Bootstrapping a spacefaring civilization

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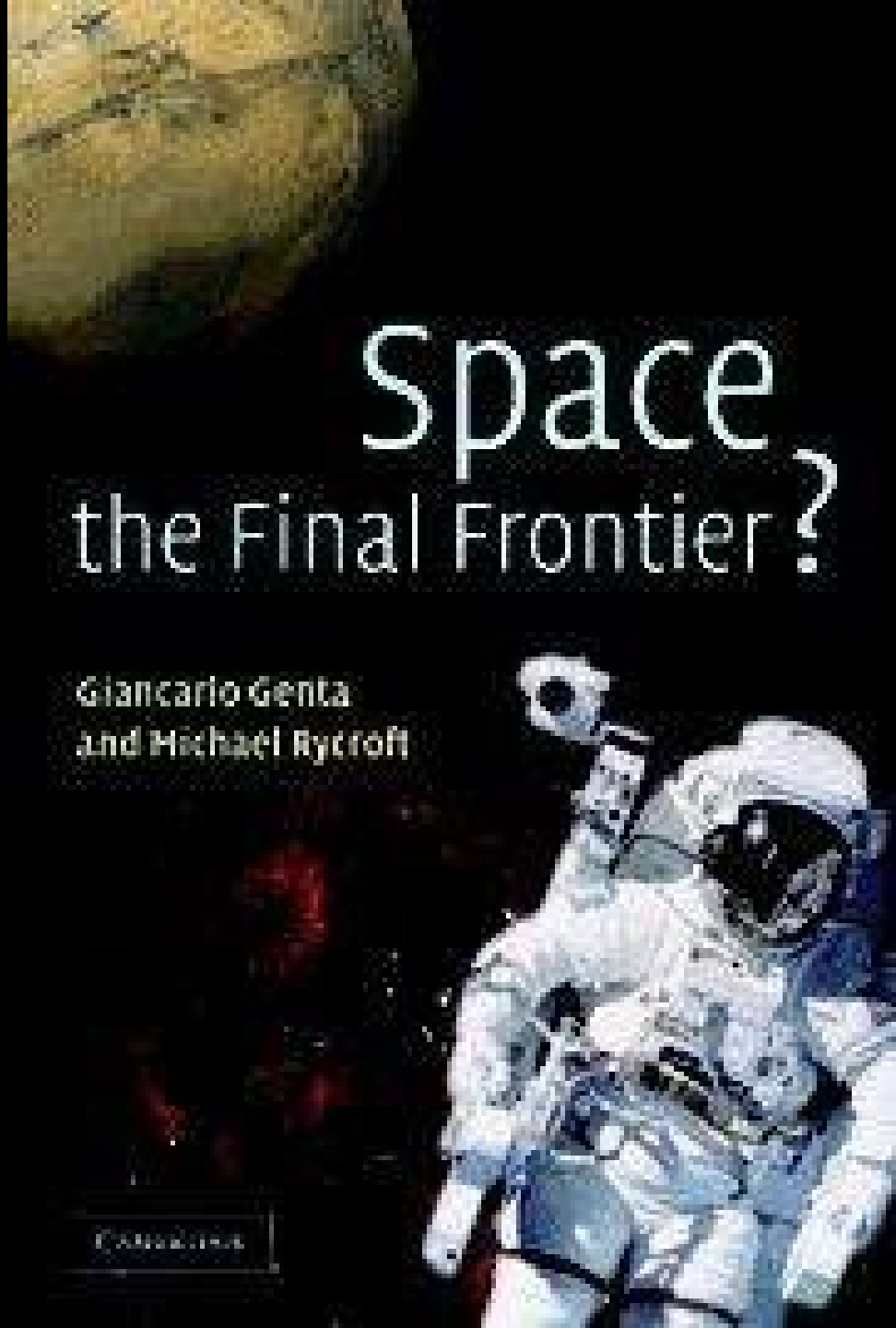
This presentation is based on

G. Genta, M. Rycroft,
Space, the Final Frontier?,
Cambridge University Press, Cambridge, 2003

G. Genta, M. Rycroft,
Will Space, Actually be the Final Frontier of Humankind?,
Acta Astronautica, 58, 2006, 287-295.



The beginning of a spacefaring civilization

Humankind is starting its way as a spacefaring civilization.

This phase is very critical and requires a large use of resources

All what is needed in the space exploration/exploitation enterprise must be carried in space from the bottom of Earth's gravitational well.

The beginning of a spacefaring civilization

The cost of launching equipment and personnel into space is the main factor hindering this effort, and only technological advances will allow humankind to achieve its goals in space.

Technology alone is however not sufficient, since commitment and an adequate resources management are also essential.

Space must not be a lab for science, but a see to be crossed to create places where not only to work but to live, to be at home and develop new cultures

The beginning of a spacefaring civilization

- THE COST ISSUE
- THE ENERGY ISSUE
- THE VELOCITY ISSUE
- TECHNOLOGICAL ISSUES
- HUMAN ISSUES
- THE TIME ISSUE

THE COST ISSUE

Space exploration is costly, but not so costly

The point is not just a matter of money. What is lacking is the willingness to invest in an enterprise making little profit in the short term, yet one with good long term prospects for business.

In recent years, privately funded space activities have attracted more money than that directly spent by space agencies.

Exploration has only occasionally been felt to be an important goal for governments.

THE COST ISSUE

There are example in history of exploration activities misfiring due to lack of commitment.

While waiting for a reduction of the costs of space activity or for the start of space exploitation to stimulate private investors in space.

- Technological advances can result in cost reductions which can attract investments in space activities by increasing the returns and reducing the times for return on investments.

THE ENERGY ISSUE

Long range space exploration is undoubtedly energy intensive, but only interstellar exploration is prohibitively so when compared with our current energy resources.

Futuristic technologies like skyhooks (spacelifts) may reduce energy requirements, but only when space exploration ead exploitation is much developed.

THE ENERGY ISSUE

However, even without futuristic devices, travelling to solar system destinations in reasonable times does not involve the expenditure of huge amounts of energy.

What is energy expensive can only be defined relative to the state of the available technology.

Even for interstellar travel (at a reasonable speed below the speed of light), the point is not how much energy is needed but how much technology has to be advanced.

THE VELOCITY ISSUE

The Moon, is so close that present technology is perfectly adequate, as the *Apollo* programme demonstrated.

The travel time to the most worthy destination within the solar system, Mars, is not much longer that the duration of the voyages of discovery of the past. Mars can be reached today without unmanageable difficulties.

There is no doubt that, with the help of moderate technological advances, the entire solar system is within the reach of humankind.

THE VELOCITY ISSUE

All problems linked with human spaceflight beyond the Moon are made simpler if a reliable means of hibernation were developed. Hibernating astronauts would require a simpler life support system; problems linked with radiation shielding and psychological problems become easier to solve.

For humankind to travel to interstellar distances, the limitation of the speed of light is a serious limitation,

Interstellar travel needs a new technology based on new scientific advancements.

THE VELOCITY ISSUE

Interstellar travel needs a new technology based on new scientific advancements.

There are some hints that even the limitations imposed by the speed of light might not be so severe that they could not be circumvented in some way.

Even if superluminal travel for ever remains a dream, this will not prevent humankind from settling on other planetary systems, provided that suitable extrasolar planets exist at a reasonable distance from the Sun.

TECHNOLOGICAL ISSUES

With present technology we can reach the Moon and travel to Mars: space exploration, and even colonization, is more a matter of commitment – or the lack of that – than of technology.

However, our know-how is barely sufficient to make space travel routine.

Research must be more focused on cost reduction than on performance increase, and more on those fields allowing a return on investment than on those linked with science alone.

TECHNOLOGICAL ISSUES

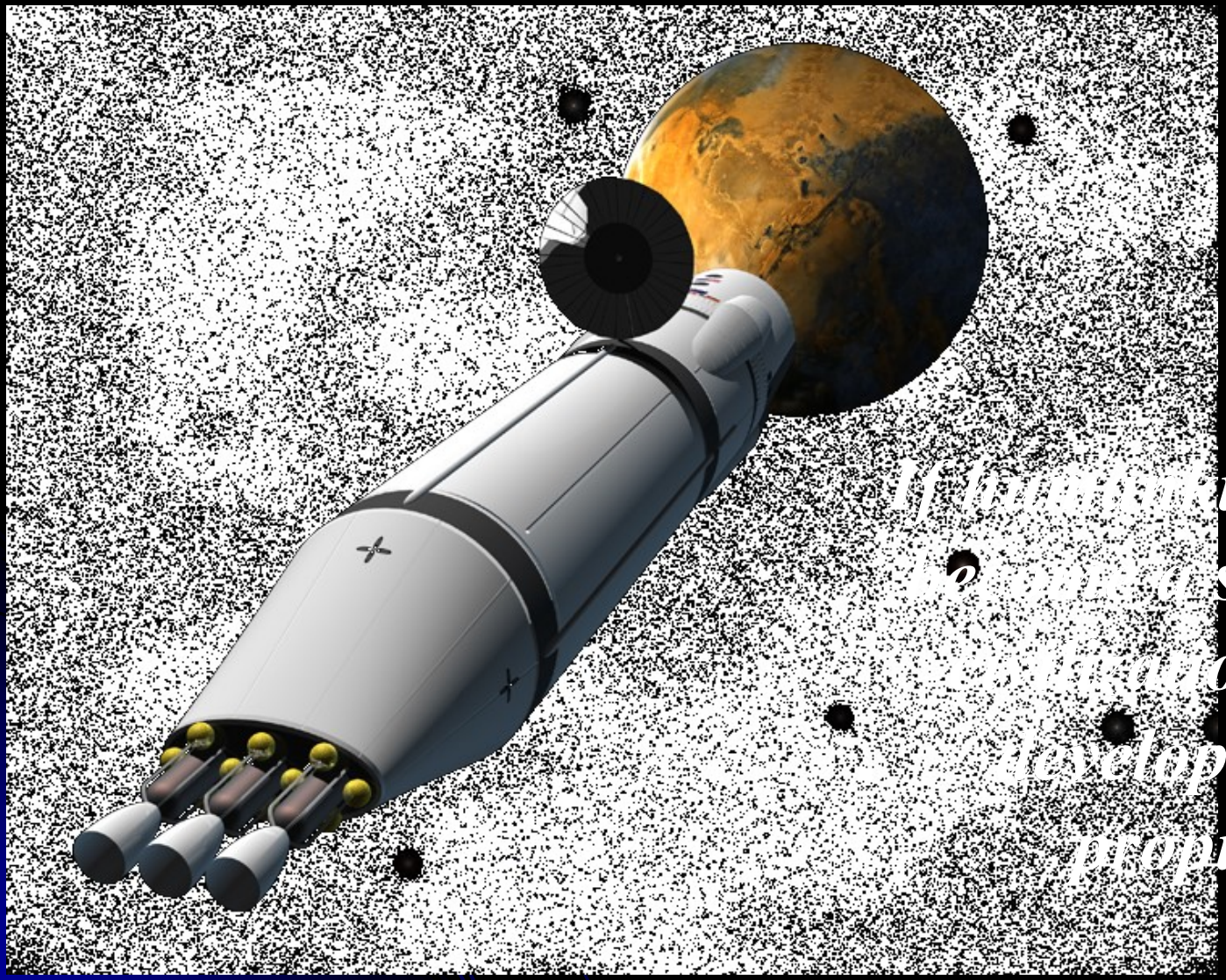
Technology can reduce the cost of space travel to the point where private investors can enter the business of deep space exploration, and exploitation and not only deal with low Earth-orbit operations.

All the main revolutions in technology were accompanied by the use of new materials, but advances in the field of materials are necessarily slow.

TECHNOLOGICAL ISSUES

A quick visit to the Moon or Mars is feasible using current materials – most parts of space vehicles are made of the light alloys used for WW2 aircraft. But large space dwellings, like those described by O' Neill, or interplanetary reusable space ships to ferry people and materials to Mars and beyond, need radically new materials.

Another need is for new propulsion technologies.



If humankind wants to become a spacefaring civilization, it must develop nuclear propulsion

TECHNOLOGICAL ISSUES

The failure to proceed with nuclear propulsion is one of the main reasons for our failure to meet the expectations of the early space age.

Nuclear thermal propulsion is the only concept which can simultaneously provide a fairly high specific impulse and a high thrust, without the need for a very long period of development. It could propel the large spacecraft needed for carrying humans as far as Mars, and beyond, and within reasonable travel times.

HUMAN ISSUES

Since its beginning the human species expanded beyond its immediate natural habitat thanks to its ability to develop suitable technologies. The use of animal skins, and then woven material, to cover a body which is not naturally protected against cold weather and the ability to light fires and to build shelters enabled humankind to colonize practically all the lands of our planet.

In particular, after the neolithic revolution, when we learned to grow our own food and to tame animals, our human environment became increasingly ‘artificial’.

HUMAN ISSUES

Lifestyles which we now regard as ‘natural’, like that of European peasants some centuries ago, are almost as artificial as ours. We perceive as being natural what is old technology, i.e. a technology which we are so used to that it appears to us as a part of nature, while we feel as artificial a technology we are not yet used to.

When the human species starts living on other planets or in space itself, this trend will continue further; no doubt the unusual environments will strain the adaptation capabilities of our descendants.

HUMAN ISSUES

The adverse conditions which humans will encounter in space will not prevent the human species from becoming a spacefaring species.

The living conditions which many people endured in the past were far worse than those which will be encountered by space travelers and settlers.

The willingness to take risks and the value which we attribute to human life are cultural issues and safety, after all, is a problem of technology.

The time issue

Those who tried to predict the path of humankind into space were completely wrong, mainly in the timing of these enterprises.

By 2003 we were expected to have permanent Moon bases and already to be well on our way in the colonization of Mars and in the exploitation of extraterrestrial resources.

All human enterprises proceed at a discontinuous pace, with sudden rushes forward followed by periods of consolidation or even regression.

The time issue

After all, if Columbus could not obtain the ships for his journey to America, sooner or later someone else would have set foot on the new continent, perhaps sailing under a Portuguese, Flemish or British flag. The details of history would have been different, but the overall picture more or less the same.

A few decades do not matter much in the context of the history of our civilization, which is increasingly a planetary civilization.

The time issue

The problem is that space exploration and exploitation are an opportunity our generation has better not to miss

Our planetary resources are becoming increasingly scarce for a growing population. Without the contribution offered by the ‘space option’ our civilization could meet a global demise accompanied by an impoverishment which would make it impossible to implement the space option in a significant way later, at least for some time.

Conclusions

Perhaps this the essence of the myth of the final frontier is the tentatively defined *Conscious Life Expansion Principle*:

An intelligent, self-conscious species evolving on a planet is eventually able to set about space exploration. This enterprise in neither an option nor a casual event in the species' history, but represents an essential way to spread high-level life beyond the place where it developed.

Conclusions

Space is likely to become *the final frontier*, but the time required may be much longer than was predicted. Several generations might be needed for just the initial phases.

Our generation might again go to the Moon and the next one or two to Mars, to settle there. In the long term, humankind should become a spacefaring civilization.

Conclusions

Progress in this direction will depend upon our solving the pressing social, political and economic problems associated with such an ambitious programme in the context of other Earth-bound problems, rather than the attendant technological and scientific problems.

We must live our time: the future is open in front of us. We need to have a new vision, a new commitment to take the initial steps soon, so that the human race can indeed make a start on its way towards the *final frontier.*