# Space Colonization

To reduce the existential risks of the human kind and to realize the potential of humanity, it is almost inevitable to expand our reach beyond the limits of planet Earth.

This would, among other things, also vastly expand the field of work for architects, expanding the design and creation of artificial structures and spaces from its traditional Earth context to new environments with new potentials and challenges, and thus giving a new boost of creativity to the field.

Currently, **the most prohibitive factor of space activities is the cost of getting the necessary equipment from Earth to space**. Even for low Earth orbit (between 160 and 2000 kilometers from ground), the current launch costs are in the order of 10 000 USD per 1 kilogram, but larger-scale space exploration requires going far beyond the low Earth orbit and using equipment with masses of tens and hundreds of tons and more.

**One of the most realistic ways to solve this problem with our current technological capabilities is to use replicating and growing artificial systems** — to launch from Earth only the "seeds" of the desired larger-scale systems that then use local materials in space (on asteroids, other planets, etc.) to achieve the desired full-scale size and functionality and numbers via growth and replication.

**For space exploration**, such self-replicating spacecraft are known as **von Neumann probes** — exploratory unmanned spacecraft that are sent to outer space and that self-replicate along the journey to increase their numbers and thus be able to explore a larger part of space and to compensate for the occasional breakdown of some of the spacecraft.

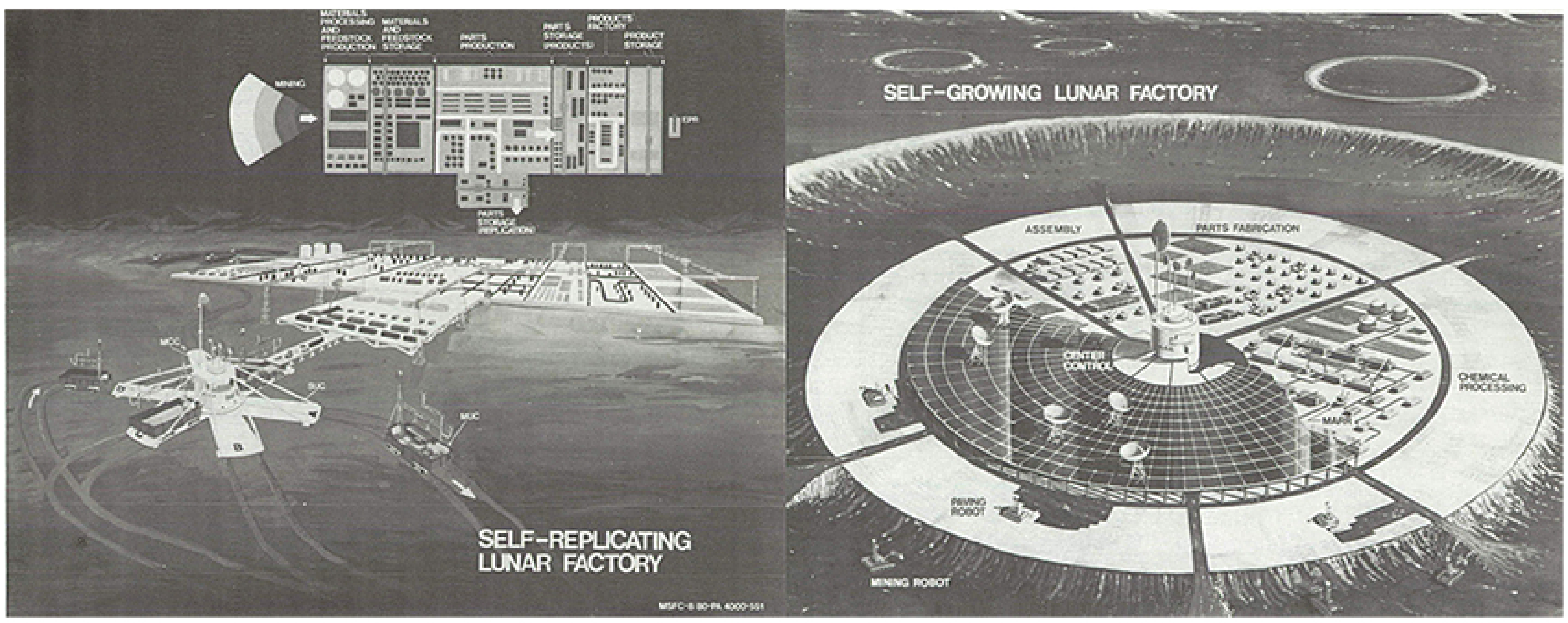
**For space colonization**, the idea is focused on creating **bases that grow and self-replicate** in space and on various celestial bodies such as planets and asteroids.

For example, a particulary thorough study of the feasibility of self-replicating lunar factories was done by NASA in 1980, resulting in an estimate that creating the initial seed factory would require in the order of 100 tons sent from the Earth to the Moon [R.A. Freitas, W.P. Gilbreath (1982), "Advanced Automation for Space Missions"].

A more recent estimation was done by a group of NASA employees in 2013, reaching to the following conclusion:

"Advances in robotics and additive manufacturing have become game-changing for the prospects of space industry. **It has become feasible to bootstrap a self-sustaining, self-expanding industry at reasonably low cost. [..] bootstrapping can be achieved with as little as 12 metric tons (MT) landed on the Moon during a period of about 20 years**. The equipment will be teleoperated and then transitioned to full autonomy so the industry can spread to the asteroid belt and beyond. The strategy begins with a sub-replicating system and evolves it toward full self-sustainability (full closure) via an in situ technology spiral. The industry grows exponentially due to the free real estate, energy, and material resources of space. The mass of industrial assets at the end of bootstrapping will be 156 MT with 60 humanoid robots, or as high as 40,000 MT with as many as 100,000 humanoid robots if faster manufacturing is supported by launching a total of 41 MT to the Moon. Within another few decades with no further investment, it can have millions of times the industrial capacity of the United States."

[P. Metzger et al. (2013), "Affordable, Rapid Bootstrapping of the Space Industry and Solar System Civilization."]




Images from R.A. Freitas, W.P. Gilbreath (1982) "Advanced Automation for Space Missions"