MoonXcribe


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Introduction

- Many of the technologies we will need for MoonXcribe already exist for Space applications. These include; solar photovoltaic devices, high specific energy batteries, power and energy management solutions, high resolution cameras and solid state LiDAR, communications links, and rover routing with detect and avoid autonomous system functions. At the same time, over 250 lunar missions are planned over the next decade with launchers, landers, and rovers all being in production and some are even a part of current lunar missions.

- So what's really missing? We are going to need very high reliability from our systems on the lunar surface. It's a harsh environment. We are going to need our rovers to last longer and travel further than those that have gone before and that means we need to think carefully about mechanical wear and tear issues particularly in terms of the rover wheels and any electro-mechanical systems too. These are by no means insurmountable challenges and we already have plenty of promising directions to explore. Just as important is how exactly are we going to imprint, emboss, or otherwise grow your messages on the lunar surface? There are so many promising options here and it's really not a question of determining if one works, but which one works the best in terms of offering good quality messages, high message generation rate, low system complexity and high reliability, low weight (we are always trying to reduce this!), and of course the cost of the message writing machinery.

- Our concepts (below) will hopefully give you a little insight into our thinking but these are by no means the full range of concepts we are exploring. We'd love to hear from you so please sign up by making a donation or just for our newsletter and get in touch with us.

Concepts

- **Many technologies already exist to do this albeit we can improve them significantly through our collective efforts (e.g., launchers, landers, rover autonomy & robotics, energy and power solutions, communications)**

- **Infinite variety of methods for creating messages on the lunar surface**

  A. ***Imprinting: Through pressure***
  B. ***Imprinting: Drawing by dragging***
  C. ***Embossing: Building dust (piling up) for embossed effects***
  D. ***Embossing: Pushing or raking dust for embossed effects***

- ***Each message writing concept and other concepts will be developed and explored so the following simply provides a set of possibilities to stimulate discussion***

Trades

- **Variety trades exist and will be explored along with many more concepts**
  - ***Development Cost***
  - ***Unit Production Costs***
  - ***Reliability, reliability, reliability!***
  - ***Message quality***
  - ***Message size***
  - ***Time to complete a message***
  - ***Lander mass (launch cost to lunar per kg!) and complexity (which also means unit cost)***

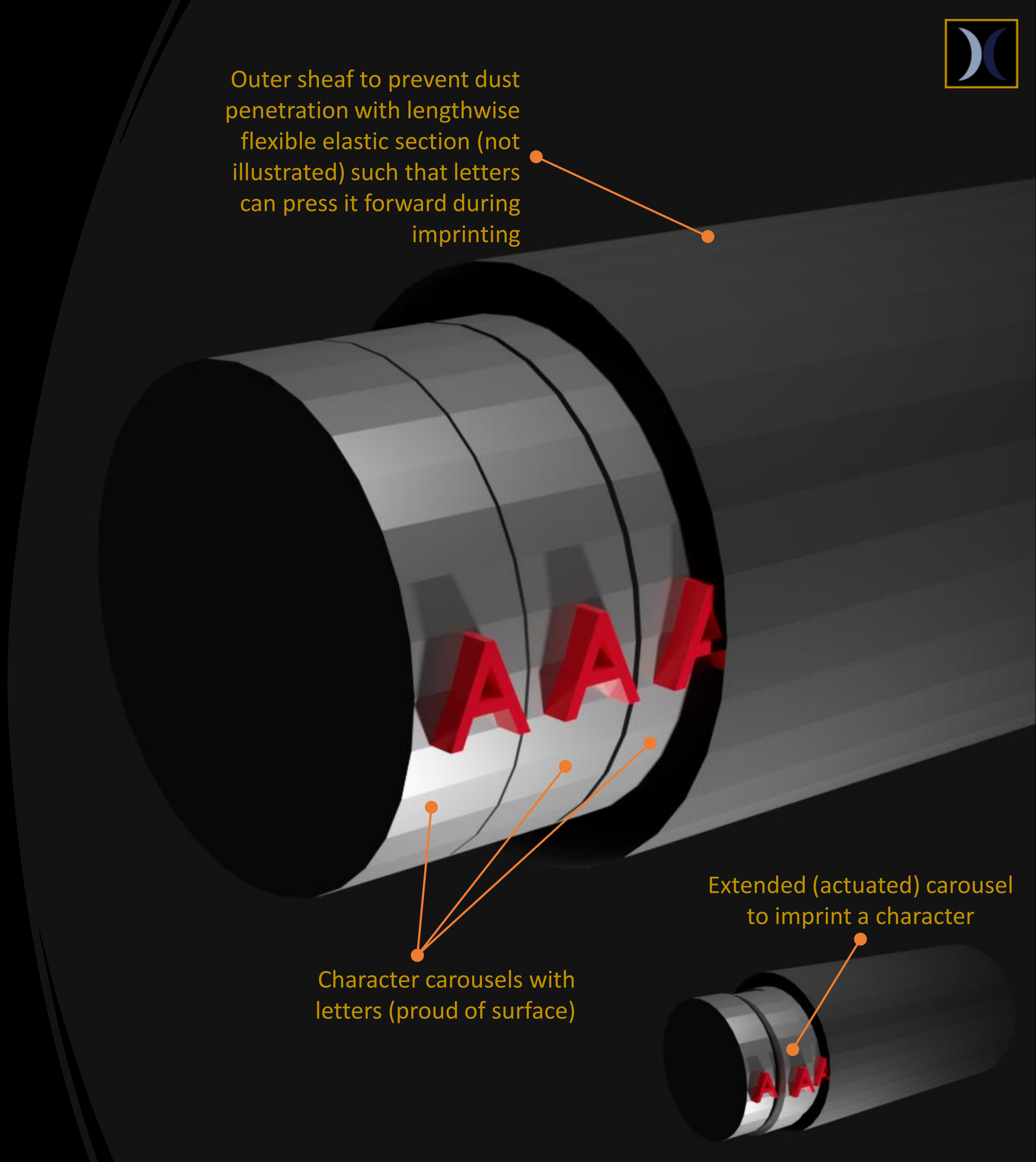
Concept 1 : Drum Roll

Imprinting : Using Pressure (A.)

- Typeface or primitive shape combinations (e.g., different sized shapes covering different angles to form letters) behind a drum (covered by flexible elastic cover to keep out dust that can clog and cause wear)
- Type face or primitive shapes can be ball-like devices, a series of stacked cylinders, or an armature arrangement which strikes – just like modern and old typewriters
- OR
- May be exposed (no cover) if dust avoidance and / or high reliability is possible (subject to research)

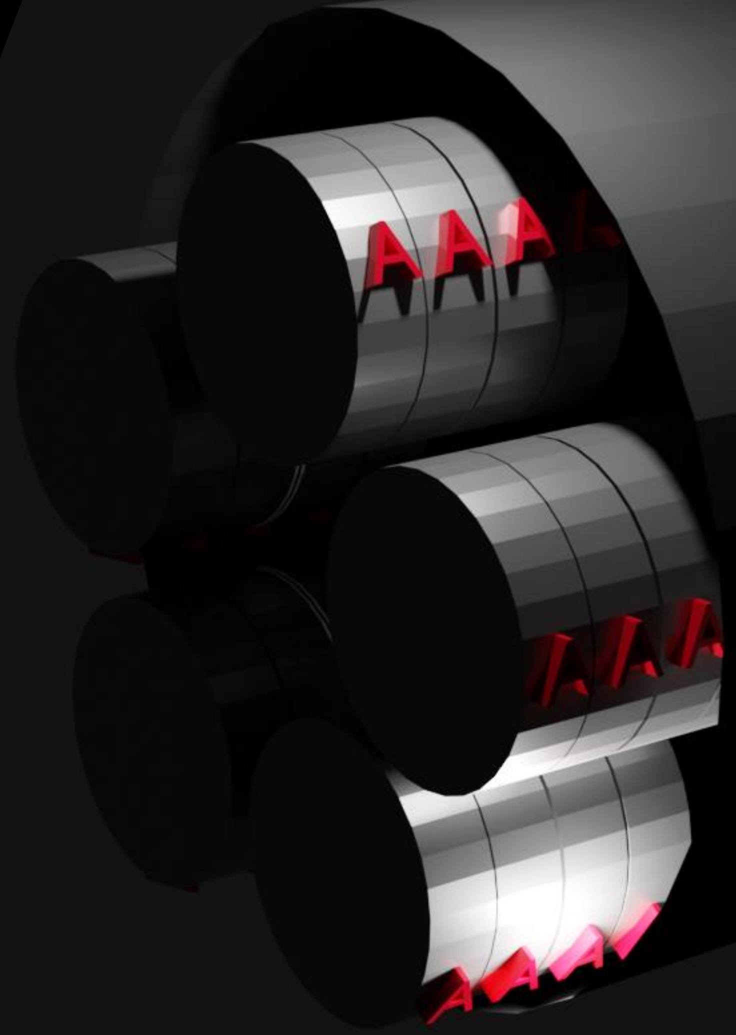
Imprinting : Using Pressure (A.)

- Depiction of one possible implementation opposite
- Words formed through rotation of each character carousel (which also contains blanks for ‘space’) then entire drum is pressed into the lunar surface (actuated outward)



Imprinting : Using Pressure (A.)

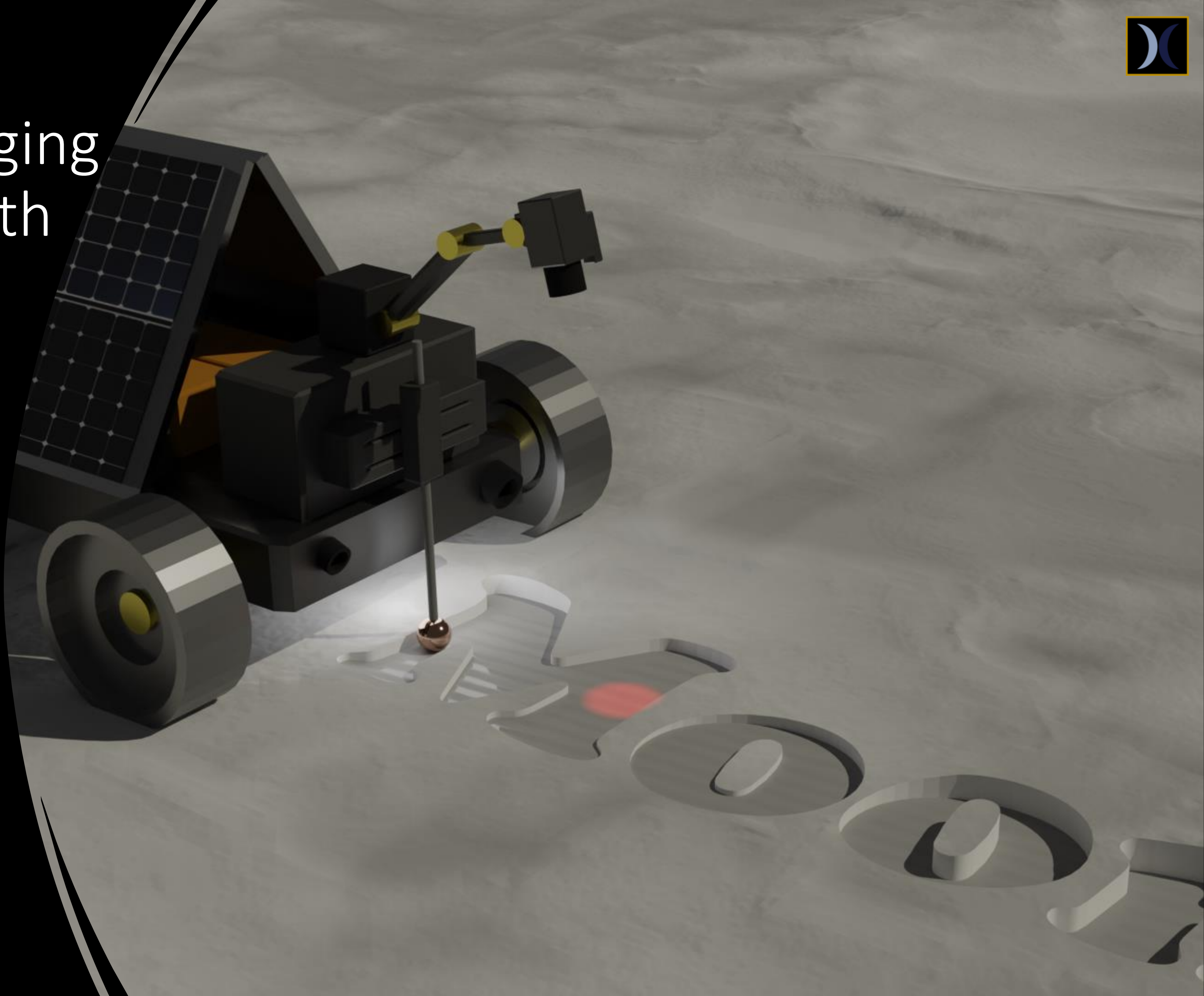
- Depiction of one possible implementation opposite
- Multiple letter carousels can be used for faster message generation



Concept 2 : The Rod

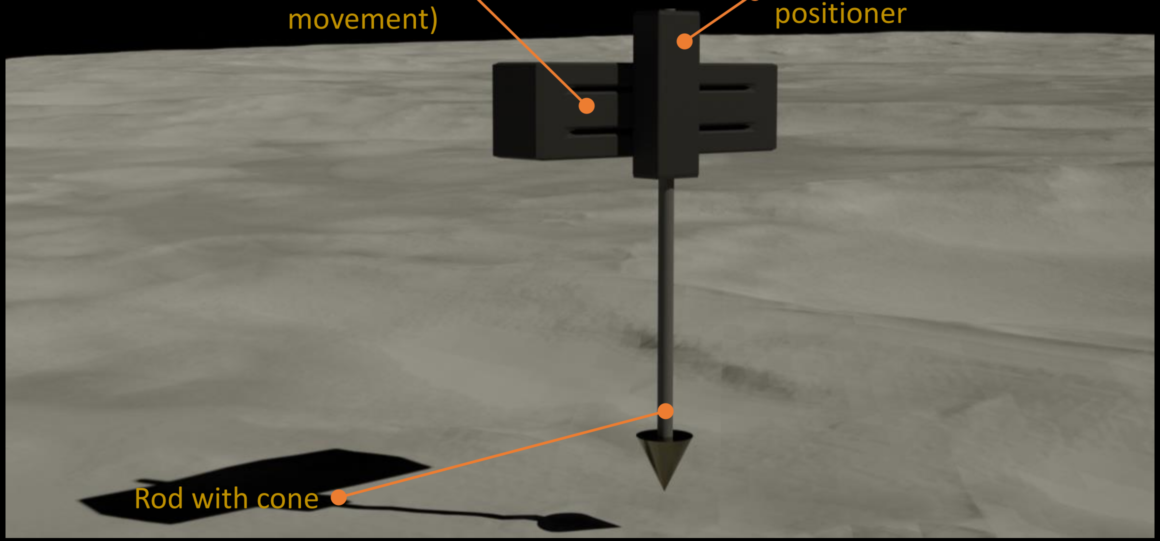
Imprinting : Dragging or Pressure or both (A. & B.)

- Dragging in the lunar dust to displace it (script-like text)
- OR
- Pressing into the dust with a rod and ball device (shown opposite) which may also be dragged
- *Assembly can be vehicle-end mounted (shown) or mid-vehicle mounted for greater stability*

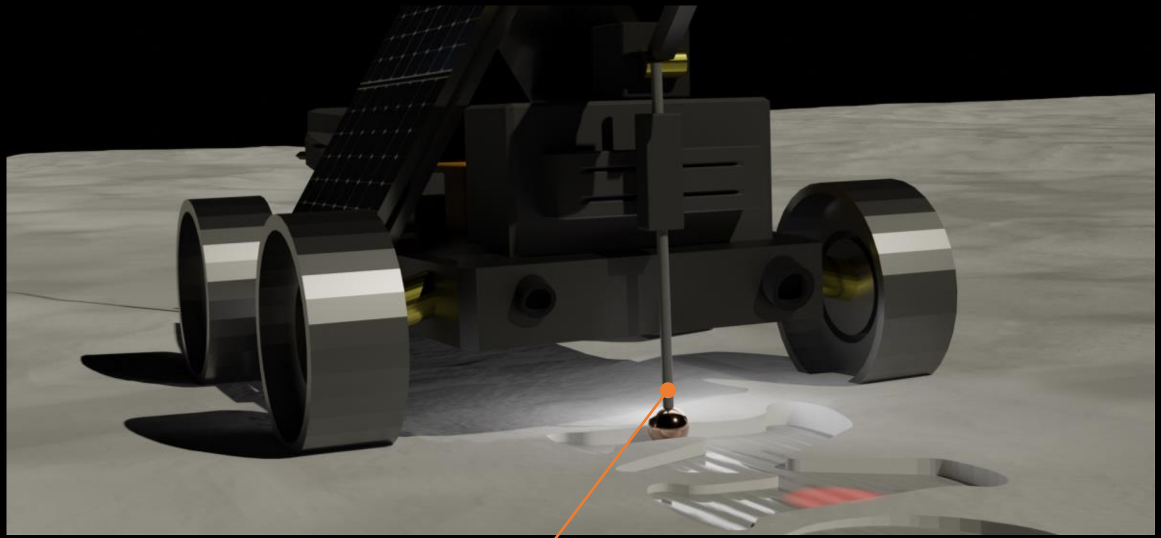


Imprinting : Dragging or Pressure

- Robotic armature presses pointed cone shaped device into lunar surface which is dragged left to right as the vehicle moves forward (including some necessary forward and aft movement)
- Robotic armature presses ball shaped device into the lunar dust, applying pressure (which may also be translated in X and Y including use of vehicle forward motion i.e., cross-track and along tack). This can combine pressure (vertical dust displacement) and dragging (lateral dust displacement)



Script effect text

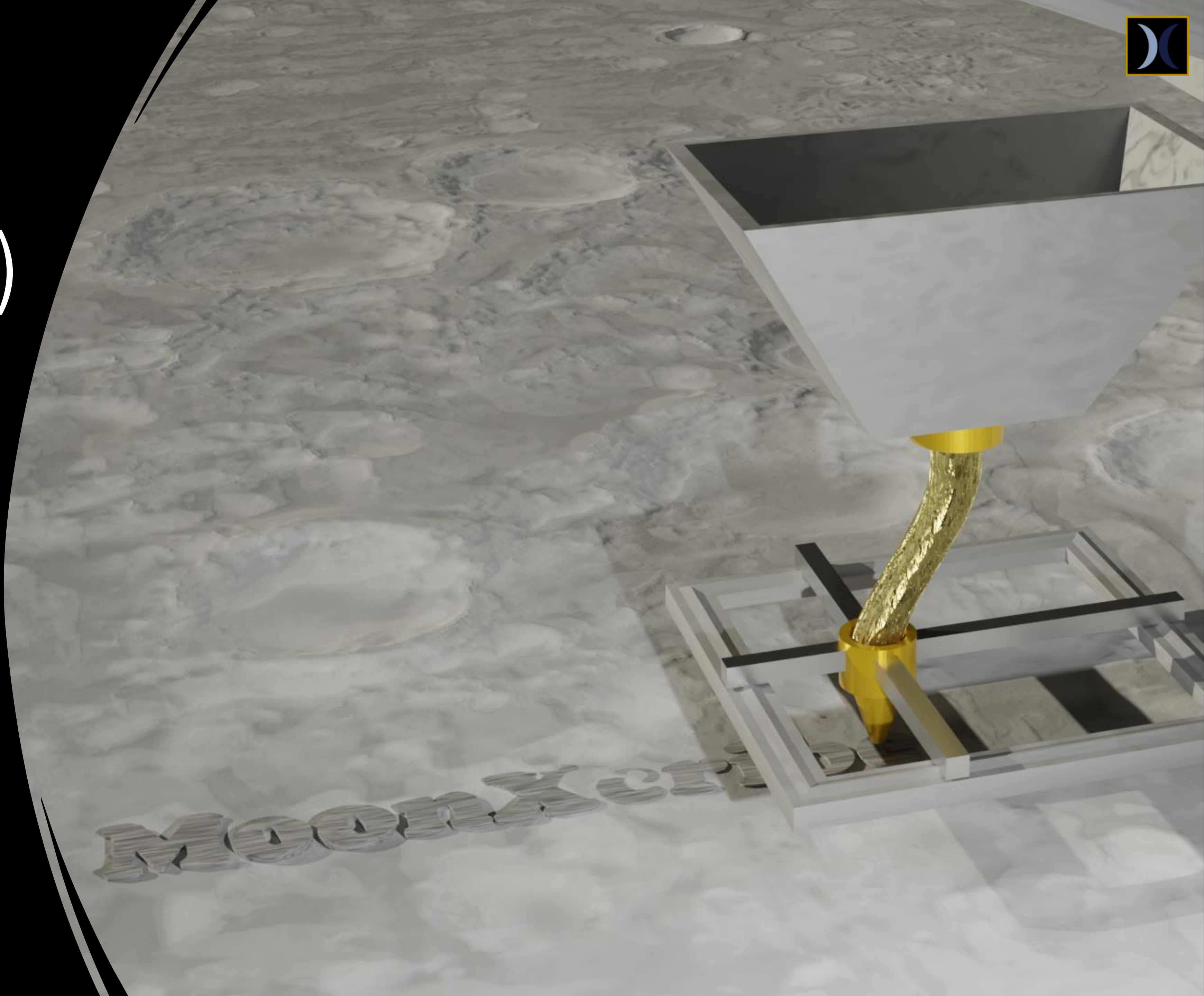


Solid effect text

Concept 3 : Builder Bob

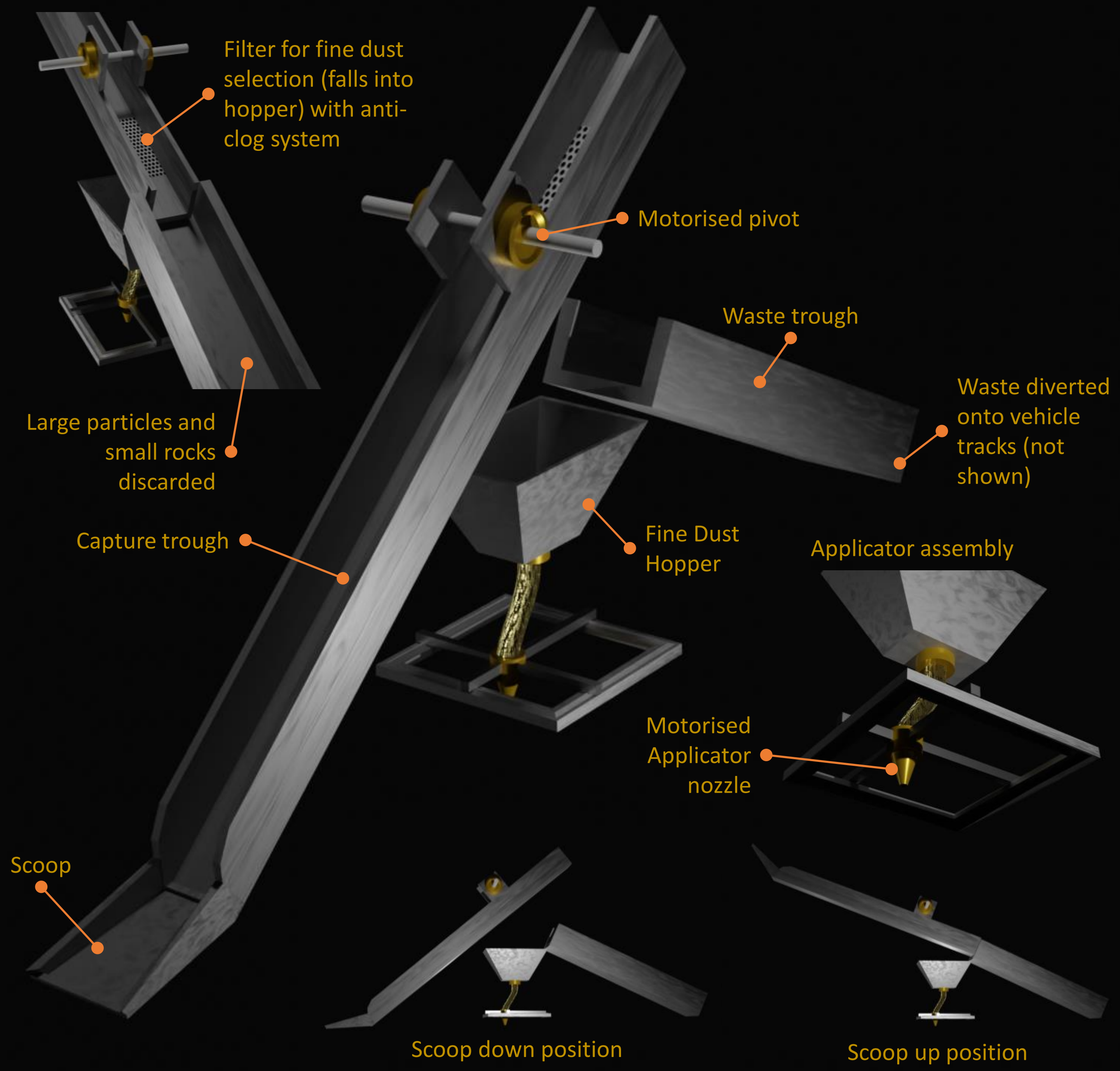
Building (C.)

- Building up dust for an embossed effect
- Creating sandcastles on the moon
- Collect dust, filter, pile in the right places to form the letters



Building

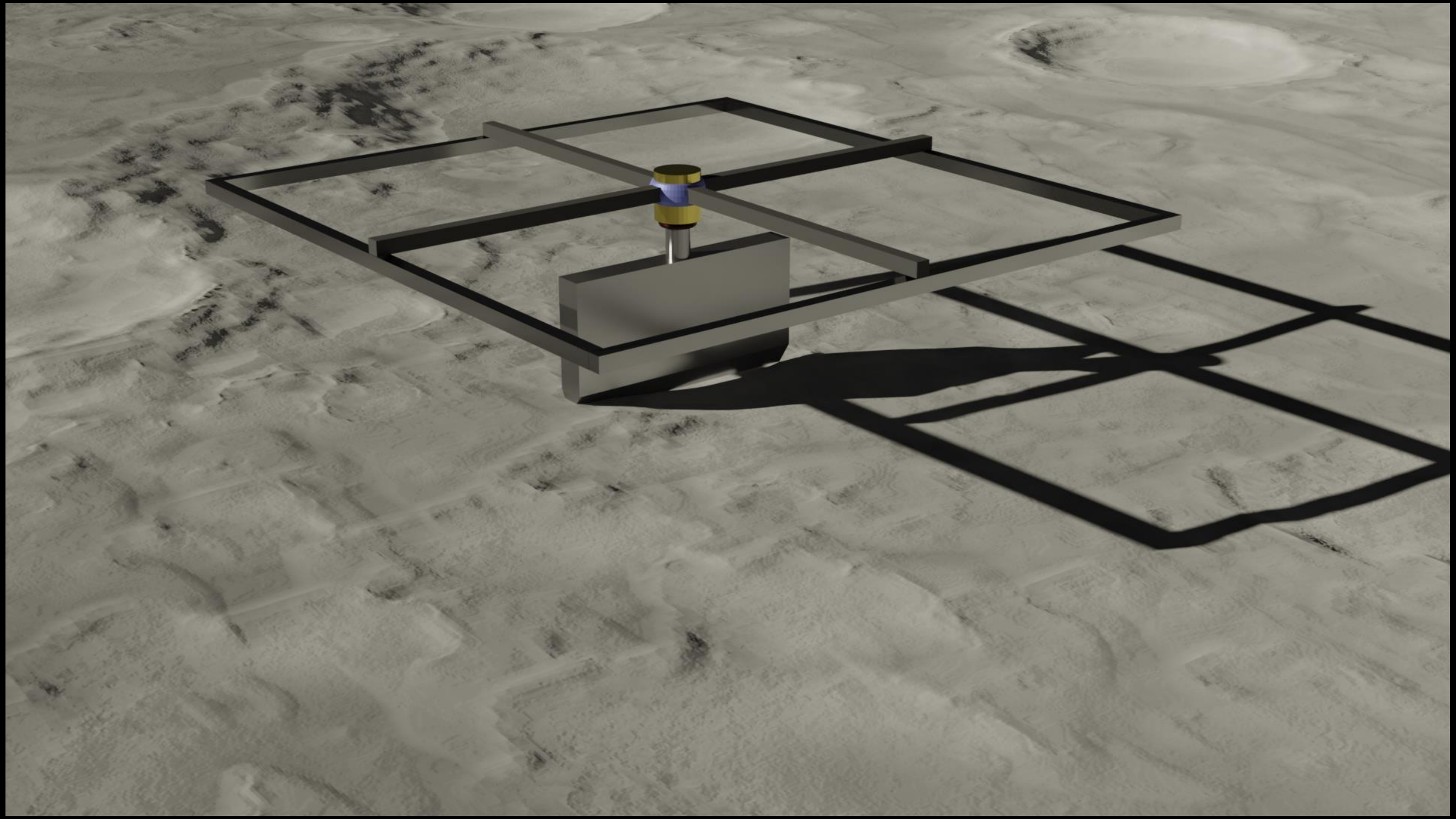
- Vehicle forward motion with scoop down captures dust
- Capture trough then rotates about pivot causing dust to slide down
- Dust is filtered and large particles discarded
- Hopper filled with small particle dust and provided to applicator
- Messages written by motorised applicator piling up dust to form letters



Concept 4 : Moonraker

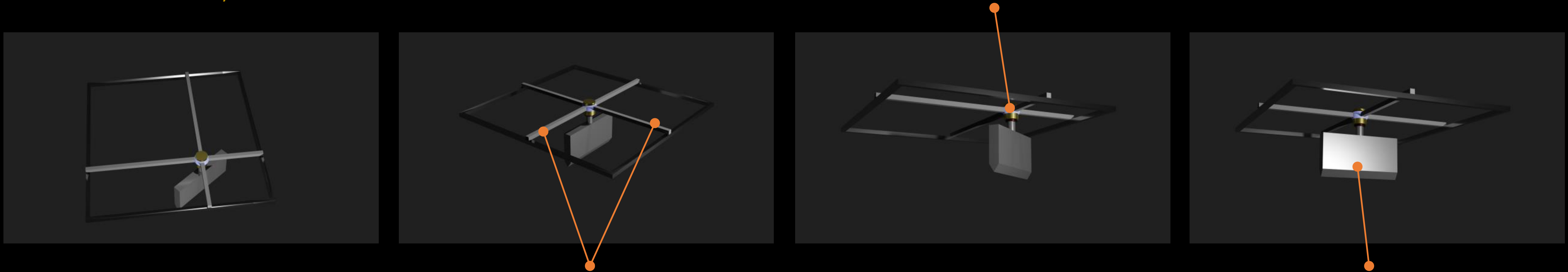
Pushing & Raking (D.)

- Depiction of one possible implementation opposite
- Letters formed by pushing or raking dust into long mounds of dust



Pushing & Raking (D.)

- Rake tool can be raised / lowered, rotated to sweep, and moved laterally via motors
- Rake tool can be asymmetric to provide wide and narrow raking functions (with further tool rotation)
- Rake tools can be numerous

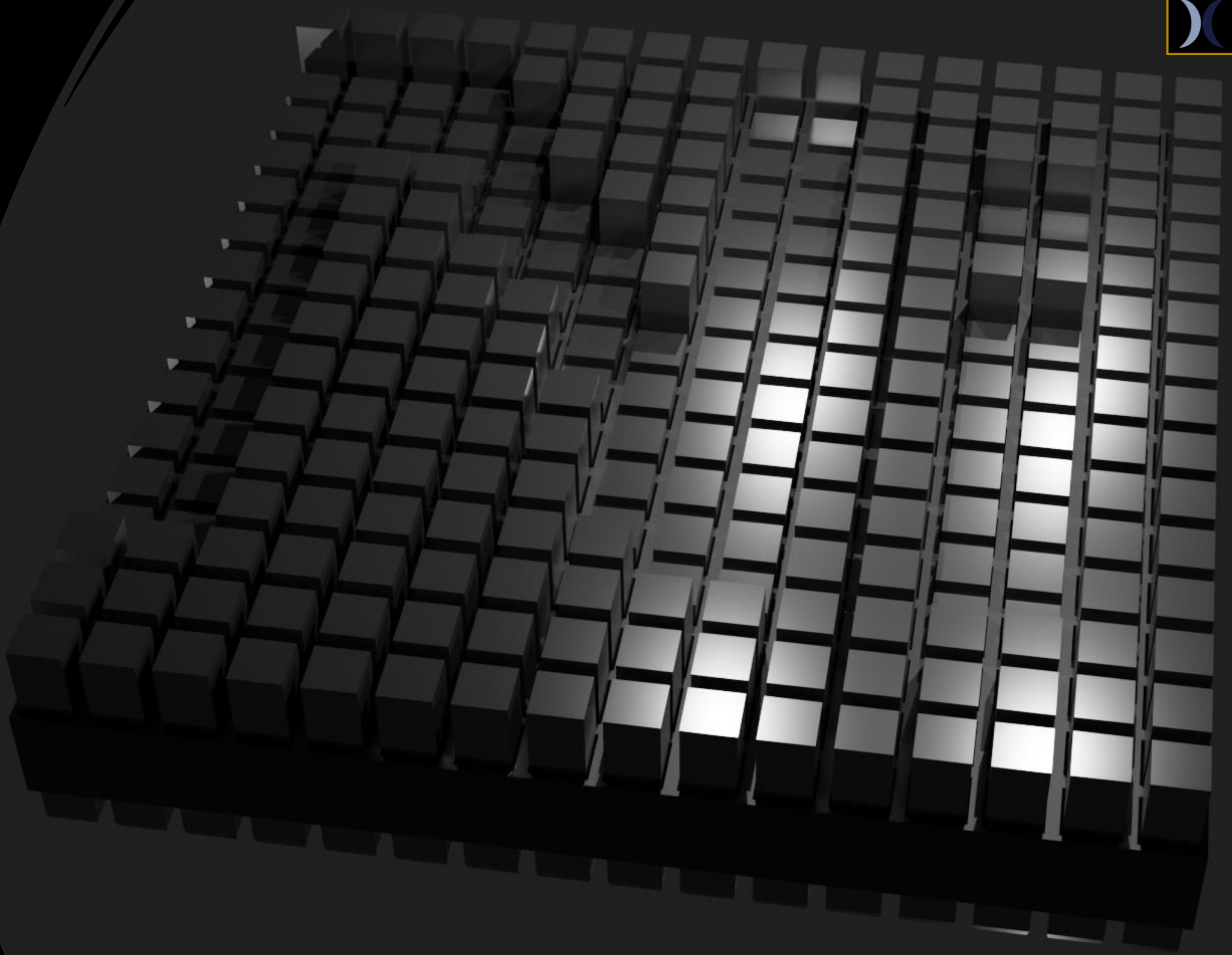


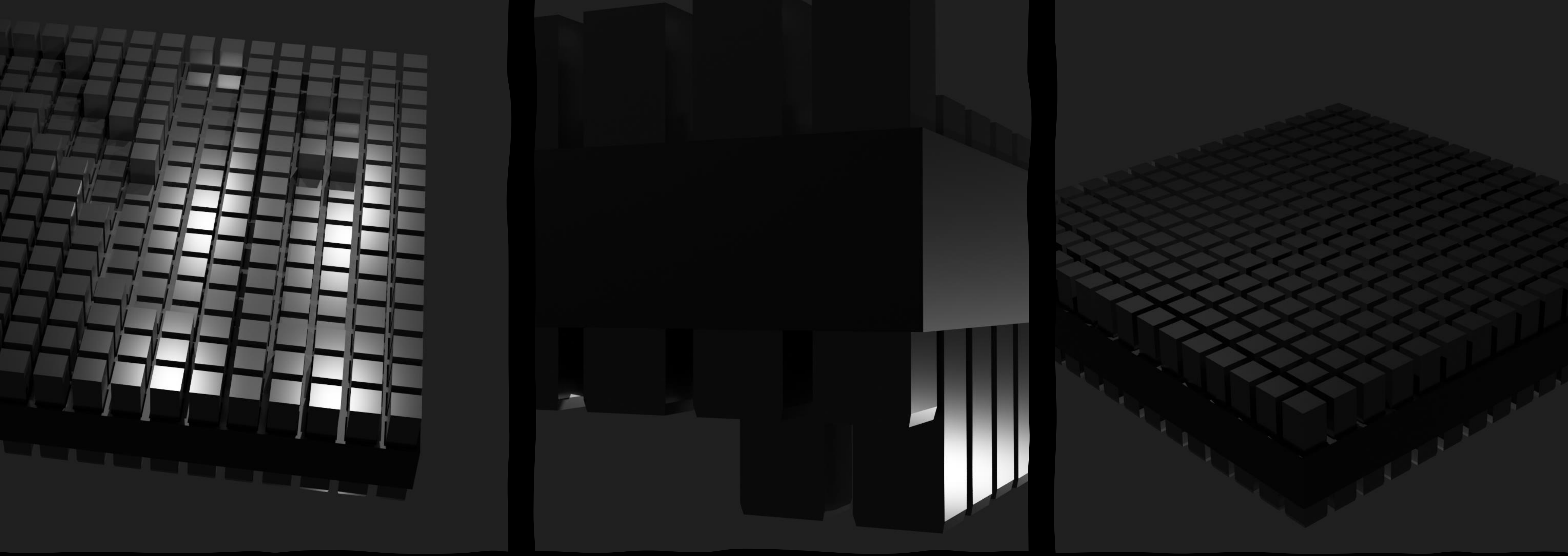
Concept 5 : Dotty4U

Imprinting : Pressure (A.)

- Individually vertically actuated rods depress the lunar dust forming dot matrix letters at higher resolution

- *Assembly can be nudged laterally to further improve resolution and quality (a.k.a. super-resolution) as well as mitigate for damaged 'pixel' rods*





Imprinting : Pressure (A.)

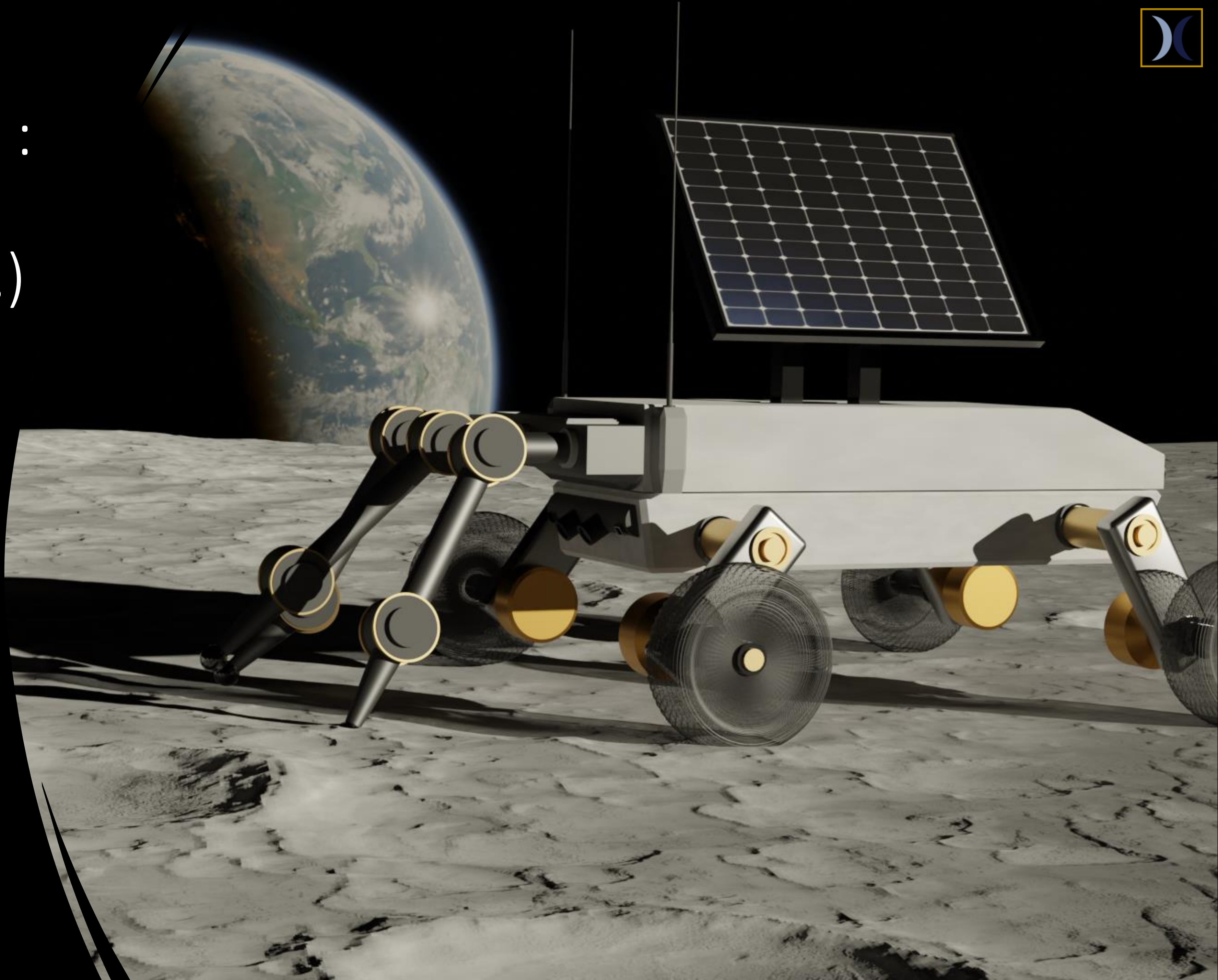
- Fast messaging but trades out some quality
- Redundancy afforded by multiple actuators


Concept 6 : Many Hands Make…

More Imprinting : Dragging & Pressure (A. & B.)

- Many robotic arms working cooperatively to more quickly and precisely create your message

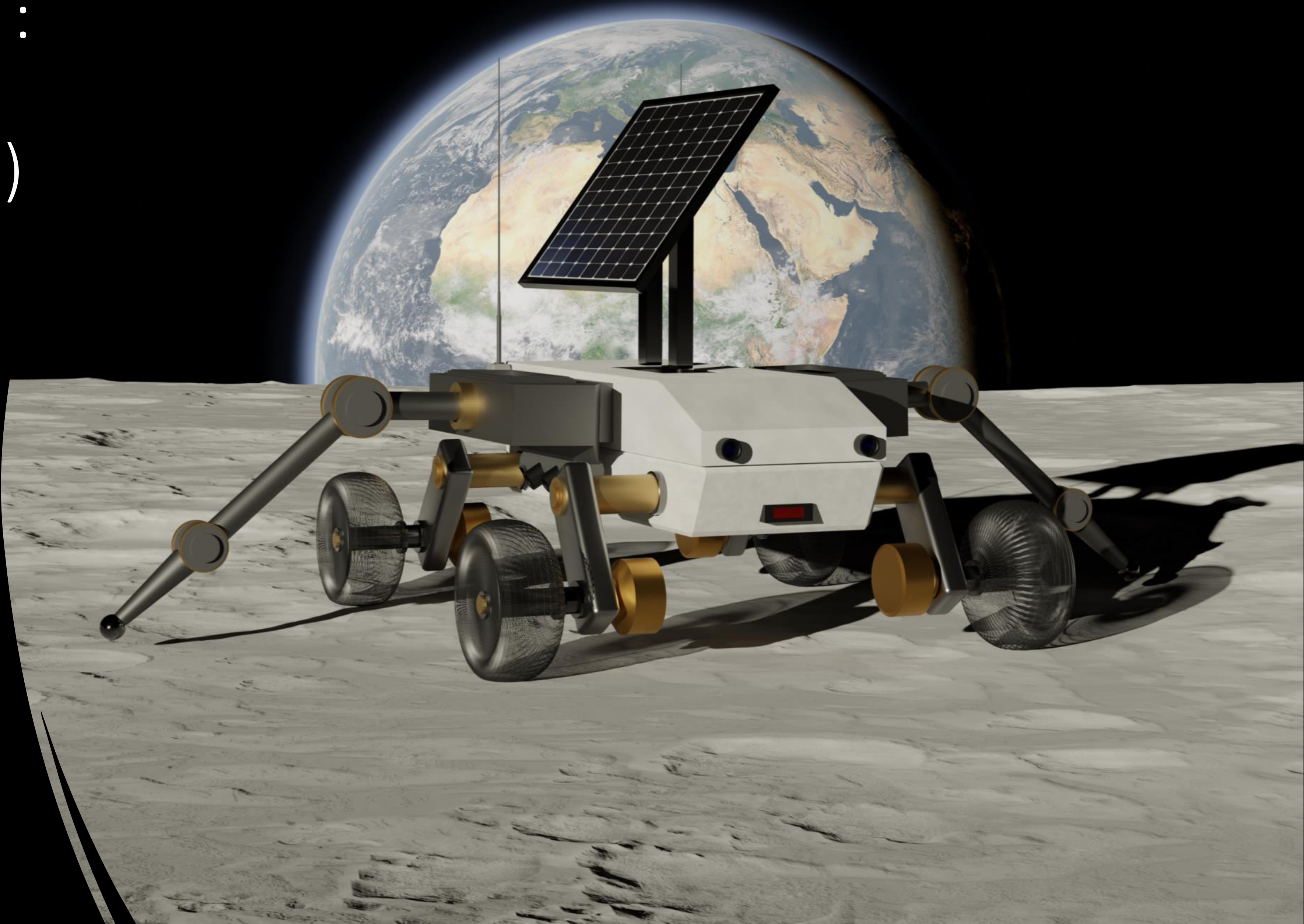
- *Provides additional redundancy should one arm fail. Robotic arms stowed during transit across the lunar surface*



More Imprinting : Dragging & Pressure (A. & B.)

- Many robotic arms working cooperatively to more quickly and precisely create your message

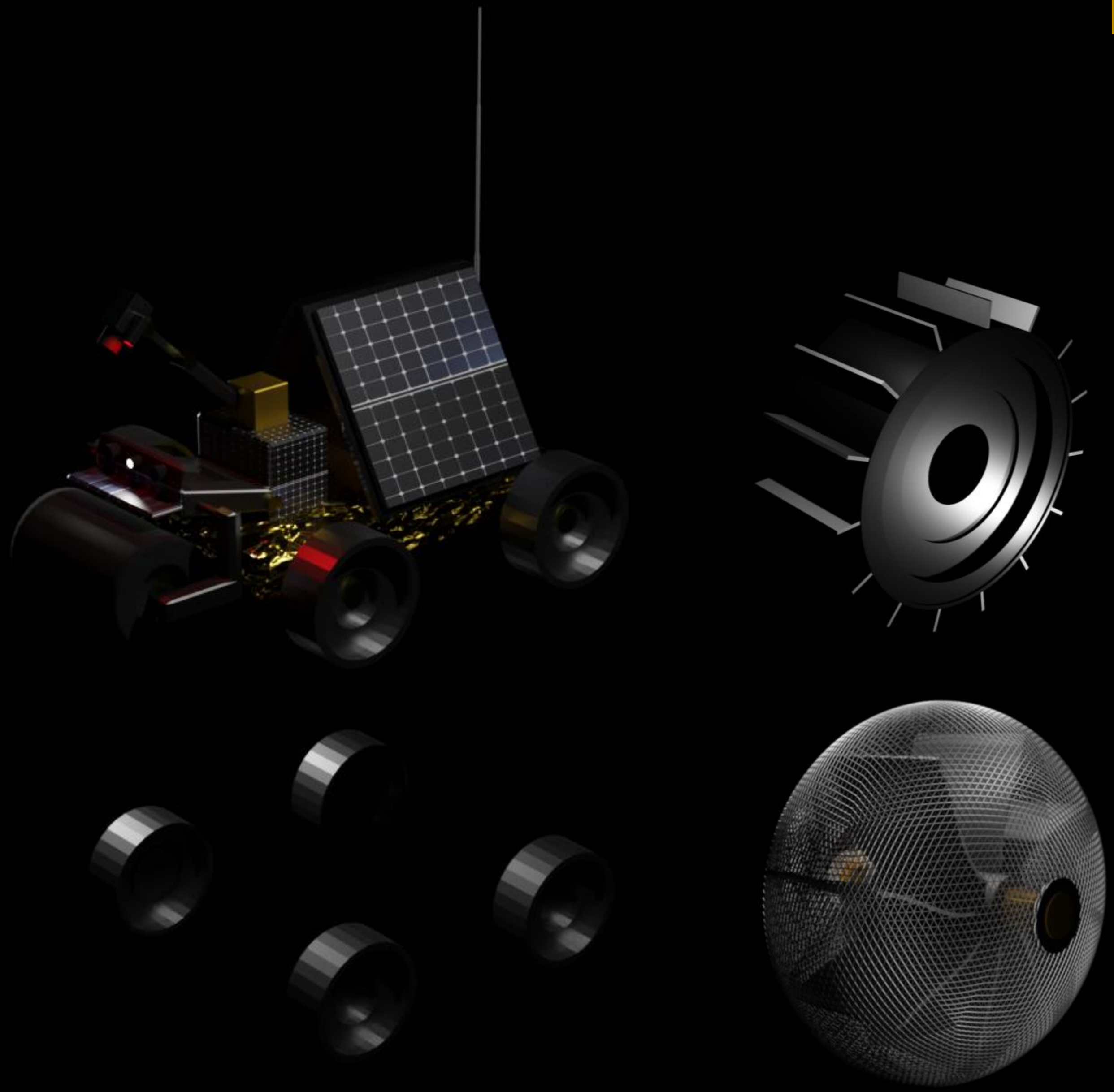
- *Side arms double up the writing rate and separate the messages from any potential vehicle tracks (we have ideas to minimize these too!)*



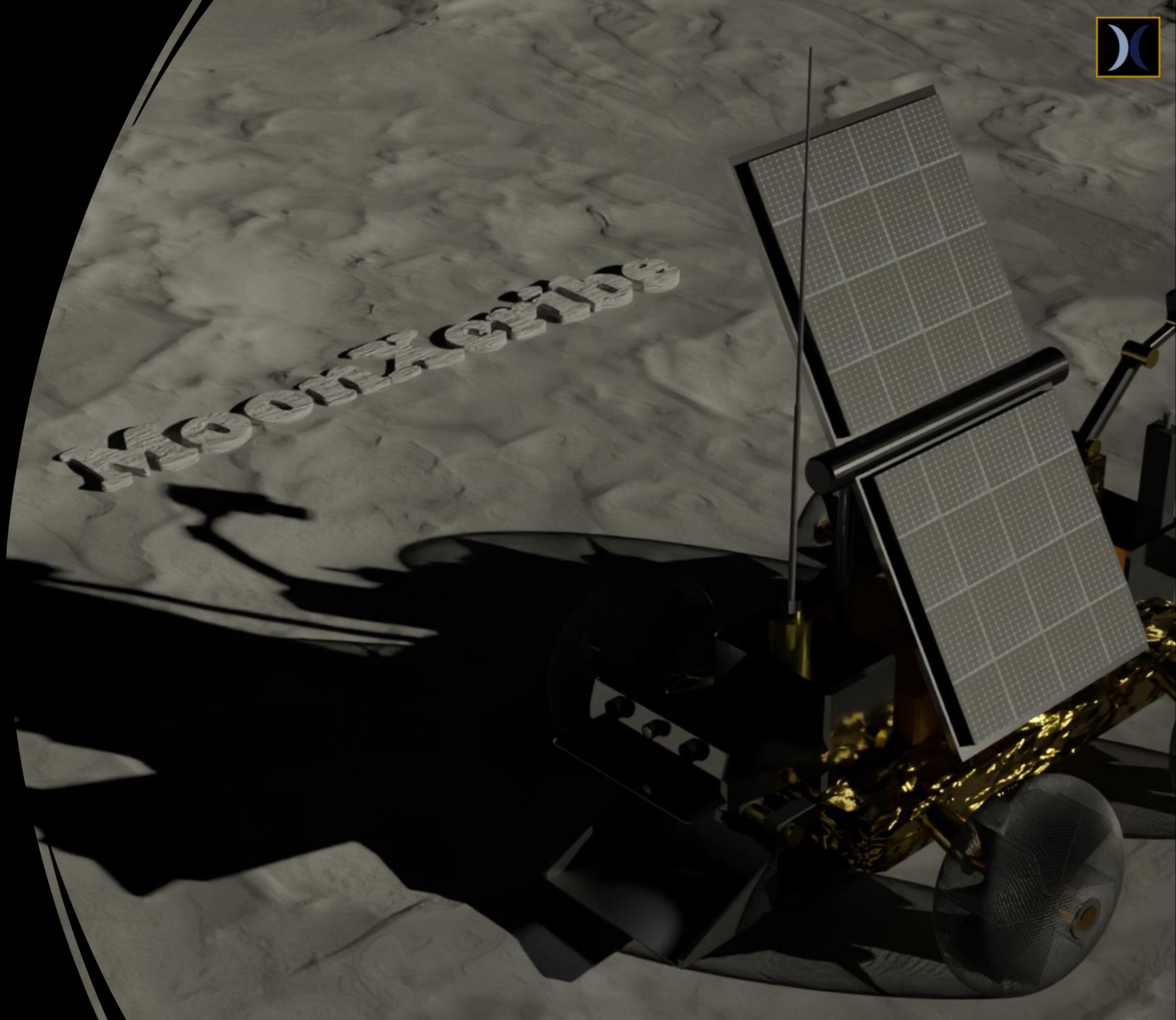
Wheels, Wear, Grip, Tracks

Wheels, Wear, Grip, Tracks

- Optimal solutions required which balance the need for high reliability against tough abrasive terrain and the need for grip whilst making minimal tracks
- *Hard metal, coated; spiked, slotted, ridged, mesh and more*
- *Opportunity for wheel tracks to complement the message through patterned imprints, or make no observable tracks at all*



Wheels, Wear, Grip, Tracks



- Optimal solutions required which balance the need for high reliability against tough abrasive terrain and the need for grip whilst making minimal tracks
- *Many wheel designs already exist, and some have been engineered to exceed 120km*

Lander Concepts, Packaging and More

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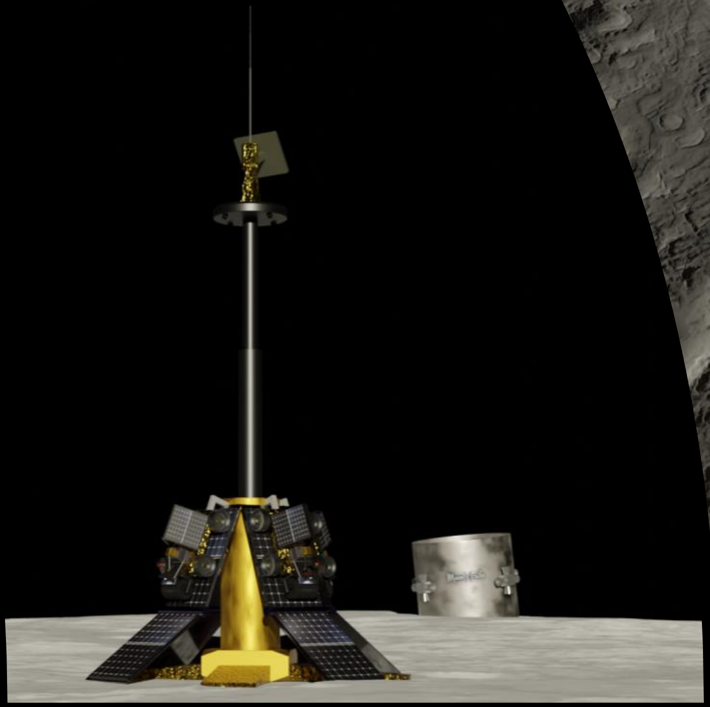
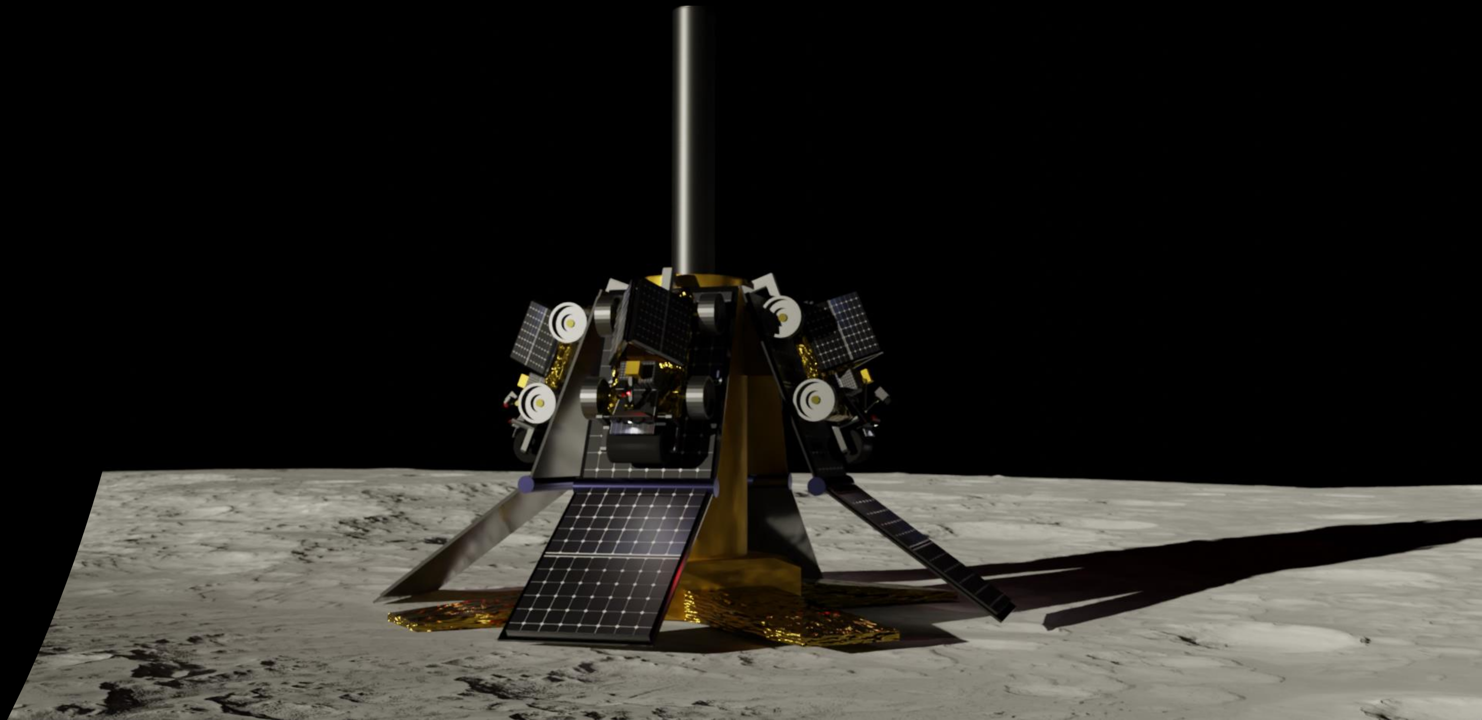
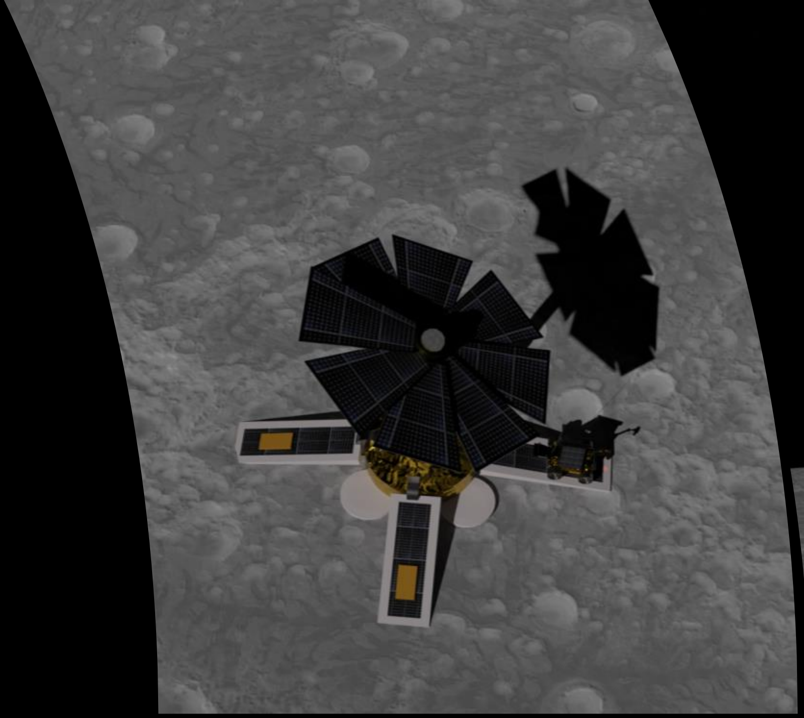
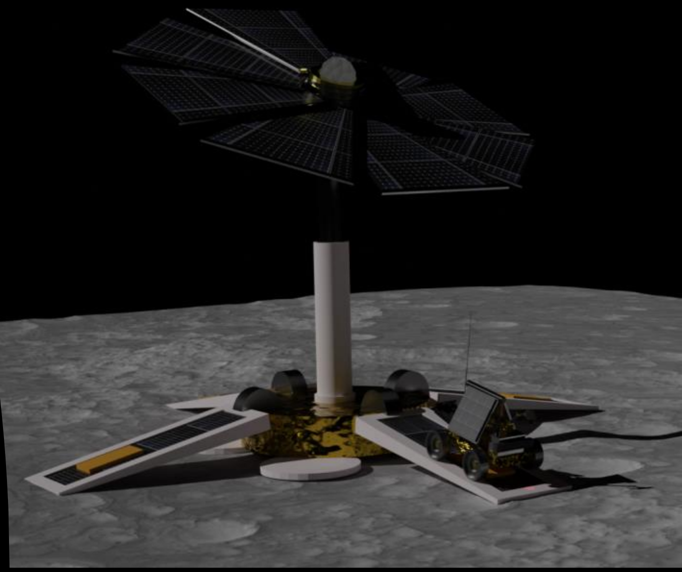
- High rover density packaging to reduce spacecraft volume, increase number of landers hence rovers per launch
- *Maximize solar PV area*
- *Provide height (vantage) through telescopic mast for lander to rover communications*

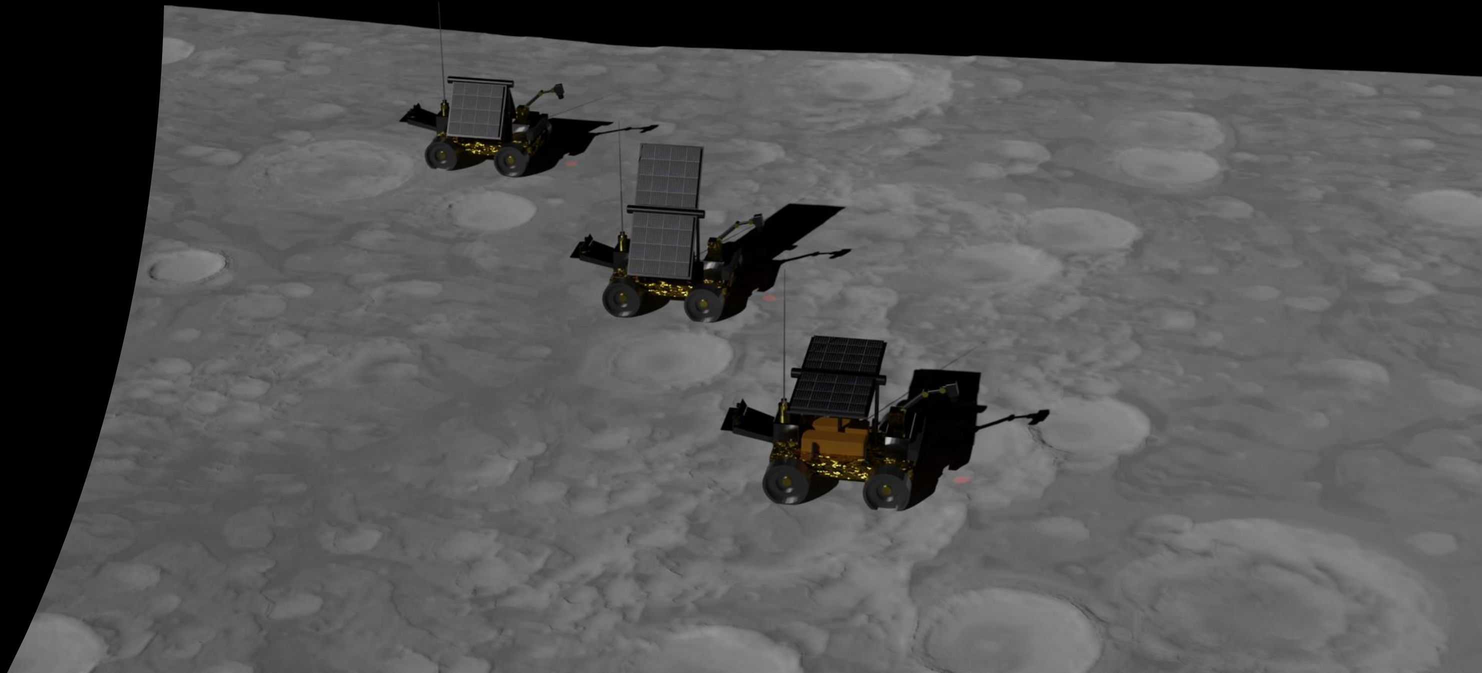




Lander Concepts, Packaging & More







- More alternatives
- *Petal solar PV with solar tracking*
- *Recharge of rovers*
- *Offset rotating disk landing pads*
- *Reconfigurable rover solar PV*

Thank you

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