**MEX-AREOHAB:**
**A HISPANIC-MEXICAN HABITAT FOR SETTLEMENT ON MARS**

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## Abstract

The Mex-AreoHab Station is the Martian operational mode of the Mexo-Hab Project ("Hab" is here now a provisional designation until the word "habitat" or "house" in Mayan be founded). The origin of the Mexo-Hab Project comes from te idea of the Mars Analogue Research Stations (MARS) Program, key element in The Mars Society's (TMS), President Robert M. Zubrin's Mars Direct Plan[1].

The Project Mexo-Hab started as a proposal from The Mars Society Spain (TMSE) for Mexico, through its President Cayetano Santana Gil, who invited Jesus Raygoza Berrelleza, Founder/President of the Mexican Space Society (SEM), and Hector Omar Pensado Diaz, Founder/Director of the Institute for Advanced Sciences (ICA).

At higher than 5,000 meters above sea level, on the Mexican volcano Pico de Orizaba (PO), our intention is to establish two Mexo-Hab Space Habitats. One, in her Mars operational mode, Mex-AreoHab, like a complementary station to Dr. Robert M. Zubrin's MARS Program and the NASA Mars Design Reference Mission[2]. The other one, in her lunar operational mode, like a Lunar Economic Development Authority, Inc. (LEDA) asset[3, 4]. Both the Mex-LunarHab and the Mex-AreoHab are being developed jointly with the University of Xalapa (UX), and a company named Proyectos and Construcciones MV.

We will be using the PO site as a place for scientific research and conducting tests in similar conditions as the early Red Planet used to have (radiation level, low pressure, topography, etc.) This idea has already been proposed by the biologist Omar Pensado D. to Dr. Christopher P. McKay from the NASA AMES Research Center in September 1997. Also, these geological conditions at the PO site give us the opportunity for scientific research and working activities as those needed to be accomplished on an inhospitable place like the lunar surface, as proposed by Jesus Raygoza B. to mines engineer Brad R. Blair, President of LEDA, and to Declan O'Donnell, Esq., President/Founder of the United Societies in Space, Inc. (USIS), founder and member of the LEDA Board of Directors.

Another intention for making the Mexo-Hab Project operative, is to generate interest for Hispanic-Mexican space activities. These space habitats pretend to be the tip of the lance in developing joint programs for supporting a very needed return to the Moon under simulated scientific exploration; actual scientific and technological research in several different areas; harnessing the robotic Mars exploration, as well as human; and, generating programs to stimulate planetary missions in Low-Earth-Orbit (LEO); and also to generate other space-related activities. Another major goal to be reached is to contribute to generate excellent international cooperative techniques; to encourage the so-long needed establishment of a Mexican Space Agency, in a short period of time; likewise, the formation of an Ibero-American space agency; and, in a long-range, an international space agency.

The Mexo-Hab's Scientific-Technologic Research Program also includes the following disciplines: Geology, Extremophyles Biology, Glaciology (9.5 $km^2$ of glacial zone), Meteorology, Medicine-Telemedicine, Psichology, Nutrition, Exobiology, Vegetal Ecology, Mining and Energy.

## The Designing of the Mex-AreoHab

The design of this spacecraft-habitat displays some technical innovations. The concepts will be managed depending on the following aspects:

1. Activity Zoning and Optimization of Spaces in Each Compartment.

2. Size Reduction.

3. Astronaut Safety and Risk Reduction Protocol.

Still under designing considerations, ahead Mex-LunarHab, the Mex-AreoHab Station is accounting with the concepts listed above. Indeed, Mex-AreoHab, compared to the MARS Stations Project, it will be constructed under an approach of optimizing compartments, a three-levels habitat. It will almost be a cylindrical-shaped spacecraft-habitat. Her size, 9.50m tall and 7.20m diameter. The level at the top will be a conical structure, with smaller diameter than the rest of the vessel, with four seats (pilot, co-pilot, and crew); being also used, being able to be operated as both command module and rescue module. The importance of this conical structure, a capsule, is involved with human life safety. In case of any failure during a take-off, the command-rescue module will be launched, separated away from the rest of the structure. Although spheric-shaped, something similar is intended to be designed for Mex-LunarHab.

For Mex-Areohab, the next level below the command/rescue module will be the sleeping compartment, resting and excercising areas, a toilet and a bathroom. In the lowest level will be the enfermery and telemedicine compartment; laboratories of geology and biology; a chamber for extravehicular activities (EVAs), containing two locks for descontamination and dust cleaning, and another one for air decompression. As an auxiliary element of this spaceship-habitat is a pressurized all-terrain vehicle*.

Powered by an engine, Mex-AreoHab would land on Mars by its own. Which also actually makes this habitat to be a spaceship. If in transit to Mars, it would be used as an extension from mother-ship, with living quarters, like a workshop, and like a scientific research laboratory.

The outer space-related environmental parameters of high radiation flux, low weight, and superior reliability limits many typical aerospace materials to a short list reducing high performance alloys, nanocomposites and thin-layer metal laminates (Al-Ag, Al-Cu) with typical dimensions less than the Frank-Reed-type (packing flaws or "weak" points crystallographically) dislocation source.

**The Pico de Orizaba Mountain: The Proposed Mex-AreoHab Simulation site on Earth**

The MexAreoHab will be placed on the Pico de Orizaba Mountain (PO) at 5,747 meters over sea level, higher than the peak's polar zone (4,200 meters over sea level). There, the warm winds of the Gulf of Mexico's weather shore are still present along the cold weather of the wide glaciers. This site is on the leeward side overlooking the State of Puebla, below the snow-covered areas. This is a dry and desert area. The same mountain's high elevation stands as a natural barrier against the Northeast winds coming from the Gulf of Mexico.

The Mex-AreoHab will be set up at the glaciers's foot, on a plain land, to still be carefully chosen, which will permit to make all kind of tests with rovers (pressurized scouting vehicles) or human expeditions to be cliffing the glaciers (including, a sandbox for touristic attraction, for people to use remote-control robots).

The Pico de Orizaba Mountain posses a total of glacial area of 9.5 $km^2$. It is the largest in Mexico, and one of the most important glacial areas in the tropical zone of the Northern Hemisphere. The glacier's dynamics will be monitored, and an inventory will be made. Also, tests and development of special drills are intended to be done.

Scouting in the glaciers of the PO would be made for searching for microcospic organisms in the snow. On Mars, if there was ever life before the planet was totally frozen, this kind of life form may have adapted itself, and it may have survived in the polar regions. It would be near the humidity sources, where the glaciers are, the places required for its survival on the Red Planet.

The immediate benefits for the people living in the PO's area will intrinsecally be related to a bigger improvement in their economical, educational and natural environment situation. 1) An increased optimization in agricultural development to generate immediate benefits to the local agriculture; an adaptation programmed for cultivating potatoes, using technology for open greenhouses will be investigated. 2) Reforestation of eroded areas at the Pico de Orizaba

Mountain, which also is a national park, by using techniques to stop the growing up of deserts. 3) An improvement in education for the younger population. And 4) an increased touristic activity.

A Possible Future Site for the Mex-AreoHab on Mars: Somewhere Around the Grand Canyon or Cydonia.

Like those exciting science-fiction novels we read today, such as Return to Mars[5], or First Landing[6], and others non-fictional such as The Snows of Olympus[7] depicting landing sites and Martian landscapes, some day, near the edge of the great canyon system of Valles Marineris which stretches 4,000 kms accross Mars, the Mex-AreoHab would probably be landing somewhere in Ius Chasma, the southwestern part of the Valles Marineris. What an spectacle to watch! As geologist Ross Irwin (the first author of such kind of study) said referring a flood of water that could erode the land that now is that great canyon. Irwin has explained, for having a sense of the scale of this event, we are to imagine more than five times the volume of water in the Great Lakes being released in a single flood. As Irwin's theory shows us, the force and volume of the water was enough to carve a valley 2,070m deep and 885 kms long within a matter of months. Also, the research in this field made by Pascal Lee, from the NASA Ames Research Center, is worthy to be considered as he proposes a possible analog mode of selective fluvial erosion on Devon Island (Artic Canada) as happened on Mars[8].

The another possible site for the Mex-AreoHab is in the Cydonia Mense region of the Red Planet, including the feature known as the "Face of Mars", located approximately 40.8 N, 9.6 W, and the "pyramids". Of course, for making some relavant choices of sites for the first outposts on Mars, much more research is needed to be made by robotic probes. Perhaps, Cydonia may not be so attractive for industrial development, but does offer the opportunity to investigate and research on one of the most intriguing subjects of a little over 25 years.

With no doubt, due to the images taken by the Viking 1 Orbiter in 1976, and more recently by the Mars Global Surveyor in 1998, a human visit is badly needed. For questions arised about that "Face", either it is a natural formation, or a probably eroded intentional sculpture? (and the "Face" is not the only object on which the artificiality hypothesis rests; there are some "pyramids" and even a "Fortress"), yet because robotic probes are not so highly efficient as humans are, the answer also only rests in human exploration itself.

Certainly, it is unclear whether these "figures" are an illusion generated by a shadow or an actual artificial feature. The "Face" is, perhaps, the most controversial[9]. Some researchers state that in some cases there is a non-optimal quality of the images; meanwhile some other researchers have argued that the "trick of light and shadow" theory advanced by some to account, for instance, the facial appearance of that hill is not valid [10, 11]. Magnificient pictures, some measuring 12" x 33", included some in 3-D also, were published by the National Geographic Society[12].

The opposite poles of viewpoints, such as both skepticism and fanatism are certainly not answers as true methods of scientific approaches; and a formed public opinion of these Mars questions from an evidently frequent reading of supermarket tabloids, either is a sound-minded approach. It is also understandable Dr. Michael Malin's position as the Mars Global Surveyor Camera Principal Investigator, who is in charge with considerable public responsability, for being very cautious in his statements regarding the pictures [13]. Anyway, to evidently reach the best evidence in support of the hypothesis, for instance, that some hills on Mars are artificial, is for humans to go to our neighbour and intriguing planet and to check by themselves.

At the end, whatever turns out, this is the first time in history that a spacecraft mission, Viking 1, has included an opportunity to engage in planetary search for extraterrestrial intelligent life, and it has had determination of whether some object on another planet's surface may be artificial or natural. Before Viking 1, Mariner 9 had shown interesting pictures too[14], as those named "Pyramids of Elysium". NASA and the Jet Propulsion Laboratory (JPL) have made a good work delivering those images to the public and to the scientific community for evaluation.

Biologists have learned that life is much more stronger than most scientist believed a little over 30 years ago[15]. Indeed, Earth microorganisms have been found thriving in astonishingly hostile

environments. Including the survival of Earthian microorganisms founded in the U.S. lunar probe, Surveyor, by the Apollo 12 astroanuts on the Moon!

Exobiology will be a Mex-Areohab's major scientific research programs, which would be made in joint to NASA's and ESA's programs. We still have much to learn about life, in general. Comets, for instance, are rich in organic materials; Earth could be colonized by some kind of extremophile.

**To Go to Mars: High-Advanced Propulsion Systems are Needed Available**

President John F. Kennedy did not believe that chemical propulsion systems were the future for our space programs, neither did Wernher von Braun. Speaking on May 25, 1961, Kennedy, in his "Special Message to the Congress on Urgent National Needs", outlined his lunar program and then requested an additional $23 million, together with the $7 million already available, to accelerate development of the Rover nuclear rocket. This President stated that "this gives promise of someday providing a means for even more exciting and ambitious exploration of space, perhaps beyond the Moon, perhaps to the very end of the Solar System itself"[16].

New materials and novel production methods must be done in the hostile Martian environment, and in some cases, allow for in situ production of structural and life support provisions. To support long duration missions to Mars, and to make trips back to earth, breakthrough materials or propulsion methods are required which may in reality, wheteher we like it or not, up to this day, depend on various "do it as you go" approaches. A good introduction to the different possible ways of generating propellant on Mars is outlined at the Mars Direct Mission process to use one type of In-Situ Resource Utilization (ISRU) which takes carbon dioxide from the Martian atmosphere and converts it to fuel (methane and oxygen) for the return trip of a human manned mission[17]. Another description of interesting analysis of power requirements for a Mars mission and those needed power systems is depicted by Frank Littman[18].

NASA former astronaut, Franklin Chang Diaz has done a fine work in the field of nuclear propulsion in space[19], as well as some others, whose proposals are very worthy to be taken into in-depth consideration, such as Richard M. Westfall's[20].

For another system to get to Mars, so far as humans are behind schedule to be settling Mars, we need the construction and operational functions of Dr. Buzz Aldrin's "The Cycler", the system of two huge spaceships, permanently traveling back and forth from Earth to Mars. The Cycler will be using the Hohmann formula. Walter Hohmann in 1925 calculated the least-energy orbits that would transfer a spaceship from Earth to Mars orbit, assuming that only chemical rockets were available. After a boost from Earth orbit, the spaceship would coast unpowered the rest of the trip. A condensed, very good description of an Earth-Mars Cycling System is shown at Dr. Buzz Aldrin's science-fiction book Encounter with Tiber[21].

**An Industrial-Manufacturing Park on Mars Will Certainly Be Needed**

The Mex-AreoHab would also be incorporate in a not-so-far future industrial-manufacturing park that is dedicated to insitu resource utilization, where raw materials will also be delivered and processed.

The Mars atmosphere is known to primarily be composed of carbon dioxide along with small amounts of nitrogen, oxygen, carbon monoxide, argon, and water. The atmosphere at the surface is only 1/100 as dense as the atmosphere at the surface of the Earth. The polar regions are composed of water ice, frozen carbon dioxide, and wind dust. All together makes the polar regions attractive sites for mining purposes. The Mars soil (or regolith) is basically composed of silicon, calcium, iron magnesium, aluminum, sulfur, chlorine, and oxygen. And, small amounts of water have been detected, it is very possible Earthian humans could grow plants in the Mars soild. Terraforming the Red Planet is precisely one of the major R&D programs in the Mex-AreoHab schedule.

With a Mars soil simulant, using soil that comes from a Hawaiian volcano which is very similar to the Martian regolith, NASA has been done tests with plants that have been succesfully grown in

this kind of simulant. And, of course, like on Earth, it could also possible to make bricks out of the Martian soil for building structures on the surface.

In the early days of human colonization electricity could come from solar arrays, then from nuclear power modules. Since Mars receives only about 45% as much sunlight as Earth, the problem is that the solar arrays will need to be much larger that the conventional ones used here on Earth.

Human settlements on Mars will require real substantial advances in control mechanisms and monitors to stay operating for a long-term control and maintenance of recycling air, water, agricultural, and waste management systems, a very advanced controlled ecological life-support systems (CELSS). In addition to plant growth techniques to help to facilitate life support systems, highly efficient recycling systems for water and air will be used which are similar to those on the International Space Station (ISS).

The Mex-AreoHab will also be conducting closed habitat tests for long period of times on its Earth site. Evidently, in order to get reliable life-support systems, we are to operate indefinitely a required substantial engineering. A big challenge for the design of CELSS will be the establishment of agricultural facilities on Mars. So far, the growth of plants from seeds and their agricultural experiments have already been conducted in the microgravity environment of space stations, but no food crop cycle has been accomplished in space. One of the Mex-AreoHab's major projects is to develop an extensive program of agricultural and forrest experiments (the growth of food crops in the lunar soil could be one of the activities in biology done in the Mexican habitat). Up to this day, apparently, Mars needs help from Earthians to support Life.

The Mex-AreoHab will be involved in the adaptation of different vegetal species by considering that the Martian soil would seemingly be favorable for cultivating vegetables. The biochemistry of the Pico de Orizaba Mountain's soil will be researched to understand biological processes occurring above the timberline. Also, Minimum Units of Terraformation (MUTs) and new technologies will be developed, and will be under tests at that mountain (e. g., a smart home system managed by Spaniard researchers from the University of Cantabria). The very valuable collaboration in these projects of terraforming Mars made in the Mex-AreoHab by Dr. Chris McKay will eventually be very important. As Dr. McKay has come describing his researches from long time ago[22,23] and those being programmed by the Mexican Terraforming Mars Team would eventually become joint programs to be accomplished in our scientific goals.

**In Search for a Healthy Economy on the Red Planet**

Economically, we are to maximize investment returns, minimizing return times, and keep investment size manageable so that venture capital and private investment can be attracted as rapidly as possible. Our goal must be the creation of a nearly self-sufficient Martian economy based on trade and sovereignity.

Therefore, industrial private enterprises on Mars will create mining and manufacturing facilities to produce semi-finished and finished products made from titanium, iron, silicon, sodium, magnesium and other raw materials. A self-sufficient extensive use of materials on the Red Planet for construction, shielding, growth of food plants, and for other purposes. All of these activities can effectively be done, as well as by using those new technologies we are certainly going to improve life on Earth; all we need is the political willingness to do so. As Dr. Robert Zubrin has asserted to say: "Mars today waits for the children of the old frontier, but Mars will not wait forever"[24].

**Conclusion**

The entire Mexo-Hab Project, the Mex-AreoHab and the Mex-LunarHab pretends to be the tip of the lance in the development of joint programs with the Lunar Economic Development Authority, Inc. (LEDA) and various space agencies for returning to the Moon; also pressing for the robotic, and then human exploration of Mars; to be generating joint programs for simulated planetary missions in Low-Earth Orbit (LEO); one of the main objectives, to create an excellent cooperative scientific-technologic R&D in many areas; and, in a long-range, to effectively launch

the Hispanic-Mexican space activities into a long-term program, for fostering the establishment of a Mexican Space Agency (then an Ibero-American space agency, and an international space agency as well).

Throughout human history, so far, both explorers and settlers were laughed at by people who did not share their views; it did not matter. They went anyway. It was not necessary for their hegemonic culture, popular opinion, as a whole to decide that it was not a waste of money, which certainly is not. So we have to go to Mars today. Because as the late Dr. Willy Z. Sadeh once clearly pointed out: "Any civilization that does not challenge the impossible is doomed to fail. And the impossible for our civilization is humankind's conquest of the infinite space frontier."

Notes:

* Another one of her Martian operational mode is for the pressurized all-terrain vehicle to carry a hookable, manageable ballon, using it as an air observation platform, increasing the potential of the Mex-AreoHab vessel. This brings up multiple advantages because two vehicles are carried in one, so also optimizing space in the station.

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