

# Engineering Disciplines In Space Travel

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## Abstract

Principles of engineering are helping to facilitate space travel. Multiple engineering disciplines are required to work together in order to aid the optimization of space travel. Making the space vessel lighter and stronger by creating rocket structures out of carbon fibers would be the main focus of Chemical Engineering. The development of graphical user interface with a more effective method of gathering and processing data generated by the spacecraft is the work of Computer Scientist and Engineers. Ensuring the health and safety of the space travelers while in space through the engineering of medical equipment is the study of the discipline of Biomedical Engineers. The perfection of a faster engine such as the Electromagnetic Drive would be the focus of Aerospace Engineering. Robotics and the construction of moving parts that aid astronauts would be the Mechanical Engineering focus. The integration of different engineering disciplines on space travel will have further the advancement of the human society through advanced and new technologies that are applied to other aspect of the human society such as traveling.

## Hypothesis

Multiple engineering disciplines are required to work together in order to optimize of space travel. The construction of vessels that have the capabilities of operating at a fast pace with efficient energy sources and helping its passengers adapt to the vacuum of space. These multiple engineering disciplines are needed to make human space travel possible and comfortable with communication systems effective enough to stay in contact with Earth over a long period of time and distance. These fields of engineering help to contribute to the optimization of space travel: Chemical Engineering (Fuel and Energy), Computer Science (Computer Programming), Biomedical Engineering (Health and safety), Aerospace Engineering (Vessel Engine), and Mechanical Engineering (Mechanical Aid).

## Introduction

Space exploration has been growing and expanding from the time the first spacecraft launched to the first moon landing till this very day. Space traveling has been successful for nearly six decades and it has been successful throughout the years. The advancement in science technology and exploration of space has made our world smaller, and universe much larger. Space is not readily accessible because it holds many dangers to humans, it is an inhospitable vacuum, barren of breathable atmosphere, nutrition and, water; which humans need to survive. People are discovering and creating more efficient and safer ways to travel space by contributing their ideas from various engineering fields to optimize space travel. Engineering disciplines like computer science, biomedical, chemical, aerospace and mechanical, all help to optimize space travel to make it more facile.

Curiosity emerged when Galileo Galilei “father of observational astronomy” created the first telescope to observe the first four moons around Saturn, lunar craters and the phases of Venus. This and many other discoveries sparked the idea of exploring space. Which lead to the Space race, between the Soviet Union and the United States. After the first successful orbital launch by the Soviet Union in the fall of 1957, engineers around the world have been busy coming up with ways to better and prolong space travel by humans. This began the sparked of a new era in space exploration. As technology advances, space shuttles, propulsion engines, Fuel usage, and life in space had many modifications which have lengthened space travel and many other aspects that can help future explorations.

## Objectives

How different engineering disciplines combine different innovative ideas to create optimal space travel.

## Computer Science

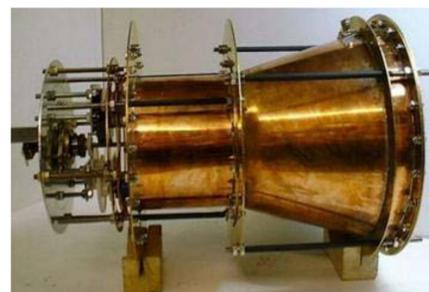
Once a satellite or a spacecraft has been launched into space we need to be able to control it. Operating Systems are designed so that the operators can control the position of the spacecraft which will include operation of any thrusters or engine o board. It is important that the operators know the status of the object and are able to engage or disengage the instruments. Due to the varied use of satellites and spacecraft, these systems will be designed and adapted specifically for that object. Incorporated into all of this is security of the systems, so hacker must not be allowed to gain control and robustness of the system. If something fails there must be a back-up system or the spacecraft may be lost.

Space missions need accurate planning and calculations of the trajectories, propulsion, and path that a space vehicle will take. It must be defined precisely after considering the motions and gravitational forces of various celestial bodies. The time, amount of fuel, duration of the mission, everything needs to be exact. Even a millisecond of miscalculation can prove disastrous. Considering all this, computers are used to carefully plan and prepare the mission.

## Computer Engineering

Computer engineering is the combinations of couple fields of electrical engineering and computer science that work together to develop hardware and software for computer. When it comes to space travel, computer engineering has made tremendously contributions. Without these people who are keeping track of spacecraft, it seems impossible for human to accomplish this mission.

Computer engineering has affect many aspects of space travel, such as designing spacecraft, celestial mechanics, writing flight software, mission control, and gather data by using computer. When designing a spacecraft, it is important to keep in mind that all subsystems have to function together, and especially in a spacecraft such as Mariner that its subsystems derived from different kinds of technical disciplines. It’s also important to consider all the physical properties of these subsystems, such as weight and distribution of mass. To use computer not only it can increase the speed and accuracy that a spacecraft and its subsystems can be designed but importantly the computer techniques can come up with all the possible designs, therefore design parameters can be chose from these possible designs quickly and more accurate. Celestial mechanics can be considered as the most important part when human tried to calculate the trajectory of a spacecraft. There are numerous trajectories a computer can come up with, and what human only need to select one that is the best accuracy. Because of computer, the accuracy has improved. Both computer science and computer engineering can write code for flight software, and the programming plays an important role in space exploration. Knowing Algorithm or data structure knowledge is helpful in flight software. The flight software also has to receive data from sensors and then send the data to other machines. It is computer engineering’s job to consider about how to convert those inputs into outputs. Computers such as IBM 7040, 7044, and 7094 are typically used for obtaining and processing spacecraft data. There are countless data from tracking stations, and by analyzing these data scientists can know about the condition for both the spacecraft and the space.



Space Travel can be extremely strenuous on the physical health of astronauts. Biomedical Engineering innovations has helped create methods in which astronauts can preserve their health, and take care of themselves up in space. The main issues that are common for astronauts to face in space are dental, skin disorders, or any wound that can be healed in space.



### Bacteria in Space

- Water helps remove any microbial contaminants, and biofilms.
- Microwaves can be used to help sterilize surfaces, and water. It helps prevent the spread of viruses and bacteria.

### Gravity and Cardiovascular Health in Space

- When traveling into space no blood is traveling to the lower body.
- Can be detrimental to the heart and body if left untreated.
- Volume of blood decreases after 1-2 weeks
- Exercise is necessary during flight to help keep the blood flowing.

### Tooth Decay and Wounds in Space

- Emergency kits are given for tooth decay and any dental emergencies.
- The Biomedical Engineering Department created a protein paste that can be applied to open wounds to heal them.
- Space travel can help create a number of medical conditions as well as, bone loss, and muscle atrophy.

## Biomedical Engineering

### Deep Sleep in Space

- Astronauts are put in hibernation chambers for long trips.
- This helps astronauts psychologically, as they won’t be awake for the majority of the trip.
- For nutrients, computers need to used monitor the astronauts and allocate food.
- Radiation is a concern; Protection against radiation can be applied to the sleep capsules instead of the whole ship, saving weight and fuel.

## Aerospace Engineering

To help advance space travel, this engineering department is tasked with the design of engines and shuttle extensions that will result in the creation of fast shuttles. These designs also lead to a more effective and green engine.

### Electromagnetic Drive

- Six times faster than the conventional engine used on the New Horizon mission to Pluto.
- Defies the laws of conservation of momentum.
- Also known as a radio frequency resonance cavity thruster.
- No reaction mass and no emission of directional radiation, i.e. no burning of fuel to gain momentum.
- Propel through the vacuum of space by bouncing microwave radiation in a closed and sealed chamber.

### Sabre Engine

#### (Synergetic Air-Breathing Rocket Engine)

- A single stage to orbit engine.
- A hybrid of rocket engine and jet engine concept.
- Uses the air in the atmosphere to provide jet thrust during planetary flight.
- Heat exchange system with the capability to cool in coming air to -150°C.

## Chemical Engineering

Chemical engineering is the branch of engineering that deals with making safe and successful space exploration, this discipline of engineering has not only contributed to producing the necessary fuels and energy needed for achieving orbit, but also to withstand the rigors of space travel. “As we move further away from earth, there is very distinct need for a new chemical process to help the means for advanced space exploration”. Since the first launch in the 1950’s, chemical engineers have been developing high-performance materials that can withstand deep space radiation, extremely hot or cold temperatures, severely corrosive environments, and highly erosive and high friction conditions.

Materials such as:

### Polyetheretherketone (PEEK)

- A high performance thermoplastic with mechanical strength to withstand to temperatures up to 170 °C (338 °F)
- Great chemical resistance
- Light weight
- Dimensional stability

### Polytetrafluoroethylene (PTFE)

- Thermoplastic polymer that can operate between temperatures of -250°C up to 250° (-482°F-482°F)
- Low coefficient of friction
- High impact strength

The advancement in fuels and engines has greatly impacted space for optimal travel.

### Cryogenic engine/fuel

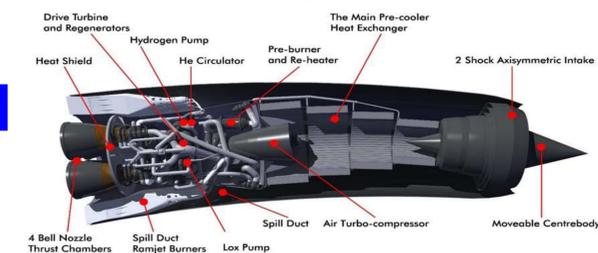
- Cryogenic engine throws mass in one direction, and the reaction to this is a thrust in the opposite direction.
- Use of liquid nitrogen, liquid hydrogen and liquid oxygen that are kept in very low cryogenic temperatures.
- Highest performing rocket motors
- The thrust comes from rapid expansion from liquid to gas with the gas emerging from motor at very high speed
- Energy needed to heat the fuels comes from burning them.

## Mechanical Engineering

This engineering focus is tasked with coming up with effective tools that serve scientific study purposes. Some of these tools are being used on the Mars Exploration Rover. They also help build the ideal engines designed by aerospace engineers.

### Rock Abrasion Tool

- Utilizes a diamond dust and a resin wheel
- Used on the Mars Exploration Rover
- Drills and dust Martian Rocks for closer scientific inspections.
- Capable of drilling 2 inches deep into Martian Rocks.



## Discussion

Different Principles of Engineering have provided new innovative ideas and inventions that has helped optimize space travel. Engineering focuses such as biomedical engineering has helped astronauts adjust to the physical environment of space. Computer Science and Engineering has helped advance the control threshold of the mechanisms and equipment used aboard space vehicles. These engineering focuses have also helped advance the technology used to record scientific data from experiments in space. Aerospace Engineering, Mechanical Engineering, and Chemical Engineering deal with the structure and propulsion of space vehicles. Innovative technologies created by engineers and scientists have helped astronauts to collect data more effectively, as well as creating a mechanism that can withstand the vacuum of space. Space Travel can cause many detrimental effects on not only on the human body, and on the space craft as well. With the help of engineers and scientists, there is a more safer and innovative way to travel space without the harmful effects. Multiple Engineering Principles are being used to help facilitate space travel and lessen the harmful effects that may come with it.

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