



Visioneering 2008 Biomedical Engineering

Background:

The United States has sent a crew of astronauts to staff a newly installed space station on the surface of Mars. Although these crew members have been selected based on their good health, but one of them has had an accident that resulted in a serious knee injury. To make things worse, the accident occurred without the presence of a trained flight surgeon that could easily treat the injury.

In this scenario, you and your team are asked to help the other crew members put together a plan for self-directed medical care that will help them treat the injured astronaut and get her back on the road to recovery.. This plan will assist the team of astronauts in making a specific diagnosis, performing surgery on the damaged knee, and putting a rehabilitation plan into place for the injured astronaut. You can assume that the crew will have the ability to communicate with your team on Earth in order to receive direction and assistance from trained medical staff.

Since these astronauts will have traveled for about nine months to reach Mars, it will not be possible for them to return to Earth quickly. With your plan, they will be prepared to perform a medical diagnosis on Mars as well as, in this worst-case scenario, having a non-physician perform a surgical procedure to repair a damaged knee.

Challenge:

NASA has commissioned your team to come up with a plan for self-directed medical care that would allow an injured astronaut to be treated on Mars and, eventually, returned safely to Earth.

The ideal plan and design should incorporate these key issues/components:

1. The type of diagnostic equipment that would be needed in a medical facility on Mars.
2. The design of a Mars-based emergency room/operating room.
3. The surgical equipment that will be needed, as well as the design of the knee replacement parts.
4. The type of rehabilitation plan an injured astronaut would need to facilitate her recovery during the nine-month trip back to Earth. According to NASA research, bone fractures incurred during and immediately after long duration space flight may require a prolonged period for healing.

Things you might consider:

- Using a Hohmann transfer orbit trip to Mars would take approximately nine months, so it will necessary for an astronaut crew to deal with medical emergencies themselves as it will be impractical to transfer an injured colleague home in a timely manner.
- The atmospheric pressure on Mars is too low for humans to survive without pressure suits. Any medical facility would be located in a structure constructed with pressure vessels just like their spacecraft.

- The round trip communication delay due to the speed of light ranges from about 6.5 minutes at closest approach to 44 minutes at superior conjunction. That mean it can take anywhere from 13-88 minutes for a question and answer to travel from Mars to Earth and back. Thus, real-time conversation with Earth, such as telephone is not possible.
- What types of medications (i.e. pain medications) should the astronauts have on Mars? Would there be a shelf life? How would they replace medications once they expire?
- Should astronauts be trained in advance to fix any piece of medical equipment they work with on Mars?
- How many of the astronauts should be trained in advance to perform minor surgical procedures?
- What if the one who's trained is the one who gets injured? Should someone else be trained in the art of anesthesiology to assist in the procedure?
- Could you somehow utilize the limited gravity on the Martian surface during rehabilitation?

Evaluation Criteria:

The Designs will be evaluated based on the following criteria and rated on a scale of 1 – 10 with 10 being the highest:

Category	Description
Teamwork	Exhibited ability to work together, involvement of all individuals on team
Creativity	Unique, out-of-the-box thinking?
Visionary	Forward thinking used? Innovation? Eye to future technology?
Versatility	Design could be easily adopted for human benefit? Useful to all mankind outside of space program.
Engineering Excellence	Project has clear objective? Is the design relevant to the user's needs? Can the design lead to an end product?
Sustainability	Design could be maintained? Design incorporates use/reuse of natural resources?