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The inadequacies and dangers of modern rocket technology

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In this open 'letter' to space entrepreneurs Jeff Bezos and Elon Musk, as well as to all those who intend to proceed with large-scale space commercialisation using carrier rockets, engineer Anatoli Yunitski calls for a complete reappraisal of our reliance on rocket-based technology if we are to complete the industrialisation and commercialisation of space in a way that will not destroy life on our planet.

The names of Jeff Bezos, CEO of Amazon and Blue Origin, and Elon Musk, CEO of SpaceX, are widely known all over the world; mine much less so. We are representatives of different cultures, citizens of far-away countries and carriers of different mentalities; and we have different financial potentials for investment in space exploration.

However, we do have some things in common: just like you, I am confident that humankind has no other route to long-term development than the exploration of outer space. But at the same time, I believe it is necessary to take all ecologically dirty industry off the planet.

Like you, I have devoted many decades to the implementation of an alternative space exploration programme. During this time, as an engineer

and scientist, I have achieved significant results and made several important conclusions that I consider necessary to share with you in order to warn against errors that could become critical for all of us - people of Earth.

The 'rocket path' of space exploration, along which mankind is proceeding today and which you have decided to follow, is ultimately a dead-end direction. Judging by data from open sources, the main goal you are pursuing is to reduce launch costs by creating reusable carrier rockets. But even if you manage to achieve significant results and reduce the cost of delivering goods to orbit to US$2 million per tonne of cargo, for example, large-scale space exploration will still remain expensive. Here, one can draw parallels with earthly reality, where it would be irrational to try building a factory where the cost of one brick was comparable to the cost of a car.

Another circumstance that makes attempts to industrialise space using rockets senseless is their extremely low energy efficiency factor. This is less than one percent, taking into account all the expenses and energy losses including pre-flight and post-flight factors - for those to obtain fuel and produce detachable and lost sections.

It sounds like a paradox, but the transportation performance of the entire modern rocket and space industry can be compared to a single earthly horse-drawn cart. Let us imagine such a cart that has continuously transported one tonne of cargo since 1957 to Earth orbit (approximately 300 km). It would have transported by now as much cargo as all the rockets together have delivered into space.

Environmental issues

In addition to inefficiency, rockets also create global environmental problems. The speed of jet exhaust at a rocket launch reaches 4 km/sec, which is five

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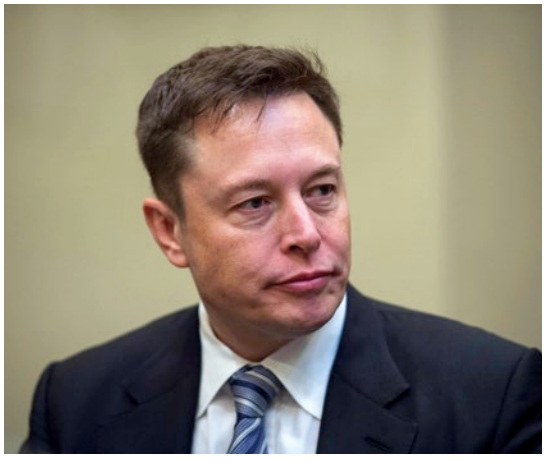
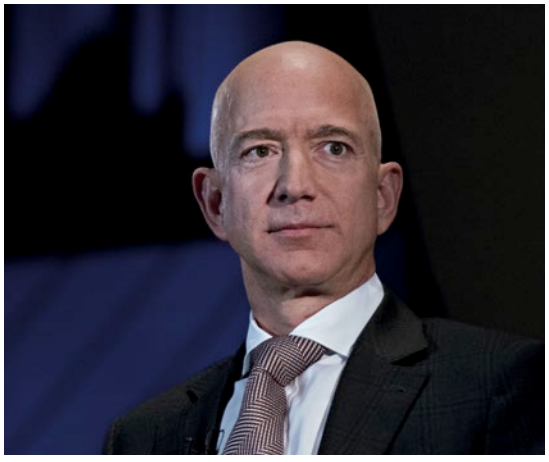
times higher than the speed of a rifle bullet. The temperature of the jet flow reaches four thousand degrees Celsius, which is almost three times higher than the melting temperature of steel. All this power is released into an extremely vulnerable ozone layer in the form of chemically active flame. Each launch of a heavy carrier rocket punches a hole in the ozone layer the size of France.

Some 40 years ago it was estimated that the US Space Shuttle would remove between 10 and 40 million tonnes of ozone in one launch (depending on ionospheric conditions), because it uses ozone-extinguishing chemical elements as fuel components. So, given that there are about four billion tonnes of this gas in Earth's atmosphere, it is easy to calculate that it will be sufficient to launch 100-200 carrier rockets of this type for the complete destruction of the ozone layer.

In addition to extinguishing ozone, rocket launches also change the physical chemistry of the upper atmosphere, causing turbulence in the ionosphere and even affecting the geomagnetic field in the launch pitch plane.

Multiple use of rockets and the transition to new types of rocket fuel will not be able to solve these problems because to achieve the proposed industrialisation of space with the current range of rockets the number of launches will need to





▶ Elon Musk (left) and Jeff Bezos.

If industry is relocated to Earth's orbit, no one will have to flee their home to other planets and other star systems

be several orders of magnitude greater than we have today. Forecasts on the launch of space vehicles for the next 10 years are not encouraging, predicting up to around 180 launches per year. This is more than a twofold increase from the current level and will simply kill life on our planet.

I presume that you understand and share my belief that Earth will be doomed if in the near future the 'technosphere' (all of industry) is not brought out into space, beyond the borders of our common home?

This will happen because it is fundamentally impossible to create closed technological cycles within industry. It is about the same as seeking a way to prohibit a cow from producing manure, urine, methane and carbon dioxide while still producing its main product - milk. It will not be possible to introduce a veto on the release into the environment of what remains as a result of subtracting the finished product (milk) from the raw material (grass).

Open systems

All industrial technologies work in exactly the same way - they take raw materials, emit products from them (sometimes through dozens or even hundreds of process stages), and what is left is thrown back into the environment. Even our biosphere as a whole is not a closed system - after all, it has transformed the previously 'dead' Earth.

Similarly, the technosphere as a whole cannot be a closed system under the conditions of a single planet. It will inevitably transform the planet for its comfort, without the need for oxygen, soil or other components necessary for human life on Earth.

As a result, the technosphere will kill, if not all life on the planet, then certainly humanity as we know it. Even today, industries of the US and China consume twice as much oxygen as green plants produce in these countries. They live in debt-consuming oxygen produced by the Russian taiga and Amazon jungles. There is a 40-year trend, moving Earth Overshoot Day – the illustrative date on which resource consumption for the year exceeds Earth's capacity to regenerate those resources that year – towards the beginning of the year. If it continues, the technosphere will irrevocably 'eat' the biosphere in just two to three generations.

Only the provision of an ecological niche to the technosphere outside the biosphere will ensure, for the latter, preservation and development according to the laws and directions formed over billions of years of evolution, as well as the harmonious interaction of the community of people, like biological objects, with the biosphere.

There is no such ecological niche for the technosphere on Earth - but it is available in space, starting at a distance of 100 km from the planet's surface, where there are ideal conditions for most technological processes: zero gravity, vacuum, high and cryogenic temperatures, unlimited raw materials, energy and spatial resources.

If industry is relocated to Earth's orbit no one will have to flee their home to other planets and other star systems. Of course, there is an alternative to even such escape – unpopulated land areas on Earth that are suitable for living such as highland areas (above 3000 m) or Antarctica.

The cost of colonisation of terrestrial mountain ranges and Antarctica is probably a thousand times cheaper than that for Mars, and it's much more comfortable to live there: warmer by 100C, we have air and oxygen, food, fresh water (it is worth melting the snow) and it is still our native planet! Moreover, an air ticket will be a million times cheaper than an interplanetary ticket - a thousand dollars instead of a billion dollars.

As you can see, humankind doesn't have much time left for large-scale space exploration - just a couple of generations before the point of no return in the development of our technocratic civilization.

▼ The overpass on which GPV is located will be used as a transportation infrastructure.

After that, nothing would be able to restore the disturbed balance between nature and industry. Due to technocratic oppression of the biosphere, its irreversible destruction and degradation will lead to the degradation of the human race. After all, our Earthly civilization lives under the principle of 'mould in a Petri dish'. After eating all the limited resources, it will die.

Large-scale space exploration and the transfer of terrestrial industry into orbit will require geo-cosmic transportation in the amount of many million tonnes per year. Neither today's thousand, nor tomorrow's ten thousand tons of cargo per year (as planned for rocket industrialisation of space) will solve the global problems of humanity living on the planet.

By the time this volume is reached, 10 billion people will live on the planet, which in terms of one earthly soul will give us only 1 gram per year, or three milligrams per day.

▲ Outer space conditions will provide new opportunities for science and industry located in orbit.

Transportation technology

As a result of analysing these problems, I came to the conclusion more than 30 years ago that the only possible transportation technology for large-scale space exploration for humanity is the non-rocket method. You probably know the idea of a space elevator and other similar concepts? All of them are difficult to implement, at least in the foreseeable future; moreover, their performance capacity does not exceed 10 thousand tons of cargo per year. But I have my own solution, which gained some publicity after my report in Moscow at a non-governmental meeting of American and Soviet public organised by the Soviet Peace Committee.

The meeting was held back in 1987 and was devoted to the problems of transferring Earth's industry into space without the use of rockets, as well as the development and colonisation of other planets.

Since then, I have done a lot of work, creating my own scientific and design school, which became the basis for researching and verifying this solution by calculation methods. As a result, the project can be implemented in the foreseeable future provided there is a political will and consolidation of businesses.

The project was named General Planetary Vehicle (GPV). This is a reusable geo-cosmic transportation system for non-rocket exploration of near space comprised of two orbital rings, one a 'string overpass' on the Earth's surface around the equator and the other a space station in low Earth orbit. It will allow the transfer of about 10 million tons of cargo and one million people into orbit for one flight without any negative interaction with the environment both on Earth and in space. These people will be involved in the creation and operation of the near-Earth space industry.

GPV will be able to exit into space up to 100 times in one year. What GPV can do in one year, would take about a million years for the modern world's rocket and space industry, in which trillions of dollars have already been invested. At the same time, the cost of delivering each ton of payload to orbit using GPV will be a thousand times lower compared to carrier rockets - no more than a thousand dollars per ton.

The environmentally-friendly GPV, working exclusively on electric energy, will allow the industrialisation of near space to be carried out in reality. After that, it will be possible to close all industrial facilities on our planet that are harmful to Earth's biosphere, having created them by that time in near-Earth orbit on principles that are environmentally friendly for space.

This will open up tremendous opportunities in the sphere of informational and energy communications. Transfer of industry away from

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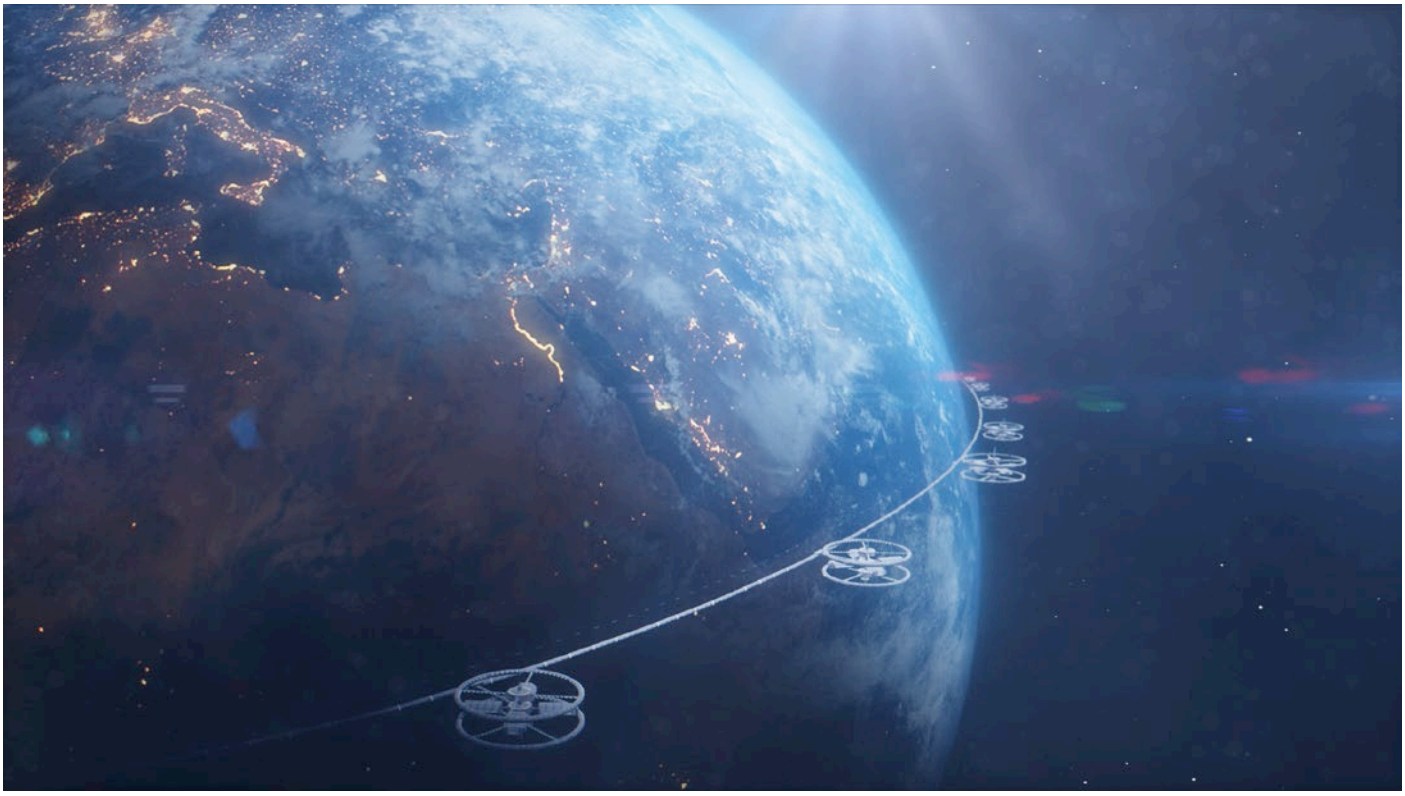

▲ GPV construction will become the mainstream global project in the history of mankind.

the planet will radically improve our common habitat, our common home - the biosphere of planet Earth - especially in industrialised regions, without any restrictions on production growth.

Almost all engineering solutions used in the project are widely known, tested in practice and are currently implemented in industry. The project's budget, calculated for a 20-year term, will be about two trillion US dollars, which is not so much - three annual US military budgets. Such a global geo-cosmic programme will make it possible to unite all developed countries around the world with common goals and objectives involving them in financing this super-ambitious project designed to save humanity.

Due to its technical features, the project will directly affect the territory of dozens of countries, mainly located along the equator - and because of its political and economic objectives, the project will affect the whole world.

GPV will also become an indispensable platform for the future exploration of deep space with reusable spacecraft, such as those being developed by your companies today. The project's implementation period will be about 20 years, taking into account socio-political, research, experimental, designing, surveying, building and assembling work.

I sincerely hope that you are like-minded people, who are not indifferent to the future of humanity and who are motivated to act not only by the interests of profit. You, as the few, should understand that in the event of the death of our common home, the earthly biosphere, no amount of money will save the lives of earthlings, their children and grandchildren. I invite you to cooperate in this shared project for the benefit of all mankind and I hope this letter initiates the start of the main event in your lives, too.

Earth is the best planet in the entire Universe. We must save it for our descendants! ■

The only possible transportation technology for a large-scale space exploration for humanity is the non-rocket method

About the author

Anatoli Yunitski is an engineer from Belarus, General Designer, SkyWay Technologies Co (Minsk, Republic of Belarus). Author of more than 140 inventions, 18 scientific monographs and more than 200 scientific papers, Yunitski has created project design schools in the field of string technologies and successfully conducted laboratory, bench, field and model tests with the basic components of innovative transport technology. Since 1977, he has been developing the concept of a non-rocket transportation system - the General Planetary Vehicle (GPV) - for the exploration of near-Earth space. The theoretical foundation and basic principles of GPV operation are described in the monograph 'String transport systems: on Earth and in space'.