogel form. Changing to the solid, brittle material forced the design into a concept similar to that of aircraft wings. Large blocks of aerogel were placed between fiberglass skins, reinforced every 10 centimeters with a Z-shaped fiberglass spar. A gold-coated substance called Kapton was placed in between blocks to reduce radiation between skins. Aerogel at this low density had never before been used as insulation, but it was necessary to determine the properties of the material in the vacuum of space and the carbon dioxide environment of Mars. Greg Hickey and Kyle Brown of Section 355 quickly produced samples of this insulation-filled structure, which were tested by an outside company. The results for the solid material were better than for the powder.

The Mars Pathfinder mission is designed to place a small lander and rover on Mars in July 1997, following a December 1996 launch. When the lander arrives at Mars, it will directly enter the Martian atmosphere and drop to the surface with the aid of parachutes and large balloons to soften its landing. The aerogel Tsou has developed for Mars Pathfinder has some surprising properties, he said. It is somewhat like glass in that it is made of silica, and it has about the same melting point. Normal levels of coldness will not disturb the gel, nor will water. Tsou's strangely fluorescent, solid-smoke-like form of the substance will float on water without absorbing moisture--the only form available that can make that claim. Aerogels can, however, absorb very large amounts of gas, because they are very porous. This porosity gives the substance a remarkable surface area. A cubic centimeter of aerogel--about a quarter of the size of an average sugar lump--has an effective surface area of 50 square meters. Along with this capability, aerogel is also the lowest density solid material known in the world, according to Tsou. The aerogel used in his experiments has a density of 15 milligrams (.015 grams) per cubic centimeter (1 gram equals 35 thousandths of an ounce). The material used in this mission has a density of 20 mg/cc. As a poor conductor of heat, aerogel is an ideal insulator and, like glass, is impervious to ultraviolet radiation, Tsou said. Some scientists have suggested that aerogel would make an effective building insulation in cold and hot climates if placed between layers of window glass. But because aerogel is not entirely transparent, it would produce a frosted or smoky-blue look. Tsou will continue to use aerogel for his primary research project--capturing cosmic dust in space, including an experiment due to be sent to the Russian Mir space station in November--but he and others have identified several other scientific and space applications.

According to Jim Cutts, manager of JPL's Advanced Concepts Program Office, "NASA has received an extraordinary payoff from Peter Tsou's pioneering work on aerogel over the last decade. And there are commercial applications, also."

A host of investigators are now seeking commercial applications for this nearly weightless, translucent material. Possibilities include use as insulation for refrigerators and security safes, filters in advanced automobile catalytic converters and high- efficiency battery electrodes.

NASA RESEARCH ANNOUNCEMENT SOLICITING PROPOSALS FOR GROUND-BASED AND SMALL PAYLOADS RESEARCH IN SPACE LIFE SCIENCES

NASA OMB Approval No. 2700-0042
NRA 95 OLMSA-01
Life and Biomedical Sciences and Applications Division Office of Life and Microgravity Sciences and Applications National Aeronautics and Space Administration

Date NRA Issued: January 26, 1995 Letters of Intent Due: March 24, 1995 Proposals Due: April 21, 1995

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals to participate in Ground-Based and Small Payloads Research in Space Life Sciences. This is a broad-based announcement that solicits research proposals for all of the major programs of the Life and Biomedical Sciences and Applications Division. The specific programs that are included in this announcement are Space Biology, Space Physiology and Countermeasures, Environmental Health, Space Radiation Health, Space Human Factors, Advanced Life Support, Advanced Extravehicular Activity Systems, Advanced Technology Development and Data Analysis. Proposals submitted in response to this Announcement may be either for standard ground- based research investigations or for small payload flight experiments or for both. Proposal to develop experiments aiming at space station utilization are particularly encouraged. Subsequent announcements similar to and based upon this Announcement will be updated and issued annually and will be the primary means of obtaining research proposals form the scientific community for ground and small payloads research in the space life sciences. Although this NRA is broad-based, it is restricted to the science programs named above and described in detail in Appendix A. The potential proposer should read the program descriptions that are of interest with care and attempt to focus the proposal on the specific research emphases defined in this Announcement. Participation in the Ground-based and Small Payloads Research in Space Life Sciences is open to all individuals and all categories of domestic and foreign organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other U.S. Governmental agencies. Proposals which will enhance or complement the scientific return from research currently being supported by the National Institutes of Health, National Science Foundation, or other Government agencies are encouraged. In addition, proposals to advance technology and develop practical applications of technology are sought under this Announcement. Because of limitations of access to flight opportunities, it is expected that the majority of proposals approved in response to this Announcement would be for ground-based research.

A letter of Intent to Propose is requested by March 24, 1995. Proposals may be submitted at any time up to April 21, 1995.

Proposals will be evaluated for scientific/technical value, soundness, intrinsic scientific/technical value, relevance, implementation feasibility, and cost. A selection announcement will be made between August and October of 1995. Funding of selected proposals will begin sometime between October 1995 and September 1996.

Proposals due: April 21, 1995
Letters of Intent Due: March 24, 1995
Number of copies Requested: 20
NASA Selecting official:
Dr. Joan Vernikos
Director, Life and Biomedical Sciences and Applications Division/ Code ULR
NASA Headquarters
Washington, DC 20564-0001
Obtain additional information from the appropriate Science Program manager, as indicated below, at the following address:
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and Applications Division
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-2530
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Proposals and Letters of Intent mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:
Ronald J. White, Ph.D.
Life and Biomedical Sciences and Applications Division/ Code UL
NASA Headquarters
Washington, DC 20546-0001
Proposals and Letters of Intent hand delivered or sent by commercial delivery or courier services are to be delivered between the hours of 8 AM and 4:30 PM:
Ronald J. White, Ph.D.
Life and Biomedical Sciences and Applications Division/ Code UL
National Aeronautics and Space Administration
ATTN: Receiving and Inspection
(Rear of Building)
300 E street, SW
Washington, DC 20024-3210
The telephone number 202-488-2940 may be used when required for reference by delivery services. NASA cannot receive deliveries on Saturdays, Sundays, or federal Holidays. Special instructions apply to foreign (non-U.S.) proposals.

FIRST ISU SYMPOSIUM (FIRST ANNOUNCEMENT):
SPACE OF SERVICE TO HUMANITY (SOS HUMANITY)

Preserving Earth and Improving Life
5-7 February 1996, Strasbourg, France
The space programmes of the world are being challenged to refocus their energies and to respond more directly to the real needs of humanity, in both developed and developing countries.

A Unique Forum

The International Space University (ISU), unconstrained by conventional approaches, offers this Symposium as an interdisciplinary, international forum. ISU aims to help both the users and the providers of space-related systems to move forward from the discussion of "problems" to the formulation of "innovative solutions.i At this Symposium, invited and contributed papers will address the scientific, technical, managerial, legal, political, economic and social issues that must be skillfully blended at an international level in order to meet the challenge. Special attention will be given to today's widespread concerns for the environment and the need for global education.

A New Approach

The Symposium will be an integral part of the Design Project within the ISU Master of Space Studies (MSS) programme. The MSS students--a body of highly motivated young professionals and postgraduate students--will work together through the academic year to formulate innovative and realistic proposals. Symposium participants are welcome to take part in the student workshop activities that will be organised on 8 and 9 February. To receive further information, including the Call for Papers, please send your name and address (e-mail and fax number as appropriate) to:

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