LUNAR MISSION ONE

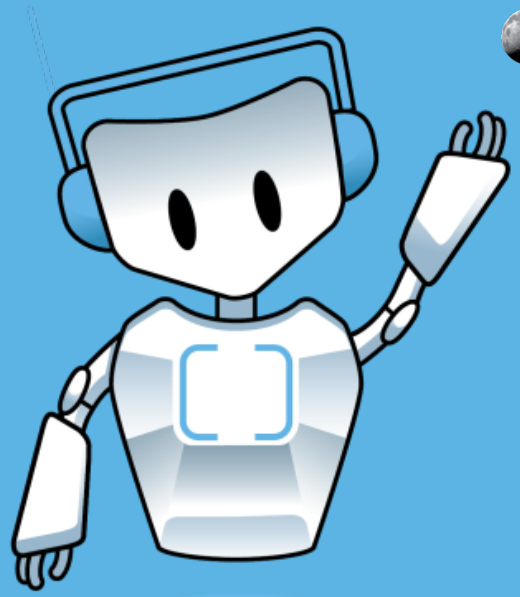
Paving the Way for Human Habitability on the Moon

51st ESLAB Symposium: “Extreme Habitable Worlds”,
04-08 December 2017 at ESA European Space Research and Technology Centre (ESTEC) in Noordwijk, the Netherlands.

Lunar Mission One: Paving the Way for Human Habitability on the Moon

What is Lunar Mission One?

- **Lunar Mission One (LM1) is a proposed robotic lander mission to the Moon, funded by public subscriptions to a billion year time capsule with an epic record of Life on Earth, with an anticipated launch date within the next ten years**



- **Stage 1 was successfully funded by international public backers through a capital funding campaign using the crowdfunding platform ‘Kickstarter’**

- **Lunar Mission One has featured in over 1,500 professional news articles and has international partnerships with scientific institutions and volunteer groups from 34 countries**

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Making the Moon habitable - What do we have to gain from a permanent lunar base?

- **Astronomy and planetary science:**
  - **Primary Cosmic-ray, Gamma and X-Ray observations from installed instrumentation in-situ without atmospheric distortion**
  - **Optical/infra-red/radio astronomy**
  - **Determining the composition/structure of lunar geology**

- **Astrobiology:**
  - **Understanding the process of formation of organic molecules within lunar ices exposed to GCRs**
  - **Studies of survival of organic material**
  - **Studies of the records of solar and galactic evolution via records within buried palaeoregolith layers**

- **Space Exploration:**
  - **Springboard and testing ground for future solar system exploration (Mars exploration and Deep Space Gateway)**
  - **Potential mining opportunities for propellant creation**

image credit: ESA – Moon Village Concept

- **Cultural Impact:**
  - **First permanent human settlement on another world and what this means for the future of humanity**
  - **Global commitment to exploration**

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How can LM1 help pave the way for human habitability on the Moon?

- **The Lunar South Pole is a primary candidate as the site for a human lunar base. LM1 would provide useful data on its feasibility**
- **The lander will carry equipment to enable analysis of the geochemistry of the lunar crust, to provide data on the usability of lunar soil as a resource for construction of a lunar base**
- **Analysis of elemental composition, local mineralogy and volatiles as well as measurements of the lunar environment**
- **Proof-of-concept for experiments that that would be enriched by a lunar base. These include low-frequency radio astronomy from the Moon, terrestrial emission, the lunar exosphere, and the effects of the lunar surface on radio propagation and communication**

Instruments / Science Goals	Goal 1: Geochemistry & Mineralogy	Goal 2: Impact chronology (including SPA Basin Age)*	Goal 3: Volatiles	Goal 4: Internal Thermal	Goal 5: Environment (Dust, radiation, seismic surface conditions)	Goal 6: Resources	Goal 7: Radio-Astronomy/ Magnetosphere Studies	Goal 8: Science Education
Landing Site Imager					X	X		X
IR Spectrometer	X				X	X		
X-ray/Gamma-ray Spectrometer	X	X (v. approx age only*)	X (if low energy response)			X		
Raman-LIBS	X		X			X		
Mass Spectrometer	X	X (v. approx age only*)	X		X	X		
Neutron spectrometer	X		X					
Seismometer				X	X	X		
Heat Flow				X				
Dust, Radiation Charging Package					X	X		
Sample Imager	X		X			X		X
Radio-astronomy demo package							X	X
Magnetospheric Imager							X	X

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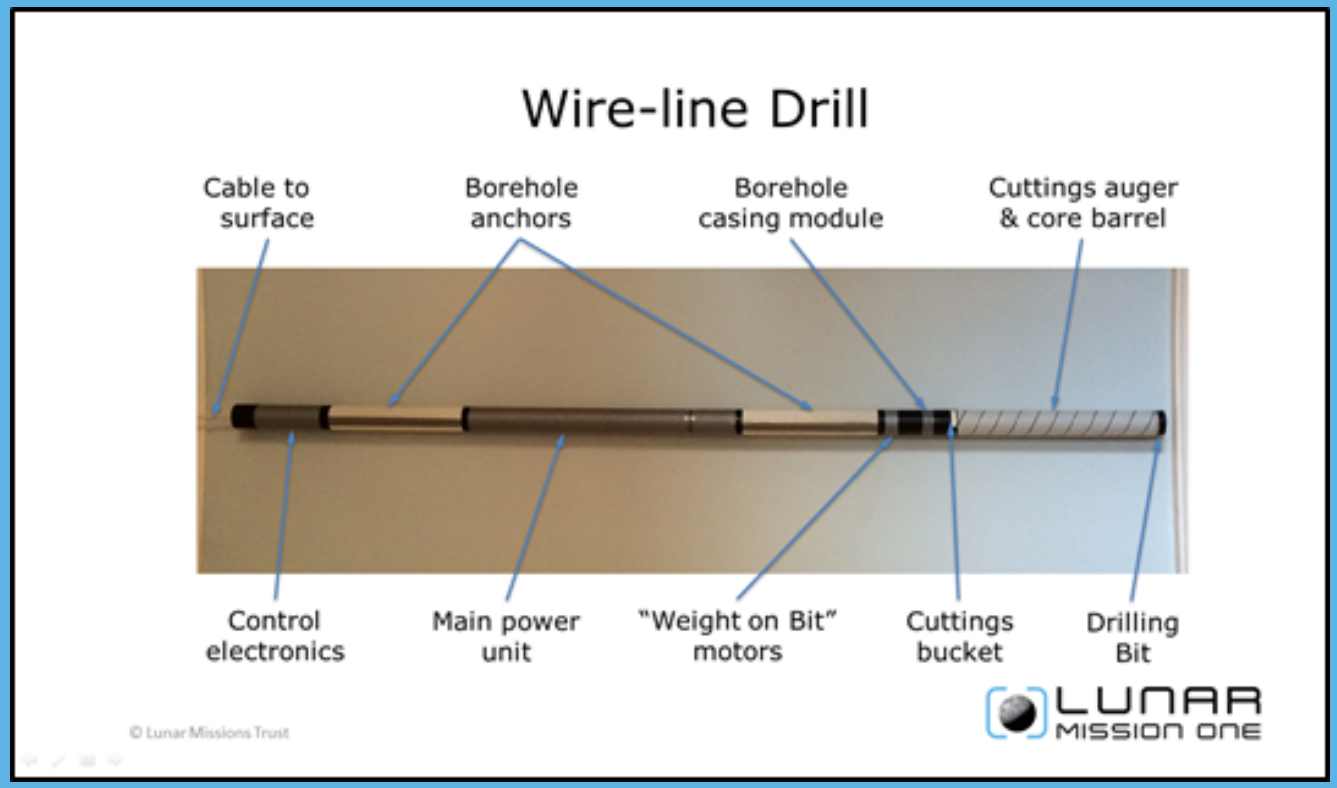
How will LM1 achieve its mission objectives?

- **The lander will carry equipment to enable analysis of the geochemistry of the lunar crust. This will include a 100 metre wire-line drilling system which will be accompanied by a jointed robotic arm for handling core samples**

- **LM1 could carry an on-board Neutron spectrometer to determine hydrogen concentrations in the local geology to be compared with orbital measurements, such as those observed by the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) on the Lunar Reconnaissance Orbiter (LRO)**

- **LM1 also proposes to analyse materials using a Raman-LIBS (Laser Induced Breakdown Spectrometer) to determine elemental composition, local mineralogy and volatiles**



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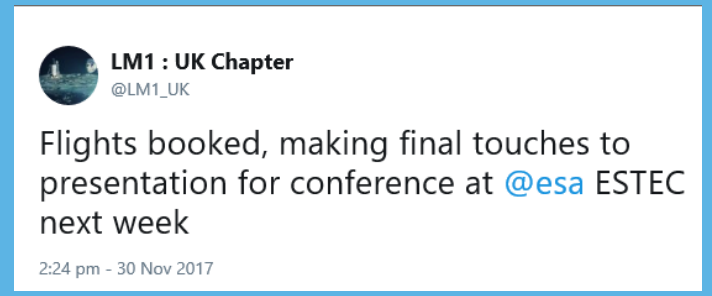
How LM1 is engaging with the public: Worldwide Chapters

- **LM1 aims to be the most accessible, interactive space mission ever.**
  As a space mission for everyone, LM1 is establishing international teams that are contributing to a real life space mission. These teams are called ‘chapters’ and are made up of voluntary members and open to anyone



- **Our chapter members are currently working on:**
  - **Marketing: promoting the mission to the world**
  - **Education: helping pilot a global education programme**
  - **Technology: designing a capsule that can survive on the Moon**
  - **Science: helping predict the survival and discovery of the archive**
  - **Languages: making the Lunar Mission One website accessible to all cultures**
  - **Art: raising awareness of the future of humanity, the Earth and the planets**

- **LM1 currently has chapters in Australia, Belgium, Bolivia, Canada, Colombia, Czech Republic, France, Germany, Ghana, India, Indonesia, Ireland, Israel, Italy, Japan, Liberia, Lithuania, Malaysia, Netherlands, Nicaragua, Nigeria, Pakistan, Romania, Russia, Saudi Arabia, Slovakia, South Africa, South Korea, Sudan, Taiwan, Turkey, UK, US and Vietnam**

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How LM1 is engaging with the public: Education Scheme

- **LM1 is a unique venture with the potential to promote knowledge and inspire learners of all ages the world over. We hope to inspire a new generation about space, science, engineering and culture. The range of subjects that can benefit from LM1 is boundless**

- **Our aim is to develop a large scale international programme of engagement with schools and colleges. We want students to play a major role in leading the education programme, working with others (students and adults) both within and beyond schools, colleges and universities**

- **LM1 has started a pilot education programme to trial ways of encouraging children and young people to create their own content and share it with their contemporaries worldwide. More than 70 schools in 32 countries are currently partaking in the pilot education programme**

Environmental Research Examples

4 to 6 years

- A group of students collect examples of local plant life and foliage. They agree on their own classifications (according to colour, shape, size etc.) The groups build a class display. The teacher (adult leader) photographs the display as a contribution to the archive.

14 to 16 years

- A group of students undertake a field trip to study their local coastline. They record the geology of the coast plus various types of coastal erosion and its causes. Students develop multimedia scientific reports and these are submitted for inclusion in the archive.

STEM and Mission Related Student Project Examples

7 to 11 years – Engineering, Design & Technology and Science (STEM Engineering – Topic Label)

- A group of students research and study the soft landing techniques that have been employed on previous planetary space missions. Working in small groups, the students design an enclosure to protect the LM1 scientific payload from impact damage at touch-down. The students junk-model their enclosure and prove its ability to protect an egg, when dropped from a set height.

16 to 18 years – Economics, Law and Politics (STEM General – Topic Label)

- College students, studying Economics, Law and / or Politics, research and study historical and current space treaties and laws. They focus their attention on the laws and treaties concerning the usage of the Earth's moon. Students develop papers and a presentation to explain the potential impacts of space law on Lunar Mission One.

18 to 21 years (First Degree) – Computer Science and Electrical Engineering (STEM Technology – Topic Label)

- Students review the storage capacity and longevity requirements of the Lunar Mission One public and private digital archives. The students then investigate the capability of currently available and proposed data storage hardware. Students present their research papers for consideration by the LM1 Science and Technology teams and for storage in the LM1 digital archive.

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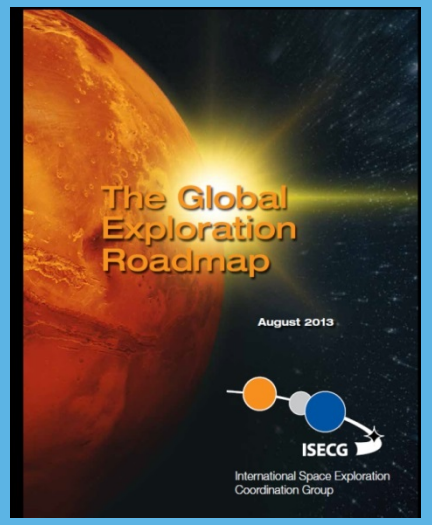
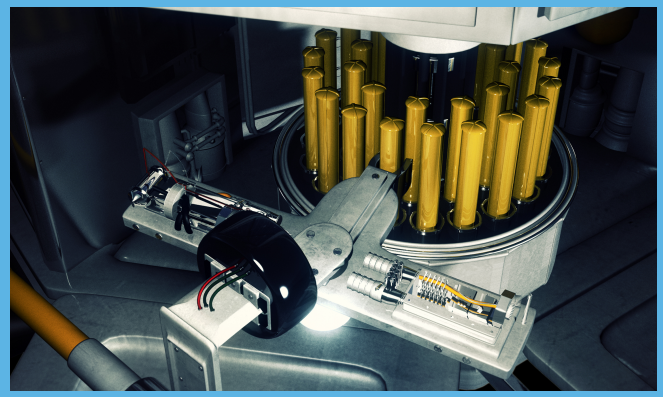
How LM1 compliments ESA's vision of the Moon Village concept



- **LM1's proposed mission objectives are aligned to the Global Exploration Roadmap:**
  - **New phase in exploration underway**
  - **Mix of robotic & manned exploration**
  - **Private sector commercial investment and management**
  - **Launchers & spacecraft**
  - **Enhancement of government programmes**
  - **Increasing involvement of citizens, international collaboration**

  LM1 advances all of these trends

- **LM1's payload could provide science essential for planning of human settlements**



- **Funding to be self-sufficient:**
  - **Sale of digital memory boxes for personal time capsules to consumers worldwide, priced by storage capacity ($50-$500 typical, $1 low cost entry), including DNA as hair a key driver – "It's me. I'm up there!" and for family, friends…..and pets**
  - **Government support for development of key technologies**
  - **Commercial cash flow funding**
  - **Sponsor investment return**
  - **Revenue projection $ Billions**

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Let’s go back to the Moon, together!

Any Questions?