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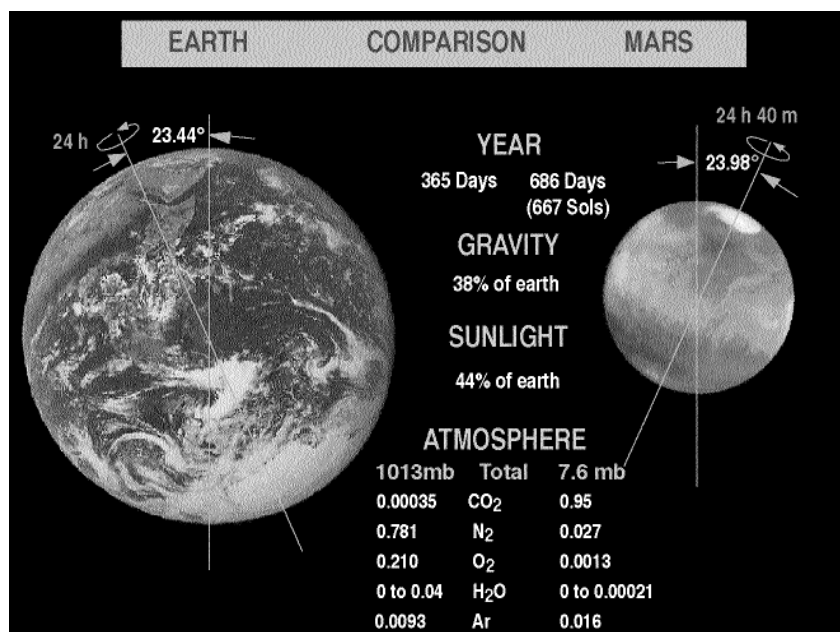
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NEW STAGE OF LIFE: BUILDING ON THE PLANET MARS

The main task is the terraforming of the planet Mars. Nowadays it is a very important task, because there are a lot of problems on the planet Earth, which deals with the exhaustion of natural resources. The solution is in the colonizing and building on the planet Mars.

Mars is the fourth planet from the Sun. It is also the nearest planet to the Earth and will probably be the first planet visited by humans. Mars is actively (pic. 1)

investigating the possibility of humans colonizing this planet, because Mars is the most Earth-like planet of all the planets in the solar system. (



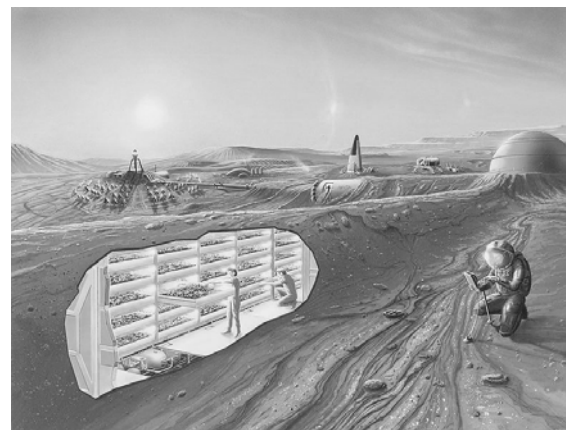
Pic. 1. Comparison of the planet Earth and Mars

Mars is the most likely to have substantial quantities of water, making it the best bet for sustaining life. But the most significant question is in possibility to live there, not only from economic point of view, but an engineering also.

As it was mentioned above, Mars is the most like planet to the Earth, but there is one main problem – the absence of the atmosphere with oxygen that's why the main tasks are the thickening Martian atmosphere, warming it to comfortable levels and transforming it into breathable air.

To realize this the first colonists should to construct the underground shelter (pic. 2).

It is very important to construct underground shelters for martian people, because the atmospheric pressure is low, and the solar radiation is too big and dangerous at which people can't survive without pressure suits.



Pic. 2. Underground shelter in cross-section

Initially, the planetary engineers and early colonists would live in their spacecraft and in prefab habitation modules brought from Earth, but soon

construction would need to begin on permanent structures. Since there are no forests existing yet on Mars to harvest, nor any cement factories, structures would need to be constructed with the available material. On Mars, rocks and dirt are plentiful, and similar materials have been used for building on Earth for thousands of years. Examples of this construction includes caves, stacked and mortared stone, adobe and rammed earth. More modern examples include cast stabilized earth, earth-bag structures and excavated underground spaces.

Caves were the first housing for humans, as this shelter solution was as simple as finding a hole to live in. Natural caves, if any exist on Mars, would be a suitable initial shelter for some aspects of Martian colonization. They likely wouldn't be suitable for most of the structures needed as it would be limited in location, size and ease of access. Underground habitation is a desirable option however, so excavation of artificial caverns will likely be used more than natural caverns.

The underground constructions has many benefits such as a more stable temperature, very secure and stable surroundings, and protection from solar radiation and micrometeorites. On Earth human underground construction is accomplished with large equipment that digs holes, explosives that break up rock, and conveyance systems to remove the debris. Since protection from above is the goal, simply digging a hole wouldn't be sufficient. Spaces would need to be created as tunnels that were expanded to form caverns. The logical choice for this is a mining device called a roadheader (pic. 3).



Pic. 3. A roadheader during work procedure

A roadheader consists of a treaded body with an extending boom that sweeps across a rock face with a cutter head. Large roadheaders are capable of remov-

Mars

ing about 40 cubic meters of rock before moving the base forwards. Recent advancements in mining technology have produced automated roadheaders, capable of selectively cutting rock faces to extract valuable ore while ignoring the rest of the rock. While mining for metals would definitely be a useful practice on Mars, the biggest benefit of this technology would be creating underground spaces automatically. Once a suitable area was selected, deep penetrating radar or acoustic sounding could be used to produce a 3D model of the underground area being studied. A computer model would then be created that would contain the desired space, and the robotic devices would set to work excavating the space. Since there are no conventional fuels on Mars, the equipment would need to be powered electrically, with power derived from solar sources. Nuclear power would also be a possible option for the automated equipment, but there are several serious issues associated with transporting the equipment to Mars as well as maintaining it once there. With solar electric equipment, excavation would continue as long as sunlight was hitting the solar generators, and could continue each day until the project was finished.

Whatever method is used to excavate caverns, there will be a tremendous amount of waste material produced, in the form of dust and rocks. This is actually an advantage, because this material can be used to build surface structures.

For the first stage of building it is necessary to utilize the existing materials on Mars to create most of the building materials we might need. Even the Martian soil itself could be used for rocket fuel.

Colonizing Mars, building underground cities and above-ground cities, developing advanced transportation methods to reach resources and other settlements, locating and using available resources in a safe and reliable way, and doing all of the construction in an alien environment will be difficult at best.

The surface cities of Mars will be enormously complex. They must have multiple backup safety measures built into every building and every wall to ensure protection from the harsh Martian air. They must be fully heated and temperature controlled, shielded from radiation, supplied with the proper mixture of gases at all times, safely powered, and reliably fed. Domed cities may be a thing of science fiction, but their ability to offer an outer layer of protection while providing the illusion of being outdoors may make them very popular.

It is necessary to come up with some clever alternatives to traditional energy sources on Mars, perhaps using new methods of capturing the energy

of the sun. Forms of transportation by air, land, (and people safely and reliably at speeds much greater than here on Earth. A train should be able to travel from one city to another in a short amount of time, thereby reducing the apparent distance between settlements. If distances appear great, colonists will feel confined and imprisoned.

Surface structures are the most common type of structure used by humans, because they're easy to construct, easy to access once built, and provide access to natural light and air. Since the initial structures on Mars will be designed to protect against the planet's air, access to light and ease of construction are the positive points. The structures need to be airtight, so right away stacked stone is ruled out as a possible construction method. Even with mortar, this would be difficult to automate due to the irregularities with the stones. The next option used on Earth is stacked adobe bricks, which was the first attempt at making synthetic stones. Adobe bricks (pic. 4) are essentially sun-dried blocks of sand and clay, and perform very well in warm dry climates. Adobe blocks have excellent thermal mass, meaning they resist quick changes in temperature by storing heat during warm times and releasing it slowly during cooler times. On a daily cycle on Earth adobe houses stay cool during the day and warm at night because by the time the blocks start heating up during the day, the sun has already gone down and the blocks begin cooling down again by releasing heat. This would be an advantage on Mars due to the large temperature swings the planet experiences. As the atmosphere thickened and warmed, this would become much less of an issue but would always serve as a means to regulate heat passively, thus saving energy.



Pic. 4. Example of adobe brick

Earth-bag construction (pic. 5) is a method where bags or tubes, commonly made of woven polypropylene, are filled with dirt, small rocks, or other finely ground material and coiled to produce dome shapes. As each layer is laid down, it is compressed to compact the material inside. It would be ideally suited to Mars structures as the materials required are lightweight and strong, and require only the addition of compactable particulate matter. Domes are a very strong structure and could be buried to provide further

eventually sea) will each have to be able to move protection from the Martian climate. Many shapes can be produced with this method, including vaults and corridors. A stabilized plaster would be created from the fine soil to cover the walls and produce a useable interior and exterior finish.



Pic. 5. Example of earth-bag construction

The last two remaining options for basic construction are rammed soil-cement and cast soil-cement. The concepts are similar in that they both involve a soil mixture being put into forms to create walls but that is where the similarities end. The rammed soil method is a very old technique, in fact the Great Wall of China was constructed with this process. The technique mimics the natural process of sedimentation and produces very strong monolithic structures. Soil is mixed with a small amount of water and often cement as a stabilizer and shoveled into the forms. Traditionally the process used workers with weights on the end of poles to hand tamp the soil mixture; in modern construction pneumatic tampers are used to speed up the process. Cast earth is a newer technique which uses a slurry of soil, water and a gypsum mixture that is poured into wall forms to dry and harden. The cast soil requires a gypsum mixture to stabilize the slurry that is formulated based on the soil used, so this would be harder to utilize initially on Mars. Once the climate was habitable enough for humans to work outside for extended periods of time however, cast and rammed soil would be excellent options for building structures that required shapes other than domes or vaults. Once mining commenced and metals were produced, more traditional buildings could eventually be constructed.

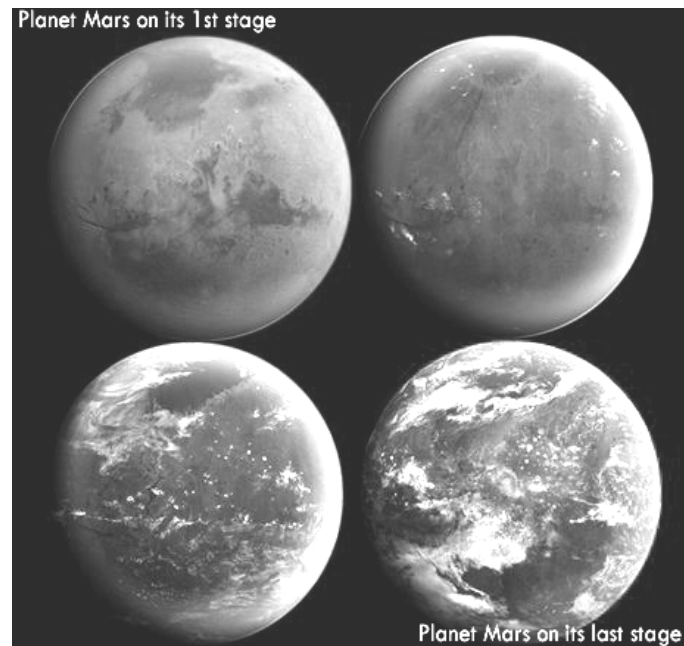
Scientists are developing different ideas and kind of materials, which will be needed for the protection from cosmic radiation, for example brick. The bricks would be made by mixing the chemical polyethyl-

ene, which would be transported from Earth, with the reddish topsoil of Mars. As well as chemical brick, the concrete is versatile material capable of withstanding solar radiation, lunar temperature extremes, high compressive stresses etc. That's why it was developed the procedure solely for the purpose of casting concrete in space.

Also it is known, that Mars has the same types of minerals we have on Earth which could be used for building materials such as concrete. Also it may be possible to make fiberglass and plastic from materials found on the planet's surface and in its atmosphere. Martian settlers may have to build their homes using the materials they find at their destination.

The entire terraforming (pic.6) (*Terraforming* – of a planet, moon, or other body is the hypothetical process of deliberately modifying its atmosphere, temperature, surface topography or ecology

to be similar to those of Earth to make it habitable by terrain organisms) process should take around a century, during which time technological advances on Earth would be occurring in the areas of energy production, nanotechnology, food production and every other aspect of our society. Regardless of the details of how a Martian colony would operate, one thing is certain; a new method of timekeeping would need to be established that was capable of relating to events and times on both planets. A standard interplanetary calendar would address this issue, and allow for Terrans and Martians to have a standard timekeeping format that could be referenced in addition to the planet specific time periods, the same as we can convert currencies or temperatures.



Pic. 6. Terraforming of the planet Mars

Many of the sustainable practices being developed here on Earth would be implemented on Mars because there are very little resources there. Every part of the colony would need to be carefully planned to account for this, but this would serve as an opportunity to create a completely new model of human civilization, doing things right from the very start.

There are different ideas and suggestion for developing the new planet for living conditions. People should to apply immense efforts for realization such space project. The implementation of new technologies will create a powerful world, which will help Earth in future.

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