A Space Renaissance Project

The urban planning of the future is in space:

Lagrange Asteroid City (LAC) - Asteropolis

a conceptual abstract

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1 Premises

1.1 Scope of this document

Scope of this document is to provide the basic concepts and rationales for the design of an space city, carved into an asteroid and placed in a Earth-Moon Lagrange point.

1.2 List of revisions

Release	Date	Reasons for review
1.00	01/08/2016	First issue of this document

2 Concept description

2.1 The missing phase in the space exploration paradigm

Why digging a city into an asteroid? The idea may seem strange at first sight, but just reason with a little, to understand that it is not at all.

This is a representation of the space exploration paradigm, as illustrated by Jeff Greason, in his speech at ISDC of the National Space Society in 2011:

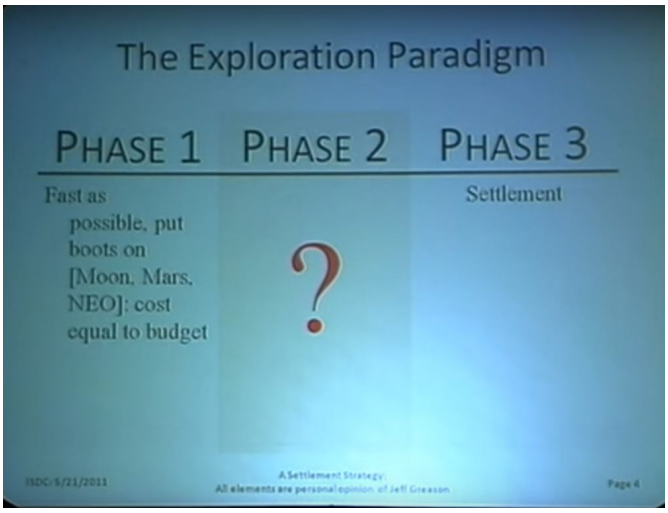

Figura 1. The lack of a phase 2, in the paradigm of space exploration, according to Jeff Greason

Phase 1 consists of round-trip missions to the Moon, Mars, near Earth asteroids and cometoids. These missions are performed by militarily trained astronauts. Phase 3 involves the settlement, not better defined, presumably on the same celestial bodies. Phase 2 - which should draw the transition strategy between phases 1 and 3, has never been sketched in any way.

2.2 Retaking the work initiated by Krafft Ehricke and Gerald O'Neill

The above is evident, looking at the NASA strategies of the last thirty years. But was it always been that way? No. The '970 years of the NASA archives contain a large number of papers, the work of many researchers, involving fully reusable launch vehicles, and strategies for the Moon and the geo-lunar space colonization. The two authors who developed the main concepts were Krafft Ehricke, who wrote extensively on the colonization, industrialization and urbanization of the Moon, and Gerald O'Neill, who designed the orbital and Lagrangian space cities, toroidal or cylindrical large artifacts, with aritificial gravity, thanks to rotation on their axis.

2.3 An urgent step: to transport and accomodate civilian travellers in space

Looking at the prospect of expansion of human activities in space from a humanist point of view, it is clear the urgency of overcoming the space exploration paradigm, which provides only for round-trip missions carried out by trained astronauts, or few civilians paying tickets inaccessible for the general public, and traveling at their absolute risk. The residence of civilians outside of our planet, for long periods, or even for undetermined time, involves a totally different strategic approach, properly designed having in mind proper anthropologic requirements. These will include at least, but not only, to travel and reside in conditions of protection from cosmic radiation, and possibly in conditions of gravity equal to Earth. In this way, migrants would not undergo drastic changes of their physiology, and could return to Earth when they wish, those which do not endure life in space, or even just for a holiday on the planet of origin, without being forced on a wheel chair, due to muscle and bone weakening, because of different gravity.

2.4 Discussion of the solutions proposed by Ehricke and O'Neill

Therefore, the Ehricke solution would solve the problem of cosmic radiation protection, building Selenopolis in the lunar subsurface. But there remains the problem of the Moon's gravity, which is one sixth that of Earth. Excellent, as regards the low cost of transportation from the lunar surface to orbit, but fatal for the inhabitants that, once addicted to the lower gravity, would suffer inevitable physiological mutations.

O'Neill's solution, on the other hand, would solve the problem of gravity, but not an equally important issue: how to shield a large structure, the size of the magnitude of kilometers, from cosmic radiations?

2.5 Solving both issues, the protecion of life from cosmic radiations and zero gravity

A solution for both problems could be using near-Earth asteroids. Some of them, for example Apophis, have a not excessive delta v, and NASA estimates that could be "captured" and taken, for example, in L5.

The asteroid could be dug inside, obtaining an enormous spheroidal space. The resulting materials may be used for the construction of dwellings and all the urban, industrial and agricultural infrastructure necessary to the settlement by thousands or even millions people. At a certain point of the development, the complex may be imprinted rotation, also through the use of large solar sails, in order to generate artificial gravity. Several meters of rock would interpose between the habitat and the outer space, providing protection against radiations and micrometeorites.

2.6 Methodology

The organizers will propose the theme to space architects, urban planners, civil engineering experts, psychologists, anthropologists, and also to students of the same matters. They will be invited to develop the theme, providing all aspects of civilian life in the colony, thus including health, economy, public services, etc...

2.7 Choosing a Near Earth Asteroid

According to projections provided by NASA, Apophis will pass very close to Earth - closer than the Moon - in 2029. Thus its capture would also have a value of defense against possible upheavals of terrestrial environment, due to too close passage, let alone a possible impact.

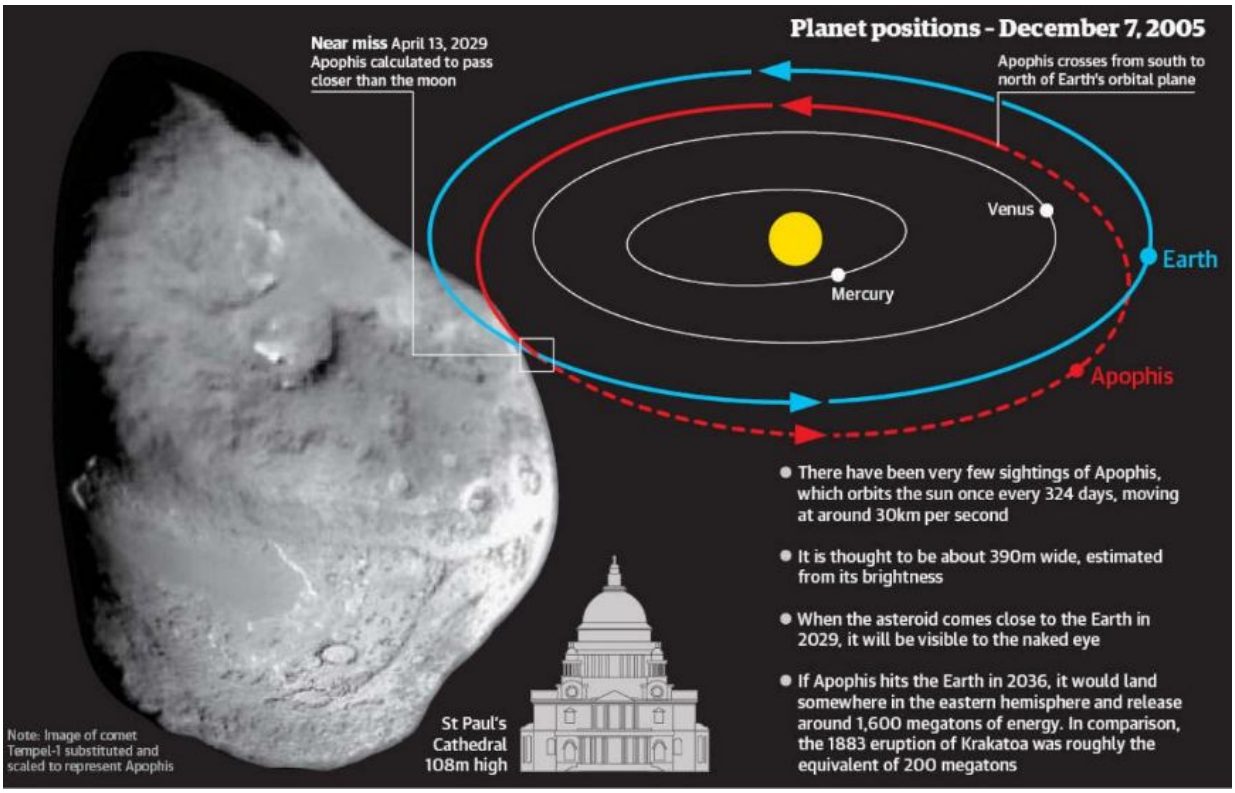

Figura 2. L'asteroide Apophis e la sua orbita quasi terrestre

Please also see this video, about Apophis: https://www.youtube.com/watch?v=ugHrmrjNlug

This paper written by Stephen D. Covey, on the NSS website, proposes a trade-off about NEAs suitable to be captured, moved to Cislunar space and "domesticated" into an habitat for -- in some cases -- up to two million people.

http://www.nss.org/settlement/asteroids/capture.html

In the list proposed by Stephen Covey, i think the most promising ones are these three: Apophis, 2005 YU55, 1999 AN10.
The easiest, and smallest, seems to be Apophis...

Apophis is fairly well characterized, although it may not be an LL chondrite, and may therefore have a different albedo, diameter, and mass. As a candidate for Earth-orbit capture, it has the advantages of passing quite close, and relatively slowly, plus launch windows occur in Aprils and Octobers near close approaches, suitable for a 1, 1.5, 2, or 2.5 year mission. It masses 27 million tons, roughly twelve times larger than the minimum useful capture size.

2005 YU55 is three times as massive as Apophis, and approaches Earth, Venus, and Mars, giving multiple possibilities for gravity assists. Next year it will pass about 20% closer than the Moon's orbit, but it won't be that close again for quite a while. It makes frequent approaches, about every 11 years, with relatively close approaches in April of 2021, 2032, 2043 (etc), and in November of 2022, 2033, 2044 (etc). We can likely tune one close approach to allow a closer approach 11 years later that can lead to a capture 11 years after that.

1999 AN10 is a large (50x Apophis), fast, and dangerous asteroid which will pass about as close as the Moon in 2027. It is large enough to build 7,500 5-Gigawatt Solar Power Satellites, or to house 2 million people in a 2 mile diameter habitat. Actually, we can solve Earth's energy problem for the next thousand years AND build a habitat for one million people, with materials to spare. While it is difficult to capture, it should be worth the effort.