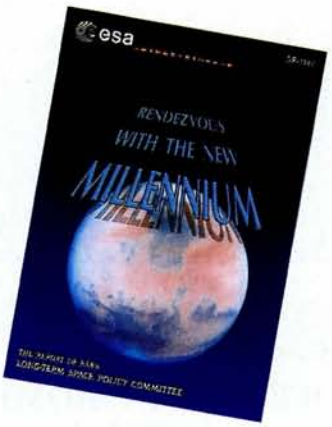
Space Visions for the 21st Century



Peter Creola is Chairman of the Long Term Space Policy Committee at the European Space Agency. And so is charged with the task of looking into our future in space. He gave the following keynote address in Vienna last Autumn, to celebrate Kuffner Sternwarte Observatory's 50th anniversary. And stuck his neck out to predict what is to come

Fundamentally, an astronomical observatory is not a very good tool to look into the future. As you all know, through the telescope we look into the past, even into the very distant past almost back to the moment our present universe began to exist. Of course, if we look with one of our telescopes at a red giant, one of the ways of a star to die, we look at least by analogy also into the future, when, some billions of years from now our own sun will expand into a giant fireball terminating life's adventurous emergence and expansion within our own solar system. Earth life, at that time, will either have spread beyond the solar system or disappear forever. But let us turn now to our immediate future, the 21st Century.

What will the next century, this tiny fraction of future, look like? In what directions will space science, space technology – and all their numerous applications – evolve? Some years ago, the Council of ESA which is not necessarily the most inspiring – and inspired – body, got interested in this question. After a gentle push from Austria and Switzerland, by far the friendliest of all ESA Member States, it created the Long Term Space Policy Committee, which I have the honour to chair. I also have the pleasure to have Ambassador Peter Jankowitsch as Austrian Member. We delivered our Report *Rendezvous with the New Millennium* according to our mandate to the October 1995 Ministerial Meeting of ESA in Toulouse.

The Ministers congratulated us, but were somewhat at a loss as to how to deal with it. After all, Ministers are not elected to look into the future but to survive the next election date. Still, Ministers wanted to be polite. And so, instead of really discussing it, they said: Your Report is fine and extremely interesting; why don't you write another one? And so, somewhat to our surprise, the Long Term Space Policy Committee is still busy charting the future of Space, and writing an even better report for the next ministerial meeting.

Let me share with you some of the visions we have as a Committee, some of the difficulties we meet, and some of my own very personal ideas and convictions.

The biggest difficulty, when you try to look into the future, is the tools you use. As I said, telescopes are excluded. Basically you have only two, and very crude tools at your disposal: extrapolation and imagination. The first pretends to be more precise than the second. You look at existing trends and assume that they will continue at least into some part of the future. The problem is: some trends continue indeed. But some stop or reverse, and new ones emerge. Which ones? This is where imagination and intuition come in. That is of course more fun than just extrapolation. But it is even more difficult. Because you need courage to imagine.

This courage is a scarce resource. The degree of in-built censorship in all of us is unbelievable. We are always afraid of being ridiculed by having too much imagination. Some time ago, I asked one of my colleagues, in fact one of the very few lady space engineers in Europe, "why is it that our US colleagues are more imaginative the we Europeans?" One recent example is Mars Pathfinder. It cost less than a medium Science Mission of ESA, it would have been perfectly feasible to do with European technology. In fact, the rover crawls around with Swiss motors and points a German detector at the Mars rocks it visits.

And still, the Pathfinder mission would have had no chance whatsoever in ESA's programme. It would have been considered too risky, slamming into Mars's

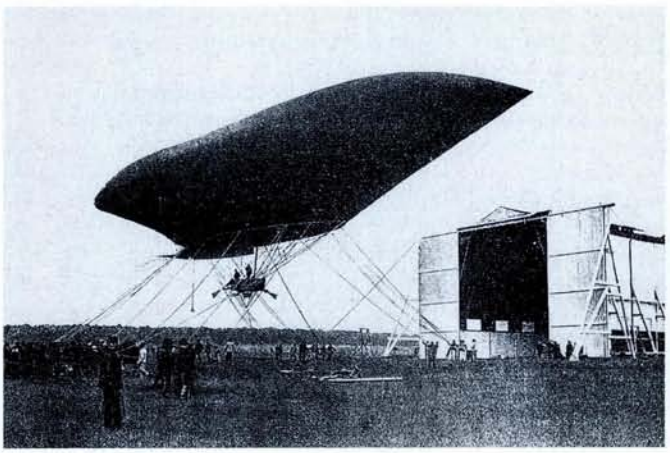


Fig 1 Frères Lebaudy airship, 1901

Fig 2 First class cabin of an Airbus 340 *Airbus Industrie*

atmosphere without retrorockets, and landing in a cocoon of airbags. You know what the lady responded to my question? "The Americans are more imaginative 'Parce qu'ils n'ont pas peur du ridicule.'" This is it. They took risks. The scheduled landing date was Independence Day. We in Europe would not have dared that either – anyway independence day is the day they got independent from us and we are still struggling to get independent from them.

NASA risked public failure before the world's eyes, and got rewarded by triumph, headlines and front pages, prime time news and the biggest Internet access of any world event ever – and a nice push to get its budget through Congress. There is a lesson there. If we are not more imaginative, inventive, innovative, and yes intuitive, we will not get on the stage of the next century, we will not even get decent seats to watch the others act on the scene. How then, to look into the future, thereby shaping it? It can only be by combining extrapolation and imagination. Personally, I recently shaped another tool, or rather tried to invent a new name (today you are nobody if you do not invent new names for old games). I call it the method of proportionate astonishment.

Let me give you an example. *Figure 1* is is a picture of the airship of frères Lebaudy, built in 1901 at the very beginning of our present century and successfully flown several times in 1902. And *figure 2* is a picture of the first Class cabin of an Airbus 340.

It proves that in 1900 not the cautious and the prudent were right. Right were the imaginative and intuitive who did not fear ridicule. But even they, if they stepped into this cabin and could cross the oceans of this world in perfect safety and comfort, at 10 km altitude, at 1000 km per hour [or so], sipping fine wine and eating good food, they would be truly astonished. The method of proportionate astonishment, applied to this example, works then as follows: you ask yourself the question, What type of transport, one century from now, will cause a proportionate degree of astonishment? Certainly not an Airbus 990 flying at 2000 km per hour at 20 km altitude. This is short term future, not long term. And not an Ariane 7 either, taking off from ordinary airports and transporting passengers to the successor of the International Space Station. This is medium term future, not long term.

I tell you what would cause, at the end of the next century, a degree of astonishment proportionate to the leap from frères Lebaudy to Airbus. It is flying from one solar system to the next in one year. I do not know how. I do not have to know how. Others will find out for me. It would have been unfair to ask the Lebaudy brothers to prove that a five hundred passenger air plane could cross the Atlantic in five hours. I only have to dare to follow my imagination. And I only have to overcome my fear of being ridiculed. This is long term future.

Of course, in the Long Term Space Policy Committee, as Chairman, I had to settle for less. At least for the first report. If you have colleagues from all 14 Member States around the conference table, some give and take is unavoidable. So, with respect to the future of air and space transport, we agreed on the following compromise formula between conservatism and true imagination.

"A vacation on the Moon in one sixth of the Earth's gravity, with our blue planet shining in a black star-sprinkled sky, could become an irresistible attraction".

This is not truly long term. But it is a nice thought, and it is nicely formulated. And, by the way, it is not my sentence, which the other Members of the Committee let slip through by shear pity for the frustrated Chairman. No, it is a phrase proposed by a sober and serious Dutchman some years older than me. He had the courage to propose it. And the others accepted it as an example of a plausible evolution of space technology towards the middle of the next century.

Well, Ladies and Gentlemen, I am halfway into my time, stuck on the moon, dreaming about interstellar travel. You might accuse me of indulging in Space fantasies in complete disconnection from our planet's true agenda at the turn of the Century.

This is not so. Space is foremost about Earth. We had to fly to the Moon in order to discover Earth. As our one and only home planet. It is only from the moon, not from the orbit of the Shuttle or Space Station Mir that you grasp in one look the totality of our globe, beautiful and fragile. The metaphor of Spaceship Earth is one of the most striking results of the Apollo programme. For the first time, humanity had a look at its cradle. Watching living Earth rise in silent beauty over the Moon's barren horizon was to me – and many others – a moment of profound emotion as intense as looking at the first human footprints on the dusty surface of our celestial neighbour.

This new notion – Spaceship Earth – is symbolic of an epochal paradigm change. To most people living today, the 'world' means still the 'Earth', whilst the universe, planets, stars and galaxies are somewhere high above and far away. But, slowly, minds are changing, and minds have to change if we want to survive the next century. To the people of the next century – and I am convinced all of you want to be part of as big as possible a portion of it – the 'world' means no longer the 'Earth but the 'universe', and our home Planet is but a tiny speck of matter circling one of one-hundred-billion stars forming themselves just one among one-hundred-billion galaxies. Thanks to gravity and good old Isaac Newton, our feet cling to the outer surface of Spaceship Earth, but with our heads we hang into the infiniteness of space. But we are responsible for Spaceship Earth and its future.

Let us have a look at Spaceship Earth. Its basic construction is quite simple: spherical, to offer maximum volume for minimal surface. Building materials are

Spaceship Earth

- Spherical iron and stone construction
- Thin outer layer of water, soil and air
- Diameter: 12,700 km
- Speed: 100,000 km/h around the Sun
- Speed: 900,000 km/h through the Galaxy

Threats

climatical change:
temp variable ± 3-5°C over a few decades
cosmic collisions:
10 m object, monthly, 1000-20,000 tonnes
50 m object (Tunguska 1908) 100-300 years,
50,000-10 million tonnes
10 km object (Jupiter 1994)
Earth, every 65 million years

Crew

5.8 billion
4.7 births / sec
2 deaths / sec
2.7 new crew members / sec
= 236,000 / day; 86 million / year;
1 billion / 12 years
within 500 years 1 square meter will remain per person

Onboard consumables

fertile soil: loss 10 million hectares / year
drinking water: rationed
natural gas, oil, uranium: 100 years

Above table taken from Peter Creola's talk

cheap: iron and stone. But it is an extremely small spacecraft by cosmic standards. Its diameter is only 12,700 km and its mass corresponds to less than 1 per cent of the total planetary mass circling our sun.

Compared to its size, the number of crew members on board Spaceship Earth is staggeringly high and increasing at the net rate of over 80 million per year, or 236,000 per day, weekends included. Every 12 years, the equivalent of a new China must be fed, housed, educated and placed on the job market on this fragile and tiny little planet. The result is no surprise: topsoil disappears at the rate of 10 million hectares per year, food and drinking water get scarce, and the fight for a decent place to live is at the root of a growing number of conflicts. Those powerful political and religious forces which still oppose education of women and efficient means of birth control should in fact be the first ones to invest in the development of interstellar travel with the aim of housing our surplus crew members on other habitable planets. This is of course futile. Because every day (weekends again included) 236 giant spaceships with one thousand passengers each would have to take off in order just to stabilize world population.

Do you feel I digress too much from the subject, space visions for the 21st century? The Earth's human population will continue to grow – up to what level is a matter of debate. We will certainly reach something of the order of 10 billion by the middle of the next century. How will we manage this mass of people without falling into global chaos where everyone fights everyone with millions and millions dying each year in the ironic drive to survive?

By planetary management. Try to manage our tiny and fragile Planet, its non-renewable and renewable resources, the consequences of our actions, the natural and man-made dangers in as rational and human a way as possible.

Managing a whole planet as one single entity, where natural systems and cycles interact with numerous man-made effects is a formidable task. Without watching from orbit, monitoring a broad range of parameters, from climate patterns affecting food production to the complexities of peacekeeping, space means are not the only, but in my view the most decisive, tool. Those nations and groups of nations which will know, thanks to space observation, what happens around the globe at any instant, affecting security, economics, politics, even cultural identity will have a decisive advantage in the multidimensional struggles of the next century. And those who do not have such systems will sail blindfolded into the next millennium.

Fig 3 In mid-August 1996 an oil tanker anchored in waters off Singapore discharged oil into the sea. The ship, lower left of image, was caught in the act by ESA's ERS satellite. Cleaning up the polluted beaches and sea surface cost more than US$700,000. The owner of the vessel was fined US$450,000; the agent and captain were both fined US$400,000; the captain also received a one-year prison sentence; the first officer received a six-week jail term

I show you just one very recent example of planetary management: the wide expanses of the world's oceans can only be monitored from space on a continuing basis. This tanker cleaned its tanks illegally off the coast of Singapore causing widespread pollution. Thanks to ESA's remote sensing satellite ERS, it got caught in the act (*figure 3*). Look at the fines resulting from it. The Alpbach summer school [an Austrian school for space science students] could be financed for sixty years with these amounts.

Other examples of planetary management are predictions of earthquakes and volcanic eruptions. Though space-based monitoring of minute variations of certain parameters of the Earth's crust might not be the only method, it is certainly a promising one whose long range economic potential alone is worth all the investments in the field of earth observation satellites.

Applying the method of proportionate astonishment to the evolution of space technology in the next century, two further areas come to mind: defence against cosmic collisions and energy production in space.

The first report of the Long Term Space Policy Committee dealt with the subject of cosmic collisions by mentioning three major events: it is commonly accepted today that 65 million years ago the impact of a body of 10 km diameter wiped out two thirds of all life forms on Earth including the entire ruling party of that time: the dinosaurs. Thanks to TV satellites and the Internet we had the privilege to watch in 1994 the impact of such an object live – fortunately not on Earth but on Jupiter. Still, it was a very nice show, and the fact that some of the scars on Jupiter were as big as the Earth should make us think. Probability is a fascinating subject. It is agreed that collisions with objects of this size are extremely rare. 65 million years is a long time – so why shouldn't we be safe for, let's say, another 10 million years? But firstly, precisely because it happened so long ago, the next cosmic visitor might be long overdue already. Or in other words: even very improbable events can happen tomorrow. At least one Swiss astronomy professor introduces the subject as follows: "I am now going to talk to you about the impact of cosmic bodies on Earth and I am well aware that I might not have time to finish this phrase."

Much more often, Earth collides with smaller objects. Once every one hundred to three hundred years, Earth trembles under the shock of a 50 metre object of

50,000 tonnes, slamming into the atmosphere with the equivalent force of a hydrogen bomb, 10 megatons. When it last happened, in 1908, several thousand square kilometres of Siberian forest were flattened. This one, indeed, can happen tomorrow – or on January 1st 2001 – to Washington, Moscow, Vienna or Berne. A world-wide spaceguard system could detect such bodies and several ideas have emerged already as to how one could intercept them far out in space and deviate them from their deadly trajectories. Do not tell me that this would pose enormous technical problems: a comet interceptor is much closer to present day space technology than the Airbus is to the Lebaudy airship.

Our report failed to mention another cosmic visitor because he called after it was published: comet Hale Bopp. Most of you admired its icy splendour when it sailed around the sun more than 100 million kilometres away. He was last seen by the pyramid builders, 4200 years ago. A minute change of orbit, far out in the solar system, caused by collision or interaction with another body, could have placed it on a collision course with Earth. And do not forget that Hale Bopp had four times the diameter and 64 times the mass of the chunk which wiped out the dinosaurs. It would have been the end of all of us, and the Kuffner Sternwarte – sadly – would not have lived to its 50th anniversary.

My personal wish concerning the Hale Bopp trajectory was a so called near miss. I surely would have loved it to cross our own orbit at less than the distance of the Moon. Ministers and Parliaments around the world, shaking and trembling from fear, would have multiplied their space budgets by ten in order to deploy in time the defence against the next cosmic visitor. Anyway, the subject is taken seriously enough by the US Air Force to figure in their defence scenarios for the next century.

To conclude on the subject of cosmic collisions: the calculated probability of being killed by one is bigger than dying in a commercial airplane accident for each of us. Of course, by spreading evenly the extinction of all of humanity in a distant future event over all those years we do not yet have to worry about it. But in the long run, it would surely be safer to sail on more than just Spaceship Earth through the uncharted depths of space. The late Carl Sagan in his marvellous book Pale Blue Dot ranks the survival of big cosmic impacts as one of the most compelling reasons for permanent human presence in space and in particular for the settlement of Mars.

Let me turn now briefly to energy production in space whose conceptual economic potential would totally overshadow the booming communications satellite business. By applying proportionate astonishment it is easy to see, after the middle of the next century, a ring of vast solar cell arrays and transmitters on the Moon based on already available technology, constructed mostly by robots and self replicating machines, beaming cheap, ecologically safe and inexhaustible energy to millions of decentralised, landscape-integrated collector areas on Earth occupying far less land than conventional energy production facilities or terrestrial solar power plants. Our report is more prudent than I personally would have liked but recognises nevertheless clearly the long term potential of energy production in Space: "For the time being, energy from space is not economically viable, because of the cost difference between Earth-based and space-based photovoltaic systems, but as fossil fuels are depleted, it could be one of the few options for meeting the huge energy needs of the next century."

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One thing is for sure: the whole economy of planet Earth will have to be converted to solar energy in the next century. The present energy production community (to use a nice word) does not like to talk about it, because it is busy selling off the last reserves of fuel on board Spaceship Earth. But sober calculations point to the depletion of fossil fuel fifty to one hundred years from now, assuming present consumption rates. That is a nice assumption, totally contradicted by reality: China, as one example, striving towards Western life-style is currently putting in to operation one power plant per day, mostly coal fired. Yes, we all know that our Western life-style cannot be exported to third world countries without massive or catastrophic consequences for the ecosystem of the planet. But those countries will not accept any advice preventing them from aspiring to what we think is a decent lifestyle. And we are anyway already quite busy in helping China to catch up because our export industries want a share of the huge pie, and many jobs depend on it.

Which brings me logically to the last subject, the search for intelligent life in the universe. If we look at the fundamental contradictions between what humanity should do in order to assure long term survival and quality of life on its home planet and what it really does, then we really should ask whether we ourselves are entitled to be called intelligent.

Be that as it may, we have developed the means to think about fundamental questions like, What is the universe? What is life and what is life's evolution and destiny in that universe? And we have the means to listen for signals from other technical civilizations. In fact, we listen since a few years on millions of frequencies simultaneously, day and night. And so far not one single intelligent signal has been received.

I must admit that this scares me more and more. At the very time we have proven the existence of planets around other stars, we discover that water and organic molecules are abundant and ubiquitous throughout the Universe and where few doubt that life will evolve everywhere given time and the right conditions, we seem to be alone. I am scared because one of the explanations might be that every species achieving our degree of so called civilisation, breaking out of the natural evolution cycle, will inevitably self destroy a very short time after it has invented wireless communication. Will we fall back into the stone age in the next century after an unimaginably brutal struggle for the last fossil and living resources of our home planet and the collapse of its ecosystem?

I still have some hope. But my hope is up there in space. We will not survive the next century without space: to manage our planet, to keep it green and blue, whilst feeding 10 billion people, and to assure our long term survival.

But there is more. When we had the President of the Club of Rome for a hearing and we asked him whether it was still legitimate to dream about space exploration in the true sense for adventure and discoveries in addition to all the mundane applications to help solve the problems on Earth, he said one sentence which moved me deeply, and still does: "Man's destiny is not to look down to Earth but up to the stars."

Do it, Ladies and Gentlemen, look at the stars, their promise and their beauty, and look at our future. If we do not do it, others will. This goes for Europe, it goes also for Austria and Switzerland.