OFFWORLD

OFFWORLD'S MASTER PLAN

Ad astra
per terram

The overarching purpose of OffWorld is to enable human expansion beyond our home planet. We believe this is a worthwhile undertaking for three reasons:

1. Life insurance policy:

Diversifying our presence throughout the solar system and beyond is a viable risk mitigation strategy to ensure the long-term survival of life and our civilization. Investing in a life insurance policy does not free us from the responsibility to do everything we can to mitigate against existential risks on our home planet, whether they are natural or human-made. However, should we fail, a self-sustaining human settlement on Mars and elsewhere could carry the torch of our civilization.

2. Sustainable development on Earth:

Some terrestrial needs are best served by going to space. Today, global communications and positioning are enabled by Earth-orbiting satellites. Tomorrow, we could manufacture new products that could only be made in microgravity, build space solar power stations made of lunar and asteroidal resources to supply billions of people on Earth with uninterrupted solar power. One day, once we figure out how to create closed-loop biological systems on Moon and Mars, we could import them to Earth to help solve the environmental challenges we have created on our home planet.

3. New frontier:

Throughout our history, pushing back on a frontier--whether it were a mountain range, an ocean or phenomena we could not explain—energized and challenged generations of explorers and pioneers. Space is “the final frontier” that continues to capture the imagination of generations of stargazers but so far fewer than 600 people, mostly government-trained astronauts, have had the opportunity to briefly venture outside the Earth’s atmosphere. We believe that a future cohort of pioneers who travel out to stay could energize and challenge how we humans think of ourselves and our place in the universe.

OUR LONG-TERM VISION

We see a new generation of industrial robots as the key enabler of human expansion beyond our home planet. Starting from scratch in a new place is hard. The first European settlements in North America were built on hard, life-shortening labor of volunteer or forced settlers. Starting from scratch on the Moon or Mars is hundred times harder as neither of these places naturally sustains life as we know it.

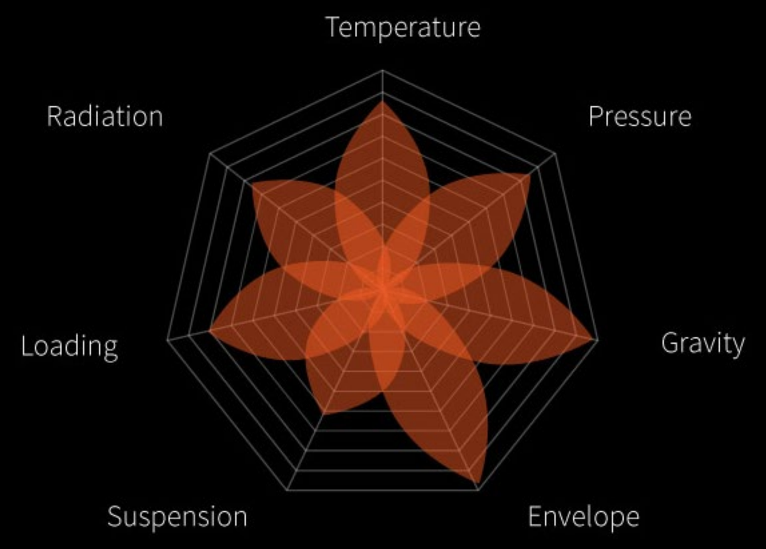
To survive, human settlers will need to endure deep space travel, battle harsh radiation, operate in lower gravity, and live in artificial atmosphere. Gettinvg help from Earth could take weeks if you are on the Moon and years if you find yourself on Mars.

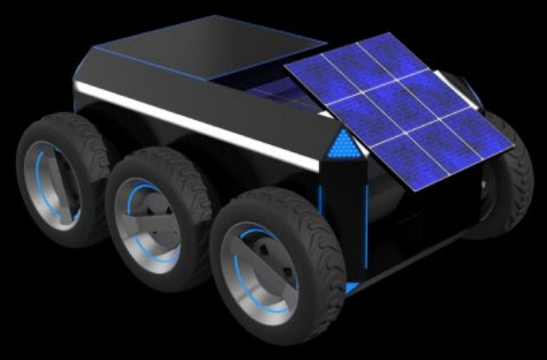
We believe the best way to reduce the extraordinary risks involved in establishing permanent and sustainable presence on other planetary surfaces is to have a local robotic workforce to do the heavy lifting: build landing pads, excavate underground habitats, extract water ice and materials, make drinkable water, breathable air and rocket propellant, manufacture basic structures and solar cells, produce electricity, and eventually replicate themselves.

Over the next decades, we will need thousands of robots that could mine, manufacture and build on the Moon, asteroids and Mars.

The robots needed for these tough industrial jobs are quite unlike our lunar resident Jade Rabbit, Martian Curiosity or the almost two million industrial robots working in factories and warehouses on Earth.

THE NEW GENERATION OF OUR INDUSTRIAL ROBOTS IS:





Small & robust...

to neatly pack into and survive launches on rockets

Extremely adaptable...

to function across a wide range of environments on Earth, Moon, asteroids and Mars without major redesign

Solar electric...

to use the one sustainable power source we can count on in the inner

Autonomous & fast learning...

to get by without onsite humans to bail them out

Modular & reconfigurable...

to maximize the re-use of launched hardware as there will be no local hardware shops or weekly Amazon deliveries on the Moon and Mars

In a nutshell, here is the logic of how we plan to get to thousands of industrial robots on the Moon, asteroids and Mars:

1. **GENUS TERRA:**
   Develop a universal robotics platform and build mining, construction and manufacturing robots for use cases on Earth

2. **GENUS ATSRA, GENUS LUNA:**
   Use that platform, experience and money to evolve terrestrial robots to do basic industrial jobs in free space and on the Moon

3. **GENUS MARTIALIS, GENUS ETIAM:**
   Evolve lunar robots to do basic industrial jobs on Mars and asteroids

4. **SELF-REPLICATION:**
   Evolve robotic self-replication capability using local resources

5. **OFFWORLD CHIPS:**
   Build the first offworld computer chips and close the robotic self-replication loop

1. GENUS TERRA

We started with a simple question: what is the minimum viable set of machines we need to jump-start industrial activity on the Moon?

We identified about two dozen species falling into three main industry buckets: Mining species to underpin the extraction of water, aluminium, silicone and other base materials; Construction species to build and maintain basic surface infrastructure; and Processing/Manufacturing species to produce the basics like rocket propellant, oxygen, simple s tructures and solar panels. Together, these species form an industrial starter kit that would enable not only the establishment of lunar outposts but also dramatically lower the cost of in-space transportation by supplying fuel from a much lower gravity well.

The problem is, technology development is hard to fund against the backdrop of markets that still need to be created and validated (there no spacecraft refuelling depots in Earth orbit today!). To overcome this problem, we looked to terrestrial markets: would the precursors to our offworld industrial robots have commercially viable applications on Earth? We went looking for terrestrial nails that could be hit with our offworld hammers and we found quite a few. Turns out, our mining robots could solve several problems in the terrestrial mining. They could take on smaller mines that are currently not economically viable with bulk mining methods; they could save human lives by replacing humans in underground mines that lend themselves to selective mining. Our construction robots could enable the vision of self-repairing cities by focusing on autonomous inspection, maintenance and repair of urban infrastructure.
And our processing/manufacturing bots could solve supply chain issues in remote locations by using local materials to produce required parts.

1. GENUS TERRA

We have started from the beginning and are currently focusing on developing the first generation of our mining robots for the terrestrial mining sector.

As our robots are based on a universal modular robotic platform, the required engineering leap to go from mining to construction and manufacturing becomes a matter of engineering new tools rather than fundamental redesign of core-systems. Furthermore, our design philosophy is fully embedded in all the contexts we expect our robots to work in, from underground mines on Earth to polar craters on the Moon and valley on Mars. We consider all contexts when making our design decisions, and where possible, we go for solutions that are universal or at least have the broadest environmental span (as long as they still make sense economically). This way we make sure that we maximize the amount of non-recurring engineering (NRE) we can do while serving terrestrial markets. Our current goal is to end up with a robust set of tens of thousands of industrial robots serving existing markets on Earth. We need both, millions of robot-hours of experience and the revenue stream they generate to get to the next logical step.

2. GENUS ASTRA, GENUS LUNA

With about 70% of NRE dismissed and with a cash-generating terrestrial business in place, we expect to be in position to underwrite further development needed to evolve our terrestrial robots for the Moon ourselves.

Our first revenue-generating business on the Moon will be the extraction of water ice and supply of rocket propellant for use in Earth orbit by commercial space transportation companies (e.g., ULA and Blue Origin for cis-lunar transport, SpaceX for Mars-bound missions) and government space agencies. We will also provide basic construction services for any interested lunar missions (e.g., CNES, ESA Moon Village), and gradually learn to manufacture simple structures and solar panels.

3. GENUS MARTIALIS, GENUS ETIAM

In the grand scheme of existence, our next logical step is incremental: draw on all the experience gathered on the Moon to evolve our lunar robots into machines that could do resource extraction on asteroids and a full set of basic industrial jobs on Mars.

We expect that by this time we will have achieved reasonably high levels of autonomy and learning in our terrestrial and lunar mining robots, making it possible for us to seriously consider resource extraction operations on asteroids. We expect asteroidal resources to first complement and eventually overwhelm the lunar supply of water, rocket propellant and basic materials. We also expect that by this time, given current commercial and government Mars ambitions, there may be a real need in the services our industrial robots will be able to provide on the surface of Mars.

4. SELF-REPLICATION (ALMOST)

Assuming we have a stable working population of industrial workforce on Moon, asteroids and/or Mars, our next big engineering challenge is to learn to build an increasing number of robotic components and modules using local resources on the Moon and Mars.

Reducing the dependency of our robotic operations on resupply from Earth is a critical factor in being able to cut the cost of the services provided by our workforce. This is a long and challenging process that may lead to significant local deviations in our Earth, Moon and Mars populations.

5. OFFWORLD CHIPS

We expect that for the first several decades, the one component we will continue shipping from Earth is the computer chip. Not only this is the most critical and most complex component of all, but it is also the enabler of the autonomy of our robots.

It does not matter as much what materials the structure of a module is made of—we can certainly improvise with most easily accessible lunar, asteroidal and Martian materials. But when it comes to the processing power, it leaves little space for improvisation—we are not going to reinvent the integrated circuit industry. The pinnacle of our engineering efforts would be to learn to manufacture this ultimate component offworld, with zero reliance on terrestrial supply. It is hard to predict when that day will come but when it does, we will have closed the robotic self-replication loop and established the conditions necessary for establishment of a solar system civilization of millions of people and vast generation ships bound for the nearest stars.