MARSBUGS:

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NASA SELECTS UNIVERSITIES FOR LIFE SCIENCES RESEARCH
NASA Press release: 95-151

NASA has selected three universities to serve as NASA Specialized Centers of Research and Training (NSCORTs) to increase scientists' understanding of the role that Earth's gravity plays in living things. North Carolina State University, Rice University and Rutgers University were selected to serve as NSCORTs for the next five years. The selections were made on the basis of merit as judged by peer review panels assembled by the American Institute of Biological Sciences. NASA plans to award each of the universities approximately $1 million a year for five years.

North Carolina State University in Raleigh was designated a NSCORT in gravitational biology. Eric Davies, Ph.D., head of the botany department, is the director of the new center. Wake Forest University in Winston-Salem is a collaborating partner.

Rice University in Houston, TX, also was designated a NSCORT in gravitational biology. The center director is Larry V. McIntire, Ph.D., the chair of the university's Institute of Biosciences and Bioengineering. NASA's Johnson Space Center in Houston is a partner with Rice.

Rutgers University in New Brunswick, NJ, was designated a NSCORT in bioregenerative life support. Harry W. Janes, Ph.D., professor of horticulture and forestry, is the director. Stevens Institute of Technology, Hoboken, NJ, is a collaborating partner.

The NSCORT program is an integral part of NASA's research and analysis activities to advance basic knowledge of the role of gravity in living systems and create effective methods for solving specific problems in the space life sciences. This program is established exclusively to support ground research and analysis in various research specialties.

The addition of these universities brings the total number of NASA-funded NSCORTs to eight. The previously selected institutions and their specialties include:

Lawrence Berkeley Laboratory, CA - Radiation Health. Northwestern University Medical School, Chicago, IL (funded jointly by NIH) - Vestibular Research. Ohio State University (funded jointly by NSF) - Plant Biology.
University of California, San Diego - Exobiology. University of Texas, Southwestern Medical Center - Integrated Physiology.

In addition, Germany is funding a NSCORT in radiation health at the University of Giessen.

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135 DAYS OF SCIENCE IN SPACE
ESA Press release 18-95

The EUROMIR 95 mission will offer European scientists an unprecedented opportunity to study living and working conditions in space. The record-breaking 135-day mission, scheduled for launch in early September, will be the second flight by an ESA astronaut aboard Russia's Mir space station.

Scientists from across Europe have devised an extensive program of experiments spanning the fields of life sciences, astrophysics, materials science and technology. In total, 41 investigations, taking 450 hours, are planned.

EUROMIR 95 astronaut Thomas Reiter and his colleague Christer Fuglesang, who is on stand-by for this mission, have completed the bulk of their training to perform the scientific program.

Life sciences

The majority of EUROMIR 95 experiments will investigate the effects of 'weightless' conditions on the human body. Since the first manned flight in space, scientists have documented significant changes in the way the body behaves in microgravity, but have yet to understand fully why these happen. Learning more about how the body reacts in space will benefit future space travelers and may also inform and improve medical practice on Earth. By removing gravity from the equation, scientists can learn more about important processes that take place inside our bodies.

The areas under research include the body's cardiovascular pressure sensor system, a network of biological sensors that measure and regulate blood pressure. In space, these receptors adjust the blood pressure to compensate for the lack of gravity. When some astronauts return to the gravity of Earth their blood pressure falls, which can cause fainting and other problems. Understanding how these receptors work will lead to advances which may benefit the millions of people who suffer health problems related to blood pressure.

Loss of bone mass has been well documented on previous space flights. The EUROMIR 95 scientists hope to reduce the extent of bone mass loss in the lower body by simulating the effects of walking. This will be done by striking an astronaut's heel bone 500 times over a ten-minute period on a daily basis, mimicking the stress the bone endures as the heel strikes the ground repeatedly during walking on Earth. The scientists are hoping this will make the bone cells maintain bone mass during the flight. The difference in bone density between the left and right heels will be monitored during the flight by an ultrasonic device called the bone densitometer (or BDM).

Scientists also hope to learn more during the mission about the excretion of fluids by the kidneys and how the body maintains its blood balance. The quantity and sodium content of the astronauts' urine will be measured over a two day period, three times during the course of the mission. The results of the experiment may eventually have important implications for the treatment of diseases associated with the balance and excretion of fluid in the human body.

Other life science experiments will study the role gravity plays in the functioning of our lungs, radiation levels inside and outside the space station will be measured and changes in the body's natural reflexes will be investigated. An ESA-designed respiratory monitoring system (RMS- II) will be used by several experiments to study the astronauts' lung function and blood flow through the heart and lung system. Changes and degradation in muscle function caused by extended exposure to weightlessness will also be studied during this space flight. These measurements are conducted before an after flight. Other experiments will be conducted related to the functioning of the balance system and how the reflex connection between the eyes and the balance is adapted in low gravity.

Astrophysics

One of the highlights of this mission will be a five-hour space walk to start an astrophysics experiment that aims to capture tiny particles of cosmic dust. Reiter's task during the space walk will be to install four experiments in the European Space Exposure Facility (ESEF) attached to the exterior of the Spektr module, which docked with Mir in June. The experiments are designed to study the natural and man-made particles found in low earth orbits.

The ESEF experiments will be housed in special airtight containers that can be opened by remote control to expose them to space. Three are simple collectors, designed to trap particles that enter them, while the fourth contains sensors to measure the number of particle impacts, their velocity, mass and distribution.

The boxes will be opened when the Earth passes through a meteor stream, a trail of dust left behind by comets orbiting the Sun. When this dust enters the atmosphere it burns up and is seen as a shooting star. Dust particles entering ESEF collectors will either fragment or be slowed and stopped, depending on their velocity. The first collection is planned in October 1995 when the Earth encounters the Draconids meteor stream, associated with Comet Giacobini-Zinner.

At the end of the experiment, the containers will be returned to Earth for analysis. Scientists hope the results will improve our understanding of the cosmic dust in our Solar System and the amount of man-made space debris in low Earth orbit. The results will also help engineers design spacecraft to survive battering by natural and artificial debris.

Material science

Material science experiments will include processing of semiconductors, alloys and glass. Material processing in microgravity conditions benefits from the lack of convection so that processes such as growth and solidification of materials can be investigated more precisely.

Material science experiments will benefit from a six-zone tubular furnace, known as TITUS. This furnace provided by the German Space Agency (DARA) is capable of achieving temperatures up to 1250 degrees Celsius.

Technology

Technology experiments include: radiation monitoring to study the effects of the space environment on electronic components; methods of measuring microbial contamination aboard the space station; and a robotic arm to evaluate microgravity disturbances caused by its movements.

A first consignment of the ESA facilities and experiments (350 kg) was flown to Mir aboard a Progress vehicle which docked with the station on 23 July. Two further Progress vehicles, in September and November, and the Soyuz carrying ESA astronaut Thomas Reiter and cosmonauts Avdeev and Ghidzenko, will complete the ESA upload to the Mir orbital facility.

For detailed descriptions of each of the experiments, contact ESA Public Relations in Paris.

Background Notes

The two EUROMIR missions were approved by the ESA Council at a ministerial level meeting in November 1992. It was a major challenge to prepare for these complex missions at such a short notice.

EUROMIR 94 was launched on 3 October 1994. ESA astronaut Ulf Merbold spent four weeks aboard Mir performing a variety of experiments spanning the fields of life and material science and technological research. The successful flight, the longest ESA manned mission to date, ended with a landing on 3 November 1994.

The Mir space station was launched into orbit on 20 February 1986. Since then it has expanded into a space complex weighing over 130 tons. Four modules packed with research equipment have been added to the station. A fifth and final module is scheduled to join the station before the end of the year.

In June the US Shuttle Atlantis made the first in a series of regular missions to dock with Mir. The second is scheduled to take place during the course of EUROMIR 95.

Beginning in late 1997, utilization of Mir will be slowly reduced as activities shift to the International Space Station, a program of Russia, the United States, ESA, Japan and Canada, as it is assembled.

MARS PATHFINDER UPDATE
By Tony Spear, Mars Pathfinder Project Manager
From *The Martian Chronicle*

September 1995

We started flight system Assembly, Test, and Launch Operations (ATLO) at JPL on June 1, 1995, 18 months before launch on December 2, 1996. Our first ATLO phase from June through December 1995 starts with initial subsystem integration, including the rover and the science instruments, and ends with system test of the launch, cruise, Entry, Descent and Landing (EDL) and surface operations phases of the mission. We work ATLO one shift per day, 5 days per week and use extra shifts and weekends to catch up if we fall behind. In addition, we have 36 workdays of schedule reserve built into the Phase 1 schedule to ensure we complete everything we set out to do before we start ATLO Phase 2.

In Phase 1, everything is laid out in a "2-dimensional configuration". For instance, the cruise and lander stages sit side by side, electrically connected through jumper cables so that we can easily get to a piece of equipment in case of a problem. Both engineering and flight model subsystems are used in Phase 1 which is like a dress rehearsal, problem shakeout period for Phase 2, the formal space qualification phase. This begins in January 1996 with all flight model equipment now on board. Here we assemble the flight system for the first time, and it goes together sort of like "Russian nested dolls": the lander folded up around the rover which is in turn enclosed inside the aeroshell/backshell cocoon.

It is in Phase 2 that we do our system environmental tests: acoustic vibration, cruise solar/thermal vacuum, surface solar thermal/Mars atmosphere, pyro shock, electromagnetic compatibility, weight and center of gravity, and spin balance with system tests inserted before and after each major environmental test. In addition, we practice all the assembly and test steps that are conducted at the launch site.

We have 33 days of workday schedule reserve built into Phase 2, the end of which culminates ATLO activities at Pasadena with completion of a final system test, a partial disassembly of the flight system for packing and its shipping with support equipment to the Eastern Test Range (ETR) at Cape Canaveral, Florida for launch preparations and launch: ATLO phase 3.

In Phase 3, September 1996 to launch, final flight system assembly is accomplished including installation of the flight aeroshell, parachute, air bags, rockets, pyro firing devices, and propellant. Flight representative models and referee propellant were used in Phase 2.

At completion of assembly, the final system test accomplished in Pasadena is repeated to verify that all subsystems remain ready for launch. A final set of cruise and entry spin balance tests are accomplished-then launch vehicle mate, launch day practice, a final end to end data flow test with Flight Mission Operations in Pasadena, countdown and launch!

In Phase 3, we have 24 workdays of schedule reserve, commonly called "beach time" for unused portions. In Phases 2 and 3, the Flight Mission Operations team trains with the flight system during system tests, commanding the spacecraft and processing its telemetry data. Actual flight sequences of events planned for use in flight are used and checked out. Just prior to launch, a final software update is loaded.

Flight system operations is handed over to the Mission Operations Team by the ATLO Team immediately after launch.

The Martian Chronicle is available on the World Wide Web: http://mpfntas.jpl.nasa.gov/MARTIANCHRONICLE/MARTIANCHRON3/

MARS GLOBAL SURVEYOR STATUS
From *The Martian Chronicle*

September 1995

The Mars Global Surveyor Project (MGS) has completed three very important milestones during May in its path toward launch in November 1996.

First, we have completed the Spacecraft Critical Design Review, a three day presentation of all of the details of the spacecraft design and the final plans to build and test it, presented by our industrial partner, Lockheed Martin Astronautics. Second, we completed the Project Critical Design Review, in which we examined all parts of the project (spacecraft, science instruments, mission design) and how they will work together for launch and in flight to Mars. Finally, we had an Independent Readiness Review in which a group of experts from NASA examine items that pose significant risks in our ability to reach the launch date with everything ready.

The special groups of experts that assessed the results of each of the reviews found that MGS was progressing well on its plan of work to be ready for launch on time. Everyone working on the project was very pleased with these results of their hard work.

We are getting very close to the start of what is called ATLO (pronounced AT-low), the assembly, test and launch operations of the spacecraft. Assembly of the spacecraft begins in September followed by electrical then environmental testing in later months. Testing of much of the already built spacecraft electronics and structural pieces is already underway. Many of the new electronics for the spacecraft and the science payload are in the middle of their assembly processes.

The first science instrument, the Ultra Stable Oscillator, which is used to conduct Radio Science experiments, will be ready in July.

We have been spending a lot of time developing the aerobraking capability that will use the drag of the upper Martian atmosphere to help put the spacecraft into the proper orbit for making the science observations of the planet. We recently made changes to the spacecraft design to add a small extra wing - which we call "flaps" - to the end of each of the two solar panels. The backsides of the solar panels provide most of the area against which the atmosphere acts to provide the drag we need. The extra area provided by these new "flaps" gives us more resiliency against unexpected changes in the atmosphere and gives us much more confidence that aerobraking will work as predicted. Aerobraking is very important to MGS because it allows us to change our orbit at Mars without have to take a lot of fuel with us for our on-board rocket engines.

In another innovation, we are about to begin putting our engineers at JPL in Pasadena, CA, closer to our industrial partners at Lockheed Martin Astronautics in Denver, CO, by means of a "virtual" working environment using small TV cameras connected to our computers. Computers in Pasadena and Denver are in turn connected to each other through the Internet. This lets engineers who are sitting a thousand miles apart work like they are sitting across the table from each other. Their computer screens will not only show the information that they are working on, but their computers will now be able to show their colleagues and allow voice communication between them at the same time.

The Martian Chronicle is also available on the World Wide Web at http://mpfntas.jpl.nasa.gov/MARTIANCHRONICLE/MARTIANCHRON3/

MARS ORBITING LASER ALTIMETER
By Bruce Banerdt

September 1995

One of the top objectives for Mars exploration since the Viking mission has been the mapping of the planet's topography, or the elevation of its surface. The instrument chosen to address this objective on Mars Global Surveyor (MGS) is the Mars Orbiting Laser Altimeter, or MOLA.

MOLA is the first of a new generation of orbital laser altimeters. It was first built for the Mars Observer mission, and instruments with similar designs have since been flown on the Clementine mission to the Moon and planned for missions both in Earth orbit (on the space shuttle) and to other bodies in the solar system (such as Mercury and an asteroid). The measurements made by this instrument will contribute immensely to our understanding of Mars.

The basic principles behind its operation are simple. A very short burst of light (about eight billionths of a second long) is shot from the laser toward the surface of the planet. At the same time, an extremely accurate timer starts counting. The pulse is reflected from the planet, and this very weak reflected light is collected by a half-meter (20 inch) diameter telescope on the spacecraft about two thousandths of a second later. When the telescope's detector senses the arrival of the returned beam, the timer is stopped. The distance from the spacecraft to the surface (or range) is then simply one-half the round trip travel time of the pulse divided by the speed of light. The timing within this instrument is accurate enough to resolve difference in range of less than 1 meter! This operation is done ten times a second, and the motion of the spacecraft over the surface results in a line of measurements that circles the globe as the orbit progresses.

Of course the details of carrying out this procedure can get quite complicated. For example, if the ground is not perfectly flat, the light that reflects from the high spots will arrive slightly before the light that reflects from the low spots. This would not be a problem if the beam remained its initial size (about the diameter of a soda straw), as the variation in height would be much less than the precision of the measurement. But by the time it has traveled the roughly 400 kilometers (about 240 miles) to the surface, it illuminates a spot about the size of two side- by-side football fields. Large variations in elevation across this "footprint" results in a phenomenon called "pulse broadening", in which the initially short pulse that was sent down comes back much more stretched out in time. This makes it harder to detect the signal above the background infrared noise, since the energy is spread over a longer time, and it is also more difficult to decide exactly where in this long pulse the actual "arrival" is. For this reason, MOLA employs four separate detector channels that are optimized for different pulse widths. This increases the probability that the returned pulse will be detected even over regions with steep terrain. This technique also may allow the detection of diffuse reflections from the tops of ground fogs such as were seen in some Viking Orbiter images.

Even though the range is measured extremely accurately, there is still a much larger uncertainty in the elevation. This is because the elevation is defined as the distance of the surface above or below a reference that is fixed to the planet (sea level on the Earth, and an equivalent imaginary surface on Mars defined by its gravity field), but the range is measured with respect to the spacecraft position. So in order to calculate the elevation, one must first determine the spacecraft's orbital position very accurately. This is a difficult task, but techniques of spacecraft navigation using the ranging and Doppler velocity determination capability of the Deep Space Network tracking system should allow the position of the spacecraft with respect to the center of Mars to be determined to an accuracy of better than 30 meters (100 feet).

In order to save cost, MOLA has borrowed designs and technology from several earlier programs. It uses an infrared laser derived from technology developed for military applications by the SDI program. These are not the "killer" lasers of course, but rather very small devices developed for determining the range to targets. The actual amount of power in the laser beam is only about a fiftieth of that in your refrigerator light. This laser uses solid- state diodes for its initial light source, giving it a much longer lifetime than earlier pulsed lasers, which used relatively short-lived flash lamps. With this technology, laser lifetimes of over a billion shots are now achievable, making possible operation over the entire two-year mapping mission envisioned for MGS. The telescope of the original MOLA built for Mars Observer was a spare unit from the Voyager IRIS instrument. When the instrument was rebuilt for MGS, it was necessary to find another source. It turned out that the Cassini project was building an instrument that uses a telescope with very nearly the same specifications, so MOLA was able to adopt their design with a minimum of modification.

Why is measuring topography such an important goal? There are a number of reasons, and they come from many different scientific disciplines. To get an idea of the magnitude of the advance that we are anticipating, consider that the current knowledge of topography on Mars is uncertain by as much as 3 kilometers, compared to the 30-meter accuracy expected from MOLA. Thus we should see a hundred-fold improvement in our knowledge of heights on Mars.

One of the basic uses of topographic information is in the construction of accurate maps which can be used both for scientific research and for mission planning of future landings on Mars. When a camera records an image, the apparent horizontal locations of features within that image are distorted by elevation variations (unless the camera is pointed precisely vertically). These distortions can easily be removed if the topography is known. And of course it helps to know when a lander can expect to meet the surface with an uncertainty of less than a few miles!

The detailed analysis of the three-dimensional shapes of geologic features can yield a greater understanding of the processes that formed and later modified them. Volcanic slopes and volumes reflect the viscosity of the lavas from which they formed (which is related to their temperature and composition) and the speeds with which they erupted. The depths of craters and the heights of their rims provide insight into the mechanics of crater formation and the strength of crustal materials.

Weather patterns are strongly affected by elevation on Mars. Regions of elevated topography affect atmospheric circulation by acting as barriers to flow and by affecting the thermal budget of the surface. Mars global circulation models, which will help us to understand the basic atmospheric processes that drive the weather on Earth as well as on Mars, require an accurate global map of the topography in order to be fully utilized. The density and structure of planetary interiors provide information on the basic processes of planetary formation and evolution. The most powerful tool we now have for exploring the interior of a planet from orbit is analysis of the fluctuations in the gravity field which originate from density variations below the surface. But in order to identify the effects of deep structure, it is necessary first to remove the gravity effects due to the topography itself, which is often the strongest single contributor to the field. Topography also reflects the response of the crust to forces within the planet, which can offer important clues to the origins of those forces and the mechanical properties of the outer layers of the planet. The thickness of the crust itself can most easily be determined from an analysis of the ratio of gravity to topography.

Topography figures into many of the fundamental questions we are trying to answer about the history of Mars and about the processes that are active on it today. MOLA will finally bring our quantitative knowledge of topography to a level at which we can begin to address these questions. By applying insight gained at Mars to the similar processes occurring on Earth, we will be able to better understand our own planet.

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OBSERVATIONS OF THE "FACE ON MARS" AND SIMILAR FEATURES BY THE MARS GLOBAL SURVEYOR ORBITER CAMERA

Michael C. Malin
Principal Investigator
Mars Global Surveyor Orbiter Camera

There is some interest concerning whether or not the Mars Global Surveyor Orbiter Camera (MOC) will observe the "Face on Mars" and other features in the Cydonia region on Mars. This page will describe why there is interest and what the MOC plans are for photographing the features described below.

Background

For those not familiar with the topic, several Viking images show features on the surface of Mars that, in the eyes of some people, resemble "faces," "pyramids," and other such "artifacts." The most famous of these is the "Face on Mars" and associated features "The City," "The Fortress," "The Cliff," "The Tholus," and "The D&M Pyramid." A fairly substantial "cottage" industry has sprung up around these features, with several books having been written about them, newsletters published, public presentations, press conferences, and, of course, "supermarket tabloid" published reports. The basic premise of these people is that the features are artificial, and are messages to us from alien beings. Their tack is to say, "These should be rephotographed by Mars Global Surveyor, since with high resolution we should be able to prove that they are artificial. If they are in fact artificial, this would rank as one of the greatest discoveries in history and thus every effort should be made to acquire images." Evidence cited as presently "proving" these are unnatural land forms include measurements of angles and distances that define "precise" mathematical relationships. One of the most popular is that "The D&M Pyramid" is located at 40.868 degrees North Latitude, relative to the control network established by Merton Davies (the RAND scientist who has been more or less singularly responsible for establishing the longitude/latitude grids on the planets) to an accuracy (actually, a precision) of order 0.017 degrees. They point out that 40.868 equals arctan (e / pi); alternatively, one of the advocates notes that the ratio of the surface area of a tetrahedron to its circumscribing sphere is 2.72069 (e = 2.71828), which, if substituted for e in the above arctan equation gives 40.893 degrees, which is both within the physical perimeter of the "Pyramid" and within the above stated precision. Other mathematical relationships abound. The advocates of this view argue that "no scientific study of these features has been conducted under NASA auspices" and that NASA and the conservative science community are conspiring to keep the "real" story from the American public.

The conventional view is that this is all nonsense. The Cydonia region lies on the boundary between ancient upland topography and low-lying plains, with the isolated hills representing remnants of the uplands that once covered the low-lying area. The features seen in these mesas and buttes (to bring terrestrial terminology from the desert southwest to bear on the problem) result from differential weathering and erosion of layers within the rock materials. The area is of considerable importance to geologists because it does provide insight into the sub-surface of Mars, and to its surface processes. The measurement of angles and distances seems so much numerology, especially when one understands the actual limitations in the control network (of order 5-10 km, or 0.1-0.2 degrees) and the imprecision of our corrections of the images (neglecting, for example, topography when reprojecting data for maps) on which people are trying to measure precise angles and distances. For example, using the latest Mars Digital Image Mosaic and the U.S. Geological Survey control network, the aforementioned "Pyramid" is located at 40.67 N, 9.62W. Using the Viking spacecraft tracking and engineering telemetry, the position is 40.71 N, 9.99 W. The difference, 0.04 deg latitude and 0.37 deg longitude, represents nearly 17 km on the ground, or 7X the size of the Pyramid. These positions differ from the e/pi position by a similar number. Even given accurate data, however, most science does not depend solely on planimetric measurements, even when using photographs. There are many other attributes used to examine features, especially those suspected of being artificial, and the Martian features do not display such attributes. No one in the planetary science community (at least to my knowledge) would waste their time doing "a scientific study" of the nature advocated by those who believe that the "Face on Mars" artificial.

Things limiting MOC observations

Before discussing the observations MOC will attempt to make of "The Face" and other such features, some facts about the camera and its ability to look at specific locations are needed.

- THE MOC IS BODY-FIXED TO THE SPACECRAFT. It has no independent pointing capability. It makes pictures the same way a fax machine does (i.e., the scene is moved past the single line detector).

- THE MOC HAS A LIMITED CROSS-TRACK FIELD OF VIEW (FOV) The MOC has a very small field of view (0.44 degrees), which is about 3 km from the 400 km orbital altitude. It typically takes very small images at very high resolution (lots of data). Anything wider than 3 km cannot be imaged in its entirety.

- THE MOC HAS A LARGE BUT NOT "INFINITE" ALONG-TRACK FIELD OF VIEW The MOC's downtrack field of view is limited by the amount of data that will fit in its buffer (about 10 MB). If one uses the entire buffer (which is not likely to be completely empty unless it's planned to be) and 2:1 real- time predictive compression, this translates to a downtrack image length of about 15 km. The camera has been designed to be able to average pixels together to synthesize poorer resolution, which frees up data. Under the best case buffer availability, an 8X summed image would be 3 km wide (but only 256 pixels across) by about 78,000 pixels long which, at 12 m/pxl (8 X 1.5) would be over 800 km long. One of the big uncertainties in taking pictures of specific places on Mars is the uncertainty in when the spacecraft will pass over that place: the timing uncertainty of 40-120 seconds translates to 120 to 360 km uncertainty in position.

- THE SPACECRAFT HAS LIMITED POINTING CONTROL. The spacecraft uses infra-red horizon sensors for in-orbit pointing control. Owing to variations in the IR flux of the horizon with latitude, season, surface topography, atmospheric dust content, cloudiness, and other meteorological and climatological conditions, the control capability is about 10 mrad (0.6 degrees = 4 km), which is larger than the MOC field of view.

- THERE WILL BE A SUBSTANTIAL UNCERTAINTY IN THE PREDICTED INERTIAL POSITION OF THE SPACECRAFT (AND HENCE, THE CAMERA). The position of the spacecraft is determined by radio tracking for 8 hours (roughly 4.5 hours of actually seeing the spacecraft) a day, and by computing the position of the Earth, Mars, and the spacecraft in an inertial coordinate system. It takes a few days to do this, and to use it to determine where the spacecraft will be a few days later. By that time, gravity perturbations, atmospheric drag, and autonomous momentum unloadings will have changed the orbit. Error studies suggest that the uncertainty seven days after the end of a given period of tracking can be represented as (at best)a 40 second uncertainty in the time the spacecraft will be at a specific point in its orbit. This translates (at the orbital rate of the spacecraft projected on the ground of 3 km/s) to 120 km downtrack and (because Mars rotates at 0.24 km/s at the equator) 9.6 km crosstrack. At 40 degrees latitude, the crosstrack uncertainty is 7.4 km, over twice the size of the MOC field of view. At some times in the mission, when the orbit geometry is unfavorable, predictions will be worse.

- THE NON-INERTIAL POSITION OF THE SPACECRAFT WILL ALSO BE UNCERTAIN. The position of the spacecraft is determined inertially. As noted above, the position of the longitude/latitude grid is also uncertain to about 5-10 km.

- THE SPACING OF ORBITS WILL BE UNCERTAIN. If, in spite of the preceding, orbits were equally spaced, then the average spacing of orbits at the equator for the 687 day mission would be about 2.5 km, which means that each spot on the equator would fall within the MOC field of view in (possibly) two images. In fact, the repeat distance is just over 3.1 km, again assuming equal spacing, and it is more than likely that each spot on the equator will only be seen once. At 40 degrees latitude, the spacing is roughly 2.4 km, and any location will be seen, at most, twice. Given Items 1-6 (above), it is most likely that some places will be overflown twice, and others not at all, and that our ability to predict this is very limited.

The MOC team is attempting to address some of these issues with, for example, optical navigation. This could reduce the spacecraft position uncertainty by perhaps a factor of five or more. An attempt will be made to generate a new control grid with higher precision (perhaps as good as 1 km). But nothing can be done about the orbit spacing or the pointing control or the width of the MOC field of view. Thus, hitting anything as small as a specific 3 km piece of the planet is going to be very difficult.

This discussion doesn't address the variability of the Martian atmosphere, which is very dynamic. Given the occurrence of dust storms during some seasons, and polar clouds during others, there is no guarantee that, even when the spacecraft flies over a specific area, the ground will actually be visible.

Plans for observing the "Face on Mars"

Despite providing a number of people involved with the "private" studies of the "Face of Mars" with exactly the same information presented above, there appears to be a continuing view that MOC will purposefully avoid taking pictures of the "Face" and other features. Much of their focus is on "conspiracies" they feel exist to keep information from the public. This, of course, isn't the case: if an image of the "Face" is acquired, it will most definitely be released. The "Face on Mars," "City," "Fortress," "Cliff," "Tholus," "D&M Pyramid," etc. are in the MOC target database. Image acquisitions will be scheduled each time the spacecraft is predicted to pass over each target. This is done automatically.

Given the factors noted above, however, there is no certainty that the images will actually include the features of interest.

Bottom line

It is planned to try to acquire images of the "Face" and other features in Cydonia. Contrary to what some people have said and written, this has been the plan for some time. This plan was not established in response to outside pressure; rather, there are two reasons for acquiring these images. First, given the interest in the general public about the "Face," it is appropriate to acquire such images for public relations purposes, especially since the public interest has been generated in no small way by the people who claim there is a conspiracy at NASA to withhold information from the public. Second, there are valid scientific reasons to examine land forms in the area (which, after all, is why the Viking spacecraft were photographing the area in the first place).

World Wide Web:
http://barsoom.msss.com/education/facepage/
face_discussion.html

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