KLOMP: Knowledge from Landing and Orbiting the Moon Program (Dutch boots on the Moon)

Description:

Soon humans will return to the moon, but until then we can still do science without humans. In this project, teams will work as moon mission engineers designing instrumentation meant to do various specific science experiments on or around the moon.

Each team member will choose a different engineering role and meet specific **thermal**, **electrical**, **communication**, and **structural** constraints.

You are lucky enough to have a fully kitted O&O lab. Because Design-Based Learning means learning by *doing*, your final project must include a **Tangible Physical Artifact** built in the lab.

Additionally, Generative AI can be used as an optional "Junior Engineer" tool, but you are the Senior Engineers. If you choose to use AI to brainstorm or check math, you must verify its output against real scientific databases. AI confidently makes things up, so you are always the final decision-maker.

On the presentation day groups will be assigned booths in a project information fair where they will be assessed by other groups as well as the instructor and instrumentation engineers from SRON.

Science missions (Max 2 groups per mission):

Surface biology lab/farm pod (stationary)
Permanent shadow region (PSR) properties (stationary with micro-rovers)
Searching for water ice/soil analysis (rover)
Tardigrade spill - collection and check up (rover)
Lunar Regolith Construction Testbed (rover or stationary)
Moon 5G network node (base satellite + cubesats)

Engineering Roles:

Each team member will choose a different engineering role. Because teams are small, everyone must work together to integrate their subsystems. For teams with three members, it is suggested to combine structural and thermal.

- ***Structural & Materials Engineer***: Focuses on the physical build, material selection, weight limits, and protecting from the abrasive lunar dust.
- ***Thermal and Environmental Engineer***: Manages heating/cooling, radiation shielding, and survival in extreme lunar cycles.
- ***Electrical, Power & Comms Engineer***: Focuses on the electrical systems including solar panels, batteries, wiring, power budgets, and data transmission.
- ***Systems & AI Verification Lead***: The Integrator. Manages the mission budget, ensures the structural, thermal and electrical designs physically fit together, and is responsible for fact-checking any AI outputs the team uses.

Engineering Solution:

Your task is to design a moon mission for one of the specific concepts that:

- Fits within a weight and size limit (for launch): **200 kg** max for piggyback on Ariane 6.
- Uses durable materials to have a minimum lifetime of 5 years (must survive extreme thermal cycling and abrasive soil).
- Has the lowest possible cost to still achieve the results (ESA small moon mission cap: **€50 million**, including materials, launch, and labor).
- Functions within strict constraints:
    - *Thermal*: Moon environment has a 28-day cycle of extreme temperature differences

(-130°C night, 120°C day, -250°C in PSRs).
    - *Electrical*: Power requirements for the experiment and all systems (200W - 20000W).
    - *Comms*: Communicate from the far side of the moon, remote control
- Will be able to perform the scientific mission

Skills and Concepts:

★ Working to constraints: Balancing thermal, electrical, comms, size, and material limits.

★ Budget optimization: Making trade-offs between material cost, launch mass, and functionality.

★ Collaboration & Integration: Dividing tasks, communicating within the team, and re-combining subsystems into a cohesive whole.

★ AI Literacy & Verification (Optional): If using GenAI, crafting precise prompts and cross-referencing outputs with trusted databases (the "Human-in-the-Loop" principle).

★ Reporting result: Creating a physical prototype and pitching the design at the information fair.

○ Pitch should: Explain features and special selling points, Defend material/power/comms design choices, Explain budget decisions

The Tangible Artifact Requirement (Mandatory)

Because you have access to a fully equipped O&O lab, your final deliverable **must include a physical, built component**. This ensures you experience the real-world challenges of engineering (e.g., things not fitting together, materials behaving unexpectedly).

Acceptable Physical Artifacts include:

- A scaled physical mockup of your rover, pod, or satellite (using cardboard, foam, 3D printing, wood, or craft materials).
- A working subsystem prototype (e.g., a deployable solar panel mechanism, a physical model of your thermal insulation layers, or a basic wired circuit demonstrating your power concept).
- A detailed, hand-drawn or physically assembled "cutaway" diagram of your design.

Groups that submit only digital slides with no physical artifact or hand-drawn/student-modeled visual component will not pass the "Design Prototype" criterion.

🚫 **Strict Policy on AI-Generated Visuals:**

To maintain academic integrity and respect copyright, AI-generated images (e.g., Midjourney, DALL-E) are strictly prohibited in your final reports, posters, or presentations.

✅ **Allowed**: Hand-drawn sketches, photos of your physical O&O lab build, student-created CAD models (Tinkercad, Blender), or Minecraft Education builds.

✅ **Allowed AI Text Use**: You may use text-based AI to brainstorm, check math, or draft outlines, but *you* must verify the facts and *you* must create the visuals.

❌ **Not Allowed AI text use**: Asking the AI to write your final report, generate fake data, or design the entire prototype without human oversight.

If you can't explain why the AI's suggestion works, you can't use it.

AI Verification Note: If your team used AI, include a brief note (max 1 paragraph) in your final report showing one prompt you used and how you fact-checked the result against a real database. If you didn't use AI, simply state that your design was verified 100% by your team using the provided scientific resources.

Suggested project milestones:

Week 45: Introduction Workshop day: Friday 6 November

Week 46: Ideation - think of lots of crazy plans for your project and pick 3 to follow up on

Week 47: Research thermal, electrical, comms, and materials

Week 48: Design, test, revise. Choose best idea

Week 49: Start prototyping. Milestone: Create a hand-drawn "Napkin Sketch" and a Lab Material Request list before touching the tools.

Week 50: Work on physical prototype and design details

Week 51: Milestone: Write a "Systems Handover Doc" summarizing what is finished and what is broken, so you can fully disconnect for the break.

Week 52/53: Kerstvakantie

Week 1: Revise, test, check prototype. Begin preparing information for presentation

Week 2: Finalize prototype. Create visuals, explanations of design choices, selling points. Practice explaining to your friends/parents/strangers

Week 3: **Presentation Day:** Thursday 21 January (Information Fair assessed by peers, instructor, and SRON engineers)

Resources:

Material database https://spacematdb.com/

ESA labs https://technology.esa.int/labs

NASA mission design https://www.nasa.gov/smallsat-institute/space-mission-design-tools/

NASA basics of spaceflight https://science.nasa.gov/learn/basics-of-space-flight/

Lunar power solutions (NASA)
https://ntrs.nasa.gov/api/citations/20220005893/downloads/Power%20and%20Energy%20for%20the%20Lunar%20Surface.pdf

Lunar and Planetary Institute (LPI) previous instruments https://www.lpi.usra.edu/lunar/instruments/

New example missions
https://www.nasa.gov/planetarymissions/lunar-surface-instrument-and-technology-payloads-lsitp/

Materials for space https://www.elementdefense.com/blog/materials-survive-in-space

ESA small moon mission

https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/To_the_Moon_ESA_seeks_ideas_for_small_lunar_missions
https://ideas.esa.int/servlet/hype/IMT?documentId=9904aa3d71cbae0c8d3d86503095f607&userAction=Browse&templateName=

Tardigrades on the moon

https://en.wikipedia.org/wiki/Tardigrades_on_the_Moon

Free 3d Design software:

Blender, Unity, Tinkercad, Spline

Tekla Structures Educational free 1 year subscription

Open source NASA software https://opensource.gsfc.nasa.gov/index.php https://www.mystran.com/