MM7: SDG6 SPACE4SDGS CLEAN WATER AND SANITATION

SDG6: Space-Based Water Filtration Systems

- Develop a water filtration system that can be used both in space and adapted for water-scarce regions on Earth.

Challenge

Imagine being on the International Space Station (ISS), where every drop of water must be filtered and reused to ensure astronauts have enough to drink, cook, and clean. Now imagine living in a place on Earth with very limited access to clean water, where people face challenges accessing fresh, safe water for their daily needs. In this project, you will design a filtration system that could work in both environments, helping astronauts in space as well as communities on Earth facing water scarcity.

Considerations

- Resource Efficiency: In space, resources are extremely limited, so your filtration system must use minimal energy and materials. Think about how this could also apply on Earth, where water-scarce areas may have limited power and resources.
- Durability and Reliability: Design a system that works consistently over time with minimal maintenance. Consider how to make it reliable and effective for both space missions and communities on Earth.
- Ease of Use: The filtration system should be easy to operate, with minimal training required. Astronauts and local communities alike should be able to use and maintain it without advanced technical skills.
- Adaptability for Different Environments: The system must work in both microgravity (space) and gravity (Earth) environments. Think about what changes might be needed to adapt it for each setting.
- Portability and Scalability: Consider designing a filtration system that can be small and portable, yet scalable for larger use on Earth.

Background

Access to clean water is a major global challenge. On Earth, more than 2 billion people live in water-scarce regions, struggling daily to access safe, drinkable water. In these areas, reliable filtration systems can make a huge difference in improving health, reducing water-borne diseases, and enhancing quality of life. Meanwhile, in space, astronauts depend on carefully designed water recycling systems, which can transform waste water into drinkable water, conserving every drop. This technology is essential to support long-term missions where resupplying water from Earth is impractical.

By combining the needs of space exploration with the challenges of water scarcity on Earth, this project aims to develop a system that can address water shortages both in space and in remote, drought-prone areas on Earth. Your design has the potential to improve life on Earth and in space by providing a model for sustainable water use, conservation, and purification. The solutions you create could be part of a global effort to make clean water accessible for all, supporting the United Nations SDG 6 for Clean Water and Sanitation.

Your Mission

Your mission is to create a dual-purpose water filtration system that can operate in space and can be adapted for water-scarce regions on Earth. The system should be compact, energy-efficient, and able to produce safe drinking water reliably. Consider how astronauts in space and people in remote communities on Earth will use your design. As you create your system, think about sustainability, ease of use, and health safety standards. Whether it's keeping astronauts hydrated on the ISS or providing clean water for communities affected by drought, your design can make a real impact.

Project Objectives

1. Create a Dual-Use Filtration System:
    - Design a water filtration system that functions effectively in space and can also be adapted for use in water-scarce regions on Earth.
    - Consider how to make it compact, efficient, and adaptable for both microgravity and gravity-based environments.
2. Focus on Sustainability:
    - Develop a system that uses minimal resources, particularly in terms of water, power, and materials, and has minimal environmental impact.
    - Think about how the system could help conserve water in places with limited access, like drought-prone regions on Earth.
3. Ensure Ease of Operation:
    - Design the system to be user-friendly so astronauts or local users with little training can operate it with ease.
    - Include clear instructions or visual guides to help users understand how the system works, monitor its effectiveness, and conduct basic maintenance.
4. Prioritise Health and Safety:
    - Ensure the filtration system provides safe, clean, and drinkable water by removing bacteria, viruses, and other contaminants.
    - Consider health standards for drinking water and make sure the system is capable of meeting these standards in both space and on Earth.

Deliverables

- User Profile: Create a profile of a typical user, like an astronaut on the ISS or a family living in a water-scarce area on Earth, describing their specific needs and challenges related to water access.
- Filtration System Overview: A one-page summary explaining how the system works, its main components, and how it adapts to different environments.
- Prototype or Concept Sketch: Design a basic sketch or model showing the main features of your filtration system and how it would work.

- Presentation: Prepare a presentation to showcase how your filtration system could improve access to clean water for both space missions and water-scarce areas on Earth, with visuals to explain its impact and ease of use.

Questions to Consider

Understanding the Users:

- Who are the people who will benefit most from this filtration system? Think about astronauts in space and people in areas with little access to clean water.
- What specific challenges do they face with accessing water, and how could a filtration system solve these challenges?

Designing for Dual Environments:

- How could the same filtration system work in both microgravity (space) and on Earth? What adaptations might be needed to make it effective in both settings?
- What key features would help the system work effectively in different environments?

Focus on Safety and Health:

- What types of contaminants need to be removed to make water safe to drink? Think about bacteria, viruses, or heavy metals.
- How can you ensure that the filtration system consistently produces clean, safe water in a reliable way?

Resource Efficiency and Sustainability:

- What are some ways to make the system efficient with minimal power and material use? Could solar energy or other renewable energy sources be used?
- How could your design conserve water in areas with limited access, and how can you prevent waste?

Ease of Use and Maintenance:

- How could the system be designed so that people without technical training can use and maintain it? What instructions or visual guides would be helpful?
- What would make the system easy to operate, clean, or repair in both space and remote Earth locations?

Design Process Overview

Step 1: Introduction: What is available and Who are your users?

- Explore examples of space technology solutions for supporting water and filtration - see links on the last page
- Think about how space technology supports earth-based activities also

Step 2: Empathy

- Create user profiles for astronauts on long missions, and people in water-scarce areas on Earth. What are their challenges, and what would help improve their lives?

Step 3: Defining the Problem

- Define the main problem that your project will solve: limited access to clean water and the need for water recycling.

Step 4: Ideate

- Brainstorm systems that can filter and purify water efficiently using minimal resources. How would people use it? What kind of information would it provide?

Step 5: Ideate 2 – Good Idea / Bad Idea

- Refine and remix your ideas. exploring scalable solutions for both space missions and Earth-based applications.

Step 6: Prototype

- Create a model or sketch of your simple filtration prototype or a concept model for a closed-loop water system or management application. This could include the type of information it provides, how people interact with it, and what it looks like.

Step 7: Test

- 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

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.

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

Step 1: Introduction: What is the available and Who are your users?

- Use the Internet to explore examples of water sanitation on earth and how space technology and space missions can help with solutions for conserving and recyling water. Visit https://www.unoosa.org/oosa/en/ourwork/space4sdgs/sdg6.html
- Explore water projects in water scarce areas and see who your users might be

Step 2: Empathy: Create user profiles for astronauts on long missions, and people in water-scarce areas on Earth.

- What are their challenges, and what would help improve their lives?

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 designing a user-centered and adaptable water filtration system that can serve both space and water-scarce areas on Earth, promoting sustainability, health, and global water access. Asking these questions will help them create user profiles and help them design their challenge solution.

Identifying Needs and Challenges of Different Users

- Who are the primary users of this filtration system? Think about astronauts who rely on recycled water in space and people in remote or drought-affected regions.
- What are the specific challenges each group faces regarding water access? List some difficulties like limited water supply, contamination, or reliance on rainwater.

Daily Life with Limited Water Access

- Imagine a day in the life of a family in a drought-prone area. How would they collect, store, and purify water? What struggles might they face in accessing safe drinking water?

- For astronauts, what might a typical day look like when it comes to using and conserving water on a space mission?

Different Environments, Different Requirements

- How might a water filtration system need to be adjusted to work in space (microgravity) compared to Earth? Think about how water behaves differently in zero gravity.
- Consider the specific needs of each environment. What aspects would be important to address, like portability, ease of use, or minimal power requirements?

User-Friendliness and Reliability

- How could your system be designed to be intuitive and simple to operate for both astronauts and local users on Earth?
- What instructions, maintenance features, or visuals would help make the system clear and user-friendly for people with different levels of technical knowledge?

Community Impact on Earth

- How could a family in a remote community use this system to access clean water daily? How might it improve their health, well-being, and daily life?
- Think about the broader impact. How could this system make a positive difference for communities or schools that struggle with access to safe drinking water?

Creating User Profiles

After working through the prompts, ask learners to create a user profile for a learner or educator who might use the system. This can include:

- Name, age, and location of the user
- A description of their daily challenges and pain points
- Technology they have access to and comfort level with digital tools
- Their specific learning or teaching needs
- An example of how they would use the system to access education

Step 3: Defining the Problem: Define the main problem that your project will solve.

For example, is it ensuring clean drinking water in space, making water accessible in drought-prone areas, or developing sustainable water-recycling systems?

Support: Use the resources in MM7: Problem to Pitch Space Design Challenge, Lesson 3, Define e.g. Create a problem tree to map the root causes and effects of water scarcity and lack of filtration in different environments e.g. root causes of the issue, such as limited access to water in remote areas, resource constraints in space, and lack of efficient filtration technology, then consider the branches or effects e.g. health risks from contaminated water, high costs of water transport, and environmental impacts of water shortages.

Step 4: Ideate: Brainstorm different ideas

E.g. how your filtration system could work effectively in both space and water-scarce regions on Earth. Consider various designs, materials, and filtering methods that could make the system compact, efficient, and suitable for different conditions. Could your system use renewable energy sources like solar power, or could it be portable for ease of transport? Think about creative features that would allow it to operate with minimal resources while ensuring high-quality water filtration, whether for astronauts in space or communities affected by drought on Earth.

Step 5: Refine your ideas. Focus on the most promising ones and think about how they could be even better or more accessible and engaging.

Think about ways to make these ideas more efficient, reliable, and user-friendly. Consider how the system could be adaptable for different environments, does it need additional support for zero-gravity in space, or can it be made easier to use for people with limited technical skills on Earth? Aim to enhance accessibility and make the design as engaging and easy-to-operate as possible, so it's practical for both space missions and water-scarce communities.

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

Step 6: Prototype: Create a prototype for a simple filtration prototype or a concept model for a closed-loop water system.

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 that might control your filtration system

Steps in Canva:

- Open a New Project:
  - Create a Custom Dimensions project, and set it to 1080x1920 pixels (this mimics a 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 "Filter" or "Recycle"
- 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 satellite data like “Recorded Classes, Books” 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: Test: Test the system’s efficiency under different conditions (e.g., limited water, contaminants) and make adjustments based on performance.

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

- United Nations (2024) Water Scarcity https://www.unwater.org/water-facts/water-scarcity
- United Nations (2024) SDG6: Clean Water and Sanitation https://www.globalgoals.org/goals/6-clean-water-and-sanitation/
- UNICEF (2024) Water scarcity and Children’s Needs https://www.unicef.org/wash/water-scarcity
- WWF (2024) Water Scarcity https://www.worldwildlife.org/threats/water-scarcity
- UNOOSA (2024) Space Water Portal https://space4water.org/
- UNOOSA (2024) Explore Projects and Initiatives https://space4water.org/projects-initiatives-missions-community-portals
- UNOOSA (2024) Case Studies https://space4water.org/local-perspectives-case-studies