Deep Space Logistics: Logistics Module for Gateway Space Station



Background



NASA's Deep Space Logistics Module (DSLM) is designing a Logistics Module for the new Gateway Space station. The Gateway Space station is a planned lunar orbit outpost that will serve as a staging point for lunar surface missions and a gateway for deep space exploration. It will be located in a halo orbit around the Moon, approximately 70,000 kilometers away from Earth. The Logistics Module will play a crucial role in delivering cargo and supplies to the Gateway Space station, supporting the needs of astronauts and scientific research.



The design of the Deep Space Logistics Module involves simulating and optimizing the loading and unloading of cargo and supplies. This includes simulating takeoff and docking procedures, as well as the collection and storage of trash. The goal is to ensure efficient and safe operations, maximizing the utilization of resources and minimizing waste. The Logistics Module will be equipped with advanced technologies and systems to support these tasks, enabling NASA to effectively sustain human presence in deep space and facilitate future exploration missions.

Overview of Simulation or Game

(a) The Logistics Module will be a payload on a SpaceX launch vehicle. Suggested steps might include the following ...

1 - loading cargo into Logistics Module.

2 - placing the Logistics Module onto a SpaceX Launch Vehicle.

3 - fueling the launch vehicle.

4 - Iaunch.

5 - transit to Gateway (this might include showing different stages of the launch Vehicle being exhausted and separating).

6 - docking with the Gateway Space station

(b) Simulate and Optimize the Loading on earth and unloading of cargo and supplies from the Logistics Module to the Gateway Space Station

(c) The mission specialist or an astronaut will load all the Trash from the Gateway space station into the Logistics Module daily, weekly and at the end of the mission.

(d) At the end of a mission, the mission specialist or an astronaut load the final Trash from the Gateway space station into the Logistics Module and launch the module for a 100-year revolution around the sun.

Please choose: VR, PC, phone, tablet, or all devices if possible.



Design and Build a VR Simulation or Game



Objective

Design and build a VR simulation or graphical game that can simulate and optimize the loading and unloading of cargo and supplies from the Supply Module to the Gateway Logistics Module.

Features

- Simulate takeoff and docking procedures between the Logistics Module and the Gateway Space Station.
- Optimize the loading and unloading of cargo and supplies.
- Implement realistic physics and interactions for a more immersive experience.

Trash Collection and Storage

- Include a feature to simulate the collection and storage of trash from the Gateway Space Station.
- Design simulation to undock after the mission and send it on a 100-year trip circling the sun.

NASA's Deep Space Logistics Module - How it will be used!

The Deep Space Logistics Module (DSLM) is a disposable container that acts as a closet or storeroom on the Gateway space station. It is used to store cargo and trash for the duration of the astronauts' stay on the station.

The DSLM is accessed by the flight crew daily to retrieve cargo and place trash. The duration of the DSLM stay at the Gateway may be about 30 days.

The DSLM is designed to optimize Cargo Management, Cargo Retrieval, Storage and Trash collection and storage on the Gateway space station to ensure a clean and functional environment for astronauts.



Simulating Takeoff and Docking

To simulate the takeoff from Earth and docking with the Gateway space station, the following procedures are followed:

- 1. Launch Process
- The launch process involves preparing the Logistics Module for liftoff, including fueling the spacecraft and conducting pre-flight checks.
- Once all systems are go, the Logistics Module is launched into space using a rocket.
- 1. Docking Procedure
- After reaching the desired orbit, the Logistics Module aligns itself with the Gateway space station.
- Using thrusters, the Logistics Module maneuvers towards the docking port of the Gateway space station.
- The docking port on the Logistics Module and the Gateway space station then connect, allowing for the transfer of cargo and supplies.

By simulating the takeoff and docking procedures, NASA's Deep Space Logistics unit can optimize the loading and unloading of cargo and supplies, ensuring efficient operations at the Gateway space station.



NASA's Deep Space Logistics Module - How it will be used! cont.

Loading and Unloading Cargo

The astronauts will first open the Logistics Module (LM) and remove any necessary items. They will then move trash from the Orion spacecraft to the LM shortly after arrival. Astronauts may access the LM daily to retrieve cargo and place trash depending on their planned routines.

When the astronauts are ready to leave Gateway, they will collect any additional trash and move it to the LM. Once the LM undocks from Gateway, it will begin a long journey that will include decreasing orbits of the Sun for many years (perhaps 100 years) until it eventually burns up near or in the Sun.



Simulation and Optimization

To optimize the loading and unloading of cargo and supplies from the Logistics Module to the Gateway Space Station, advanced simulation techniques will be used. This will allow for a more efficient and effective process, reducing the risk of errors and improving overall performance.

Simulating and Optimizing Loading and Unloading

To ensure efficient loading and unloading of cargo and supplies from the Logistics Module to the Gateway Space Station, we employ advanced simulation and optimization techniques. The goal is to minimize the number of times a mission specialist or an astronaut needs to touch a case to find an item.

Loading and Unloading Process

- 1. Categorize and Label: All cargo and supplies are categorized and labeled for easy identification and organization.
- 2. Automated Inventory Management: An automated inventory management system keeps track of all items, their locations, and quantities.
- 3. Efficient Racking System: The Logistics Module is equipped with an efficient racking system that allows for easy access and retrieval of items.

By simulating and optimizing this loading and unloading process, we can ensure smooth operations and minimize the time spent on searching for items.



Loading Trash from Gateway



Step 1: Collapse Racks and Lockers

At the end of a mission, astronauts collapse some of the racks and lockers in the Deep Space Logistics module to make room for the last pieces of trash from Gateway.

Step 2: Load the remaining Trash

The remaining trash is loaded into the module and secured in place.

Step 3: Undock Module

The module is undocked from the spacecraft and placed in a 100-year decaying orbit.

Things to Think About

The Deep Space Logistics Unit (DSLU) is a NASA organization response, as the VR Designer you can utilize any of the top designs presented in the GRABCAD library, or create your own designs. The goal is to load as many supplies as possible and efficiently access them for unloading, with the least amount of double touching.

You can choose and CAD Drawing from https://grabcad.com/library/qasis-quick-access-storage-in-space-1 NASA Challenge: Lunar Gateway Cargo Packing and Storing | Engineering & Design Challenges | Grab CAD OR

Make you own design.

Remember the Goal is to Store as many containers as possible. And access them efficiently.

Consider these other points:

- 1- There may be a Sanitation/Bathroom Station.
- 2- Do Not Block any Airflow or Air Circulation vents.
- 3- Simulate Airflow in the DL Module

4- Empty Lockers/Containers to make room for Trash, Sanitation Station, etc. **Note: Trash Packaging may take 30% more volume.**

5- Dimensions and Mass:





Cargo Transfer Bags (CTBs)





| СТВ | External Dimensions (cm) | | | Loaded Bag | External |
|---------|--------------------------|------|------|------------|-----------|
| Name | L | W | Н | Mass (kg) | Volume m3 |
| 0.5 CTB | 42.5 | 24.8 | 23.5 | 7.3 | 0.025 |
| 1.0 CTB | 50.2 | 42.5 | 24.8 | 15.4 | 0.053 |
| 2.0 CTB | 50.2 | 42.5 | 50.2 | 31.0 | 0.107 |
| 3.0 CTB | 74.9 | 42.5 | 50.2 | 46.4 | 0.160 |
| 4.0 CTB | 89.7 | 50.8 | 53.3 | 70.5 | 0.243 |
| 6.0 CTB | 89.7 | 81.9 | 53.3 | 113.7 | 0.392 |

Virtual Reality Software for Deep Space Logistics Modules

Description

The virtual reality software is a cutting-edge solution designed to enhance communication, visualization, and optimization for deep space logistics modules. This software leverages advanced virtual reality technology to provide an immersive and efficient platform for teams to collaborate and solve complex problems in deep space logistics.

Features

- Real-time communication: The software allows team members to communicate and collaborate in real-time, regardless of their physical locations.
- Visualization: Users can visualize deep space logistics modules and their components in a virtual environment, enabling better understanding and analysis.
- Optimization: The software includes optimization algorithms that help teams find the most efficient solutions for deep space logistics challenges.

Implementation Details

The virtual reality software will be developed using state-of-the-art technologies, including Unity for virtual reality development and backend systems for real-time communication and optimization algorithms. The software will be compatible with major virtual reality headsets and will support cross-platform collaboration.

Timeline

The development of the virtual reality software is expected to take approximately 6-9 months, including design, development, testing, and deployment phases.

Virtual Reality and Gaming Software

Virtual reality software can offer plenty of value to your business, however, virtual reality app development can be tricky. Robust virtual reality tools assume importance here, therefore, here are my <u>top 10</u> <u>virtual reality tools</u> to help you.

10 Great Tools for VR Development I DevTeam.Space

<u>Unity</u> is famous for game development, however, it helps you to build VR solutions for many other sectors too. E.g., you can create VR solutions for automotive, transportation, manufacturing, media & entertainment, engineering, construction, etc. with Unity.

You can get a valuable set of tools when you use Unity, e.g.:

- A powerful editor to create Unity 3D VR assets;
- Artist and designer tools;
- CAD tools;
- Collaboration tools.

Read more about them in "<u>Unity: performance by default, high-fidelity real-time graphics, and artist tools</u>". Unity works with all popular VR platforms like Oculus, Sony, etc.

Unity offers a <u>portal to learn its products</u> where a VR developer can access courses like "<u>Getting started with Unity</u>", and many more.

<u>Unreal Engine 4</u> (UE4) offers a powerful set of VR development tools. With UE4, you can build VR apps that will work on a variety of VR platforms, e.g., Oculus, Sony, Samsung Gear VR, Android, iOS, Google VR, etc.

The UE4 platform has many features, e.g.:

- It offers access to its C++ source code and Python scripts, therefore, any VR developer in your team can study the engine in detail and learn how to use it.
- UE4 has a multiplayer framework, real-time rendering of visuals, and a flexible editor.
- With the Blueprint visual scripting tool offered by UE4, you can create prototypes quickly.
- It's easy to add animation, sequence, audio, simulation, effects, etc.

You can read more on the <u>UE4 features page</u>. UE4 is extensible, and it has a rich ecosystem.

Conclusion

The Game or VR that your team develops may help the Deep Space Logistics Unit (DSLU) team and its many partners Communicate, Visualize and Optimize soloutions for the many modules of this or similar kind to be launched.



This is NASA's Deep Space Logistics Public Web Page https://www.nasa.gov/gateway-deep-space-logistics/

These are some NASA "public renderings" of the Logistics Module

https://www.flickr.com/photos/nasa2explore/51046736 462/in/album-72157716027881092/

https://www.flickr.com/photos/nasa2explore/51046735 257/in/album-72157716027881092/

https://www.flickr.com/photos/nasa2explore/51046733 772/in/album-72157716027881092/

https://www.flickr.com/photos/nasa2explore/510459141 18/in/album-72157716027881092/

Logistics Module for the Gateway Space Station

The Logistics Module for the Gateway Space Station is a critical component of NASA's Artemis program, which aims to return humans to the moon by 2024 and establish a sustainable presence on the lunar surface.

The Logistics Module is designed to provide a reliable and efficient means of transporting supplies and equipment to the Gateway, a lunar-orbiting space station that will serve as a base for future missions to the moon and beyond. The module will be capable of carrying up to 20 tons of cargo and will be equipped with advanced life support systems and other critical technologies.