

MM7: SDG9 SPACE4SDGS INDUSTRY AND INFRASTRUCTURE



SDG9: Sustainable Space Launch Infrastructure

- Design a sustainable space launch infrastructure that minimizes environmental impact.

Challenge

Imagine launching rockets and satellites into space without causing harm to our planet. While space exploration has brought many benefits, it also poses environmental challenges, including pollution from rocket fuel, noise pollution, and emissions that affect the atmosphere. This project challenges you to design a launch infrastructure that balances our pursuit of knowledge with protecting Earth. Your goal is to create a framework for launch systems, facilities, or processes that are environmentally friendly and efficient, reducing pollution and supporting sustainable space exploration.

Considerations

- **Minimising Emissions and Pollution:** Rocket launches often emit large amounts of carbon dioxide, as well as harmful chemicals. Consider materials, fuels, and processes that reduce these emissions and pollutants.
- **Energy Efficiency:** Think about ways to design launch infrastructure that conserves energy, such as using renewable energy sources at launch sites or creating reusable launch vehicles.
- **Waste Management:** Launch infrastructure should aim to reduce waste from fuel residues, rocket debris, and other byproducts. Include ideas for managing or recycling these materials.
- **Environmental Impact on Ecosystems:** Consider how noise, chemicals, and other effects from launches impact surrounding ecosystems and communities. Think about design elements that can help minimise these effects.
- **Scalability and Long-Term Sustainability:** Design for future use, creating infrastructure that is adaptable and sustainable for years to come, as demand for launches is likely to grow.

Background

Space exploration has led to remarkable advancements in science and technology, from satellites that help us understand climate change to missions exploring Mars. However, launching rockets requires infrastructure that can damage Earth's environment. Traditional rocket fuel releases large amounts of greenhouse gases, and the noise from launches disrupts nearby ecosystems. Additionally, each launch can produce a significant amount of debris, including used fuel canisters and discarded rocket parts. Building sustainable launch infrastructure is crucial for balancing scientific progress with environmental stewardship.

By creating eco-friendly launch systems, we can reduce the environmental impact of space exploration and contribute to a sustainable future on Earth and beyond. This involves rethinking every aspect of launch infrastructure, from fuel types and rocket materials to noise

management and waste reduction. As you take on this project, consider how your design could support long-term sustainability while also advancing space exploration in a way that respects Earth's resources and ecosystems.



Your Mission

Your mission is to design a sustainable space launch infrastructure that reduces environmental harm. Focus on minimising emissions, noise, and waste while promoting energy efficiency and reusability. Consider how your design can protect surrounding ecosystems and communities, create sustainable jobs, and support future space missions. Whether you're designing a green launch facility, developing reusable launch technology, or finding ways to reduce chemical pollution, your project has the potential to make space exploration more environmentally friendly and accessible.

Project Objectives

Develop a Low-Impact Launch System:

- Design a launch infrastructure or technology that reduces harmful emissions, noise, and waste.
- Consider using renewable energy sources, eco-friendly materials, and innovative waste management techniques.

Enhance Energy Efficiency and Reusability:

- Create a framework that includes energy-saving measures and reusable launch systems to limit resource use and environmental damage over time.
- Explore ideas like reusing rockets or using energy-efficient designs at launch facilities to minimise environmental impact.

Support Ecosystem and Community Health:

- Prioritise ways to minimise noise pollution, chemical pollution, and other effects that can impact nearby communities, wildlife, and ecosystems.
- Design systems that are considerate of the surrounding natural environment and human populations.

Ensure Scalability and Sustainability:

- Make your design adaptable for future use as the demand for space launches increases.
- Consider ways to build sustainable infrastructure that can scale with advancements in technology and the growing space economy.

Deliverables

- **User Profile:** Develop a profile for a typical user of the sustainable launch infrastructure, such as a launch facility technician, an environmental scientist, or a nearby community member. Describe their needs, challenges, and goals related to sustainable launch practices.
- **Sustainable Launch System Overview:** A one-page summary describing the main components of your sustainable launch infrastructure, including its goals for emissions reduction, reusability, and ecosystem protection.
- **Prototype or Concept Sketch:** Design a basic model or sketch showing the main features of your infrastructure, including renewable energy systems, eco-friendly materials, and waste management processes.
- **Presentation:** Prepare a presentation to showcase your sustainable launch infrastructure, explaining its environmental benefits, efficiency, and scalability. Use visuals to illustrate its impact on communities and ecosystems.

Questions to Consider

Understanding Environmental Challenges:

- What are the main environmental impacts of current space launch infrastructure, and what challenges do they present to communities and ecosystems near launch sites?
- How could reducing emissions and waste from launches benefit the environment and support sustainable development on Earth?

Designing for Efficiency and Reusability:

- What types of materials, fuels, or processes could help reduce the environmental impact of launches? Consider alternatives that could reduce emissions, waste, and pollution.
- How can you incorporate reusability into your design to make space launches more resource-efficient and less damaging over time?

Prioritising Ecosystem and Community Health:

- How might noise and chemical pollution from launches affect nearby wildlife, plant life, or communities? What features could you include to help minimise these effects?
- What systems or processes could help ensure that launch facilities are safe for the environment and people living nearby?

Building for Scalability and Future Use:

- How can your design be scalable and adaptable for future needs, given that space exploration and commercial launches are expected to increase?
- What would make your infrastructure sustainable and future-proof, able to support a growing space industry without increasing environmental harm?

Design Process Overview

Step 1: Introduction: What is available?

- Explore the environmental impacts of current rocket launches and innovations in green technology

Step 2: Empathy - Who are your users?

- Create user profiles for space engineers, environmentalists, and regulators. What are their challenges, and what would help improve their lives?

Step 3: Defining the Problem

- Define the environmental challenges of rocket launches (e.g., pollution, resource use).

Step 4: Ideate

- Brainstorm solutions like reusable rockets, eco-friendly fuels, or green launch pads.
- How will people be recruited what skills will they use? What kind of information would it provide?

Step 5: Ideate 2 – Good Idea / Bad Idea

- Remix ideas to enhance sustainability and cost-effectiveness.

Step 6: Prototype

- Build a model of a sustainable rocket launch system or eco-friendly launch pad.

Step 7: Test

- Test the environmental impact and feasibility of the design, gathering feedback from simulated stakeholders.



- Share your prototype with others to get feedback. Use their suggestions to make improvements and ensure it's easy to understand for your users



Each step will take one or more lessons, your teacher will guide you with lessons and resources from 'Space Design Challenge Problem to Pitch' Module and the Future of Space



VISIT

The United Nations Office for Outer Space Affairs (UNOOSA) works to promote international cooperation in the peaceful use and exploration of space, and in the utilisation of space science and technology for sustainable economic and social development.

<https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg1.html>

Step 1: Introduction: Explore the environmental impacts of current rocket launches and innovations in green technology.

Use the Internet to explore rocket launches and innovations in green technology. Visit <https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg9.html>.

Support: Use the resources in MM2,4 and 5 and the Problem to Pitch Space Design Challenge, Lesson 1, Empathy - see supporting links also on the last page

Step 2: Empathy: Explore the perspectives of those impacted by space launches, such as nearby communities, environmental scientists, and launch facility workers.

- Think about their concerns regarding pollution, noise, and waste from launches. By understanding their experiences and challenges, you can design solutions that address their needs and promote a balance between space exploration and environmental health.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 2, Empathy - see supporting links also on the last page

These prompts and deliverables will help guide learners in thinking about the development of space infrastructure and space industries and their impacts that serve earth and all its inhabitants. Asking these questions will help you create user profiles and help you design your challenge solution.

Identifying User Needs and Challenges

- Who would benefit from sustainable launch infrastructure? Think about users like facility technicians managing launches, environmental scientists studying the impact, or local communities near launch sites.
- What specific challenges do they face regarding the environmental impacts of launches? Consider difficulties like pollution, noise, and waste, and how these affect their daily lives or responsibilities.

Daily Life and Environmental Impact

- Imagine the daily experience of a person working at a launch facility or living near a launch site. What concerns might they have about emissions, noise, or safety?
- How would sustainable practices, like reduced emissions or noise-dampening technology, improve their experience or quality of life?

Innovation in Materials and Processes

- Think about the materials or processes that would make launches more eco-friendly. What types of fuels or designs could reduce waste and emissions?
- How could an environmental scientist or technician help test or monitor these innovations to ensure they are effective?



User-Friendly Features and Safety

- How can your design make the launch infrastructure safer and easier to manage for technicians, scientists, or community members?
- What instructions or guidelines would help people understand the importance of each eco-friendly feature and how to operate the system effectively?

Community and Global Benefits

- How could reducing the environmental impact of launches benefit communities around the world, especially in areas near launch sites?
- How might sustainable launch infrastructure contribute to global efforts to reduce climate change and promote green technology?

Creating User Profiles

After exploring the prompts, ask learners to create a user profile for an individual who could benefit from sustainable space launch infrastructure. This could be a launch facility technician, an environmental scientist studying launch impacts, or a nearby community member affected by launch activities. This can include

- Name, age, and location of the user
- A description of their daily challenges and pain points, such as concerns over environmental impact, exposure to noise pollution, or limited access to green technology in their field or community
- Technology they have access to and comfort level with eco-friendly tools or monitoring equipment, noting whether they have experience with environmental data collection, pollution tracking, or digital monitoring systems
- Their specific needs or goals related to sustainable space launches, such as access to environmental impact studies, noise reduction tools, or eco-friendly practices for managing launch emissions and waste
- An example of how they would use sustainable launch infrastructure to improve their work or daily life, such as how reduced emissions or noise would benefit their community or how new technology would help them monitor environmental impact effectively

Step 3: Define the core issue your project addresses. For example, is it reducing emissions from rocket launches, managing noise pollution, or creating reusable components?

Create a problem tree to map root causes, such as reliance on high-emission fuels or limited waste management solutions. The “branches” or effects might include pollution, habitat disruption, or health impacts on nearby communities. This will clarify the problem and show the importance of developing sustainable solutions.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 4 and 5, Ideate

Step 4: Ideate Brainstorm solutions for creating sustainable space launch infrastructure.

- Consider eco-friendly fuels, noise-dampening technology, and waste-reduction processes. Think about innovative designs that could reduce emissions or reuse rocket components, and explore how renewable energy might power launch facilities.



Step 5: Refine your ideas, focusing on the most promising concepts.

- Think about how to make the design both environmentally friendly and scalable for future growth. Could you use alternative materials or incorporate noise-reducing features? Ensure the design considers both environmental protection and user safety.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 4 and 5, Ideate

Step 6: Prototype Create a model or sketch of your sustainable launch infrastructure, showing its main features and eco-friendly components.

- Include renewable energy sources, noise reduction features, and waste management processes. This prototype should illustrate how your design reduces environmental impact while supporting safe and effective space launches.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 6 Prototype

Prototypes can be 3D or 2D if using wireframes for software / apps. You can read this article to help you <https://www.figma.com/resource-library/what-is-wireframing/>

Mock-ups can help you imagine how a user might interact with your satellite data-based app or system. The following links in Canva to create prototypes for any platform

- <https://www.canva.com/prototypes/templates/>
- <https://www.canva.com/prototypes/>

Follow the steps in Canva to create a user interface (UI) Mock-up for a mobile interface

Steps in Canva:

- Open a New Project:
 - Create a Custom Size project, 1080x1920 pixels - mobile screen format.
- Set Up a Mobile Background:
 - In Elements, search for “mobile screen” to find a blank phone outline. Place it in the centre of the canvas.
- Design the App’s Home Screen:
 - Inside the mobile frame, add a rectangle for a menu bar at the bottom and a circle or square near the top for the main icon or app name.
 - Use text to title this screen as “Launch” or “Monitor”, ‘Store’
- Add Buttons or Icons for Key Functions:
 - Create buttons or icons for each function as a means to navigate the \
 - programme
 - Place each button within the phone / tablet screen as a tapable icon.
 - Label each icon clearly with small text beneath or beside it.



- Add a Sample Data Preview:
 - Use a rectangle as a sample “data preview” section in the middle, where data from the launch like “Engine, Time to Re-entry” would appear.
 - Use smaller text for this data to simulate a realistic UI (user interface) feel.
- Enhance with Colours and Borders:
 - Add borders to each button/icon for a polished look, and apply a consistent colour theme (e.g., blue and white for a “tech” feel).
- Review, Download, and Save:
 - Make sure everything is aligned neatly and easy to read.
 - Download the mock-up once it’s polished!

You can also use cardboard - Cardboard Prototyping | Techniques, Cal Maritime Makerspace see <https://www.youtube.com/watch?v=qxXj2RhKjZY>

Or Paper Mobile Application Design: Paper Prototype Video, Cor-mac <https://www.youtube.com/watch?v=y20E3qBmHpg>

Step 7: Present your design to classmates, teachers, or potential users and gather feedback.

- Share with classmates, and teachers and role-played stakeholders (e.g., engineers, workers) Ask questions to find out if the design addresses key environmental and user needs. Use this feedback to improve the design’s effectiveness, accessibility, and environmental impact, ensuring it can support sustainable launches.

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 7 Test

Supporting links to help you define your users and testing

- Airport Technology (2023) Aim for the stars: Making rocket launches more sustainable <https://www.airport-technology.com/sponsored/aim-for-the-stars-making-rocket-launches-more-sustainable/>
- Marvelous Cosmos (2019) Why Rocket Launches Need So Much Water?
- Radar Reach (2024) SpaceX: Pioneering the Future of Reusable Rockets
- United Nations (2024) SDG7 Targets and Indicator https://sdgs.un.org/goals/goal9#targets_and_indicators
- UNOOSA (2024) Decent Work and Economic Growth <https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg8.html>