L'ESPLORAZIONE SPAZIALE PRIVATA: UN NUOVO APPROCCIO PER DARE VITA ALLA 'SPACEFARING SOCIETY'?

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# **Space exploration**

The model for space exploration that prevailed since the end of the 1950s, was based on a direct involvement of governments, through the military and then through space agencies.

- General climate of cold war
- The non-existence of a private sector in one of the two main actors
- The novelty of this enterprise, that lead to costs beyond the possibilities of private organizations.

#### **International treaties**

Treaties were heavily influenced by the premises that

- The actors in space were the states and
- Exploration could be peaceful only if states refrain from
  - claiming ownership of 'things' that exist beyond the Earth as their own and
- taking any sort of weapons in space
  Everything of value was to be considered as belonging to humankind in general

# **Space industry**

The space activity allowed the development of a space industry.

The governmental agencies were customers of these companies, and managed the missions directly.

A new model started emerging: space agencies were not to deal with all kinds of space activities, leaving all the industrial ones to private companies, concentrating on their main business, namely science and exploration.

#### **The semi-private way**

Later, the idea that also in science and exploration missions the space agencies should buy many services from private companies emerged.

The launchers required for scientific and exploration missions should then not only be built, but also studied, designed and operated by privates.

#### **The semi-private way**

NASA awarded Commercial Orbital Transportation Services (COTS) contracts to private companies like Orbital Science Corp. and Space X to demonstrate delivery of cargo to the ISS.

Science and exploration activities could benefit from the cost reduction due to the increase of commercial activities and to the better efficiency of 'private' models in the managing of the access to space.

# The semi-private way

- Failure of the Space Shuttle in achieving its economical goals
- Return to expendable rockets
- Need of reducing the cost of satellization

At present this has proved to be feasible for unmanned missions. Private launchers need to be qualified to carry humans



Another approach is that exploration missions should be completely run by private enterprises, that decide their goals, recruit the crew (if any), build the equipment, operate the mission and finally own the outcome, of whichever nature it is.

This is possible only if the outcome of the mission is lucrative enough to justify the investments and the risks. This was the case for the ancient sea exploration journeys

#### **Conditions:**

- decrease of the overall cost of space travel
- identification of business model and markets
- legislative background and incentives

#### Advantages:

- decrease of the cost of space exploration
- possibility of maintaining longer term engagements, without the frequent changes of objectives and priorities imposed by politics

The reduction of the cost of space travel is both a prerequisite and an outcome of the privatization of space activities.

Technological innovation, mainly advances in propulsion technology, is essential

Is it realistic that private companies develop nuclear thermal or nuclear electric propulsion systems in a completely autonomous way?

Research receives public funds in all countries, through many different organizations

Most of the advances in aviation, even civil aviation, were made possible by military funding (e.g. the Boeing 707 was made possible by the B-47 Stratojet, C-97 Stratofreighter and KC-135 Stratotanker. The B 70 Valkyrie became a testbed for developing the SST SuperSonic Transport)

#### **Private launch vehicles**

Privately developed launch vehicles

Space X - Falcon series with the Dragon spacecraft (first to launch, orbit, and recover a spacecraft). Now building the Falcon Heavy (53 t) and plans for reusable rockets and heavy lift rockets (140 t).

Orbital Science, Yuzhnoye and others – Antares with the Cygnus spacecraft with Thales Alenia Space.

Other companies are developing spaceplanes, like the Skylon by the Reaction Engines Ltd.

#### **Space tourism**

Space tourism is already a fact, with 7 tourists visiting the ISS through Space Adventures

Private access to space capability needs to be developed, likely using spaceplanes

Suborbital: Scaled Composites Spaceship Two (6 passengers and 2 pilots).

XCOR Aerospace Lynx

Orbital: SpaceX, Boeing, Excalibur Almaz



# **Space tourism: infrastructures**

Orbital and Lunar hotels:

Bigelow aerospace: with Inflatable habitat modules Space Island Group: Space island Project, for 20,000 people and more

Lunar tourism. Circumlunar flights by Space Adventures Roundtrip missions to the moon by Golden Spike by 2020



## **Private space exploration**

Space exploration is the core of space activities and is essential in creating a spacefaring civilization.

Space tourism is not private space exploration

Through tourism it will be possible to build the vehicles allowing a low cost access to space and the infrastructures for spending extended periods in space, and to acquire the ability to manage long duration human space missions.

Safety issue must be the primary issue in this field

#### **Private science missions**

Scientific missions are likely to be run in the future by space agencies, but there is space for privates also in this field.

The existence of a strong space transportation industry may make it possible that many scientific space missions are run in the same way.



# **Private exploration**

For private exploration it is essential that the company that performs the mission has a return from the investment.

- A space agency gives a contract to a private organization for exploration missions
- Exploration is connected with a scientific activity funded by a public or private organization,
- Exploration is connected with a touristic activity,
- Exploration is connected with a resource exploitation activity, and
- Exploration is connected with a commercial activity of other kind.

# Prizes

Private or governmental organizations may award a prize for performing a given mission. (like the prized for aviation)

Prizes are not sufficient in themselves but the presence of the prize can make attractive missions that may produce an economical reward that is uncertain or much postponed in time.

- 10 million \$ Ansari X Prize (won in 2004 by Burt Rutan with the Spaceship One)
- 30 million \$Google Lunar X Prize (33 participants)

# Google Lunar X Prize

Almost all teams are ready to rent some space on board to research teams

- Team Italia is trying to raise funding in the advertising market,
- Moon Express has a contract with NASA for carrying scientific instruments and plans to make prospecting work for mining
- Astrobotic *Icebreaker* will explore for methane, ammonia, and water at the Moon's north pole
- Omega Envoy team offers to fly one's DNA to the moon for 10,000 \$ and ashes for 20.000\$

#### Lunar and asteroid exploration

- Artemis Project: permanent, self-supporting manned lunar base
- Shackleton Energy Company: producing liquid oxigen and hydrogen on the Moon from water as early as 2020.
- Planetary Resources: asteroid mining. Creating a fuel depot in space by 2020
- Deep Space industries: prospecting for asteroids suitable for mining by 2015 and to begin mining asteroids by 2023.

# **Asteroid mining**

Profitable at present costs of space travel? Water to produce fuel, profitability depends on the intensity of traffic beyond LEO.

- A 1.6 km metallic asteroid contains more than \$20 trillion \$ worth of industrial and precious metals
- A 1 km M-type asteroid contains more than two billion metric tons of iron-nickel ore, to 2-3 times the annual production of 2004.
- Asteroid 16 Psyche contains 1.7×10<sup>19</sup> kg of nickel—iron, which is equivalent to several million times the yearly requirement
- Platinum extracted from a 30-meter asteroid is worth 25-50 billion

# **Asteroid mining**

There is little doubt that asteroid mining will be one of the foundations of a spacefaring civilization and will allow an increasing abundance and wealth.

What is in doubt is whether it can be pursued before establishing a civilization of that type, and be one of the factors that allow it to start.

Those who are now investing in it clearly believe that this can be done.



# **Mars Exploration**

Inspiration Mars Foundation: space cruise for two people on a 501-day Mars flyby travel in the 2018 launch window



# **Mars Exploration**

Mars One aims to land four colonists on Mars by 2023. Cost: about \$6 billion, that can be paid for with a reality-TV event

SpaceX plans to establish a Mars colony in a more far away, but not-toodistant, future. The long term goal is to establish a settlement of up to 80,000 people.



#### Infrastructures

Ground infrastructures in the 'public approach' have always been owned and run by the space agencies

- Spaceports
- Ground sector (control rooms, training facilities, communication networks etc.)
- Space stations, bases on the Moon, Mars and asteroids, orbital depots, orbital and lunar power stations (both solar and nuclear), transportation systems on the surface of celestial bodies, repair centers in space and on planets, etc.

#### Infrastructures

Running these off-Earth infrastructures will provide jobs and opportunities both on Earth and in space

O'Neil realized in the 1960s that in a spacefaring civilization many activities and jobs will be transferred from Earth to space, a thing that will allow an unprecedented wealth and a lightening of the pressure on the Earth environment. These are the pillars of the Space Option.

Space elevators: technical feasibility? economic feasibility? Viable only if the traffic between the Earth surface and space will exceed a certain minimum

# Legal background

International treaties on space activities hardly take into account private space exploration

This must be changed to encourage private organizations to play an active role in space, not only with regard to the commercial activities in LEO and GEO, but also in deep space exploration and exploitation, if the opportunity for a new golden age of space exploration is not to be lost.

The international treaties and the laws regarding space activities must be revised

# Legal background

Safety regulations are essential. Exploration cannot avoid to be risky and people occasionally have always died, and will always die, in exploration journeys

Risky activities may be made safer

We are much more risk averse but how we perceive risks is a cultural matter and varies in different countries and among subcultures.

# **Public-private relationships**

One of the worst things that may happen is to see space agencies fighting against the birth of a private sector in space

NASA issued COTS contracts and this shows that this space agency has fully understood the advantages to have space transportation managed by private organizations

It is hoped that also the other space agencies are equally open to the cooperation with private operators, and that in the future there will be many competing companies operating in space.

# **Funding research**

To really start a spacefaring civilization, new technologies must be developed, in particular nuclear thermal and/or nuclear electric propulsion

This may prove beyond the possibilities of space transportation companies

The role of governments may prove to be essential, either performing the required research work directly, through the space agencies or national laboratories or through public funding to the involved companies.

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