Rocket (Vostok 1)

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Prepared by : Group 4

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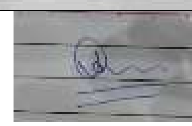
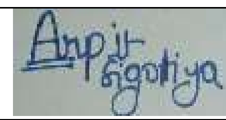
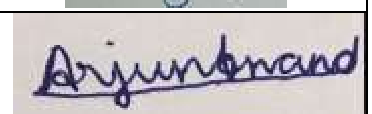
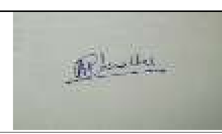
2	Anuj Joshi (23110033)	
3	Arpit Sigotiya (23110044)	
4	Arjun Anand (23110039)	
5	Arjun B Dikshit (23110040)	
6	Anuja Chaudhari (23110034)	
7	Apoorv Rane (23110036)	
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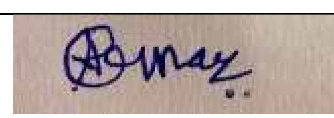
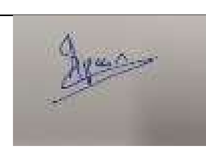
9	Arnav Gogate (23110043)	
10	Arjun Paan (23110041)	

Introduction and Motivation

"Orbiting Earth in the spaceship, I saw how beautiful our planet is. People, let us preserve and increase this beauty, not destroy it!"

— Yuri Gagarin

On April 12, 1961, the Vostok 1 was launched, and Yuri Gagarin became the first human to venture into space. This event had a significant impact on the world, not only in space exploration but throughout science and engineering.

The Vostok 1 program and Yuri Gagarin's flight left a legacy. They laid the groundwork for subsequent human spaceflight endeavours and contributed to the development of space exploration technology.

The achievement of engineers and scientists, who designed and made Vostok 1 a success, affected the world in many aspects and changed the world for good. Some of the important effects of this historical achievement are:

- Improved space technology → The Vostok 1 was an engineering marvel of its own, as it was not only the first crewed space mission but also the first orbital flight in the history of humankind. The technology used in Vostok 1 laid the basis of current advanced technology used in modern rockets, and it also serves as the starting point of future space research.

- Fueled up the moon mission of NASA → This achievement of science and engineering inspired the USA to launch the Apollo Missions and thus, this achievement in a way, fueled the Apollo missions.

- Creating general awareness and interest in space → Before the advent of space exploration, only few scientists, engineers and astronomers were enthusiastic about exploring the universe. But, after the launch of Vostok and, subsequently, the Apollo mission, people became more enthusiastic about the concept of space.

It has been more than 60 years since the Vostok 8K72 launched a human into space for the first time in history, yet the engineering marvel continues to inspire today. It was the pinnacle of engineering at its time and some of its parts are still in use in modern rockets. Its engine and thrust system are still used in rockets.

The universe is a vast and unexplored region filled with strange mysteries and weird anomalies. It is a source of intrigue and passion for a vast majority of our group members. This, coupled with a hunger for innovation, creativity and a burning desire to touch and understand the cosmos, served as a primary incentive to recreate and celebrate the first ever rocket to have launched a human into space.

The second main motivator for our team is that we wanted to create a model which can serve as an educative tool to aid in further research of rocket-based technology and help inspire the future generations to pursue the interesting field of astronomy and space exploration. The model can serve as a reference point for the analytical study of various research fields.

Our team will be making the Vostok rocket with a few modifications. It consists of a space cabin which can house one cosmonaut. The cabin is retrofitted with instruments that indicate cabin pressure temperature and orbital position from the earth. It has a vizor and ejector seats. Below the cabin, there are spherical tanks filled with oxygen and nitrogen for life support and propulsion. The instrument module contains all the important wiring and circuitry required for collecting and displaying data. The outer body of the Vostok rocket contains the nose cone, main cylindrical part and fins. These are vital for the safety and durability of the spacecraft. The nose cone surrounds the space cabin and protects it from heat. The nose cone is connected to the rest of the rocket body by shock cords. The shock cords help keep the parts of the rocket together by absorbing the shock when the rocket is deployed. The fuel tank is the part which contains the propellant used to power the rocket engine. The rocket also has an oxidizer tank which contains the oxides and is imperative to propel the rocket upwards. The thrust gears are essential for the working of the thrusters and are fueled by cold nitrogen.

Before the advent of space exploration, our understanding of space was limited to what we could observe from the Earth. Still, after it, we realized that we were just a pale blue dot in an endless plane of infinite possibilities. We humans did many things which were once thought to be impossible, broke all known barriers and did new miracles. We redefined the limits of their unlimited potential, innovated and created gadgets to explore uncharted spaces and made the impossible possible, and this is what engineering is all about.

In conclusion, we chose the Vostok rocket not only because of its impact on the engineering field but also due to its historical significance. This project will help us learn how to work together as a team and solve a complex problem by resolving into smaller parts. Moreover, since many parts of the rocket are not available online, this project will challenge us to think out of the box and embrace the essence of true engineering.

Part Name: - Space Cabin and Nose Cone

Anurag Singh (23110035)

Introduction

Since childhood, I have been fascinated by space exploration, especially rockets, and say it was luck or destiny that our team decided just that as the project. More specifically, the rocket we have chosen is the Vostok 1, developed by the Soviet Union. Vostok 1 is renowned as the rocket which carried Yuri Gagarin into space and made him the first human to go into space. It was launched on April 12, 1961, from Baikonur Cosmodrome, and its orbital spaceflight consisted of a single orbit around the Earth. It was also a vital space mission in terms of political aspects because of the space race between the USA and the USSR. Thus, Vostok 1 intensified the fire of the space race and played an essential role in further advancements in space technology. Hence, Vostok 1 was one of human history's most important space missions.

Thus, paying homage to Vostok 1, we will be making a model of Vostok 1, and for this, we have divided the model into 16-17 parts. The parts which I will be making are "Space Cabin and Nose Cone".

Basic Structure

- Space Cabin → The space cabin of Vostok 1 was spherical in shape and was designed to carry a single cosmonaut. It also had antennas on the outer body and 3 portholes. Four straps surrounded the spherical body with an entry/ejection hatch, capsule recovery, and technological hatch. It also had a 16-point multi-pin umbilical and an optical device for manual altitude control called Vzor(Visor).

- Nose Cone → The nose cone of Vostok 1 had an aerodynamic shape designed to reduce the air drag during the flight of the rocket in the atmosphere. It consisted of a heat shield made of ablative materials, and it surrounded the space cabin and thus protected it from the immense heat.

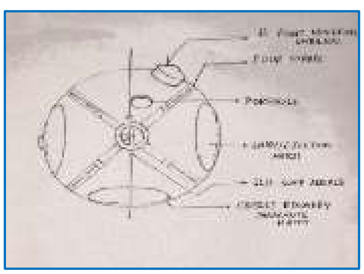
Importance

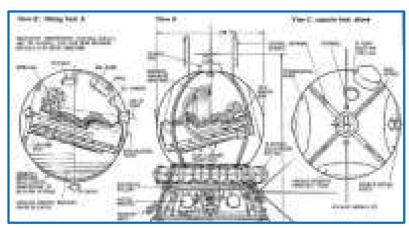
- Space Cabin → As mentioned earlier, the Vostok 1 was the first crewed spaceflight; for the success of the mission, it was necessary to ensure the safety of Yuri Gagarin, and hence, the space cabin was one of the most essential components of the rocket. It is made up of an aluminium alloy and was covered with an ablative material that slowly burnt off at re-entry, thus protecting the inner space cabin and Yuri Gagarin. It also had antennas for communication, three windows or portholes, which allowed Yuri to see outer space, a few hatches for entry/ejection, an optical device for manual altitude control and many other sensors and devices.

- Nose Cone → It was an essential part of the rocket and helped in reducing the drag and gave an aerodynamic shape to the rocket, which becomes decisive in terms of the fuel required depending on how much the drag is reduced. It acted as a shield for the space cabin protecting it from immense heat, drag and other debris.

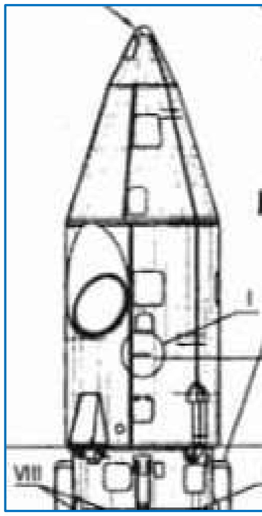
Challenges to be faced

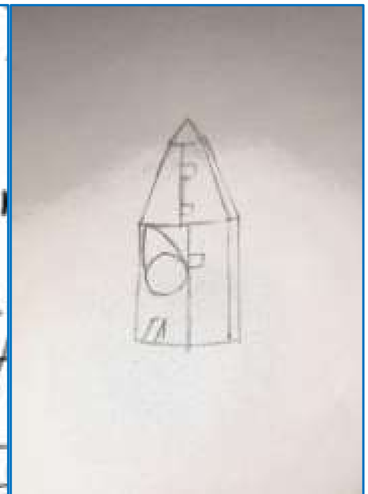
1. Space Cabin → The shape of the cabin is spherical which would be easy to make. However, the components on its surface would be quite challenging to make as I have not done anything like that till now. Also, making the portholes and hatches would be pretty challenging. But the toughest part would be to make the model of the straps, as they have a kind of an arc-like shape but are not entirely circular and I have to make them on the sphere.





2. Nose Cone → Although the nose cone is a simple-looking component making a model of it would not be a cakewalk due to its specific shape. So, the only challenge is to draw an accurate aerodynamic shape of the nose cone.





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Part Name-Storages and Antennas

Anuj Joshi (23110033)

Introduction: -

Our group has decided to make a model of the Vostok spaceship. The Vostok spaceship an iconic symbol of human exploration. It was developed by the Soviet Union during the peak of the space race in the 1950s and 1960s, and the Vostok spacecraft played a pivotal role in shaping our understanding of space and paved the way for historic accomplishments. Remarkably, it carried the first human, Yuri Gagarin, into space in 1961, marking a landmark in the history of space exploration. The Vostok program incorporated a series of spacecrafts that contributed precious data and experience to the early days of human spaceflight and exploration, leaving an permanent mark on the history of space. This brief content will delve into the fascinating story of the Vostok spacecraft, its critical missions, and its lasting legacy in space exploration.

As a tribute to the legendary spaceship, our group has decided to understand the criticalities of the spaceship and explore more.

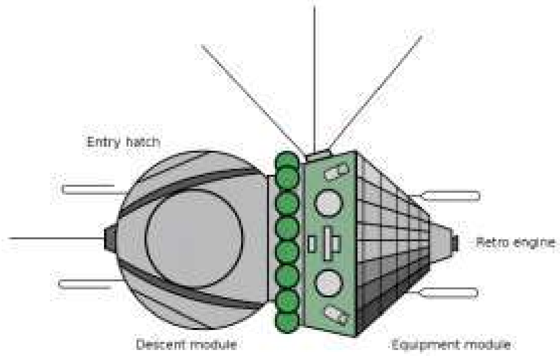
Basic Structure: -

1) Storages: -

The oxygen and nitrogen cylinders within the Vostok spacecraft had a fundamental cylindrical design, characteristically crafted from lightweight, robust materials such as Aluminium or other advanced composites. These cylinders were tactically integrated into the spacecraft's interior, often within designated compartments, to optimize space efficiency. They featured precision-engineered valves and regulators, necessary for controlling the flow of gases with great accuracy, ensuring a continuous and controlled supply of life-sustaining oxygen and nitrogen throughout the mission.

2) Antennas: -

The antennas on the Vostok spacecraft included a bold, durable structure, primarily consisting of whip antennas strategically positioned on the spacecraft's exterior to transmit and receive VHF and UHF radio signals. These antennas served as crucial communication links between the spacecraft and mission control on Earth, facilitating the exchange of vital data during the mission. Given the absence of modern GPS systems during Vostok's missions, these antennas played an important role in tracking and guiding the spacecraft's trajectory, also ensuring accurate navigation and successful mission outcomes in challenging space conditions.



Functions:

1)Storages: -

The role of the oxygen and nitrogen cylinders within the Vostok spaceship cannot be overstated. These cylinders were the lifeline for the astronauts (cosmonauts in this case), providing the essential elements to survive the harsh conditions of space. The oxygen cylinders stored a valuable supply of pure oxygen, which was providing life by letting the humans breathe amidst the vacuum of space. It ensured that the cosmonaut had a continuous and reliable source of breathable air throughout the mission, ensuring their existence.

Simultaneously, nitrogen assumed a dual role of paramount importance. Firstly, it functioned as a diluent gas, expertly mixed with oxygen to establish a life-sustaining atmosphere within the spacecraft. This delicate balance was vital, preventing the cosmonaut from experiencing oxygen-related health issues. Secondly, nitrogen was a pressurizing agent, so upholding the necessary atmospheric pressure levels across various spacecraft systems was a task. This ensured that critical components, such as the cabin and fuel tanks, operated optimally and safely in the vacuum of space. Regulators and valves precisely designed the complex composition of this life support system. They controlled the accurate flow of gases, assuring a stable and habitable environment throughout the mission's duration. In essence, the cosmonaut's existence rested on the proper functioning of these cylinders. They stood as integral components of the spacecraft's life support system, highlighting their critical role in ensuring the safety and success of every Vostok mission.

2)Antennas: -

The antennas on the Vostok spacecraft were pivotal components, serving as the primary means of communication and tracking in an era when advanced technology was in its infancy. These whip antennas, strategically positioned on the spacecraft's exterior, exhibited a simple yet robust design, capable of transmi ing and receiving radio signals across Very High Frequency (VHF) and Ultra High-Frequency (UHF) bands. During missions, these antennas extended, establishing a vital link between the spacecraft and ground control. This allowed for real-time data exchange, enabling mission-critical communication and tracking. However, their role went beyond mere data transmission; they were helpful in guiding the spacecraft's trajectory, a particularly challenging act in the absence of modern GPS systems. Furthermore, these antennas displayed flexibility and adaptability by withdrawing during launch and re-entry, minimizing aerodynamic forces on the spacecraft.

The antennas on the Vostok spaceship were not just communication devices; they were connecting the cosmonaut to Earth, ensuring mission success in a technology-restricted era.

Challenges to be faced: -

It has just been a month since we started using Autodesk Inventor. While we are trying our best to get used to Autodesk Inventor, we have minimal knowledge of Autodesk Inventor right now. The oxygen and nitrogen cylinders are cylindrical and are attached to a curved belt. So, it will be a challenge to model them perfectly. As far as the antennas are concerned, the positioning of the antennas is very crucial to the structure and must be drawn very cautiously.

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Part name: Oxidiser Tank

Arjun Anand (23110039)

Introduction:

From my childhood, I have always been passionate about solving problems and science experiments. So, when our team came up with the idea of a rocket, I was ready to take on the challenge. Our team has decided to make the Vostok Rocket. We chose the Vostok rocket because of its historical significance and the fact that it is a milestone for humanity. The Vostok Rocket was the rocket that carried Yuri Gaggarin, a Soviet cosmonaut, to space.

The part that I have been assigned is the oxidizer tank. The oxidizer tank is one of the most essential parts of the Vostok rocket. The tank is a crucial component of the rocket's propulsion system. It plays a significant role in ensuring the rocket's engines can operate effectively by supplying the oxidizer to support combustion with its fuel.

Basic structure and working:

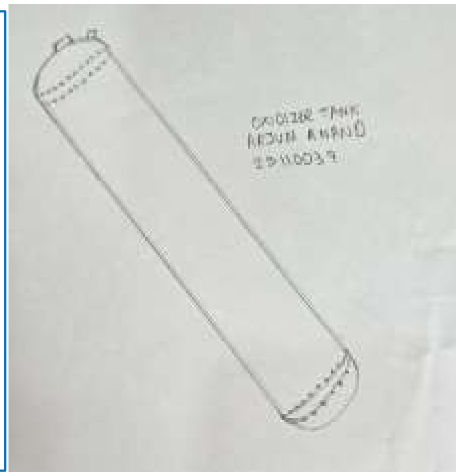
Oxidiser tanks are used in rockets to store oxidizers, which are essential for the process of combustion. Usually, combustion on Earth only requires fuel, as oxygen is everywhere in the atmosphere. However, no atmosphere exists in space, so rockets must carry their own oxidizers. When the rocket is fired, the oxidizer is released in the proper amount with the fuel. These oxidizers, in combination with the fuel, will propel the rocket upwards.

The tank in our rocket needs to be designed in order to operate under high pressure. It needs to use a material which can withstand high-temperature ranges. During fuelling, the temperatures get lowered, while the temperatures are very high during the boost phase. Furthermore, the oxidizers in the tank are to be kept at high pressures. This will prevent instability in combustion.

There are various forces from all directions in space. So, the tanks need to be built in such a way that they can withstand them. Therefore, the oxidizer tank in our rocket is made of aluminium. The advantage of aluminium is that it is very durable while also being light weight.

The oxidizer tank consists of a cylindrical body attached to two domes. Ellipsoid caps are welded to these domes. The tank is made from an aluminium alloy to help in reducing the weight. It contains the oxidizer, a substance that provides oxygen required for fuel combustion. In the case of the Vostok rocket, the oxidizer used was liquid oxygen. It had various valves and pipes to ensure the proper oxidizer flow during the rockets' journey to space. The tank has an outer diameter of approximately 200 mm and a length of 1.6 m. The volume will be approximately 4L.

Fig. 4: Oxidizer tank solid model, featuring top-view with main and secondary outlets (right) and the overall tank (left).



Possible Challenges:

Since this is our first project using Autodesk Inventor, we will face several challenges during our project. Firstly, some dimensions and information may not be available online, and we may have to simplify some parts. Also, although the shape and design of the tank are simple, the dimensions are not available online. However, we might face some problems in the assembly of the rocket. The assembly will be complex as my dimensions have to match with the parts of my teammates.

Conclusion:

In conclusion, designing this rocket will help us learn about how complex things can be made simple by breaking them into parts. When I first saw the whole model of the Vostok rocket, it looked very complicated. But once we split it into parts, it seems doable. In addition, this project will help me get more familiar with AutoDesk Inventor as well.

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Part Name: Instrument Module

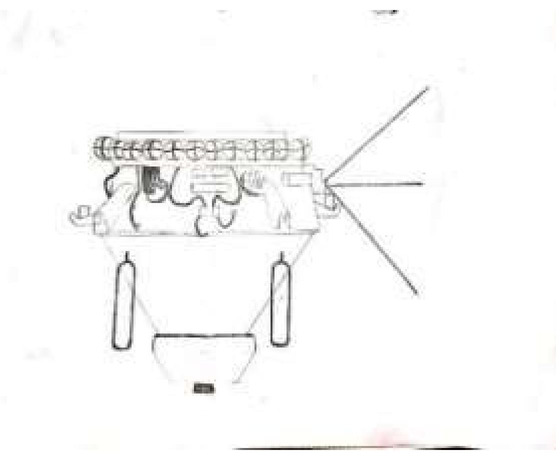
Arpit Sigotiya (23110044)

Introduction:

Our group decided to select a model which is of significance in both engineering and history. So, we chose a rocket carrying Vostok 1, the spacecraft carrying a human. It was launched on April 12, 1961. Moreover, it was a significant achievement for the human race. Earlier, it was named as Orion 1. That day was the dawn of a new era for astronomy and the human race. For the same reason, it was named Vostok, sounding similar to Voskhod("dawn"). Vostok means "East" in Russian. Yuri Gagarin became the first human to orbit Earth. It was a more remarkable achievement because there was much opposition to this not only from the other countries but also from the USSR army's side itself. The flight was celebrated as a great triumph of Soviet science and technology. In 2011, the day of it's launch was declared as the International Day of Human Space Flight by the United Nations(UN). Gagarin's informal reply, Poyekhali! Which means 'let's go!' became a historical phrase used to mark the arrival of the Space Age in human history.

Structure and Properties:

The instrumental module generally consists of antennas, a TDU-1 retro engine, Vernier Units, an Electrical Gallery, turbopump shaft speed Access Matches, Oxygen, and Nitrogen Bottles, and several machines for the spacecraft's speed and direction. The primary function of the instrument module is to control the rocket's orientation. It was a critical component of Vostok 1.
Vostok 1 had a two-part design:
Orbital Module: It's the upper section of the spacecraft that contains the cosmonaut during flight. After completing the mission, the orbital module was separated from the descent module, and the cosmonaut re-entered the Earth in the descent module.
Descent Module: It contained the cosmonaut's ejection sea, the re-entry heat shield, and the landing systems like parachutes. Descent Module is also known as Protective Fairing.
The Vostok 1 instrument module generally refers to the combination of both the Orbital Module and Descent Module. The instrument module contained the critical systems and instruments essential for the mission, consisting of the spacecraft's guidance, navigation, control systems, communication equipment, and various weather, thermal sensors, pressure, and radiation levels.



Functions:

1-Maintaining the correct orientation and trajectory of the spacecraft, it had various navigation systems, including gyroscopes and accelerometers, and radio equipment for communicating with mission control on the ground.
2-Telemetry: It collected telemetric data from various sensors and instruments and relayed it to mission control on the ground. It allowed the USSR's scientists on the ground to monitor the latest status of spacecraft and, if necessary, make required adjustments.
3-Life support: It contained life-supporting systems including oxygen and temperature, radiation control, and ensuring the cosmonaut's safety and comfort.
4-Retropack, also called retrorocket part, is used to initiate the rocket's re-entry into Earth's atmosphere. After the retrofire explosion, the instrument module was separated from the descent module.

Challenges to be faced:

As we have just started learning Autodesk Inventor, we find it a little challenging to make our model. Mainly, my design is very complex, but I will enjoy this challenge. Not only making the 3D model but making the sketch of our respective parts is also a tedious task. It becomes more difficult because the instrument module lacks basic shapes or figures like cylinders, squares, etc.

Conclusion:

During this historic mission, the Instrument Module had a vital role. It did so by controlling spacecraft navigation systems and establishing excellent communication between Yuri Gagarin and the mission control room on Earth. It played a pivotal role in ensuring the return of the cosmonaut Yuri Gagarin.

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Part Name :- Thrust Gears(LOX dome with injector and Gimbal Bearing)

Arjun B Dikshit (23110040)

Introduction:

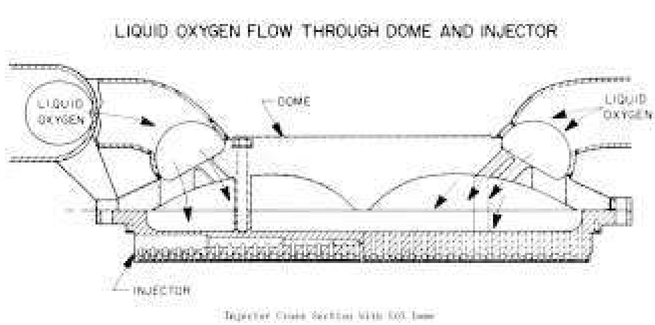
Our team has decided to recreate the Vostok rocket with some modifications. It was the first rocket to launch a human into space and was a pinnacle of engineering and innovation at its time. Most of the rocket's original design came from R-7 Semyorka, which was a Russian missile (ICBM). The ICBM design was modified to carry the Vostok. The Vostok used a thrust system fuelled by cold nitrogen. However, due to a lack of information about the thrust system of the Vostok, we have decided to modify the design and add an F-1 engine from the Saturn-V rockets. I will make three gears (LOX dome, gimbal bearing, and Injector plate), which are essential for the operation of thrusters and serve as a connecting link between the engine and the thrusters. They are crucial in providing an area for the chemicals to react and produce liftoff thrust.

Information:

A bearing is present at the top of the engine to enable flexible movement and control over direction. It is called the "gimbal bearing," and it resembles the ball and socket joint in our shoulder, but the gimbal bearing has to carry the full thrust load of the engine while maintaining its flexibility. Gimbals can also be used to manoeuvre rocket engines during liftoff and during the thrusting and ejection phases, which provides control of the trajectory the spacecraft takes during its liftoff stages. Due to effective manoeuvring, the spacecraft can save on propellants and fuel consumption, thus extending the mission duration. In the space between the bearing and the injector plate, there is a LOX dome. It is also connected to the engine system's front portion. The injector plates and the liquid oxygen dome were connected by 16 bolts each, while the system as a whole was connected to the thrust body and the Vostok shell's bottom by 64 bolts. The injector was 8 inches thick and had a diameter of roughly 44 inches.

Functionality:

The LOX dome forces Liquid oxygen into the injector from the turbopump. In the injector, liquid oxygen is mixed with RP-1(Rocket propellant -1) before being burned to produce thrust. Kerosene in a highly refined version is known as Rocket Propellant-1 and was frequently employed as rocket fuel. In order to maintain a controlled and sustained combustion process, the injector's function is to release propellants into the combustion chamber at the precise ratio and pressure. Although the rocket propellant-1 and liquid oxygen (LOX) are inflammable, they need an external ignition source to burn and produce thrust. The hypergol manifold assembly was used to provide external ignition. It released a fluid containing 85% triethyl borane and 15% triethylaluminium through orifices during the engine initiation sequence, initiating the combustion reaction. After external ignition, the reaction between RP-1 and LOX was responsible for producing thrust.



Challenges to Be Faced:

--Despite being an integral part of the rocket, the gears are incredibly complex in design. This, coupled with the lack of expertise in using Autodesk Inventor and the lack of knowledge of the full capabilities of the application, can pose a significant challenge.

--The blueprint for the gears and the exact dimensions of the gears are unavailable on the internet or any other source, which poses a significant problem. The gears have to fit precisely into the rings attached to the thruster, so assigning the right dimensions is crucial

--Coordination with other team members to decide the correct dimensions to ensure a smooth assembly of parts is again a crucial element, and miscommunication may pose a critical problem, especially in the case of thrust gears.

--The assembly of the final thruster, while fitting the gears into the main thruster body properly, is also going to be a challenging affair and may require some remodelling and adjustments on both parts to assemble the final thruster satisfactorily

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Outer Body of A Rocket

Anuja Chaudhari (23110034)

I. INTRODUCTION: -

I have a great interest in design and architecture. I have read many sci-fi books and watched movies, which developed my interest in astronomy. So, I was really excited and fascinated to work on this project because it included researching and learning about rocket manufacturing and model designing. During this project, I learned the whole process of human space exploration from scratch.

The Outer body of a rocket has a vital role in its performance. It plays a critical role in its safety and durability. We have tried to advance the materials and design of outer rocket bodies. Our main objective is to increase rocket efficiency, reduce manufacturing costs, and improve safety through innovative materials and construction techniques. As technology evolves and mission becomes more complicated, we need innovative techniques and approaches for outer body rocket design to enhance the rocket's durability, sustainability and functionality.

II. STRUCTURE: -

1]Nose The nose cone is a rounded curve in shape, which causes the air to flow around the rocket. The shape is designed in such a way that it reduces friction or drag force by air. Making a rocket as narrow as possible is very beneficial.

2]Main cylindrical part (middle portion): -The hollow cylindrical part covers the payload, thrust chamber, fuel tank, etc. A cylindrical shape is chosen as it ensures less weight on the rocket's wall. One of the factors is that cylinders are easy to make.

3] Fins: Fins are used to control the direction of the rocket. They also provide stability to the rocket. Placing fins at the bottom part moves the centre of pressure a bit closer towards the bottom and enhances stability. However, this results in an increase in air resistance, which is why we chose the optimal size in order to ensure stability without having much drag.

III. CHOICE OF MATERIAL: -

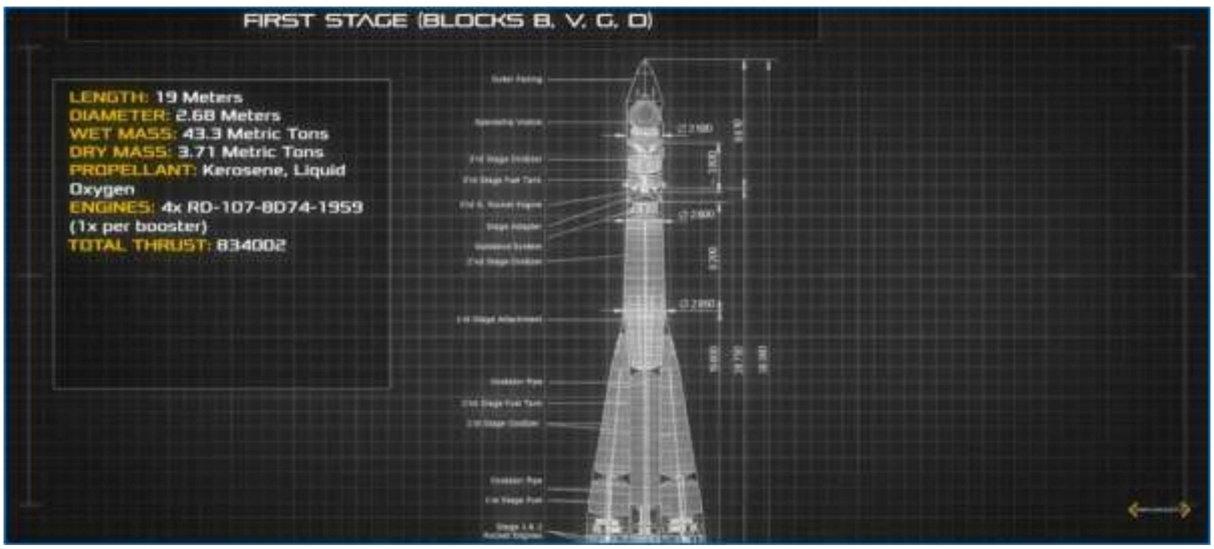
One of the most common aspects of rocket design is the selection of materials for the design of the outer body.

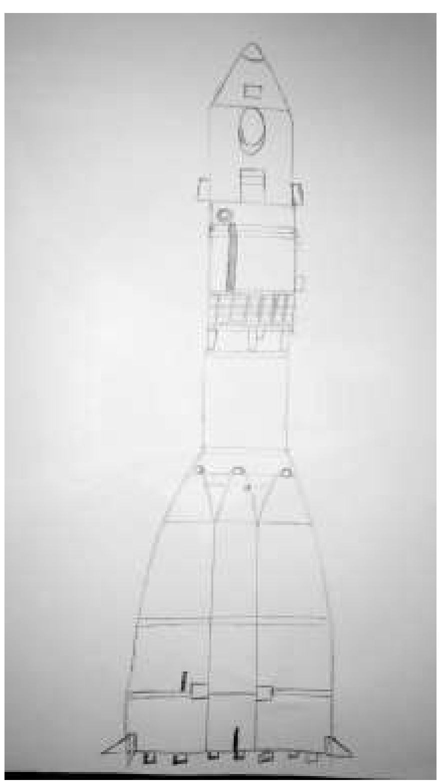
- Most common materials like steel and aluminium have been used for many years, but the demands of modern space missions necessitate new materials.
- We have proposed to develop and find high-strength, lightweight materials, such as carbon composites, which offer significant weight savings while maintaining structural integrity.
- Reinforced carbon-carbon is used in the nose cap and landing gear doors. The outer part is covered with a thick aluminium layer, which is 3 inches (76mm) in diameter and has a wall thickness of 0.035 inches (0.9mm).
- Rocket bodies are very likely to be exposed to very high temperatures at the time of launch. For this, we have a TPS (Thermal Protection system).
- Our proposal also includes exploring new innovative TPS materials, such as active cooling systems and heat shields.

- Active cooling systems, such as heat pipes and regenerative cooling, will be used to maintain optimal temperature. TPS is used to maintain the optimal temperature both in high and low-temperature environments.

IV. Challenges expected: -

We have to be very precise about the structure or outer shape of the rocket to ensure that it maintains structural integrity under high acceleration forces, vibration, and aerodynamic loads. Also, we know that rockets are highly sensitive to weight, so balancing structural strength with lightweight materials is still challenging.





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Part Name: - Vostok Engine (RD-107)

Arnav Gogate (23110043)

Introduction: -

This project provides a great opportunity for me to research rockets, something I had never done before. Deep diving into space technology has been exciting for me during the time of this project and has helped me develop an interest in it. Engine is the heart of the rocket and I feel privileged to get a chance to work on the engine.

The Vostok Rocket uses the RD-107 engine as its main engine. This engine was revolutionary in the rocket industry. It is a variant of the famous V-2 rocket engine technology. Hardcore information about the engine of Vostok is not available on the internet as it is now used in missiles and is considered classified information. However, it is interesting to note that this engine is used to launch rockets. An engine once used to forward mankind is now used for destruction.

Liquid oxygen and kerosene are the fuels used by the gas generator cycle of the RD-107. Steam produced by the catalytic decomposition of water powers the turbine, as was usual for all V2 Rocket technology's offspring.

The RD-107 had two smaller control engines in addition to its four main rocket engines. Four fixed main combustion chambers are used in each engine. In order to provide attitude control, the RD-107 has two extra vernier combustion chambers that can point the rocket in a single direction. There are six combustion chambers in all.

The rocket overall has 3 different engines which are used for various stages of the launch. The rocket itself is launched in 3 stages. The main engine is the main player in the launch. We will be presenting only the main engine in this project as it is the most crucial.

One important innovation of this engine was the capability to use a variable mixture ratio between fuel and oxidizer. The fuel tank and oxidizer will be presented as separate parts. They are present in proximity of the engine. Immediately above the engine.

Few technical details about the Vostok engine RD-107

- Main Engine (the S5.4) (TDU): 397 kg
- Main Engine Thrust: 15.83 kN
- Main Engine Propellants: RFNA/Amine
- Main Engine Propellants: 275 kg
- Main Engine Isp: 266 s (2.61 kN·s/kg)
- Main Engine Burn Time: 1 minute (typical retro burn = 42 seconds)

Challenges: -

However, there are a few problems that will be encountered while designing the RD107 engine:

- The engine as expected, has a highly complicated structure. There are an infinite number of curves and rounded pipes. However, as said earlier, our focus is not on the engine only but on the rocket as a whole.
- The cylindrical parts have hyperbolic structures on the top, which are very difficult to design on Autodesk Inventor as of now.
- Hence, I will be presenting a simplified model of the engine. The breakup of the engine will be made into smaller, simpler shapes and assembled to make the engine.

Image: Vostok Engine (Source: Wikipedia)

- The final model will be based on this image taken from Wikipedia.
- There can be seen six chambers as noted above.

Sources and References: -

- https://en.wikipedia.org/wiki/Vostok

Shock Cord and Fuel Tank

ARIN MEHTA(23110038)

INTRODUCTION

The Shock Cord is a part of the Vostok Rocket, which was launched in the year 1961. It was a massive advancement in the world of space exploration that changed the history of the world we live in. The shock cord helps to keep the parts of the rocket together after the ejection of the rocket.

The shock cord connects the rocket's body tube and nosecone, a part of the rocket after the parachute has been deployed. It is beneficial because, after the deployment of the parachute, the parts of the rocket wouldn't stay attached if it wasn't for the shock cord. And it's safe to say that the shock cord is the holding part of the rocket.

A rocket's fuel tank is a part of the rocket that holds the liquid propellant inside a container. The liquid propellant is used to power the rocket engine. It consists of two components: fuel and oxidizer. The fuel and oxidizer are stored in separate tanks. These react with each other to produce a thrust. They ignite and create a high-pressure thrust. It comes through the exhaust coming out of the nozzle in the form of high-temperature, high-velocity gas. The optimum shape of the tank is spherical because it results in a tank with the least weight in a given volume.

IMPORTANCE

Shock Cord

When the parachute deploys at apogee, it exerts a tremendous force on the rocket parts that are still intact. The shock is so big that it could damage the rocket or its payload. The shock cord absorbs that shock and holds the parts of the rockets together. In this way, it prevents the rocket from experiencing a sudden jolt. This allows a more gentle rocket descent, ensuring the recovery system can function properly.

Fuel Tank

The fuel tank is one of the most essential parts of the rocket as it helps the rocket in in holding the most important material required for the engine to function: the fuel. The fuel tank also has a role in the weight of the rocket, as the material used to hold the fuel should be chosen with great care to reduce the weight of the rocket as much as possible.

PROPERTIES OF FUEL TANK

The tank must be strong enough to withstand the thrust provided by the combustion. It also has to withstand high temperatures. It needs to be non-reactive with the fuel and oxidizer used to avoid being corrosive.

Cryogenic Tank

Cryogenic tanks are used to store very cold propellants. These include materials such as liquid hydrogen and liquid oxygen. As these are very cold, both vessels are divided with vacuum space to guarantee insulation. Additionally, these tanks are provided with a pressure regulation system specifically designed to keep pressure constant.

MATERIALS

Shock cords are made from elastic materials such as rubber. It is because these materials can stretch and return to their original length, an essential property for absorbing the shock. For the rocket recovery system, only Kevlar shock cords should be used. The shock cords made of Nylon and other substances will melt or snap under the loads of deployment.

CHALLENGES

Shock Cord

Due to it's complicated design, the shock cord might be challenging to design and sketch perfectly. It has so many rod-like structures that it will be difficult to attain all the minor but very useful details.

Fuel Tank

As we are relatively new to Autodesk Inventor, so designing a fuel tank in it would be pretty difficult. Furthermore, it's shape is a bit complicated, so it might be a bit difficult to create that shape.

SOURCES

1) https://richsrockets.wordpress.com/2015/10/02/shock-cords/

2) https://cryospain.com/cryogenic-vessel

3) How Rocket Engines Work | HowStuffWorks

4) Propellant tank - Wikipedia

5) Shock cords | Rich's Rockets

6) What does the shock cord do in a rocket? - Answers

Part Name: - Space Cabin interior equipments

Apoorv Rane (23110036)

Introduction:

Space is full of unanswered questions. These mysteries intrigue scientists and drive exploration. The universe's enormity sparks curiosity about what else might be out there. Space exploration has always been one of the priorities of humans.

Our team has selected to model the spacecraft used in the first manned mission to space - VOSTOK 1. The astronaut aboard Vostok 1 was Yuri Gagarin, who became the first human to travel to space. The Soviet Union launched the Vostok 1 mission on April 12, 1961. The mission's success intensified humans' urge to explore space.

So, my group will be making a model of Vostok 1. We have divided the model into 15-20 more minor parts. I have been tasked to make the interior equipment of the space capsule.

Importance:

Vostok 1 was the first attempt to send a man to space. So, for the mission to be successful, it was crucial to design the space capsule efficiently, keeping the astronaut safe.

The entire cabin of the spacecraft was almost spherical and was coated in an abrasive substance. External antennas and three portholes were present. This cabin was fastened to a service module that contained additional system support gear, orientation rockets, chemical batteries, the central retro system, and support equipment. The inside manned cabin that I am making consists of the following parts:

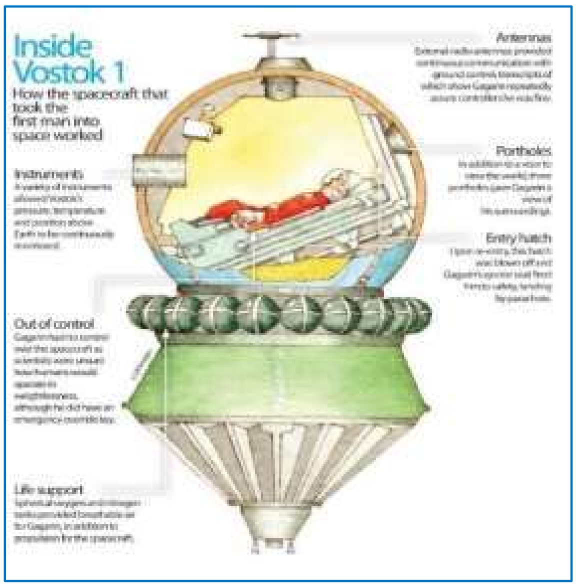
1) Radio
2) Life support system
3) An instrument that will allow the astronaut to see outside
   It had a 16-point multi-umbilical and an optical device
called Vzor(Visor)

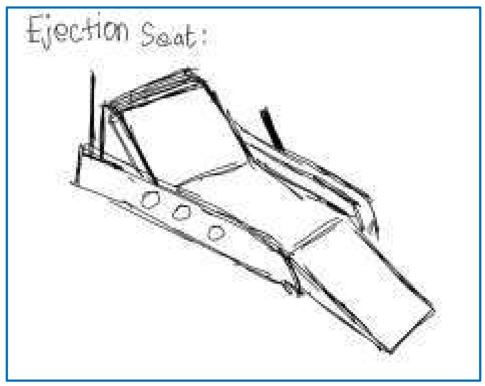
4) Ejection Seat

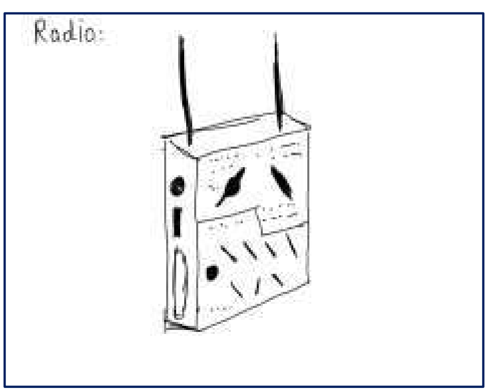
Challenges to be faced:

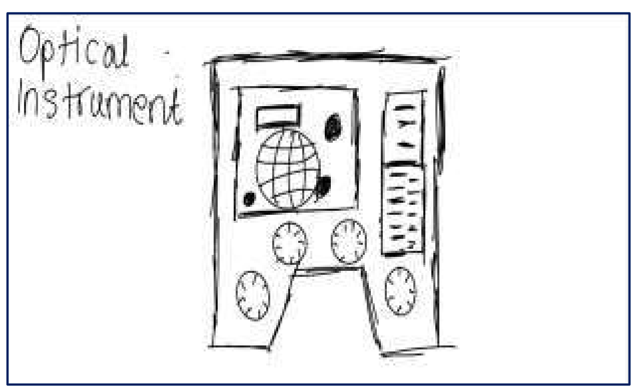
The interior equipment of the space cabin is one the most essential components of the spacecraft. The shapes of the various parts are very complex.

- Radio system:
  The radio is an easy part to model using the Autodesk inventor, as it is basically a box with various buttons and controls.
- Life support system:
  It is basically the oxygen and nitrogen tanks essential for Yuri Gagarin and the rocket's propulsion.
- Optical Instruments:
  This is one of the most challenging parts of all. As the structure of the instruments is pretty complex.
- Ejection Seat:
  The modelling of the astronaut seat is also tricky. It should be comfortable and minimalistic. It is the main seat of the astronaut from where he should be able to operate all the devices in the space cabin.









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- https://en.wikipedia.org/wiki/Vostok_1

Part Name: Thrust Chamber

ARJUN PAAN (23110041)

Introduction

Thrust chamber contains combustion of propellant and produces the thrust, which consists of one main thrust chamber and four vernier thrusters. The main thrust chamber is similar to the boosters. The booster has an RD-107-8D74-1959 engine, which has four thrust chambers and four vernier thrusters. The thrust chambers were cylindrical with a conical nozzle at the end. The nozzle has a variable area ratio to optimize the performance at different altitudes. The thrust chambers had a maximum thrust of 970.86 kN each and a burn time of 118 seconds. The first stage has the RD-108-8D75-1959 engine, with a larger nozzle and a high thrust of 912 kN. The first stage also used RP-1 and LOX as propellant and had a burn time of 301 seconds. The second stage was powered by the RD-0109 engine, which had one thrust chamber and four small nozzles for roll control. The thrust chamber had a spherical shape with a bell-shaped nozzle.

Work of thrust chamber

An equal force acting in the opposite direction is created by simply accelerating something in one direction. No maer whether there is land or atmosphere, a space craft is propelled upward or into space by this exhaust reaction.
The propellants are burned in the combustion chamber, and the high-velocity gases that result are expelled into the expansion nozzle to provide thrust.
In order to overcome the drag of an aircraft and the weight of a rocket, thrust is used. Through some type of propulsion system, the aircraft's engines provide thrust.

Parts of Thrust chamber

1. Fuel Inlet
The inlet pipe is the pipe that carries the fuel from the top part of the thrust chamber
2. Fuel manifold
A bypass orifice plug brazed into the tube above this hole allowed 30% of the fuel to be admied straight to the fuel injector manifold. Each down tube had a slot on its outboard side where the gasoline was directed to it at the fuel inlet manifold area. The thrust chamber's regenerative cooling required the remaining 70% of the fuel, which was sent down the tube.
3. Prefill Check Valve
Its role is to allow fuel to flow in one direction and automatically prevent fuel flow in the reverse direction. Check valves are completely self-automated and do not require any kind of help from human command
4. Top mounting pads
Mounting pad is used to aach cable ties to the surface of the thrust chamber

5. Gimbal outrigger
The nozzle of the rocket can be rotated in either direction. The outrigger serves to protect it while the nozzle is shifted, changing the thrust's direction.
6. Turbopump support outrigger
They produce the required pressure in the combustion chamber and transfer the propellants to the injection head of the combustion chamber
7. Body of trust chamber
All the parts of the fuel injection and trust power chamber are inside the body and it protects it from heat
8. Turbine exhaust manifold
Its major role is to collect and distribute the gasses inside the walls of the nozzle extension
9. Fuel return manifold
It works to transfer the fuel from return tubes to the fuel injector manifold
10. Drain adapters
It is used to drain the chamber

CHALLENGES TO BE FACED

Thrust chamber might be moderate to design, but it will become more difficult because we are new users of Autodesk when the diminutive- -small parts are more added because in Autodesk it is pre◎y challenging to make fuel inlet, top mounting pads, prefill valves etc. The other major task is to fit the thrust gear inside the thrust chamber and many more

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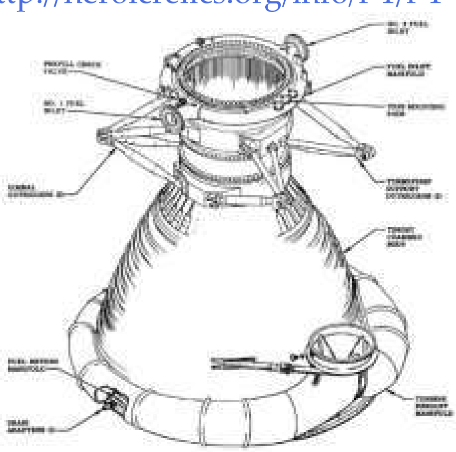
Thrust Chamber