(Excerpt)

IAA-97-IAA.8.2.07

A space art proposal : the Archeological Bird of the Future

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48th International Astronautical Congress
October 6-10, 1997/Turin, Italy

This project consists in inviting the largest number of today's inhabitants of Planet Earth to take part in a common endeavour that will compel each of us to deepen one's reflections about who we are and what we choose to do - as an individual and as a community - with ourselves and our environment.

The Archeological Bird of the Future is a satellite that will be launched into space in 2001 for a long journey orbiting Planet Earth, returning, safe and sound, in some 50,000 years. It will then act as our messenger, delivering to our distant descendants, all the messages that each of us wishes to pass on to the future.

By projecting us to an overwhelming distance in time, it invites us to share our thoughts and aspirations, our fears and beliefs and to imagine a future for mankind, far from the constraints of the moment. At the light of this ideal, it compels us to reexamine the use we make of the exceptional capabilities our species is endowed with.

This paper will first describe the aims of this project and the symbolic means by which it hopes to reach them (I). It will then demonstrate its technical feasibility and detail the contribution of the technical partners involved (II). Finally, it will briefly outline how the communication side will be lead at an international level (III).

"When just one man makes a dream, it is only a dream…

When a number of men, together, make the same dream, it is the beginning of a new reality."

Hundertwasser

I- AIMS AND SYMBOLIC MEANS

When space/time is hailing us

By sending a message to the future inhabitants of Earth through space and time, the Archeological Bird of the Future invites us to join in an unusual moment of reflection on both our history and our destiny.

2,5 million years ago, Man made his first tools. 500,000 years ago, he domesticated fire. 100,000 years ago, he started burying his dead. 50,000 years ago, he created art. Later came the writing, the religions, the laws and philosophy. More recently, we saw the advent of the printing press, the industrial revolution and the expansion of international trade. And now we see a disconcerting acceleration of our development, communication at the speed of light, control of nuclear energy, conquest of space and most recently genetic manipulation.

In 50,000 years, what will Life be like? Will Man still inhabit Earth? Will he be endowed with new senses? What will everyday life look like? Which course will History take ? What will be the successes? The defeats? Will there be harmony between living beings? …

It's an unusual invitation to imagine our own future, to dream what life could be like…

The human kaleidoscope reveals itself

By offering each of us an equal space for free expression (four typewritten uncensored pages), this project hopes to become a common endeavour for us which will result in a collective work, a kaleidoscope through which our differences and personal richness will appear.

We are all invited to leave a message for the generations to come : a message to share our aspirations, our reason for living, to express our doubts and our beliefs.

Through the different responses to this same question - what do you wish to pass on to the distant inheritants of Earth in 50,000 years?- and the information each author will be asked to give about himself (first and last name (optional), date of birth and nationality, issuing country, type of employment, pursuits or hobbies, and other, possibly ethnic groups, religious beliefs, political affiliations, …), we might be able to perceive through new eyes our common values and our deep aspirations. It will allow us to give a voice to the divergences and commonalties between cultures, between generations and between relatives.

This "Fresco of Messages" - where the words from the chief of an African village, a winner of the Nobel Price for Economics, a child from the favelas or a child from our well-to-do countries, a nun or a politician will be placed side by side - could give rise to a new awareness of one another. All the messages for the Archeological Bird of the Future will be disseminated to the media and made universally available for access on the Internet. Additionally the messages will be distributed in school systems and all manner of educational media. By sharing our thoughts, our concerns and our questions for the world of the future, we might be able to bring the world of today closer together.

Creating the archeology of tomorrow

Powerfull tool to have us reflect differently on ourselves, the Archeological Bird of the Future will constitute a wonderful present to our distant descendants.

Preserved in space from all possible cataclysms on Earth of human or cosmic origin and preserved within our satellite from the aggressiveness of space environment (see technical description), our "Fresco of messages" will resist the erosion of time and arrive intact in the hands of Earth's inhabitants in 50,000 years. Our words will then enable the world of today to be revived in the world of tomorrow.

In complement to our messages, we will also send a more factual image of today by creating a contemporary "Library of Alexandria" that will give a rational description of us and our time by describing our level of development, our body of knowledge, customs and beliefs, the state of our planet and today's living species as we currently understand it.

A symbolic setting

A symbolic setting has been created to guide our distant descendants in the discovery of our present and of its meaning. It is also a way to enhance the imagination of us today thereby inciting the largest number of people to participate in this common endeavour.

1- During its first years of flight, the Archeological Bird of the Future will fly and glide like a large migratory bird. Indeed, shape memory alloy junctions will impose to the wing-shaped solar panels to move down when the satellite enters Earth cone of shadow and move up again when back in the sun.

2- Upon its return, right before landing, the Archeological Bird of the Future will create a sort of artificial aurora borealis, which should catch the attention of our distant descendants. Indeed, while crossing the dense layers of the atmosphere, its specially prepared thermal shield will heat up and create a large visible stream of light in the sky.

3- Once landed - be it on the ground or in the sea - the Archeological Bird of the Future should be able to convey immediately to its finder the idea of its preciousness. Its upper internal envelope which should be visible at first sight will offer an engraved view of today's Earth : it will depict today's contours of seas and continents that will have changed with climate alterations and geological shifts.

4- Once their curiosity triggered, our distant descendants will hopefully pursue their investigations … At the core of the satellite, they will find a first glass plate depicting portraits of men, women, and children of today. That will give them a view of the various races existing at the dawn of the third millennium, which will have blended together through the numerous love stories to come.

5- Next to it, they will discover an diamond holding four precious gifts : a sample of sea water, a sample of the air we breathe, and some fertile soil, attesting to the present state of the key elements without which we would not exist, and as testimony for ourselves, a few drops of human blood containing our genetic signature. Furthermore, the DNA double helix, common ground to most life forms, and a DNA sequence specific to Homo Sapiens will be engraved on one of the diamond's facets.

6- Following their search, our distant descendants will find a second glass plate specifying the location in the sky of several radio pulsars and their current rotation speed. If they master technologies at least as "sophisticated" as ours, they will be able to calculate by comparison the date of the Archeological Bird of the Future launch.

7- After this "initiatory" passage, they will find two distinct piles of glass discs, the first one containing our "Library of Alexandria" and the second one our utmost present, the "Fresco of Messages", sort of instantaneous photography of the human thinking sphere in year 2000. An explanation on how to read and decode them will be included in "easy-access" symbols.

Imagining that a satellite will come back in 50,000 years to deliver our messages on Earth may have been sufficient to have us reflect and write differently about ourselves. But making it happen for real renders it all the more powerful and attractive. This is made possible through state-of-the-art technologies and thanks to the will of men and women, who choose to combine their capabilities for the sake of this endeavour.

II- TECHNICAL FEASIBILITY AND PARTNERSHIP

Approached in 1996, Aerospatiale soon decided to take up the challenge and undertook the feasibility study of this project with the help of Sup'Aero engineer students.

The technical challenge of the project is to guarantee the reentry, the recovery and the information delivery after a duration of about 50,000 years. The first step is a technical analysis to study the feasibility of the project with state-of-the-art technologies.

II-1 General analysis

The life cycle of the Archeological Bird of the Future (OAF) project presents 5 phases with each specific problems to analyze

- storage and launch : launcher interfaces
- ballistic phase : choice of the starting orbit and impact of radiation, micro meteorites and space debris on the OAF payload integrity structure.
- atmosphere reentry : definition of heat shield system
- impact : structure integrity, buoyancy
- information delivery : procedure to decode the message

The first part of feasibility study focuses on the two main points, the definition of the starting orbit and the OAF probe design structure, coupled with the mission duration analysis.

Main specifications were defined as follows:

- Payload : 80 Compact-Discs, 1 decoding procedure (volume equivalent to 10 CD), 1 diamond, 1 dating system, 1 glass plate (figure 1 : payload configuration - diameter about 200 mm)

• Probe mass and volume : target V = 600*600*800 mm, M = 80 kg

• Impact velocity : no more that 100 m/s

• No active system

A first quick technical loop indicated that the more robust shape for the probe is the sphere due to its insensibility to impact and flux direction. The analysis of the wings feasibility showed that the realization with state-of-the-art deployment systems for satellite presents low problem.

A first list of materials for the probe structure, based on their aging capability, was defined and we selected metal and ceramic material to have best potential versus project goals.

II-2 starting orbit choice

The choice of the orbit is a compromise between different parameters :

• the duration of the mission

• the capability of the structure to sustain radiation, micro meteorite and debris impacts.

• launch possibilities

To minimize radiation problems we need to be under Van Allen belts (under 2000 km of altitude and 60° of inclination). The debris concentration is at its maximum at low altitude and in geosynchroneous orbit but there are some hollow regions between 1000 and 1500 km.(see figure 2)

To initiate study of parameters, we selected a circular orbit (1400, 52°) that would limit the radiation effect and that is often selected for satellite constellations (launch access).

The duration of the mission will depend on altitude injection, orbit eccentricity , mass and surface of the object.(see figure 3). Therefore we needed a first design of the object to estimate the total duration of ballistic flight. We supposed that the wings would come off after a decade and these effects were neglected for calculation of the total mission duration.

II-3 Probe preliminary design

To define a preliminary design of the probe structure we needed to study the protections against radiation, micro meteorites and debris, reentry flux and ground impact.

II-3-1 Radiation hardening

The total dose during 10 years at 1400 km of altitude is 80 Mrad behind 20 mm of aluminum (see figure 4). We supposed this value constant during the entire mission. Neglecting the bremsstrahlung effect and taking into account the ionization effect, the hardening capacity of material is proportional to its density. So the material with higher density leads to smaller thickness.

To minimize OAF mass and diameter, to minimize reentry heat shield thickness, we selected a shield of 3mm of tungsten. The payload behind such a shield is exposed to 8 10E9 rad. (The radiate test on the CD is in progress)

II-3-2 micro meteorites and debris

II-3-2-1 micro meteorite flux and velocity

The table figure 5 shows the number of impact and the probability of impact versus micro meteorites diameter for 50,000 years of flight and a probe diameter of 500mm. We noted a large number of impact of small particles and a very low probability of one impact with a large particle (D>1cm). The average velocity is taken to 20 km/s.

II-3-2-2 debris flux and velocity

If we extrapolate the classical model of flux (increase of 5% per year for new debris, increase of 2 or 4% by impact), the number of impact with large debris (>1cm) would too important to give a chance to OAF to survive. This project emphasizes the catastrophic impact of debris increase for safety in space.

To go ahead and analyze this impact, two hypotheses have been made : no new debris in space beyond 2101, and beyond 2051. Figure 6 and 7 present the flux of debris and probability of impact versus these two hypotheses.

We realize that only the second hypothesis is reasonable to have a chance to built a shield that could protect the probe. So if we continue to increase the number of debris so quickly beyond 2051 the chance of OAF success is very low.

The average velocity of debris is taken to 10 km/s (for 14 km/s max.)

II-3-2-3 shield design

A parametric study lead to select a multi-shock shield with a minimum of three bumpers (aluminum and nextel/kevlar tissues- thickness 2mm) and an internal skin (aluminum or titanium- 10mm). The total thickness of the shield is about 100 mm. This conception is based on COF MDPS experience.

It's a preliminary design that needs to be improved through a more precise study on probability of impact versus probe diameter, and material behaviour study versus multiple impacts and aging.

II-3-3 reentry shield

A parametric study of trajectory was made for several OAF configurations (mass and diameter). We obtained: from 70 to 150 m/s2 for the maximum deceleration, 50 to 135 m/s for ground impact velocity, and 5 to 15 mn for reentry duration. The maximum heat flux ranges from 1 to 3.5 MW/m2. These values are classical in reentry vehicle design and don't present any specific problem.

II-3-3-1 heat shield design

The limit temperature for the payload was fixed at 250°C.

First computations showed that the debris shield was blown out at high altitude (between 120 and 100 km).

The concept selected (see figure 8) for the heat shield is a multiple skin based on carbon/carbon material in the front (absorb the flux with ablation until the altitude of maximum of flux-thickness 10mm), tungsten material (radiate shield + reentry material- thickness 3mm), two type of insulating material (based on carbon foam with different density- total thickness of insulated materials 130mm) and finally a structure with titanium material (thickness 3mm)

II-3-4 Ground impact study

No specific study has been made but we selected a compact architecture and material (titanium and foam) that have been qualified to more than 100g ground impact.

II-3-4-1 Mass and volume

With concepts define thereunder, the total mass of OAF is 178 kg, the diameter is 770mm.That leads to a duration of ballistic flight of 57000 years and a final density of the object on the ground is 0.852. Therefore the buoyancy is acquired.

This concept seems to be robust but is far from target mass of 80 kg.

So several configurations are under study to optimize OAF mass.

• off-centering of the gravity center (see figure 9)

This configuration leads to off-centering the center of gravity to create a rotation and a stabilization of the OAF which presents a defined side to the reentry heat flux. That allows an optimization of insulated material thickness and a decrease in mass and in diameter of the probe. We estimated a reduction of 75kg for the mass and 70mm for the diameter.

• splitting of tungsten shield

We can optimize the tungsten shield by keeping the minimum for reentry shield (1mm) and the remainder would be just around the payload. The mass reduction obtained is of about 20kg.

• increase of temperature limit of the payload

The increase of limit temperature of the payload from 250 to 350°C (that is the continuous limit temperature of the CD) permits a mass reduction of 50kg.

Therefore the potential of mass reduction is about 80 kg versus robust solution and the target of 80kg isn't impossible to realize. For diameter the limit seems to be about 700mm.

With these design and the starting orbit near 1400km of altitude a duration of 50,000 years is a most probable case.

II-4 Conclusion of the technical study

The realization of OAF probe seems to be realistic with state-of-the-art technologies, and preliminary design leads to a probe of 80 and 120 kg in mass and of about 700mm in diameter. The estimated duration of the ballistic flight is about 50,000 years.

The main problem remains debris impact because an increase of debris number beyond 2051 would be a problem for the safety of the probe. In this case the possibility to inject OAF on a higher altitude orbit (around 1800 km) could be a back-up solution. A great effort must be done during probe development to test current concepts of shield versus multiple impacts and aging.

The other aspects, reentry impact, buoyancy, seem to be feasible based on AEROSPATIALE state-of-the-art know-how on reentry vehicle.

The project is going ahead with an analysis of the OAF development and more detailed design of the probe.

As of today, several companies, institutions and engineer schools have confirmed their interest in participating in the realization of the satellite, namely Aerospatiale, CEA, Digipress, Ecoles des Mines de Paris and Sup'Aéro.

In order to preserve the full transparency towards the public, this project has to be kept far from any commercial aim, thereby preventing itself from any criticism of a possible better use of the funds it would have required. All partners have very well received this requirement and agreed to offer their distinctive competencies for sake of this endeavour, for it to be a real present from a group a men and women to the entire human community. Any partner willing to give time and skills to help ensure the success of this project is very welcome to join.

III-INTERNATIONAL COMMUNICATION

Next to the technological challenge, this project has also to take up the challenge of giving to everyone an equal chance

to participate in this collective endeavour, despite the differences in communication infrastructure and in level of illiteracy among the populations.

The first public presentation occurred last May at Unesco Headquarters within an exhibition entitled "The Sciences in Art". It was followed by a 4-month exhibition at the Musée de la Découverte in Paris. Both experiences have confirmed the public's astonishment and interest in such a project. The short term objective - reflection on oneself and one's society - is easily understood ; if the personal answer to the question "What will your message be?" appears as a difficult task, it is mostly taken as a challenge and understood as a personal responsibility, all the more so that the desire to read other people's messages is strong. In August, the International Youth Days gathered up to 1,000,000 young people from around the world : they were an occasion for us to "test" if this project was equally well received by different cultures. Fortunately the answer was yes. They were spontaneously enthusiastic about the idea, didn't question much the feasibility and are very drawn by the possibility the project offers them to express their aspirations or their deceptions about society and to be heard.

It is now time to gather benevolent energies to insure a worldwide communication campaign and collection of messages: translation of the project into the appropriate cultural metaphors, elaboration of communication medium, identification of "spokespeople" who would endorse the project thereby prompting their compatriots to participate, involvement of institutional and informal media, federation of numerous structures enabling a large collection of messages (associations, churches, schools, universities, post offices, embassies, internet, …).

In this respect, we have already received the encouraging support of prominent people such as Ilya Prigogyne in the scientific field or Agusto França in the arts community, who are willing to help increase the public's awareness. The BDDP Group has joined in taking charge for the conception of the necessary communication products and Babel@stal for the design and realization of our website, which will open January 98. Discussions are underway with as diverse non-governmental organizations as the Unesco Clubs and Schools, the Federation of Rotary Clubs, International Business Network, the Vatican and the Muslim World League, to maximize the possibilities for each inhabitant to hear of the project as least once.

Bottle to the sea intended for our distant descendants, at the crossing of the symbolic function and the current technological know-how, the Archeological Bird of the Future means to create in his own manner an élan among the men and women of today.

This project is a vivid demonstration of how technology can serve poetry and of how by combining their state-to-art know-how skilled people can serve the entire human community.

At this stage of its realization, we would be happy to integrate any professional person, company or institution willing to offer their competences. Participating in an endavour destined to all human beings and representing such a technological and communication challenge has shown to be an incredible source of motivation, non only for the professionals directly involved, but also for all employees of our partners. Furthermore, the group of partners is slowly becoming a new club of its kind, where relationships build on a common vision and a common pride to take part in a project realized far from any commercial aim, and projecting us into the future with hope and enthusiasm

Cet article a été écrit en 1997. Depuis lors, les ingénieurs civils et militaires ont dans sa version technique la plus récente ramené la masse de « KEO, l'Oiseau Archéologique du Futur » à moins de 100Kg.
En 1997, il avait été imaginé lancer KEO en 2001 mais la durée de la collecte des messages à travers le monde ainsi que sa mise en orbite ont été décalées.
Se reporter au site www.keo.org