HAVE SEEDS WILL TRAVEL!

OVERVIEW

Creating a space mission is a great challenge. There are many circumstances that should be taken into consideration. We have to deal with lack of volume and mass especially when the mission is predicted to last for many days. When the duration of a mission is long there is a significant problem with providing appropriate nutrition to astronauts. Not only is there not enough space for supplies, but also food (even package products) run out of date. First mission on Mars will last for approximately 1,5 years (in some configurations even for 3). Achieving Mars and deep space only with supplies brought from Earth is hardly possible. In long duration missions crew of the spacecraft must have their own crop production system. Due to this problem Interstellar Diet LAW came up with ideas on how to develop life-sustaining systems and what should be brought with astronauts to the spacecraft. The main goal of our mission is to deliver astronauts safely to Mars.

LAUNCHING SYSTEM

We propose 3 spacecraft missions. The first one spacecraft will be launched at the beginning of the launch window to Mars and will contain: water and food supplies, all necessary equipment to build martian habitat and also planting set (fertilizers, seeds, planting tools). The ship will land near the landing point for the main spacecraft with crew. Crewed spacecraft will be launched after the supplies rocket. After start and reaching orbit it will wait for the third rocket. Why third rocket? As we mentioned, the longer duration of the mission is really long, which forces us to support crew with renewable food system. In the third rocket we will send them "space greenhouse". Sending initial rocket with that much mass will be highly fuel consuming as well as it will be hard to conduct due to the fact that it takes a lot of space, oxygen, water and energy. That is why we suggest that the "space greenhouse" should be a separate module with its own life-support systems (which will be evaluated further). How will it be done? The segment with astronauts will be orbiting around Earth and waiting for the greenhouse module. After launching they will meet in space and initiate procedure of docking. When the docking procedure will be complete crew will be ready to begin journey toward Mars. If the docking procedure will be a failure astronauts still have possibility to turn back to Earth. The mission will have to be aborted but without risking life from the crew members. Main focus is on the second module - "space greenhouse". It is invaluable part of the mission. This is the place where will be most of supplies for the mission. But the most important task for this module will be producing food! The whole module will be filled with system proposed and already tested by NASA on the ISS - advanced plant habitat. However, we suggest to try filling walls with hydroponic plants. The main advantage of such solution is lowering mass of the spacecraft, because the crops does not require soil to grow. Such system can be embuilt in walls what make it easier to water and fertilize, what provide additional

space for another supplies such as water, seeds, fertilizers and package food. In next paragraphs we will focus on different details of the module.

SPACE MANAGEMENT

As mentioned above, volume is crucial in space missions. Suggested hydroponic system in walls enables to increase room for package food, water supplies, fertilizers, seeds. Space in this module will be divided into two sections: crop production section - mostly walls, and the supplies section where crew will storage water and food brought from Earth and harvested. To maximize effects we suggest to change our attitude to package food. Instead of taking ready products what about trying powders? Such powders will work similar to popular on Earth supplements. These can have different tastes and are highly nutritious as well as caloric which is very important in given circumstances. Protein powders have also long-term expire date and can be treated as emergency supply. Not only are there protein powders, there can be powders made with vitamins and other important macro and micronutricients. They are light and have small volume. Even though powders have so many advantages they cannot be the only diet source, which is why section with crop production is so important.

CROPS

Plantation should be grown without soil due to the mass of the soil. There should be used hydroponic system of planting. It is high efficient if well fertilized and watered. The spacecraft will have separated module only with this crop plantation and supplies so there should be enough water even if current water reuse systems are 80% efficient. After some time we will have something of microclimate in our greenhouse, oxygen and water will circulated in very similar way as they do on the Earth.

The plants that should be planted must have appropriate calories and nutrition. Our team seek for such plants and we suggest planting spinach, tomatoes, peppers, beans and berries. Spinach is high calorie plant, it is also easy-digest and nutricient rich as it contain many minerals and vitamins, but what's most important it is easy to plant and possible to grow hydroponically. Beans are known from being good protein source, research shows that they are good for apetite control which will be very useful in such though conditions and strict diet discipline. The berries are considered as super food they are highly nutricient and provide lot of important vitamins. Diet based on such grown products supplemented with soluble powders with proteins and minerals can lead to successful mission. It will give opportunity to astronauts to work on high level during entire mission. It will provide additional tasks to maintain the crops and lead the experiments with growing plants in microgravity what is really important aspect in terms of psychology. Flight duration in one way is (in the best option) about 7 months and after some time astronauts just will be bored, providing them constant task which is important and gives regular outcomes will be great for astronauts mental health. Another aspect is that using package food for such a long time will be

exhausting, by crops astronauts will have opportunity to have fresh vegetable and fruits (what study says they miss the most on long duration stays on ISS), different taste of powders will give them some kind of pleasure as it is proved that some tastes (for example chocolate) stimulates endorphins and dopamine which improves overall well-being.

ENERGY AND PROTECTION

Providing enough energy for system is really important, plants need appropriate temperatures and light to grow properly and (what most important) to conduct photosynthesis. We cannot take too many energy from the main spacecraft module because it have to provide constant electricity to the avionics systems and power for astronauts. That is why team considered using separate module energy system based on solar energy. Solar batteries will be placed around spacecraft segment and will be hidden. They will expand after successful docking in perpendicular position to the spacecraft.The most of energy will be used for LED lamps which will provide light and temperature for plant, water circulation system, life-sustaining system and for electronic measurement system, which will provide data about condition of the crop. Crew and crop must have protection from cosmic rays as they deteriorate health if life forms have too big dose of them. During long duration mission it must be taken into consideration. The solution for protection is to use material that does not let cosmic radiation go into the spacecraft. Our proposal is to use multi-layered walls, which will be built with carbon nanotubes and aerogel.

USING "SPACE GREENHOUSE"

The crop production will start as soon as there will come space docking to the main module. Astronauts will have to seed plants. After production starts it will continue as long as there will be enough water and energy in system. Crop will have to be manually fertilized but all data about plants will be gathered by computer systems which will alert the crew if something is going wrong. It will also remind to fertilize and suggest when to harvest. Such electronic system will be also power by solar energy from segment. All harvested food will be divided into 3 groups: first one will be used as fresh food for the crew, second will be storaged with other supplies (but no longer than for 3-4 days), third is mentioned to be used for germination.

System which team is proposing is in the early stage of development, there should be added some specific calculations about how long our hydroponics chambers can be used, what amounts of food we should take and what we can take to the space in terms of mass and volume that can be launched from Earth. The average human eat approximately 2500kcal per day, but for every astronaut that amount will differ in terms of their weight, sex and their performance, so depending on crew there will be different amount of supplies on the spacecraft what will have many consequences it terms of energy, oxygen, water and food use. Definitely there should be at least one botany on board who have knowledge about crop production and how to deal with any plant diseases. There is many circumstances that should

be taken into consideration, however, this is the core of idea that we hope can be developed in nearby future and be used in first long-term missions to Mars and beyond the Asteroid Belt .