



A (C)osmosis Art
in-between Disciplines

Edited by

Ioannis Michaloudis and Yuri Tanaka

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INTRODUCTION

FRANK WHITE

“Space” has many meanings.

To some, it refers to Earthly things, like the distance between people and places. During the recent coronavirus crisis, this definition became critical, as we were told to practice “social distancing.” In more normal times, “space” can also refer to individuals singly, as in “personal space.”

However, to a select group of artists, space refers to something else entirely, i.e., the cosmos, the universe, everything that is *not the Earth*. These artists focus their work on a field simply known as “space art.”

As I wrote in a 2019 paper for the International Astronautical Congress (IAC), “space art” has been around for a very long time. If we include *writing* in our definition of the arts, we can find evidence of early “science fiction” dating back to Ancient Rome and the Renaissance:

Some observers mark the beginning of science fiction with the ancient Sumerian epic, *Gilgamesh*, while others suggest this genre began with the scientific revolutions of the 16th and 17th centuries. Johannes Kepler himself, one of our greatest astronomers, wrote a fictional description of a trip to the moon called *Somnium*.

Closer to our own time, Chesley Bonestell pioneered “space art” with his depictions of a potential human future in the solar

system, complete with multi-stage rockets and space stations. In the mid-1950s, his illustrations of Wernher von Braun's space exploration vision gave a huge boost to the idea of an American space program¹.

When we look at both the past and the present, we can clearly see that artists are drawn to portraying space exploration and the human place in the universe. Perhaps this is because they are charged with the mission of all the humanities, which is to interpret what it means to be human. That meaning cannot possibly be described without dealing with the universe, cosmology, and in a word, "space." Being human means something specific if you believe the Earth is the center of the universe and that human beings were created by a divine force—the perspective of most people until the Renaissance dawned in Europe. It means something else altogether if you believe that the Earth is a small planet at the edge of the Milky Way galaxy and there are billions and billions of other planets in the universe, many of them capable of supporting intelligent life like us—which is today's perspective.

Science and technology are the driving forces in shifting our worldviews as they consistently transform our knowledge of the cosmos and our identity as a species. The Overview Effect, which I have spent more than three decades investigating, is an identity-shifting experience that many astronauts have shared with us surface dwellers. When in Earth orbit or on lunar missions, they see our home planet and the cosmos from a distance, an experience unique in human history. As my colleagues and I often say, they see the Earth "from space and in space."

¹ Frank White, *The Overview Effect and the Arts*, Paper presented at the 70th International Astronautical Congress, 21-25 October 2019, Washington, D.C., United States. cf. www.iafastro.org

The view of the Earth “in space” has been somewhat neglected until recently. The astronauts not only see the Earth uniquely but they also view the universe in a special way, especially when they travel to the Moon.

A number of artists have found the Overview Effect to be a topic of great interest, and there are numerous paintings, videos, and even symphonies called “the Overview Effect” or some variation on that theme. However, the “Overview Effect genre” is really only a subset of this much larger category of space art.

This book highlights the efforts of several artists to make sense of the human place in the universe through art. In reading about their work, it is not difficult to conclude that “The cosmos is art.”

The Artists

Ioannis Michalou(di)s (co-editor)

His artistic sensibilities have guided construction of the volume from the first day. Like the other practitioners featured here, his creations are powerfully connected to space exploration through “aerogel.”

Developed by NASA to collect stardust, these substances are 99.9 percent air and .1 percent glass. Michaloudis states that the resulting “aer () sculptures” transcend the limits of Euclidean geometry and open up the possibility to represent the space of Poincare and Picasso.

He says further that he was “looking for a cloud and found heaven.”

Yuri Tanaka (co-editor)

Yuri Tanaka's work derives from her interest in a wide range of topics: the universe, mediation, "concealing beauty," and the "art of life."

She sees "the universe" as "everything," including all of nature and humans within the natural world. An interest in mediation for conflict resolution led her to mediation among diverse disciplines to create artistic installations evoking the experience that we are human beings in a universe that is alive and beautiful. She draws on a longstanding Japanese artistic tradition of "concealing beauty" to reveal this reality for all who are willing to see it.

Tanaka's work reflects her notion of "the art of life," which suggests that lived experience is itself art and that what we call "art" as something separate is a misnomer.

Her installations, almost all of which are located outside, reflect her transdisciplinary philosophy, involving engineers and collaborators with multiple skill sets. With Tanaka's encouragement, all of them become artists!

Arthur Woods

Arthur Woods offers the reader a comprehensive view of his own artistic journey, opening his essay with an analysis of humanity's efforts through the centuries to understand our place in the universe through cosmologies, at first supernatural, later scientific. He then describes how he grew up near Cape Canaveral and watched hundreds of rocket launches, including those of the Apollo program. Perhaps it was inevitable that his work would center on the cosmos.

Woods' artistic expressions emerge from his own cosmological musings, from his concept of "Greater Earth" (a grand extension of the physical Earth) to his idea of "The Space Option" (an evolutionary plan to meet the needs of humanity through space-based resources).

Among his more audacious projects was OURS (Orbital Unification Ring Satellite), a structure that would always be visible in the sky to symbolize unity and oneness.

While OURS never came to fruition, another project, Cosmic Dancer, made it to the Mir Space Station in 1993. Woods is clearly both a student of cosmology and an extremely talented space artist.

Dan Goods

While visiting NASA's Deep Space Network site at Goldstone, California, Goods experienced an epiphany. While staring at the large white antenna that sat there in the middle of the desert, he realized that it was sending and receiving signals that were far, far from the Earth. As just one example, the Voyager probe was, at the time, on the edge of the solar system, some 11 billion miles from where he was standing.

This moment propelled him as an artist on a quest to somehow visualize the two-way "conversation" that was going on between the antenna and the spacecraft. Would there be a way to represent that discussion visually or through sound, he asked. It took years, but ultimately resulted in three projects that use sight and sound to communicate something profound about our spacefaring machines, and their messages to Earthlings as they probe the depths of the universe.

Charles Ross

One word comes to mind in contemplating the work of Charles Ross: monumental. That is because the specific work featured in this book, "Star Axis," is indeed a *monument*. Rising out of the New Mexico landscape, it recalls the pyramids and ziggurats of the Aztecs, Mayans, and Babylonians. Like those earlier monuments, this one links the Earth to the heavens through its design and positioning on the Earth and in relation to the stars and planets above. The artist offers Earthbound humans a chance to uniquely experience the cosmos, with special reference to Polaris, the North Star.

The monument includes four chambers, "each with its own distinct energy." The Star Tunnel is at the heart of it, a stairway aligned precisely with the axis of the Earth. As you climb the stairs, you see an opening that frames increasingly larger circles in the sky, representing an orbit of Polaris in the 26,000 year cycle of Earth's alignment with the stars.

Ross says, "I realized I had to build Star Axis when I discovered that Polaris pulses in the human visual field." For Ross, the stars may be far away, but they are not inaccessible to us.

Richard Clar

The motivation driving Richard Clar's art is breaking through limitations and boundaries, and the limitation that all humans on Earth experience daily is gravity. The only people in the universe who, at this moment, are free from what we call "1-g" are those on the International Space Station! Thus, all Earthbound artists work within the constraints of gravitational forces. Clar says in his article:

For nearly four decades, my art has challenged the limitations of gravity...As artists, it is incumbent upon us to break free of

the boundaries that limit artistic expression.

Clar's work has taken many forms, but it always involved human exploration of the space environment, and often involved working with NASA to realize his vision.

From the "space dolphin" he hoped to launch as part of the Space Shuttle "Getaway Special" program to a visual representation of the space debris that is dancing around our planet to bouncing a recording of Neil Armstrong's heartbeat off the Moon, Clar sees boundaries as something to overcome in service to his art. And overcome them he has.

Sarah Jane Pell

It has often been said that all of us are the astronauts of Spaceship Earth. If this is so, how can we experience this reality when we exist within the gravity well of Earth, comfortably protected from the vacuum of space by our atmosphere?

Sarah Jane Pell has taken the challenge to heart, it seems, as she considers herself to be an "artist astronaut." Though she has (not yet) left planet Earth, she sees her terrestrial practice of art to be "performing astronautics." In pursuit of her quest, she has commanded and participated in analogue missions that reproduced, as nearly as possible, the conditions of outer space. She looks ahead to "Humanity 2.0," a new kind of human being adapted to the extreme environment that confronts us once we depart from the cocoon of our home planet. Pell never strays far from the physical, from the reality of being "embodied" and, in her words, "The artist astronaut asks new questions of the body in time/space," a body that may evolve in unexpected ways as it experiences the cosmos.

María Edwards

In a different format from the other sections in this book, María Edwards is interviewed by Alexia Talia to reveal her process of creating art and how it relates to the cosmos. For Edwards, “space” is that which lies between objects, and that which gives them relationship. She is fascinated with what she calls “the void,” which she wishes to represent, without invading it.

For this artist, “time” also has a dimension of space, as the distance between what she calls “indivisible moments.” As one experiment in time, she returned to New York City, where she had lived for four years. In forays throughout the city, she attempted to reproduce the earlier experience in one month and nineteen days.

Not to be limited to one place on the Earth, Edwards created a global work that involved “building an instrument that could connect distant times and places. It consisted of 11 swings installed in 8 European countries; 3 observatories in Northern Chile; and a piano in Austria as the sounding board of this fragmented instrument.” For Edwards, the entire planet becomes her canvas.

Lumen Studios

Lumen Studios, a collective influenced in part by my work on the Overview Effect, (an honor, thank you) chose to curate an exhibition of “Cosmic Perspectives.” While the Overview Effect is a concept that transports us out of our usual views of the universe, allowing us to see the Earth in space and from space, “Cosmic Perspectives” expand the discussion even further, allowing us to consider the universe itself, not only as a spatial construct but also in an “overview of time.”

Lumen decided to make the title of their show plural to account for the many voices that would speak to this theme, in this case, 50 interdisciplinary artists. In other words, while one might expect that there is *a cosmic perspective*, the artists asserted that there are many perspectives, each depending on the perceiver, and that this openness to interpretation sends a message for our moment in time.

This volume considers the works of the artist/curators for the exhibition. They demonstrate deep concern with non-hierarchical structures and decolonization on the Earth as well as significant interest in the human relationship to the cosmos. As above, so below.

Summary

For many years, we have perhaps felt that describing outer space, the universe, the cosmos, is best left to scientists. We tend to think they understand the speed of light, black holes, and dark matter, after all (although they might admit that they don't!). However, the time has come, it seems, when artists are taking their rightful place as interpreters of the human experience of space with a capital "S." Is it possible that the structure of outer space is accurately reflected in the inner space of the artistic mind?

Read on!

I

(C)OSMOSIS ART

IOANNIS MICHALOU(DI)S
YURI TANAKA

The relationship of humankind to the cosmos has a very long history, and has raised many more questions than can be adequately answered. In the contemporary setting, some such questions can be cast as follows. Why has the cosmos been a source of awe and wonder for humankind since the beginning of human history? How are the arts of today related to our engagement with the cosmos? Who are the contemporary practitioners working in this field?

While this book represents a comprehensive attempt to respond to such questions, it also raises numerous others. Paradoxically, the more irrational such questions may seem, the greater the need for an idea such as *(C)osmosis Art*. This is because this anthology does not present a singular thesis on the topic of arts in the era of space science and exploration. Rather, through its parenthetical play on the terms 'cosmos' and 'osmosis', it proposes a radical opening up of new interpretive pathways between the multidisciplinary fields which constitute space science, and art which takes the cosmos as its broad theme.

The impetus for this anthology is to present both science and art as allegorical endeavors driven by experimentation, innovation and speculation. From the poetic mythology of Icarus, to the scientific rigors of rocket technology, the artworks and philosophies presented in this book clearly show the nexus between art, science and technology. Artists/researchers who have both been dedicated to the subject of cosmic art will edit this anthology, which will be the first publication on this particular theme for a general audience. Through the writings of the artists, we initiate a discourse on art inspired and driven by the fact that, from now on, we are enthusiastic observers of our Earth and the universe surrounding it.

Since the Earthrise photograph of our planet taken by the astronaut William Anders during the Apollo 8 mission in 1968, we have seen ourselves differently. We have been able to reduce enormous distances, expand our thinking and attempt to embrace the entire universe, open new cosmic vistas through the Hubble Space Telescope and create a plethora of new communications. These developments require a radically different artistic language able to identify and express new perspectives, concepts and opportunities. We expect this book to act as a point of departure, engendering the exploration of new artistic expressions.

Furthermore, by proposing the syncretic idea of *(C)osmosis Art*, we aim to introduce a new conceptual framework inspired by the interactions between art, science and technology. *(C)osmosis Art* is an invented word which combines the terms 'cosmos', 'osmosis' and 'art'. 'Cosmos' signifies the entire universe, both visible and invisible – as well as the ideas of causation, consequence and contingency. 'Osmosis' denotes the movement between semi-permeable boundaries

and the diffusion of elements in the search for equilibrium. We are convinced that art operates through the membrane of allegory to produce complex meanings subject to the constant play of disruption and equilibrium – across boundaries and between disciplines, and able to generate numerous interpretive possibilities.

II

(C)OSMOS IS ART:
THE OSMOSIS BETWEEN SCIENCE&ART
AS A CREATIVE TOOL

IOANNIS MICHALOU(DI)S

Prologos

Pythagoras called the universe "cosmos" which means jewel in Greek. Cosmos encompasses paradox, so does art. Earth's atmosphere as the last layer of planet Earth could be considered like a diaphanous membrane protecting (but also connecting) our home planet to cosmos. For the author, imagination is a semi-permeable membrane uniting art and science through osmosis. As an artist, but also as a researcher and educator, I trust that the involvement of science and technology in art is not only beautiful but also defined to reshape the world in which we live in search of originality. Art should have innovation as science should have passion. Artists are the most influenced by the surroundings around them and thus, through their endeavors to express this, they use unexpected mediums and materials. With this perspective, I present here some of the practice of my work based on a technological medium used by NASA as a thermo monotonous nanomaterial to capture interstellar dust. To explore this nanomaterial named silica aerogel, I create sculpts from this, the lightest material in the world, thus enriching science's

messages from an artistic point of view. My objective is to explore the intangible and see it taking form in a substance that has no space. Nevertheless, you need more than all of your senses if you wish to “touch” it. This article explores, through various works made of silica aerogel, the osmosis between the cosmoses of art, science and technology as three inseparable domains.

Artistic Development and Realization

The author was invited in September 2001 by the artist Otto Piene, founder of “Sky Art,” and Stephen A. Benton, physicist, inventor of the “rainbow hologram” [1] and ex-Director of the Massachusetts Institute of Technology’s Center for Advanced Visual Studies, to conduct post doctoral artistic research with the title (*Nephele*)³: *Nephele to the third power*. In Greek *nephele* means “cloud,” and the objective of this project was to realize what seems unrealistic and crazy: a cubic cloud, a cloud delimited in space by six invisible planes. For this research, the author had received a Fulbright Grant and a Research Scholarship from the Hellenic Government. During that collaboration with scientists and engineers at MIT, the author had the chance to see a small piece of silica aerogel. “. . . I was so surprised by the appearance of something that one is not quite sure is there! To believe your eyes, you need your hand, not only to touch, but also to handle, to move around, to press the material... thus you discover that this “frozen smoke” is so lightweight and delicate.” Immediately, I thought of creating immaterial, ethereal sculptures with it. I knew nothing about aerogels, and the difficulties of its expensive fabrication, but I was certain that I had something important to do with it. I was looking for a cubic *Nephele* and I found the sky itself!...” [2].

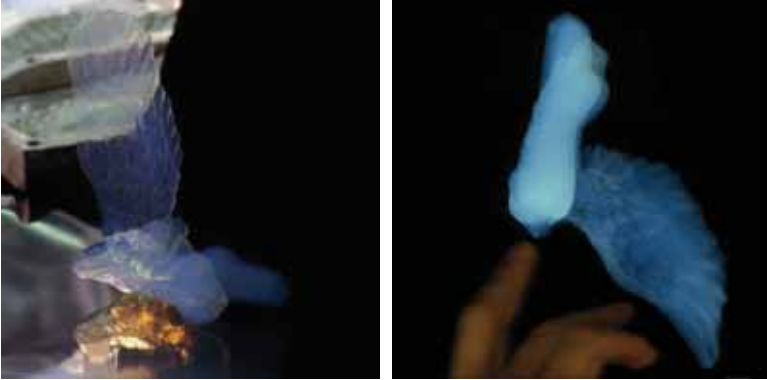
In September 2005, the double vessel of a 20 L high-temperature supercritical drying system (Fig. 2-1) was installed in a workshop in Greece under the author's responsibility. The setup was made by Dr. Michael Droege (Ocellus Technologies, CA, USA) who trained the author. Since then, all his *aer()sculptures* have been created in the 20 litre vessel (diameter of 24 cm and height of 42 cm). The small vessel of one litre is for sampling, research and development. Using a new,



Fig. 2-1. The artist is opening the 20 litter high-temperature supercritical drying reactor after a continuous 48 hours run. The vessel was installed in Greece, September 2005, and all the *aer()sculptures* have been created since then in it (photograph and copyright: Massimo Pizzocarò 2/2008).

two-step condensed silica process, Ocellus Technologies produces a light aerogel that contains 99.98% air. Ocellus make silica aerogels in a patented process that begins with a partially hydrolyzed silica solution to which they add water, a solvent, and a basic catalyst to form a gel. They then remove the solvent by supercritical conditions in an autoclave and replace it with air. This process takes a few hours; other methods can take days or weeks. Moreover, the process is flexible enough to let us produce aerogels with a wide range of densities from 0.7 to 0.001 g/cm³. These data and the equipment we see in Fig. 2-1 indicate that even the 'production of ethereality' is dependent upon the heavy 'materiality' of an apparatus and process used for supercritical drying [3].

Functional materials usually find uses in technology. The author's writings are therefore, quite unusual for scientific and technological publications, as he presents a series of silica aerogel-based *aer()sculptures* realized since 2002. No hypothesis is obvious in his papers... Instead, repeated concepts are resemblant of silica aerogel - a strange eerie substance, unfamiliar and alien. This material is the lightest solid on Earth and is used by NASA as a heat insulator for spacecraft and for the collection of stardust. Silica aerogel is indeed a remarkable substance: some 99% air and 1% glass. Silica aerogel is an amorphous form of common sand which is nonflammable, nontoxic and environmentally safe [2]. Also, it has an extraordinarily low density, averaging at 0.1 g/cm³. Its lightness is ethereal, and is a property that provided to the author an advantage in his quest for omni-absence. When one encounters silica aerogel, particularly for the first time, one is compelled to touch it, to know it by extending her/his eyes to the fingertips. It is a substance that excites curiosity and projects mystery.

-Icare... I care / 2002

Figs. 2-2 and 2-3. Michalous, *-Icare... I care*, silica aerogel, 2002, CA, USA, © Michalous.

The first *aer()*sculpture, made from this ethereal material was '*-Icare...I care*', (Figs. 2-2 and 2-3) and was realized in collaboration with Dr. Michael Droege, at Ocellus Inc in California. The author took on the myth of Icarus as its subject matter; the famous story of the son of master craftsman Daedalus who constructed for his son a pair of wings from feathers and wax in order to escape Crete and the oppression of king Minos. Daedalus also made himself a pair of wings and tested them before his son took flight. When fleeing the island, he warned the young Icarus not to fly too close the ocean nor the sun, but to follow only in his trail of light. However, the foolhardy boy drunk on the feeling of both liberation and flight soared in the heavens, too close to the sun and melted the wax bonding the feathers to his body; plunging eventually to both the sea and to his death.

Every *aer()*sculpture appears blue only when its background is black. The same optic phenomenon – raylight scattering – explains why our sky is blue, as behind it lays the darkness of

chaos. *-Icare...*, *I care*, is made out of two pieces, the torso and the left wing to represent the first mythological pilot Icarus on his fall from the sky. In this sculpture, the torso is thicker than the wing, and for this reason, when white light scatters at its silica and air components, the torso of Icarus appears more blue/white than the blue/transparent wing. But this natural blue color is present not only of Raylight scattering, but also for a second reason. Behind the wing is a clear background, but behind the torso there is a black background. The *aer()sculpture* appears blue only when its background is black. In other words, the sky is blue because behind it there is the darkness of chaos.

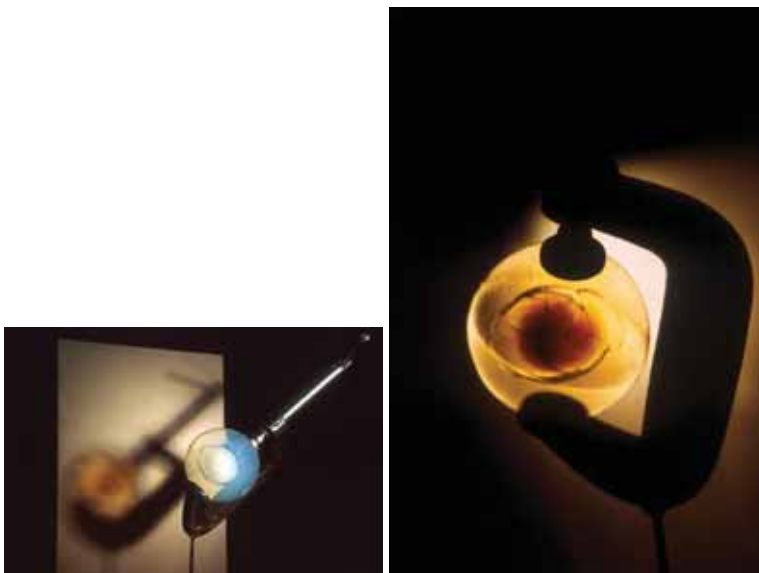
For its creation, the author twice visited Ocellus Technologies in California, in May and October 2002, when these pictures were captured. Using a new, two-step condensed silica process, Ocellus Technologies produces a light aerogel that contains 99.98% air. "We make silica aerogels in a patented process that begins with a partially hydrolyzed silica solution to which we add water, a solvent, and a basic catalyst to form a gel. We then remove the solvent by supercritical conditions in an autoclave and replace it with air. This process takes a few hours; other methods can take days or weeks. Moreover, the process is flexible enough to let us produce aerogels with a wide range of densities from 0.7 to 0.001 g/cm³" [4]. In his first encounters with aerogel, the author found the ecstasy of Icarus. Through this material, he soars into the heavens and touches the sky.

A Portable Sunset | 2002



Figs. 2-4, 2-5, and 2-6. *A Portable Sunset*, water vapors, hydrophobic silica aerogel, ©Michalous, 2002, MIT, MA, USA.

The work *A Portable Sunset* (Figs. 2-4, 2-5, and 2-6) shows another successful experiment at MIT. There are two reasons for the title of this work. The first, obviously, is the Mie scattered sunset color of all three images (which is obtained by keeping a piece of hydrophobic silica aerogel between a white light and the camera). The second reason for the title is that hot water vapors were imprisoned within the mesoporous structure of this sample. These vapors had created a lenticular cloud that completely disappeared after 9 min (the series of three photographs were taken 3 min apart). In every *aer()sculpture*, the orange–gold hue can appear if we keep the sculpture between our eyes and light; then the sculpture has an orange and not a blue hue [3].

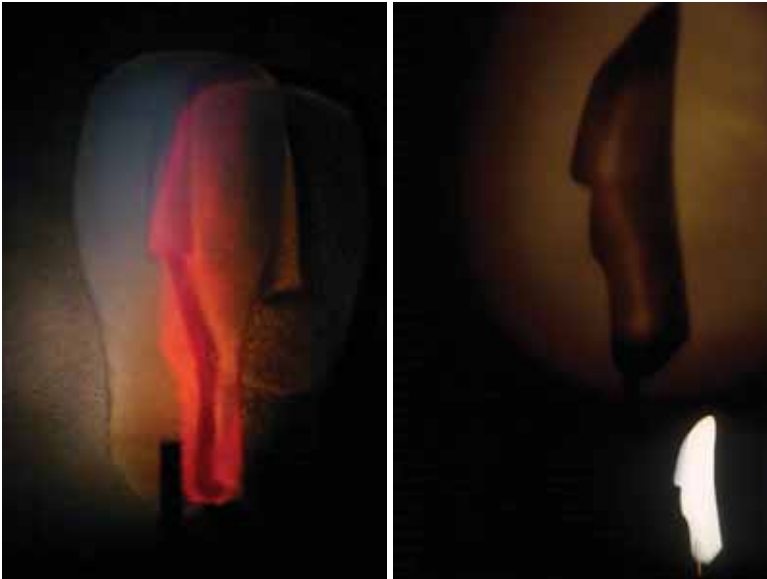
E(r)gonomic | 2003

Figs. 2-7 and 2-8. *E(r)gonomic*, silica aerogel & C-clamp, Alexandria, VA, USA, © MICHALOUS, 11/2003.

For the work *E(r)gonomic* (Fig. 2-7) we had used a C-clamp to hold a sphere of silica aerogel of a diameter of 50mm. The center of this sphere was intentionally not supercritically dried well. As a result, the center of the sphere remains white, a transparent white. Thus, the white center becomes a gold-orange one, once the light transpierces it (Fig. 2-8). The above inspection of our aerogel sculptures and their exotic beauty - deriving from the same natural phenomena that create the colors of the sky - drives us to our first conclusion that every *aer()sculpture* is made out of light! And that is because the 99.98% of air that every sculpture contains is not free, but captured forever in all these open nano-pockets of silica, into all these billions of transparent "silica parentheses". Therefore, thanks to the supercritical drying, the glass foam forming our sculptures

will not be ephemeral [2]. After the formation of the gel, supercritical drying will alchemize the evanescent beauty of silica bubbles into a frozen-forever magnificence. Only this process - and the photography - can capture and keep for evermore the short-lived foam beauty. The 0.02% of silica and the supercritical drying can metamorphose the silica's nothingness into ethereality.

MneC₂H₅OH (Mnemonic Ethanol) | 2003



Figs. 2-9 and 2-10. *MneC₂H₅OH (Mnemonic Ethanol)* Cambridge, MA, USA, © MICHALOUS, 2/2003).

The work *MneC₂H₅OH (Mnemonic Ethanol)* (Figs. 2-9 and 2-10) shows how peripheral light transpierces and embraces the silica aerogel sculpture. This sculptures form is derived from the head of a Protocycladic small idol made around 3000 BCE. We kept the same form, but changed the material from marble to

silica aerogel. By exchanging the heavy white marble with the ethereal blue silica aerogel, we give this almost archetypal form the impression of a cloudy cultural memory. In Fig. 2-9 we can perceive three colors and three shapes. The silica aerogel sculpture is on the left side of the picture, positioned on a black aluminum rod to help the display the sculpture. The attendees of the 7th International Symposium on Aerogels may remember that $MneC_2H_5OH$ was on display in the main lobby of the hotel and a red laser line scanned the *aer()sculpture*. The result of this red laser scanning is the reddish profile we see in the middle of Fig. 2-9. As far as the well-detailed orange head seen on the right of the photograph in Fig. 2-9, this is the Mie-scattered paradoxical shadow-projection. Thus, by using a white light and a laser beam we can have three different images and colors from the same *aer()sculpture*. Our sculpture has more than one image and it is hard to understand which of these images is the real one (if reality means materiality). And each of these images refutes oneself: as silica aerogel is doing the same [2].

A Piece of Sky Between Your Fingers | 2004



Fig. 11. *A Piece of Sky Between Your Fingers*, hydrophobic silica aerogel, water, India, 2004, ©Michalous.

A Piece of Sky Between Your Fingers (Fig. 2-11), is the first successful experiment of creating a cumulus cloud within a fragment of hydrophobic silica aerogel, exploring the enigmatic idea that a cloud can be held between one's fingers. This scientific test, into the nanostructure of silica aerogel, was a serendipitous research 'accident' during my residence at the Physics Department of Shivaji University, in Maharashtra, India. We understand that the blue color of the silica aerogel is due to the Raylight scattering and the black background. The white cumulus cloud in the sample is created using water vapors, and is the same atmospheric phenomenon as cumulus clouds which are formed near mountain peaks [3].

The artist work in small-scale with the material silica aerogel in which a sense of vast space is captured. Like spiritual talismans,

these works are powerful not despite but because of their scale - unlike the ancient, tiny stone figurines we can dominate with our comparative human scale. Despite an ability to stand back, and “blot the work out with a thumb”, on close inspection a miniature universe is revealed and the viewer is left feeling very, very tiny [5].

(e.g)gnosis | 2004



Fig. 2-12. *(e.g)gnosis*, silica aerogel plates, aluminum, glass, letters, iron. 220X40X40 cm, © Michalous 2004.

The work *(e.g)gnosis*, Fig. 2-12, is an outdoor installation which was made in 2004 with the kind collaboration of Mr. Jorgen Schultz (Technical University of Denmark) and Mr. Leif Cullberg

(Airglass, Sweden). There are six plates measuring 25X25X1.5 cm and in between them are placed two Greek letters and the personal symbol of parenthesis (), as a letter O. All three double aerogel plates and the letters are forming the Greek word *oon* "egg" that – thanks to the transparency of silica aerogel – can be read also from the end to the beginning as *noo*, I comprehend [11].

Ephebos Head | 2006



Fig. 2-13. *Ephebos Head*, silica aerogel, mirror, fabric, © Michalous 2006, private collection, Bahrain.

The work *Ephebos Head* (Fig. 2-13), also begins to explore the possibility of re-contextualizing the space an artwork can inhabit. In extra-terrestrial space, the frame does not exist. For an artist, particularly a sculptor, the space around an artwork is as important to the conception of an artwork as the work itself. In other words, we frame our images to conceptualize how our sculptures inhabit space [6]. Space informs and interacts with form, giving meaning to the work, and our images do not exist in infinity. Art/science research considers the extra-terrestrial space as a new frame and a new medium for artworks. The author is proposing new possibilities for redefining the traditional roles of scientist and artist by suggesting interdisciplinary collaborations between them. If we choose to shift our perspective, we could leap to the conclusion that there should not be any dichotomous separation between the works of the artist and the scientist. [5].

***Veria Girl* | 2006**

Fig. 2-14. *Veria girl*, silica aerogel, brass, laser liner beam, © MICHALOULS, 2006.

For the *Veria Girl* in Fig. 2-14, a laser liner creates the red “scanning” plane we see. Thus, the bi-dimensional line is transformed in a three-dimensional surface, thanks to the quality of silica aerogel to react as frozen smoke. The *aer(sculpture)* was placed directly into the foundry’s sand where the melted brass was poured all around it [11].

Bottled Sky | 2007

Fig. 2-15. *Bottled Sky*, cf. <http://skyforsale.com> © Michalous, 2007, Greece.

Paradoxically, a cloud is visually ephemeral but substantially enduring. Although a cloud is a collection of water vapor and dust in our sky, we see it as a mass, moving freely and without restraint. It is this phenomenon that makes *Bottled Sky* (Fig. 2-15) particularly striking, because it appears to have captured not only a sky-fragment, but also a cloud. *Bottled Sky* demonstrates the immateriality of the artwork while simultaneously showing the physicality. The edges of the glass tube are invisible against the black background, and as the

viewer, we are unsure where the extent of the product inside (the aerogel) begins and ends: we are left uncertain of the boundary between the material and the immaterial. *Bottled Sky* shows a fragment of the sky captured inside a bottle. The bottle contains a solitary feather cloud that hauntingly “floats” within the solid sky; the bottle veils the fragmented sky. It is a gentle, unobtrusive way to present the sky as it appears to be preserved. Yet it is not. Its angelic presence masks the ecological reality that our own sky is falling into pieces.

The sky rests inside the vessel, like the water within a jug. The water fills the empty void of a vessel. It is in the state where it can be perceived as water, yet it is contained, it cannot flow. Images of water or clouds in the sky bring forth the ideas of movement, freedom and purity. These are qualities which are associated with the absence of control and restriction. If the vessel were empty of water, would it be considered empty? [7]. Surely it would still be filled with air (a substance more elusive than water), which can be described as a kind of invisible fluid. Much like air fills the empty vessel, light fills the cloudless sky. ‘Seeing light is a metaphor for seeing the invisible in the visible, or seeing things in an intelligible form that holds all that exists together but is it self-devoid of sensible qualities’ [8, p. 3]. ‘Silence’, ‘air’, ‘light’ and ‘atmosphere’ are terms given to invisible elements which always surround us. It is not that they do not exist; rather, they linger as imagined realities.

***Bottled Nymph* | 2008**

The artwork *Bottled Nymph* (Fig. 2-16) is made from silica aerogel, which has an ethereal (im)material quality, resembling our sky. The *aer()sculpture* appears blue only when its background is black. The same optic phenomenon—Raylight scattering—explains why our sky is blue, as behind it lays the darkness of chaos. The color and quality of the work speak to this experience of viewing, consciously, the ephemeral nature of our sky and the consciousness that this creates in us as human beings about our relationship and interdependence with our planet. This artwork has been selected and will be rocketed in 2021 to the moon as part of Carnegie Mellon University's *MoonArk* project. The sculpture/capsule will be shuttled to the moon from Cape Kennedy on an Astrobotic Robotic Lunar mission and exist there for potentially billions of years [9].



Fig. 2-16. *Bottled Nymph*, silica aerogel, glass, rubber, aluminum, 22cm×4cm×4 cm, ©Michalous, 2008.

(M)other Earth | 2008



Fig. 2-18. *(M)other Earth* [detail], silica aerogel, golden leaf, stainless steel, 50X10X3cm, ©Michalous 2008, Greece.

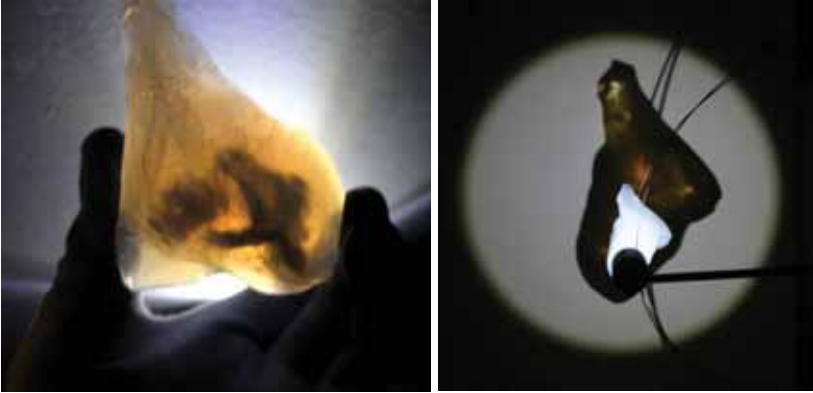
The work *(M)other Earth* (Fig. 2-18), contrasts the enduring significance we place on 'the world', with the impermanence of our existence. Considering the age of the earth, our existence is a mere speck in the expanse of time. Despite this seeming insignificance, and although our existence on this planet is fleeting, it is only possible under the protective veil of the atmosphere. One possible response to this destruction of the atmosphere is through the *poiesis* of new atmospheric domes. Here, the term *poiesis* is given its widest semantic latitude, as both 'poetry' and 'creation'. In Plato's *The Symposium* (205c), Diotima explains how *poiesis* entails bringing into being that which has not previously existed [10, p.42]. In this sense, *logos spermatikos* and *Etherospermia* are combined through the allegory of *(M)other Earth*, and this act of *poiesis* is seen as linking human procreation, the creation of material form and the creation of knowledge [3].

(L)imited Sky | 2008



Fig. 2-19. *(L)imited Sky*. Four liters of small pieces-spores of silica aerogel, birdcage, white LED, 40 x 40 x 25 cm., ©Michalou 2008, Greece.

A “Free-Dimensional” space is suggested through the artwork *(L)imited Sky* (Fig. 2-19). The use of containment is less visually obstructive in *Bottled Sky* than in *(L)imited Sky*, where the sky is caged. The metallic structure obstructs the sky; it restricts its existence. The boundary of the cage has been created by humankind, and undermines the balance of the environment. It is not only the atmosphere that is trapped within the cage, but our balance of existence also comes into question: if we cannot live on Earth, where can we? [3].

***Karditsa's Heart* | 2009**

Figs. 2-20 and 2-21. *Karditsa's Heart*, photographs and copyright: MICHALOUS, 2009.

The work *Karditsa's Heart* (Figs. 2-20 and 2-21), is a permanent museum installation. The idea of a heart made of aerogel was of the artist Ms. Yi-Zhou. In August 2008, the author tried to make it for her but without success (because of the big volume of the alcogel). In April 2009, Ms. Fenia Lekka, the director of the Museum of the town of Karditsa, asked the author to make an artwork for the Museum. As the Greek word Karditsa means "little heart" (it is the author's native town in the middle of Greece) and to this museum it belongs to the heart of the ever-memorable Greek Prime Minister Nicholaos Plastiras, the idea of a silica aerogel heart came again. With a very slow drying the author created the silica aerogel heart with two clouds in it. On the final display, the heart is placed into the orbits of five planets. Two LEDs illuniates the total: the first one lights the silica aerogel heart and thus creates a golden hue shadow and a second heart. The second LED lights a stainless-steel capsule with the donated heart [11].

Double Sky | 2011

Fig. 2-22. *Double Sky*, silica aerogel, 20X20X10 cm., ©Michalous, 2011.

Thanks to a black and glossy surface behind the sculpture, we can focus, simultaneously, on the magnificent sky-blue and the sunset-orange natural colors of the *Double Sky* (Fig. 2-22). Apart from the sky-blue color observed previously, here we also observe another important color, an orange-gold hue. This orange-gold hue comes from a reflective transparent sheet on which the artwork rests. The shape of the cloud, its reflection, can clearly be seen. However, if this is the sky's mirror-image, why is its color orange rather than blue? Only the phenomenon of Mie scattering can explain this visual enigma. This orange hue results from the light that transpierces the silica aerogel

semi sphere and travels on the top of the plastic sheet, where it is reflected to our eyes as an orange color. In fact, as we have observed in relation to the artwork *Portable Sunset*, if we keep the sculpture between our eyes and a source of light, the sculpture will have an orange rather than a blue hue. It is these natural color characteristics of silica aerogel which give the impression that holding a piece in one's hand, is like holding a piece of sky. Through the creation of fragments of sky, where the ephemeral becomes permanent, ways to replicate different formations of clouds in the silica aerogel that mimic natural cloud formations have been developed. One of our ongoing projects is to realize silica aerogel sculptures in which the clouds appear, move and disappear within the sculpture [3].

My First Time I Touch a Cloud | 2011



Figs. 2-23 and 2-24. *My First Time I Touch a Cloud*, interactive video surveillance installation, Istanbul, ©Michalous 2011.

In recent times, climate change and related 'greenhouse' phenomena have presented humankind, for the first time, with an almost unthinkable question: will the sky continue to

surround our planet? [3]. The interactive installation *My First Time I Touch a Cloud*, (Figs. 2-23 and 2-24) is an allegorical response to the potential chaos being caused by catastrophic climate change. The work invites the audience to interact with his aerogel sculpture, to touch it and experience as he did the ecstasy of Icarus, touching the heavens for the first time. The viewer is invited to insert their fingers through an acrylic slit, a wound-like opening behind which the aerogel is suspended. In the same way that the aerogel appears only just there, it can only just be touched. On a screen is projected each visitor's way of caressing this piece of sky: experiencing the sky-fragment as something unique and precious – or as a new material to explore – and being invited to reflect on the extreme possibility of the earth losing its protective atmosphere. The installation echoes this urgent call by sending an S.O.S (Save Our Sky) message for the planet's life-protecting veil. *My First Time I Touch a Cloud* has an audio accompaniment which creates an all-encompassing soundscape. The music for this audio is based on the S.O.S Morse code distress signal (...____...), and the installation invites the viewer to touch what seems to be a fragment of the atmosphere in danger. As the viewer touches the cloud, a camera records the experience and projects this touch live to a monitor outside the exhibition space (Fig. 2-24). The experience of touching something as impermanent as a cloud is utterly unique. The curiosity and innocence evoked by this touch act as a reminder of the broken sky-dome. The audio that is played alongside this work is an SOS that projects the need for us to respond. The question arises: do we, the participants, become the atmosphere's saviors – or its explorers? Such a question reflects the cautious wonderment with which participants engaged with this installation. It also indicates an ambivalence, and an emotional response vacillating between exhilaration at the first touch of the cloud,

and mild frustration (indicated by smiling) when they fail to insert a second finger to hook the cloud. Participants also seem genuinely surprised when they later observe the quasi-violent actions of others displayed on the monitor. The concepts of 'breakage' and 'rupture' are central to the allegorical meaning in *My First Time I Touch a Cloud*, and are linked to the notion of catastrophe as the necessary precondition for creation in the trope of *etherospermia*. The breakage of the sky-dome in *My First Time I Touch a Cloud* is not only a metaphor for the rupturing of Earth's atmosphere. It also signifies that our existence will come to an end if we do not respond with concern to this urgent SOS. The fragments of the broken dome must be gathered. In the moment of catastrophe – which is the breakage – we must come to a resolution, the drive to create new skies, new clouds and new atmospheres, which will be developed on new planets [3].

The interactive installation *My First Time I Touch a Cloud*, responds to this, allegorically, by placing the viewer in a 'take-care-of-the-sky' position. It seeks to explore the 'bottled message' within a breaking sky. The idea of this interactive installation emerged from interest in the potential to embody the concept of 'catastrophe', and the implications for this in the author's own work. The title of *My First Time I Touch a Cloud* plays with the notion of ungrammaticality in 'the brokenness' of a child's innocent misuse of correct grammatical form. Substituting the definite article with the personal pronoun 'my', and the past tense 'touched' with the present/infinitive 'touch', the title evokes the fragility, ephemerality and 'breaking' of ether. To think allegorically about 'brokenness', the term 'catastrophe' must be considered more closely. From Greek (katastrophe), the word signifies 'breaking' and 'rupture'. The fertilization of an egg occurs when a sperm penetrates its boundary, but in this moment of disruption,

breaking and rupturing, life is created. The implication is clearly that the creation of life is not possible without a moment of catastrophe. By observing moments of catastrophe we must prepare to respond to our breaking atmosphere. Our existence is in balance with nature, as we ourselves are part of it. This existence, although impermanent, is having sudden, permanent and dramatic effects on Earth. In response to this moment of catastrophe, the imperative is clear: we must prepare ourselves for a moment of creation.

***Skymarket* | 2015**

Skymarket (Fig. 2-25) may be read as an allegorical portent of the future danger faced by humanity if the unfettered commodification of the sky and space beyond is permitted. Humans want to be at the apex of the ladder, to have and own everything in their power. *Skymarket* adds an accessible visual voice to science's suggestion that to address climate change, human beings need a "climaXchange" to gain perspective on what they want and "need" in order to preserve the finite resources available to humanity [5].



Fig. 2-25. *Skymarket* (shadow), silica aerogel, metal 50×20×30cm, ©Michalous, 2015.

Epilogos

For the author, art, science and technology cannot be separated. Many issues are reflected in this tripartite collaboration, resulting in a richness of nuances and a diversity looking for the unknown. It is a non-Euclidean but representative space in between these disciplines, which cannot be measured but only be felt. Over the years, the

advancements in technology have made it possible for artists to explore different ways to express themselves and to provide meaningful and interesting experiences to audiences beyond the limits of imagination. Science can intrigue visual arts – and, vice-versa, art can inspire science. Just as in the chaos of the cosmos our earth can be perceived as an ethereal and beautiful nothingness, likewise silica aerogel ‘exists’ as an artistic creation of science.

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<<http://www.photonics.com/dictionary>> a rainbow hologram is essentially a hologram of a hologram, in which the first-generation hologram is masked with a narrow slit. During image reconstruction, the slit operates as the exit pupil in image space. The hologram’s white-light exit pupil is spread out to form a spectrum by the grating’s dispersions – the rainbow from blue to red.

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III

A SEA OF MEDIATION – ANYWHERE AND EVERYWHERE

YURI TANAKA

The universe, humans, and art

The universe, humans, and art can coexist in harmony. Assuming this, my practice-based research seeks to create an artistic expression of the human mind touching the inner beauty of the universe. To explore this, I strive to enhance collaboration between artists/designers and scientists/engineers through creating art installations, mostly in public spaces or at art/science festivals. I believe that art – a way of life – intrinsically should be open to anyone, as is the universe. Similarly, I believe that each of us is capable of finding the beauty of life and the universe, and that such capability enriches the quality of human life.

The universe encompasses everything – the physical environment and all life-forms. From an artistic point of view, the universe also denotes space and time, from which arises a question for humans to think about how to find an artistic way of life within this universe. With this perspective – what I call the cosmic perspective – I have been exploring a fundamental way of collaboration through the mediated dialogue.

Mediation

For over ten years, I have been pursuing my practice-based research, mediating between diverse experts by posing 'the universe' as a mutually acceptable idea among them. The idea of mediation originates in my background during my undergraduate studies: mediation in conflict transformations. Given that a cause of any conflict can be found in miscommunication or misunderstanding among humans, an intimate dialogue between disputants will be facilitated by an impartial mediator to reach mutually agreeable solutions. Although the word 'conflict' may imply a war, in this context, it indicates any human small conflict-rooted in miscommunication/misunderstanding. Therefore, the task of a mediator will be transforming those negative causes and their dynamics into a positive and peaceful situation. A mediator firstly identifies the disputants' underlying needs or interests, sets the ground rules for the dialogue, enhances communication in a constructive way, and then finally creates a solution with an agreement for a compromise/collaboration. Importantly, a mediator does not make decisions; rather he/she provides a framework for enabling disputants to develop a willingness to find a solution. The situations of mediation are diverse and vary case-by-case, which means that a mediator has to be flexible and creative.

With this background, I develop this fundamental methodology of mediation into a methodology for collaboration among the experts from different disciplines.

Concealing beauty

'Concealing beauty' – a methodology of art that has had a profound influence on Japanese aesthetics over the centuries – has been also one of my conceptual focuses.

The core of this aesthetics and its way of appreciating art can be found in the thoughts of Kakuzo Okakura (1863-1913)¹, a scholar who once was a principal of the national art school in Japan (today it is called Tokyo University of the Arts) in the 19th century. From ancient times in Japan, humans and nature have been considered to be relatively linked, in other words, nature coexistently embraces humans. All the ideas from ancient Shintoism, Buddhism, Taoism, and Confucianism are integrated into Japanese culture in a particular way.

From this perceptive, nature is relative – and in this sense, it is another word for the universe as everything. Everything ever flows. Although those of that era didn't yet know about outer space or the laws of the universe scientifically, the thoughts of Okakura cultivated a way of thinking towards the world in which he and his contemporaries lived. It is a way of life in which humans adjust their living to the relatively linked nature, which leads to a sense of 'the art of life'. Since art is not just an object, 'the art of life' can be transformed into art itself. In this kind of culture, it is difficult to discern whether something is considered to be art or not. Rather, art naturally remains an ambiguous conception. For instance, in relating a story of the origin of art, it is told that a man picked a flower and gave it to his lover.

¹ Kakuzo Okakura, *The Book of Tea*, Dover Publications, New York, 1964.

This aesthetics tries to appreciate every subtle beauty in life, which is imperfect in nature. Okakura even mentioned that true beauty can only be found when we mentally complete the incomplete². In essence, it is an imagination towards an imperfect universe, which could complete the absence of perfection.

What we see is not what it appears to be, nor is what we hear. Assuming that nature has beauty within itself, then what is the meaning of artistic creation for humans? In the realm of this aesthetics, it is 'the art of concealing beauty' to let people find deep beauty in nature, and enhance their appreciation towards beauty in life, rather than taking nature 'just as it is'. An artist may deliberately conceal beauty in nature in order to appreciate it in different ways. It is also a way of enhancing human imagination to substitute the unknown of the universe, for the unknown of what humans don't recognize in their lives.

Subtle uncertainty is a fertile source of imagination to explore the possibility of the unknown. How do we ever know what is true or not? The sense of belief is within us. The process of unveiling the unknown is a compelling attraction to evoke our curiosity.

² Okakura, *ibid.*

Practice

Moons of Naoshima



Fig. 3-1. *Moons of Naoshima*, photo: Daisuke Aochi.

Period: December 6, 2013 – January 13, 2014

Venue: Miyanoura Port, Naoshima, Japan

Member: Yuri Tanaka, Takaharu Ito

In collaboration with the town of Naoshima, a small island in the Seto Inland Sea, this work was installed at the main port of the island. To enrich the beauty of the winter landscape and winter life there, and also to encourage people to realize the beauty of the environment, these imaginary ‘moons’ made by the pupils of Naoshima elementary school appeared as if they were floating in the sky. The glass fibre rods allowed the whole installation to be kinetic, to naturally move with the wind. It created a delightful atmosphere over the holidays for local residents and travelers from around the world.

Uy-uni-verse≒Multiverse

Fig. 3-2. *Uy-uni-verse≒Multiverse*, photo: Mitsuharu Kume.

Period: August 10 – September 15, 2014

Venue: Tanegashima Space Center, Minamitane-cho, Japan

Member: Yuri Tanaka, Ryu Sakurai, Hajime Shimoyama, Ryo Takahashi

In *Mission in Tanegashima – the Preliminary Event for Tanegashima Space Art Festival 2014*, this work was made in collaboration with Japan Aerospace Exploration Agency (JAXA) and local entities and residents. It creates space and time where people can experience a feeling of as if they were part of the vast universe, surrounding a human with the beautiful clear sky above the island of Tanegashima, and also the sky reflected on the stainless mirrors inside.

Flowers behind the back of the universe

Fig. 3-3. *Flowers behind the back of the universe*, credit: the Polytech Festival of Science, Art & Technology (Moscow, Russia).

Period: May 27 – 28, 2017

Venue: Gorky Park, Moscow, Russia

Member: Yuri Tanaka, Ryu Sakurai, Hajime Shimoyama, Ryo Takahashi, Noboru Makizuka, Michael Doser

In collaboration with Gunma Astronomical Observatory

In *the Polytech Festival of Science, Art & Technology*, this work was laid out capturing a moment of constellations from the antipode of Moscow on the dates of the festival. Flowers as a metaphor of the beauty and transience of life in the universe, these constellations become illuminated with flowers of *origami*. Visitors can collaborate in making these flowers with the members. The invisible scenery behind the back of the universe explores their imagination towards the universe.

Cosmic Table



Fig. 3-4. *Cosmic Table*, photo: Yuri Tanaka.

Period: June 29 – July 8, 2018

Venue: Globe, CERN, Geneva, Switzerland

Member: Yuri Tanaka, Aurélien Mabilat, Neal Hartman

In *CineGlobe*, a film festival at CERN (Conseil Européen pour la Recherche Nucléaire), this work was installed as a picnic table for visitors. Through the mediated dialogue between artists/designers and scientists/engineers which began with fundamental questions about the universe, firstly with the core concept: “how can we happily coexist within this universe?”, the texts and the graphics on the table reflect members’ dialogue over these open-ended questions. It creates a moment through which people can transform their usual perspectives, and opens up their usual, limited ways of experiencing the world.

Particle Post – Letters from the Universe

Fig. 3-5. *Particle Post – Letters from the Universe*, photo: Pavle Dinulović.

Period: September 5 – 9, 2019

Venue: POSTCITY, Linz, Austria

Member: Yuri Tanaka, Pavle Dinulović, Umüt Kose, Chris Bruckmayr

In collaboration with sound designers, artists, and an experimental physicist, this sound installation was presented at the Ars Electronica Festival 2019. Receiving cosmic muons³ through a scintillation detector, a postbox subtly emits sound like a sound of raindrops, and light as a direct consequence to each particle it detects. This unheard sound of the universe is the result of a poetic and artistic transformation. It is through

³ One of the fundamental particles constantly created by the interactions of the cosmic rays with the Earth's atmosphere.

this process that the implied aesthetics of the unperceivable are being explored, as are the means by which it could be indirectly appreciated in different ways through the bodies and minds of humans.

Poetics

A seed of poetry is always within us – as it is within anywhere and everywhere in this universe. This seed will flourish when humans touch the beauty of life and the universe. It is a hidden flower within everything. It is also a spring of creating an artistic way of life. Every time we utter sound, poetry creates our words. This is a poetics of our hearts/minds. Every time we create a form, poetry fertilizes our thoughts that lead to the architecture of a form. Mediating the universe, humans, and art, is a poetics to cultivate our way of life in a beautiful way.

What is the freedom of humans within the universe? How can we appreciate freedom of life? Like a bird in the sky, or a fish in the water, how can humans live in freedom on the earth, or in the universe?

Expression is a freedom within humans. When we realize that we have an infinite freedom of expression, or when we encounter a chance to explore this freedom, what will humans create? How can humans appreciate this freedom together? Humans can be much more free through an earnest expression. Freedom is a possibility within each of us to live aesthetically, to share lasting delight and happiness.

There is a transparent beauty within this universe. What kind of freedom would this bring us? How will humans find a meaning to life, through touching on that beauty?

IV

MYTHOCOSMOLOGY IN ART

ARTHUR WOODS

Part 1: An Introduction to Mythocosmology

Throughout millennia humanity has wondered about its relation to the cosmos and about its ultimate role and purpose in the matrix of life. Based on the available knowledge of the particular moment in time, different perceptions - *Cosmological Myths* - were created to try to satisfy its quest to find meaningful explanations to fundamental existential questions explaining the dynamic structure and order of the cosmos. As knowledge increased through a process of making finer and finer discriminations about the nature of reality, the prevailing models of understanding were consequently modified or replaced by newer ones in order to have a more precise and believable explanation of where we came from, who we are and why are we here. This continuing process influences the way our species formulates its beliefs and conducts its affairs.

Both art and science are humanity's attempts to describe the natural world and its place and purpose in the universe. The methods and subject matter may be different as well as their traditions, but the ultimate goals and motivations of scientists and artists are in fact similar. To understand the meaning our existence and to share that insight is one of the fundamental needs of our species. In today's flood of scientific data, artists

and scientists increasingly collaborate to give meaning to contemporary scientific concepts and discoveries which represent current cosmological interpretations. In literature, film and in the visual arts, some artists are using this scientific information to propose their own cosmological theories.

Cosmological myths - both ancient and more modern - have always been accompanied by the creation of artifacts such as images, objects and structures which become visual symbols of the information embodied in a particular myth and used to communicate and/or access the perceived understanding. The earliest lunar calendars, the Egyptian and Mayan pyramids, Stonehenge, the Native American medicine wheel, the Hindu statue of *Shiva*, Johannes Kepler's *Somnium*, Carl Sagan's *Contact* and Arthur C. Clark's and Stanley Kubrick's *2001, A Space Odyssey* are all examples of how artisans and artists have imagined and visualized descriptions of the cosmos and humanity's role.

Cosmological myths can be viewed from different perspectives. Scientific cosmologies, which are based on the study of the universe through astronomy and physics, constantly provides additional information which has successively challenged and replaced the ancient and older myths with newer ones. However, the focus on scientific questions often overlooks the impact these theories have on culture including politics and the arts. Thus, there are also anthropological cosmologies which are based on the proposition that ideas about the cosmos are an integral part of human cultural and social systems and are used to describe how the world works. Anthropological cosmologies draw upon scientific theories in

order to construct models for activities in disciplines, such as politics, psychology and the arts.¹

Questions about the origins of the universe, of the sky, of the Earth, of life and of humanity have given rise to many different myths and legends and continue to be the subject of intensive research by astrophysicists, biologists and anthropologists.² Subsequently, a greater sense of permanence in the daily existence of human societies led to the development of myths, particularly creation myths to explain the origin of the universe and how individuals fit in.

Ancient cosmological myths emerged once primitive groups of humanity developed language and then made their first attempts to understand and communicate the world around them. Their universe was very local consisting of the weather, natural occurrences such as volcanoes or earthquakes, abrupt changes in the environment and the day-to-day survival in their natural and social context. Anything beyond this immediate environment was considered to be supernatural.³ These early cultures projected their inner thoughts and feelings onto an outer animistic world, a world where everything was alive. Through prayers, sacrifices and gifts to the spirits, ancient humans gained control of the phenomena of their world. This was an anthropomorphic worldview of the living earth, water, wind and fire, onto which humans projected their emotions and perceptions as guiding forces.

¹ Nicholas Campion, *The Importance of Cosmology in Culture: Contexts and Consequences*, 2017, <https://doi.org/10.5772/67976>.

² Jean-Pierre Luminet, *Creation, Chaos, Time: from Myth to Modern Cosmology*, <https://arxiv.org/ftp/arxiv/papers/1604/1604.03332.pdf>.

³ *History of Cosmology*, Univ. of Oregon Lectures, viewed 18 June, 2020. <http://abyss.uoregon.edu/~js/ast123/lectures/lec01.html>.

While most ancient myths maintain supernatural themes, with gods, divine and semi-divine figures, there was usually an internal logical consistency to the narrative. Myths were most often attempts at a rational explanation of the everyday world. Their purpose and goal was to teach and share the particular perception. Even though some of these stories today appear somewhat ridiculous, they were, in actuality, humanity's first scientific theories.⁴ Most often, these early cosmological myths closely followed a particular religion and were characterized by a close marriage of science and religion.

Around 20,000 years ago, humankind began to organize itself and develop what can be called "culture" which is a complex term but can be generally stated to be: - *a method of transmitting meanings embodied in symbols, by which humans communicate and perpetuate their knowledge of and attitudes towards life.*⁵ Thus, cosmological myths that were often shared via symbolic means significantly impacted specific cultures as they became a vehicle to ideologically organize communities and societies into a particular belief system.

Scientific cosmologies – those that did not rely on supernatural or divine beings – began with the ancient Greeks. By the 5th century B.C., Empedocles and Anaxagoras offered arguments for the spherical nature of the Earth.⁶ Pythagoras may have believed that the motions of the heavenly bodies suggested a

⁴ *History of Cosmology*, Univ. of Oregon Lectures. Ibid.

⁵ Clifford Geertz, *The Interpretation of Cultures*, Basic Books, New York, 1973, p. 89.

⁶ *Ancient Greek Astronomy and Cosmology*, Library of Congress, viewed 18 June, 2020. <https://www.loc.gov/collections/finding-our-place-in-the-cosmos-with-carl-sagan/articles-and-essays/modeling-the-cosmos/ancient-greek-astronomy-and-cosmology/>.

kind of cosmic music that determined their paths⁷. Aristotle, believed that there were four fundamental elements, fire, air, water and earth and that Earth was place for birth and death of these elements whereas the heavens were a spatial realm governed by its own rules.⁸

Modern cosmologies can be traced back to the Renaissance covering the span between the 14th and 17th centuries and marking the transition from the middle ages to the modern era. For nearly two thousand years prior, classical cosmology – with the Earth as the unmoving center of the universe – had dominated astronomical thought. Nicolaus Copernicus (1473–1543) was a Renaissance polymath specializing in mathematics and astronomy. The publishing of his thesis *On the Revolutions of Celestial Spheres* is considered the landmark moment of the *Copernican Revolution* and a seminal event in the development of modern science. Copernicus proposed that it was in fact the Sun that was the center of the universe, with the motion of the celestial spheres having the Sun as their mid-point. Day was not caused by the Sun's movements, but rather by the diurnal rotation of the Earth on a fixed axis. Often described as the lone astronomer credited with the *Copernican Revolution*, there were actually other thinkers that were arriving at a similar insight including Johannes Kepler who developed mathematical models for elliptical orbits and Tycho Brahe who collected substantial observational data for his own competing cosmological model.⁹

⁷ *Pythagoras*, Stanford Encyclopedia of Philosophy, 2018, viewed 18 June, 2020. <https://plato.stanford.edu/entries/pythagoras/>.

⁸ *Ancient Greek Astronomy and Cosmology*, Library of Congress. Ibid.

⁹ Library of Congress: *Whose Revolution? Copernicus, Brahe & Kepler*, viewed 18 June, 2020.

Numerous books and articles in all cultures have documented and explained these ancient and modern cosmological myths and their contributions to understanding humanity's place and purpose in the universe.

Nicholas Campion writes:

*“Modern scientific cosmology is valuable in itself for what it reveals about the nature of the cosmos we inhabit. It is a demonstration of the power of modern science to transform our understanding of who we are and where we came from. However, most cosmologists focus on scientific questions and are not fully aware of the impact of cosmological theories on culture, including politics and the arts.”*¹⁰

*“If we select four fundamental causes of changes in our perceptions of the world in the last century, then they would be first relativity, second quantum mechanics, third the expanding universe and fourth, the space program.”*¹¹

In 1917 Einstein published a paper *“Cosmological considerations in the general theory of relativity”* that applied general relativity to the universe, changing our view of the cosmos forever.¹² Indeed, his formula $E=mc^2$ sums up all of the action

<https://www.loc.gov/collections/finding-our-place-in-the-cosmos-with-carl-sagan/articles-and-essays/modeling-the-cosmos/whose-revolution-copernicus-brahe-and-kepler>.

¹⁰ Nicholas Campion, *Cosmos and Cosmology*, in Segal R, Stukrad K (eds.) *Vocabulary for the Study of Religion*, Brill, Leiden, 2015, pp. 359-364.

¹¹ Nicholas Campion, *The Importance of Cosmology in Culture: Contexts and Consequences*, 2017, viewed 18 June, 2020.

<https://www.intechopen.com/books/trends-in-modern-cosmology/the-importance-of-cosmology-in-culture-contexts-and-consequences>.

¹² Cormac O’Raifeartaigh, *Albert Einstein and the origins of modern cosmology*, 2017, viewed 18 June, 2020.

<https://physicstoday.scitation.org/doi/10.1063/PT.5.9085/full/>.

and creation in the universe.¹³ Today, the *Big Bang Cosmological Model* is the most broadly accepted scientific model for the origin and evolution of the universe. This model rests on two theoretical pillars: General Relativity and the Cosmological Principle.¹⁴ By assuming that the matter in the universe is distributed uniformly on the largest scales, one can use General Relativity to compute the corresponding gravitational effects of that matter. Since gravity is a property of space-time in General Relativity, this is equivalent to computing the dynamics of space-time itself. The Cosmological Principle assumes the matter is distributed homogeneously and isotropically on large scales. The corresponding distortion of space-time (due to the gravitational effects of this matter) can only have one of three forms: The universe can be “positively” curved like the surface of a ball and finite in extent; it can be “negatively” curved like a saddle and infinite in extent; or it can be “flat” and infinite in extent – which is our “ordinary” conception of space.¹⁵ Of course, what preceded the Big Bang is not covered by the current standard model of cosmology nor is the “space” into which the universe as we know it is expanding into – topics that will surely be the focus of future cosmological theories.

Indeed, there are other non-standard models for the origin of the universe which applies to any cosmological theory that does not conform to the current scientific consensus. Non-standard models include: the quasi-steady state model, the plasma cosmology model, non-cosmological redshifts,

¹³ Nigel Calder, *Einstein's Universe*, The Viking Press, New York, 1979, p. 13.

¹⁴ *Big Bang Cosmology*, NASA, viewed 18 June, 2020.
https://map.gsfc.nasa.gov/universe/bb_theory.html.

¹⁵ *Foundations of Big Bang Cosmology*, NASA, viewed 18 June.
https://wmap.gsfc.nasa.gov/universe/bb_concepts.html.

alternatives to non-baryonic dark matter and/or dark energy, as well as others. As most cosmologists do not usually work within the framework of alternative cosmologies because they are outside of the current standard model which receives the majority of the research funding and publication attention, these non-standard cosmological models are lesser developed. In his paper: "*Non-standard Models and the Sociology of Cosmology*", Martín López-Corredoira provides an overview of these non-standard models and the issues inherent in contemporary cosmological discourse.¹⁶

When Earth was perceived of as the entire universe it gave rise to anthropological cosmological myths that continue to permeate and influence society into the present time. With the advent of space exploration humanity's perception of its home planet became that of the *Whole Earth* - a blue sphere floating in the vast expanse of the cosmos. This perception has catalyzed the globalization of its cultures and defines many of its present activities. Significantly, humanity also discovered the "overview effect" as documented by space writer Frank White in his book "*The Overview Effect: Space Exploration and Human Evolution*" (1987) – a view from the unique perspective of astronauts resulting in a cognitive shift in awareness that our planet is a sublimely beautiful vibrant but fragile living organism shielded and nourished by a paper-thin atmosphere.¹⁷ In his recent book "*The Cosma Hypothesis: Implications of the Overview Effect*" (2019) White proposes that humanity's ultimate purpose in exploring space should transcend focusing

¹⁶ Martín López-Corredoira, *Non Standard Models and the Sociology of Cosmology*, Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics, vol. 46, Part A, May 2014, pp. 86-96.

¹⁷ Frank White, *The Overview Effect: Space Exploration and Human Evolution*, Houghton Mifflin Company, Boston, 1987.

on how it will benefit humanity but rather on how to create a symbiotic relationship with the universe, giving back as much as we take, and spreading life, intelligence, and self-awareness throughout the solar system and beyond.¹⁸

Earth Systems Science (ESS), which has many correlations with the *Gaia Hypothesis* proposed by James Lovelock and co-developed by Lynn Margulis in the 1970's¹⁹, is a relatively new discipline which considers interactions between the Earth's spheres: atmosphere, hydrosphere, cryosphere, geosphere, pedosphere, biosphere and, even, the magnetosphere - as well as the impact of human societies on these components. Earth system science brings together researchers across both the natural and social sciences, from fields including ecology, economics, geology, glaciology, meteorology, oceanography, paleontology, sociology, and space science. Earth system science assumes a holistic view of the dynamic interaction between the Earth's spheres and their many constituent subsystems, the resulting organization and time evolution of these systems, and their stability or instability.²⁰

All celestial bodies of significant concentrated mass exert a field of gravitational attraction around their cores which extends to the point of tangential intersection with other celestial bodies. This has led to a new perception of our planet which adds an additional sphere to the ESS concept. Called *Greater Earth*, it is based on Earth's true cosmic dimensions as defined by the laws of physics and celestial mechanics. Earth's gravitational influence extends 1.5 million kilometers in all

¹⁸ Frank White, *The Cosma Hypothesis: Implications of the Overview Effect*, Morgan Brook Media, New York, 2019.

¹⁹ James Lovelock, *GAIA, A New Look at Life on Earth*, Oxford University Press, Oxford, 1979.

²⁰ Tim Lenten, *Earth System Science: A Very Short Introduction*, Oxford University Press, Oxford, 1st edition, 2016.

directions from its center where it meets the gravitational influence of the Sun.²¹ This larger sphere, has a diameter of 3 million kilometers and which encompasses the Moon, has 13 million times the volume of the physical Earth and through it, passes some more than 55,000 times the amount of solar energy which is available on the surface of the planet.

At this boundary between the Earth and the Sun is the Lagrange Point 1 (L1) where the combined gravitational forces of the Sun and the Earth create an area of equilibrium.²²

At this location a small object maintains a nearly stable position relative to the Sun and the Earth, and is where NASA has placed its Deep Space Climate Observatory (DSCOVR) and its Earth Polychromatic Imaging Camera (EPIC) which takes a photo of the Earth every two hours - in essence our planet continuously observing itself.²³

However, *Greater Earth* is more than a region it is also a dynamic system. The Sun's energy that reaches Earth warms the planet, drives the hydrologic cycle and is the primary source of energy for the climate system which keeps Earth suitable for life. Earth's moon played an important role in the origin and evolution of life. Whereas the Earth's gravity keeps the Moon in orbit, the Moon's gravitational influence on the Earth produces the ocean tides, earth or body tides, and the slight lengthening of the day and stabilizes its rotation period.

²¹ Arthur Woods, "A Space Age on Earth", 2014 competition: How Should Humanity Steer the Future?, viewed 18 June, 2020.
<https://fqxi.org/community/forum/topic/2076>.

²² *Lagrangian points, The Lagrange points associated with the Sun-Earth system*, European Space Agency, viewed 5 May, 2021.
https://www.esa.int/ESA_Multimedia/Images/2017/11/Lagrange_points.

²³ *DSCOVR:EPIC*, NASA, viewed 18 June, 2020.
<https://epic.gsfc.nasa.gov>.

In earlier times, the Moon was much closer to the Earth and its gravitational influence was much stronger, leading some scientists to believe the Moon played a significant role in the early evolution of life as the enormous tidal forces may have catalyzed reactions within the organic soup of early Earth. Over millions of years, Earth's rotation slowed significantly by tidal acceleration through gravitational interactions with the Moon and the Sun. The gravitational influence of the Moon may have played a significant role in the Earth specific phenomena of plate tectonics and continental drift, forces that may also have been important to the evolution of life on Earth. Thus, the Sun's energy and its gravitational influence on the Earth and the Moon and the interaction of these celestial bodies have created a complex and dynamic interactive system that has allowed for life to emerge and evolve on Earth – *a system that is rare if not unique in the universe as far as we now know.*

Looking outwards beyond Earth, space telescopes and spacecraft such as NASA's Wilkinson Microwave Anisotropy Probe (WMAP) that was launched in June 2001 to make fundamental measurements of cosmology have reached out to the edge of the known universe, with its billions of galaxies.²⁴ Looking inwards, particle accelerators such as the Large Hadron Collider at CERN (Conseil Européen pour la Recherche Nucléaire) are exploring the structure of matter at its very basic level. It is believed that 27% of the matter of the universe is a form of invisible 'dark matter' whose presence is discerned from its gravitational attraction rather than its luminosity, and 68% consists of 'dark energy' which appears to be associated with the vacuum of space. The remaining 5% is 'ordinary' visible

²⁴ *Big Bang Cosmology: NASA WMAP's Universe Wilkinson Microwave Anisotropy Probe*, NASA, viewed 18 June, 2020.
<https://map.gsfc.nasa.gov>.

matter.²⁵ This indicates that today's perceptions of the universe and of the Earth which constitute humanity's current cosmological myth will continue to evolve and will surely be replaced by a newer, more precise and, as yet, unarticulated myth in the future.

Part 2: My Mythocosmological Art Journey

In 1959, my father moved our family to Merritt Island, Florida. Although I didn't realize it at the time, this fortunate experience of being a first-hand witness of the beginning of the U.S. space program while living in the immediate vicinity of Cape Canaveral was the beginning of my artistic journey leading to the development of my own cosmological concepts. In 1962, when president Kennedy announced "*We choose to go to the Moon...*", the Apollo program became an electrifying and contagious effort as everyone where I lived seemed to be involved in one way or another with the nation's goal of going to the Moon. While I was a university student I twice held summer jobs at the space center during the summers of 1967 and 1968 where I worked as a document courier - basically as human e-mail.

In this period I witnessed hundreds of launches including all of the Mercury and Gemini manned launches and, on July 20, 1969, along many thousands of other spectators from around the country, I was there to cheer the launch of Apollo 11 and astronauts Neil Armstrong, Buzz Aldrin and Michel Collins on their way to the Moon. Like many others of my family and friends, and the approximately 400,000 people involved, I was also proud of my small contribution to humanity's first steps to leave the planet and visit to our Moon. These were formative

²⁵ *Dark Matter*, CERN, viewed 5 May, 2021.
<https://home.cern/science/physics/dark-matter>.

years and this unique experience obviously had a significant influence on my later career as an astronomical artist.

I moved to Switzerland in 1973. Immersion in a new cultural environment was very stimulating for my artistic development and I also had much time for reading and reflection. As an artist, I wanted to create meaningful artworks about my views and understandings of life and I eventually turned to science to discover what scientists were thinking about when considering the nature of reality. Perhaps because CERN - the European center for particle physics research - was close by, I became curious about particle physics and the insights of physicists into the fundamental aspects of the universe on the microcosmic level which also seemed to me to approach a spiritual dimension. This spiritual aspect was pointed out by physicist Fritjof Capra in his book *"The Tao of Physics"* (1975) which explored the parallels between particle physics research and Eastern mysticism.²⁶

Gravity and My Art

"A Point of Singularity" from 1979 is an early attempt to express these cosmological ideas in an artwork. This work consisted of a small black dot on a piece of paper with a pin-hole in the center which represented the concept of "gravitational singularity" based on Einstein's theory of general relativity.²⁷

"Your Personal Singularity" is an artwork from 1984 that depicts an approximation of the cosmic relationship of a human being vis-a-vis the universe. This relationship can be expressed by the number 10^{-50} which is the ratio between the number of atoms

²⁶ Fritjof Capra, *The Tao of Physics*, Shambhala, Boulder, 1975.

²⁷ *Spacetime Singularities*, Einstein Online, viewed 5 May, 2021.
<https://www.einstein-online.info/en/spotlight/singularities/>.

in the human body 10^{28} and the number of atoms in the observable universe 10^{78} . I found the first number in Carl Sagan’s book *Cosmos*.²⁸ The second number in this cosmic relationship comes from the book written by Martin Rees, *Just Six Numbers: The Deep Forces That Shape the Universe*.²⁹ By dividing the number of atoms in the universe into the number of atoms in a human body creates a ratio that compares the mass of the human body to that of the universe expressed as the number 10^{-50} which can also be written like this:

0.001

Applying these cosmological insights to my painting, I subsequently developed a technique utilizing millions of points of color as a metaphorical representation of the dynamic, inter-connected micro-macro universe that we all exist in. I first approached this in an abstract mode of expression which later evolved into a pointillistic hyperrealistic painting style which I still pursue today. Like other artists throughout history, this was my personal attempt to visualizing a prevailing cosmological myth that was based on accepted scientific information of the moment.

Of the four fundamental forces in physics, gravity is the weakest force at the microcosmic level but the strongest force on the macrocosmic scale by which all things with mass and energy – including planets, stars, galaxies and even light are brought toward each other. Locally, gravity has to do with the force that the acceleration of Earth imparts to objects on or near its surface. As a terrestrial environmental factor, gravity is rarely considered as essential to the creation of art, yet it has

²⁸ Carl Sagan, *Cosmos*, Random House, New York, 1980, p. 219.

²⁹ Martin Rees, *Just Six Numbers: The Deep Forces That Shape The Universe*, Weidenfeld & Nicolson, London, 1999, p. 84.

profoundly influenced and determined both the conception and the perception of art since its beginnings. Basically gravity gives us an “up and down” orientation to the environment in which we live. Therefore, paintings, particularly those with a rectangular shape, usually have a “natural” top and bottom orientation because this reflects how the viewer and the artist perceive the world we live in.

I began to explore how gravity influenced my painting in a series of works that have a six-sided geometric shape. As there was no natural “top or bottom” orientation, these two-dimensional works could then be mounted in any position. The shading of some the triangular areas created by the intersections of the lines, added an additional perceptual component to the works which resulted in a three-dimensional effect. How the work was positioned imparted a specific uniqueness to its perception as seen in the images of the same painting below.



Fig. 4-1. *Voyager Series*. Acrylic on Canvas, 120 x 150 cm. Photo credit: Arthur Woods.

Likewise, because they are created in a terrestrial environment, all sculptures have a “resting point” - a point of contact in which their mass interacts with the gravity of the Earth. Consciously or unconsciously, artists conceive and carry out their sculptural creations with gravity determining the eventual resting point of the work, and, by so doing, they pre-determine how the sculpture will eventually be perceived and

appreciated by the public. Thus the influence of gravity has much to do with our perception and appreciation of sculpture - as our response to its aesthetic "rightness" is based on our own experiences within the terrestrial environment.

I applied these ideas and my painting technique to a series of three-dimensional geometrically shaped objects I call *Cosmic Dancers*. The geometric form of these sculptures enabled them to be positioned and viewed from different perspectives and, in relation to their surroundings; the same sculpture could appear as a unique three dimensional form as a result of its varied positioning. Depending on the geometric complexity, usually between four and eight resting positions could be found for each sculpture and its interaction with gravity - *its resting point* - being the ultimate determining factor. As these works were painted in my pointillistic technique they were also three-dimensional paintings as well as sculptural works.

When imagining human civilization extended into outer space, it seems obvious that the art of this civilization will take advantage of its new environment. Much like the influence of gravity has had on the evolution of terrestrial art, the qualities specific to the space environment will have a fundamental effect on both the conception and perception of the artworks designed and realized there. In the zero-gravity (zero-G) or microgravity environments of outer space, the influence of gravity disappears and artworks become weightless and motion becomes isotropic. As a consequence, the conception, perception and the appreciation of an artwork is altered in this environment. For example, a sculpture floating in a zero-G environment can be viewed from an infinite number of perspectives or angles – something that is not normally possible in a typical art setting on Earth. These insights into art, gravity and the scientific understandings about the nature of the universe would later be applied to a version of the *Cosmic*

Dancer that investigated the art of sculpture in the weightless environment of outer space.

The O.U.R.S. Projects

Because of my earlier personal experience having lived near the space center in Florida, and perhaps due to the reinvigoration of the US space program with the early flights of the U.S. Space Shuttle, in the early 1980's, I began to consider conceptual artworks designed for the space environment. In 1984 I initiated the *O.U.R.S. – the Orbiting Universal Ring Satellite* project. My idea was to celebrate the coming new millennium with a sculpture in Earth orbit which would be large enough to create a "circle in the sky" that would be visible to most people on the planet in order to commemorate humanity's passing into an exciting new millennium with a symbol of hope, peace and unity. I considered the symbolic use of a circle to be an uncontroversial and universally recognized symbol representing the infinite nature of energy and the inclusivity of the universe. Over the course of the next few years and in collaboration with the aeronautical engineer Dr. Marco C. Bernasconi at the Swiss space company Contraves A.G., we were able to come up with a realistic technical definition of the *O.U.R.S.* orbital sculpture based on the Inflatable Space Rigidized Structures (ISRS) technology that was being developed at Contraves which indicated a continuous torus with a diameter of 1 kilometer and a ring thickness of 10 meters. Such an object placed in a 400 km orbit would be visible to viewers on Earth as a "circle in the sky" approximately 1/4 the size of the Moon.³⁰

³⁰ Arthur R. Woods, *OURS- The Orbiting Unification Ring Satellite: A Global Artwork in Space for the Year 2000: Communicating the Urgency of Outer Space Development*, Paper ESW 92-26 presented to the 1st European Space Art Symposium, Montreux, Switzerland, 21-27 March, 1992.

In 1987, Contraves constructed an ISRS torus with a diameter of 6 meters for development and test purposes. Dr. Bernasconi and I felt using such an object would be a suitable and relatively inexpensive prototype for the *O.U.R.S.* development program. To differentiate from the larger *O.U.R.S.* 2000 project and to make the object more interesting we added a central quadrant and a sphere to the design. This design – a circle divided by a central cross is also the Greek astronomical symbol of the Earth where the vertical line represents the meridian and the horizontal line the equator. Versions of the symbol can be found in various ancient cultures predating Christianity often in the form of an astrolabe, historically used by astronomers and navigators to measure the altitude above the horizon of a celestial body, and identify stars, planets and day and night. Native American cultures used this symbol as a medicine wheel indicating the four seasons, the four directions, the four stages of life, and the four elements of fire, air, water and earth. We called this precursor project the *OUR-Space Peace Sculpture (OUR-SPS)* and we set a goal to realize the project in conjunction with the 1992 International Space Year (ISY) to commemorate international cooperation in space as a positive alternative to the Cold War that was at its peak. As with the circle, I intended to use another ancient mythological symbol to express an emerging contemporary concept directly related to the promise of space exploration.

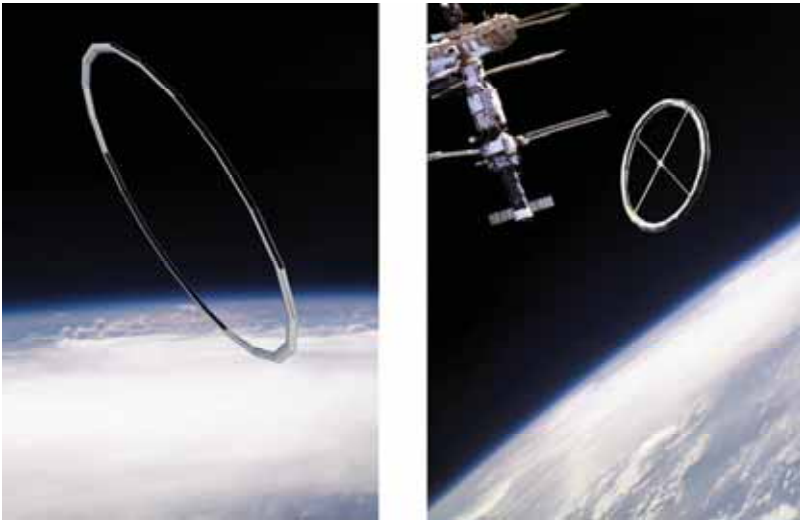


Fig. 4-2. *Orbiting Unification Ring Satellite, OUR-Space Peace Sculpture*. Artist conception. Photo credit: Arthur Woods.

On February 25, 1988, I signed a “Letter of Intent” with the Soviet launch service provider Glavkosmos to deploy the *OUR-SPS* from their Mir space station. Perhaps, due to the political dimensions inherent in the project, the Swiss space company decided to withdraw its support for the project. Coincidentally, the Russian space company NPO Energia who was responsible for the Mir space station, had also been developing their own inflatable space structure technology and proposed to continue the *OUR-SPS* project using their technology. They built a full size 6 meter inflatable sculpture in 1990 which was exhibited in various space and art events in Switzerland.

With these ongoing activities, developments, and with the full cooperation of the Soviet space organizations using their own space technology, everyone involved in the project was confident about the eventual realization of the *OUR-SPS* in 1992. However, in 1991 the Cold War unexpectedly ended and, in

December of that year, the USSR officially dissolved. Due to the uncertainties associated with pursuing the project within this new political context, sponsor support for the 1992 ISY opportunity was withdrawn and the *OUR-SPS* project was postponed which, in turn, impacted the development program for the realization of the *O.U.R.S.* project intended for the year 2000.

The Spaceflight of the Cosmic Dancer and its Cosmological Context

As the uncertainties related to the previous Soviet program settled, I learned through a former space associate that the Russian space program was still open for business and they would welcome another art project suitable for the Mir space station. With the desire to take advantage of this opportunity, the geometric shapes of the *Cosmic Dancer* sculpture series seemed to be appropriate for exploring the concept of sculpture in the microgravity environment of a space habitat. From a technical and financial standpoint, the *Cosmic Dancer* would be a much less complex project to realize than the previous orbital art projects. As a three-dimensional artwork specifically conceived for and officially realized in a space habitat, the *Cosmic Dancer* project would also serve to ascertain the process, the impact and the value of integrating a cultural dimension into the human space program. Additionally, this art intervention initiated by an American artist based in Switzerland taking place on the Russian Mir space station could also be interpreted as statement of international cultural cooperation in space.

The name *Cosmic Dancer* added another dimension to the artwork as an abstraction of *Nataraja*, (Sanskrit: “*Lord of the Dance*”) the Hindu god Shiva in his form as the cosmic dancer commonly depicted with four arms and flying locks of hair. Interestingly, a 2 m high version of the statue, symbolizing

Shiva's cosmic dance of creation and destruction, was given to CERN by the Indian government in 2004 to celebrate the research center's long association with India. A special plaque next to the Shiva statue explains the significance of the metaphor of Shiva's cosmic dance with quotations from the physicist Fritjof Capra:

*"Hundreds of years ago, Indian artists created visual images of dancing Shivas in a beautiful series of bronzes. In our time, physicists have used the most advanced technology to portray the patterns of the cosmic dance. The metaphor of the cosmic dance thus unifies ancient mythology, religious art and modern physics."*³¹

An article recently published in Quartz India titled *"Lord of the Cosmic Dance: How the Indian icon Nataraja danced his way from ancient history to modern physics, places the Cosmic Dancer on the Mir space station in an historical timeline."*³²



Fig. 4-3. Cosmic Dancer on the Mir space station (1993). Photo credit: Cosmonauts Gennadi Manakov and Alexander Polischuk. Copyright Arthur Woods.

³¹ Fritjof Capra, *Shiva's Cosmic Dance at CERN*, viewed 6 May, 2021. <http://www.fritjofcapra.net/shivas-cosmic-dance-at-cern/>.

³² Harish Pullanoor, *Lord of the Cosmic Dance: How the Indian icon Nataraja danced his way from ancient history to modern physics*. co-editor, Quartz India, 18 December 2019, viewed 18 June, 2020. <https://qz.com/india/1759244/a-brief-history-of-nataraja-the-dancing-hindu-god-shiva/>.

On May 22, at 10:43 a.m. (Moscow time), a Soyuz rocket was launched to the Mir space station. After its arrival two days later, cosmonauts Gennadi Manakov and Alexander Polishchuk unpacked the *Cosmic Dancer* inside the Progress capsule and allowed it to freely float and spin in their living space. As part of the mission, the cosmonauts were instructed to evaluate the impact of having art share their weightless environment and were given a questionnaire. The cosmonauts, on their own initiative responded to this artistic intervention in a creative and playful way by dancing with the sculpture. A photographic and video documentation was returned to Earth in September 1993.

The *Cosmic Dancer* was not only a sculpture in a traditional sense, but also a kinetic, minimal abstract painting in three dimensions and it represented a convergence of several directions in my art that I had been developing since 1976. At that time I looked to science to see what physics had to say about the nature of reality and the universe. What I discovered and, what has influenced my art ever since, was a description of the universe at the microcosmic level consisting of sub-atomic particles in an inseparable network of interactions. These interactions involve a ceaseless flow of energy which gives rise to the stable structures of the material world - the macrocosmos. The structures that make up physical reality do not remain static but are transient and oscillate in rhythmic movements. Thus, I became aware that the entire universe is engaged in endless motion and activity - in a continual *cosmic dance* of energy. Both the aesthetic aspects of this description as well as the environmental implications of an interdependent and interconnected universe have had much relevance for my own world view. As this insight existed in both modern physics as well as in Eastern cosmological concepts, I was both influenced and inspired by this seeming merging of diverse

cultures and these different yet similar ways of describing the cosmos. This seemed to indicate that knowledge about the nature of the universe was somehow imbedded into our consciousness.

The *Cosmic Dancer*, painted in my pointillistic technique, was originally conceived of as investigation of sculpture spinning effortlessly in the weightless of a space habitat. However, its realization in the macrocosmic environment of space as an artistic visual interpretation of the "cosmic dance" at the microcosmic level, it assumes a broader cosmological interpretation directly related to humanity's current and widely accepted cosmological myth.

The Space Option and Greater Earth

Throughout history artists have been essential in creating a robust cultural dimension to humanity's cosmological myths. In the development of the *O.U.R.S.* projects, Marco Bernasconi and I reached a moment where a rationale for our activities was needed to answer public criticisms about our artistic proposals for outer space and, indeed, space development in general. This led us to develop the *Space Option* concept which is an evolutionary plan to meet the basic and anticipated needs of humanity through the utilization of near Earth resources – *not only for the in-situ support of science or exploration* - but rather to apply these resources and/or their products for use on Earth at a conspicuous level. Most immediately, the harnessing of energy from space would replace humanity's reliance on the use of finite fossil fuels, whereas, none of the alternative terrestrial energy options – nuclear, wind and ground solar – can be sufficiently scaled to achieve the goal of divesting from fossil fuels while meeting the growing needs and demands of present and future populations. Of all the options currently available to our

species at this critical moment in its history, we believe only the *Space Option* offers humanity the most optimistic path to its long-term sustainability and survival.³³

This led to discovering a new perception of our planet as an emerging anthropological cosmological myth based on the true cosmic dimensions of our planet as defined by the laws of physics and celestial mechanics mentioned in Part 1. *Greater Earth* defines a region and a dynamic system that has been essential for the appearance and maintenance of life. Awareness of the *Space Option* and *Greater Earth* may help catalyze an optimistic path to a sustainable and prosperous human future by demonstrating the additional territory and the necessary resources for perpetuating civilization. I first came across this concept in an article by Elisa Griffin Wynn and Kevin Griffin published in *Space News* in 1994.³⁴ Between 1997 and 1998, Marco and I participated in an extended online group discussion among space enthusiasts which further elaborated the concept and resulted in "*The Greater Earth Manifesto*".³⁵

As the group had since disbanded and the topic was no longer being developed anywhere else, I decided to revive the

³³ Marco C. Bernasconi and Arthur R. Woods, 1993, *Implementing the Space Option: Elaboration & Dissemination of a New Rationale for Space. Part 1: The Rationale, Part 2: The Space Option*, Paper IAA.8.1-93-764 a & b presented at the 44th International Astronautical Congress, Graz, Austria.

³⁴ Elisa Griffin Wynn and Kevin Griffin, *It is Greater Earth, Stupid*, *Space News*, March 21, 1994, viewed 18 June, 2020.

https://greater.earth/GEO_DOCS/about_the_name_greater-earth.php.

³⁵ Stephen Ashworth, Adriano Autino, Marco Bernasconi, Daniel Christlein, Michael Martin-Smith, Arthur Woods, *The Greater Earth Manifesto*, 1998, viewed 18 June, 2020.

https://greater.earth/GEO_DOCS/preamble_to_the_greater_earth-manifesto.php.

concept in 2016 and develop the website *Greater.Earth* as an art intervention. As such, I am the *resident artist* within my own alternative virtual space program including launch vehicles, satellites, a reusable spaceplane and a space station.³⁶ From this vantage point in orbit, I am publishing regular video communications, articles, interviews and observations about *Greater Earth* as well as developing non-virtual astronomical art projects related to or designed to take place within this region. Computer generated video animations are being combined with my knowledge about how space development and space technologies can significantly address the many environmental, geopolitical, economic and cultural challenges that humanity currently faces.

³⁶ Arthur Woods, *Greater Earth Website*, viewed 18 June, 2020. <https://greater.earth>.

V

(C)OSMOSIS ART EXPLORATION

V-I

INVISIBLE MOMENTS

DAN GOODS

Introduction

Humans have had a fascination with the night sky since time immemorial. Perhaps it is the aesthetics of all those slightly vibrating dots slowly moving around. Perhaps it is our mind connecting those dots, creating patterns and epic stories that shaped our culture. More recently in human history, it might be the knowledge of what those dots are, their unfathomable distances, or the possibility that they may harbor life that could tell us whether or not we are alone in the vastness of space. But it has only been in the past 60 years that some of those tiny dots have been objects made by humans. It started with a tiny sphere called Sputnik, placed in space by the Soviet Union. Today, there are over 8,000 spacecraft, and that number is rapidly increasing every year. At the same time, there are fewer and fewer opportunities to see a clear night sky. The technological movement that ultimately put us into space also polluted our sky with so much light that the average urban child has never seen the majesty of the Milky Way or had the excitement of spotting a moving “star” and finding out that it was made by humans. In the following pages I will discuss three projects of NASA’s Jet Propulsion Laboratory that use various

methods to bring the viewer closer to those invisible movements that surround us.



Fig. 5-1. Radio antennae seen from above at NASA's Deep Space Network in Goldstone California.

Inspiration

One day my colleague David Delgado and I took a day trip to NASA's Goldstone Deep Space Communications Complex in Goldstone, California, about halfway between Los Angeles and Las Vegas. There, NASA has one of its three centers for the Deep Space Network (DSN), which communicates with spacecraft that are at the Moon or beyond. Currently there are about 40 such objects from NASA and space agencies in Europe, Japan, and India. The three antenna complexes are placed equidistant from each other around the Earth so that as the Earth spins, one antenna can always be facing toward a particular region of the sky. Let's say there is a spacecraft at Mars. As the Earth spins, if there were only one location on Earth

that had an antenna, the antenna would not be facing Mars 2/3rds of the time and there would be no communication during those gaps. But, if you have three locations equidistant from each other, one can communicate with the spacecraft, and as the Earth spins, that antenna can hand off to the next one. The locations are placed in Goldstone, which is in California's Mojave Desert in the United States; Madrid; Spain; and Canberra; Australia.



Fig. 5-2. The DSS-13 RARG / VENUS antennae at NASA's Deep Space Network in Goldstone California.

Walking around these complexes is impressive, as each location has an antenna that is an astounding 70 meters wide, and several others that are 35 meters and 26 meters. They are so large because the signal being received from some of the

spacecraft is so faint. As an example, the Voyager probes are beyond the edge of the solar system and currently over 11 billion miles from Earth. The amount of energy they are trying to detect is a billionth of a billionth of a watt. Looking up at these enormous structures, knowing they are communicating with human-made objects millions, sometimes billions of miles away, is awe-inspiring.

During our tour of the Goldstone complex, David and I had a particularly odd feeling. Goldstone has a desert-like landscape, we were there on a very warm day, and it was absolutely quiet. When I looked up at the antenna, I couldn't help but look at the sky, but, I couldn't see the other end of the line. I knew in an abstract way that there were objects far away moving, taking measurements, and waiting for the next signal in the quietness of space, but on the ground it seemed as though it was a one-way conversation. As if I were on a phone with no connection, just talking to myself. I felt disconnected from the great mission that was going on there. During that day, two questions formed in our heads that fueled concepts that years later turned into projects. The first was related to the signal going back and forth. What if we could see it? They use radio waves that are invisible to the human eye, but what if we had radio-wave vision and could see the billionth of a billionth of a watt, as well as all the other stronger signals? What would the sky look like? Would the data rain down on us? What would we see going to space vs what would we see coming down? This question spawned all sorts of ideas about how to represent the conversation between human and machine. The second question revolved around the fact that we could not see the other end of the line nor would we ever. Those spacecraft are so impossibly far away that we would never, even if it were dark, be able to see them. So what if we could use a different sense to detect their location? What if we could hear them?

What if, like hearing a bird fly across the sky, we could hear them as they roam the solar system? Those two sets of questions set my mind ablaze, and I was excited to get to work.

Pulse

While we were at Goldstone, we also had an opportunity to see some of the storage areas. In one particular storage area, there was a group of white cones about 3 meters tall. It was hard to place them because on the antenna they look so small, but they were the feed horns, the part where the radio wave enters into the center of the telescope. I asked what they were doing with them, and they said they had a couple of extras, and I could have one if I wanted. I was ecstatic but didn't really know where to put this enormous object, so I took pictures and started dreaming of what I could do with it. At this time, I had been enamored with the idea of lots of independently moving objects that could be independently controlled by data. I wondered, what if I covered the entire surface of the feed horn with little motors that moved back and forth and attached 2-inch sticks to the motors? When moving, the entire object would feel as if it had little hairs moving all over it, and the movement could be connected to the data flowing back and forth from the various antennas at the DSN. I started to get really excited about this possibility of having an object respond to deep space communications. Unfortunately, right about the time I started to really pursue the project, my funding changed and I no longer had the funds to pursue the project.

Years later I was asked to update the lobby of the main administration building at JPL, known as Building 180. In the lobby were a few exhibits of objects in space that JPL controlled, but I felt there was something missing. I didn't feel

the immediacy of what was happening right at this moment that the Lab was involved in. At some point I recalled the idea of connecting the live data from the DSN to some sort of object. We didn't have access to the feed horn we had seen at Goldstone, nor did it seem practical or budget conscious to program thousands of motors for this purpose, so I brought on Andrew Nagata to help me think through various technologies. Andrew had just graduated from the Graduate Media Design program at the nearby Art Center College of Design in Pasadena. He had proven himself as an expert in taking data and controlling objects in the real world with the data. I also worked with Daniel Inocente, a recent graduate of SciArc, an architecture school in Los Angeles. He was a wiz at creating various 3D renderings and thought about form and how things would work in physical space. At some point we realized that LEDs would be the most practical, affordable, and flexible technology for this project. We just needed to figure out what the form would be.

The lobby entrance has a large sliding door. Unfortunately, the first view one had when walking in was of wall with the bathrooms behind it. Not exactly the type of first view one would want of an organization that is hallowed ground for space exploration. That said, putting something in front of the wall would be the first thing people would see, and if there was something engaging it would be a great way to welcome people to that building. We explored various ways of arraying LEDs in that area, but over time we realized that the original cone idea wasn't so far off for the space we were in. Instead of a cone, we started nesting cylinders of LEDs going the 3 meters from floor to ceiling to give a sense of volume. Because they were floor to ceiling, it felt as though we were looking at a pipe of communication that burrowed through the entire building, but we were just seeing a portion of it. Andrew

created a piece of software that would allow us to easily try out various schemes. With a set of sliders, I could create more or fewer rings of LEDs, we could change their spacing or how many LEDs were in a ring or vertical in the line, and we could even turn the arrays one way or another, which was important. One of the aspects I wanted to deal with was to use the sculpture, as opposed to a separate screen, to tell the viewer which spacecraft is being spoken to. That would mean the resolution of the LEDs would have to be high enough for the viewer to read text. It seemed that the center cylinder would be the best for that, but if we had too many LEDs in the other cylinders, one couldn't see through them to see the words going up and down on the center ring. With this tool we could just move a few sliders, and over the course of a few days we found the optimum location and quantity to make for a compelling piece.

What the story would be and how much information should be shown in a digital sculpture such as this is always a fine balance. There are so many things you could say about the spacecraft. Their distance, speed, direction, how much information is being sent to and from them, what kind of information, the options go on and on. Ultimately, I chose to keep it simple. When lights go up, that means at this second a signal is going to a spacecraft. When lights go down, a spacecraft is sending a signal to us. The live data come from a direct link to our mission control room at JPL. The volume of light that goes up and down represents how much information is going back and forth. The Voyager spacecraft can only send bytes of information, so it looks as though the light is trickling up and down. For other spacecraft that can send and receive high volumes of information, the entire sculpture lights up. At any one time the sculpture is showing the communication to and from a single spacecraft and one of the antennas in the

DSN system. Every 20 seconds the sculpture switches to another active antenna. When that happens, the name of the spacecraft it is speaking to travels up the center column of the sculpture. Twenty seconds later, a different name appears, and the volume of light and the direction changes according to what is happening in real time.



Fig. 5-3. Unused feed horns at NASA's Deep Space Network in Goldstone California. A feed horn goes in the middle of a radio antennae dish.

I called this the Pulse. To me it feels as though it is showing the heartbeat of space communications. Each light represents a cell in the life of the work of humans exploring space. It has become an icon for JPL, where employees get excited showing visitors that the projects they work on now are real and active in space. The Pulse has been active for a number of years now. It is a joy to walk into the building and see new employees, who have no idea that I had anything to do with



Fig. 5-4. The Pulse sculpture, which responds to live communications with spacecraft beyond the Moon, in the lobby of the main administration building at JPL (building 180).

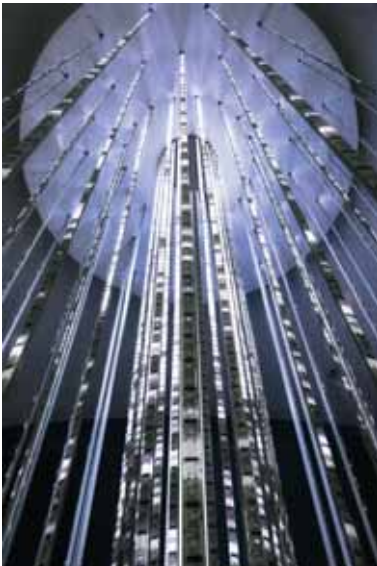


Fig. 5-5. The Pulse sculpture, which responds to live communications with spacecraft beyond the Moon, in the lobby of the main administration building at JPL (building 180).

the piece, explaining it to their visitors and watching them smile, feeling connected to our tools in space.

Orbit

For years after going to Goldstone, the idea of tracking spacecraft with sounds would come up as an idea to pursue, but it always seemed too challenging from a technical standpoint. The language and coding used for tracking spacecraft is quite complicated, and only people with very specialized training can understand it. Creating an all-encompassing sound system also seemed daunting. We needed more than just surround sound. While surround sound gives you a sense of front, back, left and right, we also needed above and below. At some point I got a tour of a lab at Stanford where they had a system I had never seen before that had embedded speakers in the floor and in the ceiling, so they could literally place a sound anywhere. This gave me great hope, but our attempts to marry the coding of spacecraft locations and the coding of this new system did not work out as it was mainly an after-hours experiment.

Years later I gave a talk at an event, and at the after-party, I walked up to a stranger and asked what they were interested in. Shane Myrbeck told me he was a sound engineer and composer. Knowing he would probably have no idea what I was talking about, I told him that I had seen this amazing room years ago where there were speakers in the ceiling and in the floor and they could place a sound anywhere in the room. He smiled and said, "That's funny, I sit in one of those all day long." It turned out that Shane worked for a large engineering firm which is well known for concert venues. They have several "sound labs" around the world. As they are designing a venue, they can take the CAD models of the spaces, plug them into

their specialized sound system, and literally hear what the building will sound like when built. I told him about my dream of being able to listen to the location of satellites, and we both got really excited about the idea. Shane is a rare breed in that he knows how to create one of these sound systems and he can compose music, but he also knows how to code and work with architects and engineers. This seemed perfect, but the only issue was that I didn't have a project with funding for such an endeavor. We traded information with the hope that someday things would work out to collaborate on this project.

A year or so later, David Delgado and I had put together a project called Metamorphosis. It was a large aluminum sculpture of a comet with fog emanating from it. As the wind would blow, the fog would become the tail of the comet. At night, lights made it glow from the inside. It was meant to draw attention to a mission called Rosetta, which was about to become the first spacecraft to attempt to land on a comet. This foggy comet was displayed at various locations, including Brooklyn Bridge Park in New York City during a large science festival. The display became the visual icon of the event, with news organizations using pictures of it to describe the festival. Its unique form and dynamic tail drew people to it and started to spark questions by the viewers. What is a comet? Why does it have a tail? How in the world would humans land on it? People all over New York City were suddenly talking about comets.

The next year, David and I were asked to develop another idea, but this time to communicate the fact that NASA studies the Earth. When most people think of NASA they usually think of astronauts and the Hubble Space Telescope, perhaps they will think of the rovers that are on Mars, but studying the Earth is not something that comes to mind as often. In fact, at the time we were working on this project, NASA had 19 satellites



Fig. 5-6. Inside Orbit, a sound installation that tracks Earth orbiting NASA spacecraft, at the Huntington Gardens in San Marino California.

that were studying everything from our oceans, to chemicals in the atmosphere, to hurricanes, to earthquakes. How could we get this story across? On a conference call David whispered to me, "What about that sound concept?" We explained the concept, and even though the requesters didn't completely understand what we were getting at, they took a risk and allowed us to investigate the concept further. The basic idea was that we wanted to have a room where you could stand in the middle, and wherever you heard a sound, that would represent the exact location of one of the 19 NASA satellites that were studying the Earth. But it had to be real time. These satellites are orbiting our planet all the time, so their location changes constantly, and we wanted that reflected in the experience. If you were there at one moment, they would all be somewhere else 30 minutes later. We called up Shane and checked to see if he really thought he could accomplish

this. We pointed him to the publicly available data streams that reveal the location of these satellites, and he tested it in his lab. Fortunately, it worked!

David and I got approval to continue working on the project. As we continued, David had an important insight. The previous year, the visual look of the comet sculpture caught people's imaginations. We wondered how, in a busy landscape, do you draw people to a sound installation? A cluster of speakers and wires is probably not going to draw people to it the same way as a glowing object with fog coming out of it. David said, "We need an object of wonder, where people are drawn inside." We tried a few times, unsuccessfully, to design something that could be an object of wonder, but we knew this was not our design strength, so we called up the designer of the comet sculpture from the year before. Jason Klimoski loved the sound installation concept and came back to us with a few ideas, one of which was a giant sea shell. It was a brilliant idea, when you listen to a sea shell you can hear the ocean, in our seashell we would allow you to hear where objects are in outer space.

There were many iterations on every aspect of the project. David and I had never before worked on a piece that was distinctly sound based. I thought we would just assign interesting sounds to each satellite and that would allow us to hear their locations. It turns out that deeper sounds with more bass are more omnidirectional, which means they sound as if they are coming from anywhere. Not exactly what you want when trying to pinpoint a location. Higher pitched sounds are easier to locate, but to make them easier to find, we discovered that if you stutter the sound, we could give more precision to the sound. As an example, if you have a beep every three seconds, you may be able to locate the sound, but if you have a beep five times a second, you will perceive it much faster. Shane then had the challenge of making 19

distinct “voices” for each of the spacecraft. We categorized them into three areas: land, sky and sea, so any satellite that studied the sky would sound like wind, those that studied the sea might sound like the ocean, and those that studied the land sounded like musical instruments. Shane custom made each sound, recording everything from wind, to water, to various instruments. The International Space Station is the only spacecraft that had humans in it. That sound recording was Shane’s wife singing. For the seashell, Jason created a hole in the ceiling to draw your eye to the sky. And the pattern on the skin was created for two purposes. The first was that the piece had to be 50% open so that the sound did not bounce around. The second was a reference to the long exposure photos of the North Star, where the star is a point and everything else spins in a circle around it. This pattern gave a dynamic look to the piece.



Fig. 5-7. Orbit, a sound installation, at the Huntington Gardens in San Marino California.

In June of 2016 Orbit opened to the public and immediately there were long lines to get in. It stayed in New York City for a week, traveled to a nearby museum, and is now at the Huntington Gardens in San Marino, California, not far from JPL. This setting allows it to be in nature, so when you are inside you can see nature through the holes, and the reflective nature of the aluminum allows the green from the trees and the blue from the sky to reflect off of the material. Walking into the gardens, people hear subtle sounds emitting from the shell. It really is an object of wonder, and it draws people into the space. Once there, the sounds are very calming, so people will sit with their eyes closed, almost in meditation, connected to a world of science that they may not have known was there. One evening at dusk, it was one of those rare moments where I could see the International Space Station streaking across the sky. I then heard Shane's wife's singing from that exact location. It was a surreal moment -- over a decade of dreaming and planning had finally come together.

Line of Sight

I lead a team of creatives called The Studio, which is part of JPL's DesignLab. We are a group of artists, designers, makers and strategists who help engineers and scientists think through their complicated projects and create ways of communicating about the universe we live in. In addition to David Delgado and others, Lois Kim is on the team. She had the opportunity to develop an installation in the main mall area of JPL where people can have lunch, take their coffee breaks and hold small outdoor meetings. Lois had always been interested in the street signs we have at JPL. Many of them are named after famous robotic missions such as Pioneer and Explorer, but she wondered, "What if we made a robotic street sign that pointed to things in space?" The idea was to have a

digital sign that could point in 360 degrees to anything in the sky. She made a quick sketch and got approval to continue researching the idea. The sketch looked so simple, just a spinning stick on a pole, but to make it a reality took an army of people from mechanical engineers, trajectory designers, data and software specialists, custom digital sign designers, typographers, structural engineers, IT and security, fabricators, and of course the installation crew. It took several years, but these three poles



Fig. 5-8. Prototypes and sketches by Lois Kim of Line of Sight, a robotic installation that points to objects in outer space.

have become another icon at JPL. Every 20 to 30 seconds they all move and point to a physically different point in the sky, and the words on the screen change to reflect what it is pointing to. Sometimes it is a star, other times it's a planet, some are planets around other stars, and other times it's the exact location of one of our robotic missions. The first morning it was working, a person was standing next to it with their laptop. Turns out it was a trajectory specialist checking to see if it was correctly showing the right direction. Lois was a bit nervous

having such scrutiny of her project by a technical genius, but it turns out the person was super excited that yes indeed, it was real and working, and Lois was relieved.



Fig. 5-9. The Line of Sight installation at NASA's Jet Propulsion Laboratory, a robotic installation that points to objects in outer space.

Conclusion

I remember the first time I was in a location with a dark sky and could see the Milky Way galaxy. I couldn't believe what I was looking at. How could there be so many stars? How could they be so far away? What does this all mean? What is our place in all this? I am so energized that I get to work at a place full of people trying to understand these questions. They are sending probes into space to help us understand who we are and where we came from. Robots being built here, once launched, may never be seen again, yet they are doing the world a tremendous service. We are learning about the Earth and how it changes, about the other planets and their moons and whether life ever existed on one of them, and about the stars and other galaxies far, far away that might give us clues to

profound questions of existence. We are honored to have the opportunity to give people visceral experiences pointing them to these great tools of humanity.

Dan Goods, Manager, The Studio. Jet Propulsion Laboratory, California Institute of Technology

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V-II

STAR AXIS

CHARLES ROSS

Star Axis

Standing at the boundary where the earth meets the sky.

Entering the earth to reach the stars.

Star alignments form the architecture,
capturing star geometry in human scale.

A whole body experience.

There are four chambers within Star Axis, each with its own
distinct energy.

The Equatorial Chamber at the entrance to the Star Tunnel,
the Star Tunnel, the Upper Room, and the Hour Chamber.

In the Star Tunnel, aligned with the axis of the earth, moving
through space, moving through star time as you climb the
Star Tunnel stairs.

The further back in time or deeper into the future you go,
the greater your physical effort.

The celestial axis goes straight through you.

Only one person at a time in the Star Tunnel.
Just you, Polaris, and the axis of the earth.

— Charles Ross

About Star Axis

Star Axis is an earthwork built to observe the stars.

Created by artist Charles Ross, all of Star Axis' shapes and angles are determined by earth-to-star alignments built into the architecture so they can be experienced in physical form and human scale.

Ross' artwork involves light, time, and planetary motion. Star Axis, his largest project, was conceived in 1971. After a four-year search throughout the southwest, Ross broke ground in 1976. Built with earth, granite, sandstone, stainless steel, and bronze, Star Axis is 11 stories high and 1/10th mile across.

Star Axis' five main elements are: the Star Tunnel, at the core of Star Axis; the Solar Pyramid, built to solstice alignments—its collected shadows over the course of a year draw the shape of the Shadow Field. From the Equatorial Chamber you see the stars that travel along the equator, and from the Hour Chamber you can view one hour of Earth's rotation.

“Enter the earth to reach the stars.”

The central element of Star Axis, the Star Tunnel, holds a stairway precisely aligned with Earth's axis. At the top of the stairs is an aperture. As you climb the stairs this aperture frames larger and larger circles of sky. Each of these circles is a particular orbit of Polaris in the 26,000-year cycle of Earth's changing alignment to the stars. The stairs will be dated to identify the years—from present to 13,000 years into the past and 13,000 years into the future.

“I realized I had to build Star Axis when I discovered that Polaris pulses in the human visual field—from a circle smaller than a dime held at arms length at present, to a circle that

encompasses our entire field of vision 13,000 years from now. It wasn't enough to just know about this. I wanted to walk through it."



Fig. 5-1. Star Axis, Star Trails, exposure for 1.5 hours. The brightest star near the center is our current north star, Polaris. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-2. Star Axis, Entrance to Star Tunnel. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-3. Star Axis, Star Tunnel. The stairs in the Star Tunnel are exactly parallel to the axis of the earth. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-4. Star Axis, Equatorial Chamber. The opening at the top of the Equatorial Chamber frames the stars over the equator and the motion of the sun on the equinoxes. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-5. Star Axis, Solar Pyramid Spine. The stairs on the spine of the Solar Pyramid are exactly parallel to the axis of the earth. The Solar Pyramid is actually a tetrahedron. The face of the Solar Pyramid is the angle of the sun at summer solstice and the back of the tetrahedron is the angle of the sun at winter solstice. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-6. Star Axis, Solar Pyramid and the Entrance to the Hour Chamber. The face of the Solar Pyramid is the angle of the sun at summer solstice. The triangular opening is the entrance to the Hour Chamber, which frames the motion of the earth for exactly one hour. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-7. Star Axis, Shadow Field. The Shadow Field has not yet been constructed. It's bow-tie shape is determined by the collection of all of the shadows cast by the Solar Pyramid. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-8. Model of Star Axis showing the Shadow Field. The bow tie shape of the Shadow Field is determined by collecting all of the shadows of the Solar Pyramid over the course of one year. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-9. Star Axis, Stars seen through the Hour Chamber opening at night. It takes exactly one hour for any star on the left side of the opening to travel to the right side of the opening. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-10. Star Axis, New Mexico Landscape seen through the opening of the Hour Chamber. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-11. Star Axis in the landscape. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York



Fig. 5-12. Star Axis in the landscape. Credit: © 2021 Charles Ross / Artists Rights Society (ARS), New York

V-III

ART UNCOVERS SPACE

RICHARD CLAR – 37 YEARS OF SPACE ART

For nearly four decades, my art has challenged the limitations of gravity. It is a test of the curious mind. As artists, it is incumbent upon us to break free of the boundaries that limit artistic expression. The precepts of dimension and time, surface and structure, light and dark, pinnacle and abyss, reality and conjecture. As a space artist, an environmental artist using outer space as my medium, my work has been emblematic of what Paul Klee described when he said, "Art does not reproduce the visible; rather it makes visible."¹

Making the invisible visible, providing shape and substance, articulating and manifesting the transformative from nothing, sounds something akin to alchemy. But that very melding of the ordinary to produce something extraordinary is the job of the artist. It requires a willingness to suspend the conventional and question the perception of the walls that want to keep us safe. Fortunately, limitations crumble before the curious mind.

But truth be told, space, in all its vastness, can be scary. As a young child growing up at the end of World War II, terror dropped from the skies. Not too many years later, Sputnik 1,

¹ Paul Klee, *Creative Credo 1920*, Quotes.net. STANDS4 LLC, viewed 3 June, 2020. <https://www.quotes.net/quote/36770>.

could be tracked across the night sky. It was the height of the cold war, and the unknown created a level of uncertainty and anxiety that more evil might fall from above.

But for all the constraints layered on us by fear, we as artists, tasked with describing the world as we experience it, are given license to explore the uncharted.

I learned this as a young boy when my grandmother didn't bring me toys and candy, but old clocks, to which I eagerly and diligently dissected into its various parts and pieces. What made this tick? Can I make it tick again? What can I do with all these left-over parts? Hmmm?

As it turns out, curiosity never killed this cat, it just made me want to know more. When I attended an international sculpture conference in 1982 I met a wild fellow named, Joe Davis. He was, in fact, a fellow at MIT's Center for Advanced Visual Studies. Davis was giving a talk about an art project of his that was set to fly on the Space Shuttle via NASA's Get Away Special (GAS) program².

Joe and I spoke after the talk and he convinced me that despite my lack of engineering credentials, I could still create a project that could fly in space and figure out how to make that happen. Joe's enthusiasm was contagious and I couldn't stop thinking about the possibility. And then it arrived. Almost fully formed. The whole picture as clear as the night sky. *Spaceflight Dolphin*³.

² NASA's Get Away Special Program: Twenty Years and No Sign of Running out of GAS, Goddard Space Flight Center, viewed 27 April, 2021. <http://www.spaceref.com/news/viewpr.html?pid=8744>.

³ Richard Clar, 'Spaceflight Dolphin: A Site-Specific Art and Technology Payload for the U.S. Space Shuttle', Leonardo, vol. 26, no. 4, 1993, pp. 293-296.

Spaceflight Dolphin: A Site-Specific Art and Technology Payload for the U.S. Space Shuttle

Spaceflight Dolphin was my entre and first foray into the art-in-space universe. The enabler in those early stages of the Space Shuttle, was NASA's new program christened as Get Away Special's. At that time, most of the Shuttle flights took off with only a partially filled payload bay. And as with any flying machine, balance was crucial to the Shuttle's ability to fly. What some smart engineer at NASA devised was that instead of using dead weight as ballast, they could incorporate canisters that could contain a five cubic foot payload. Each canister was designed to carry a small self-contained scientific or technical experiment. And in a creative stroke, they also developed purposeful ballast that both stabilized the Shuttle and helped fulfill its mission.

And in the interest of the Shuttle's international spirit, the GAS program was open to anyone around the world; government agencies, universities, private industry, and even artists. Low cost rates for GAS payloads made them very attractive. There was one important stipulation that affected artists: all payloads had to contain scientific or technical benefit. NASA would not fly an art project for art's sake alone. Once the science/technology requirement was met, NASA would at least consider an art payload.

To satisfy this requirement, *Spaceflight Dolphin* was designed as an interdisciplinary site-specific art-in-space Search for Extraterrestrial Intelligence (SETI) project intended for deployment into low-Earth orbit.

Project Description

The official project description had to be written in NASA speak and detail all their specifications. *Spaceflight Dolphin* (SFD) (Fig. 5-1) is a transitional dolphin sculpture/satellite that can be deployed from a GAS canister (Fig. 5-2) into low earth orbit. After deployment from the Shuttle, *Spaceflight Dolphin* transmits a signal modulated by dolphin voices/sounds that when emitted out into space could be detectable or sensed by an extraterrestrial intelligence (ETI). I had always thought it quite arrogant of humans to think that extraterrestrial intelligence would speak as we do and not, as other intelligent life on earth might, like cetaceans.



Fig. 5-1. *Spaceflight Dolphin* Full-Scale Mockup, permanent collection, Culver Gallery, University of California, Riverside. Photograph UCR.



Fig. 5-2. Get Away Special Canisters inside the U.S. Space Shuttle cargo bay. Photograph NASA.

As the sculpture/satellite then orbited Earth, a SETI scientist, or interested person, could listen in on the dolphin voices over the Internet, as well as in various art venues around the world. This connection could provide a link between different people and cultures on our own planet, providing an experience of the vastness of lifeforms located close at hand and the variety of expression that might be necessary to communicate with lifeforms other than our own.

The approximately life-sized dolphin sculpture/satellite is constructed out of a memory alloy, 55-Nitinol wire. Nitinol is a nickel-titanium alloy developed by the Naval Ordnance Laboratory, White Oak, Maryland⁴. The alloy has “shape memory” that allows for distortion by bending, twisting, or plastically compressing it out of shape at room temperature. Upon heating the alloy to 150°F (which, after deployment, is achievable with sunlight in space), the deformed Nitinol springs back to its original shape. There is a certain poetry in

⁴ AZO Materials 2002, *Nickel-Titanium Shape Memory Alloys*, viewed 3 June, 2020. <https://www.azom.com/article.aspx?ArticleID=1365>.

the metamorphic resilient quality of Nitinol that makes it appealing for *Spaceflight Dolphin*.

The final step, once the structure is produced is the selection of a dolphin message, which is then digitized and encoded on a microprocessor for integration into the sculpture satellite.

Spaceflight Dolphin received its approval to fly by NASA, in 1982. Unfortunately, after the 1986 Space Shuttle Challenger accident, things changed dramatically, as did the GAS program rules. Ejectable payloads, those designed to leave the space shuttle, were no longer acceptable.

Artistic Merit

Scientifically, *Spaceflight Dolphin* was an acceptable payload. But for me, there was also a need to make sure that the artistic merit of the project was front and center.

It began with a simple question that has been asked as long as humans have looked to the stars. Are we alone? It is a question that is deeply engrained in our psyches. What intelligent lifeforms might exist in the vastness of the universe? And can we communicate with them?

Spaceflight Dolphin uses art and technology to address these questions. Putting a dolphin sculpture/satellite into space says a great deal about two intelligent species on earth, humans and dolphins. It recognizes that intelligence, itself, is an evolving concept. It could very easily take many different forms throughout the universe. Attempting communication with extraterrestrial intelligence through the sounds and voices of dolphins says we are not so egocentric or arrogant to think that meaningful communication only takes place within a specific species. Dolphins have long been recognized for their demonstrated abilities to communicate intelligently. It was

wholly appropriate to consider that outside the realm of earth-bound, human interaction, that extraterrestrial communication could just as easily consist of cetacean utterances as those created by humans.

One endeavor that seems to be singularly human is our ability to communicate through art and symbols. It is a practice that has allowed us to transcend the boundaries of time and culture. Working alongside space scientists and engineers, artists are now capable of creating and developing new art forms, which were never possible in prior generations. For one, the medium of space does not limit the artist to work in just two-dimensions as on a painting or three with sculpture. The interactivity it allows provides a multi-dimensional quality capable of radiating and projecting in all directions. And unlike traditional art, it can go beyond just the display of its message, reaching out into the nether ethers to consider *how* it will be received. This is a unique opportunity for artists to use these available space-age technologies to create work that extends outside of the known and into the new.

Spaceflight Dolphin is Process Art, where the process of creating the artwork is as important, if not more important, than the final art object.⁵ There are those who would argue that a static piece of art is really nothing more than an artifact, and that the real art is everything that goes into the making of the piece. Creating process art recognizes the living interaction between the artist and the universe out of which that art emerges. And then breaks through those limitations by incorporating what evolves back into the process to open new space.

⁵ Process art, The Solomon R. Guggenheim Foundation, viewed 3 June, 2020.
<https://www.guggenheim.org/artwork/movement/process-art>.

Using art as a tool, an interstellar message can be constructed without relying on language or logic, and in creating that communicate we reveal an important aspect of who we are as a species. We also open ourselves, as a technological civilization capable of ending all life on our planet at any moment, to the opportunity and possibility of new answers to our conflicts and confusion. Reaching out and making contact with an advanced technological extraterrestrial intelligence could provide answers that might take our society millennia to conceive, let alone resolve. We don't know. *Spaceflight Dolphin* was designed as a means of extending that question, are we alone to, Are You There? Which, as the man who introduced me to the Get Away Special opportunity, Joe Davis once said, "That's a great job for an artist."

COLLISION II: An Orbital Debris Constellation Sculpture

We may not know who is out there, but what we can say for certain is that, as humans, what is out there is something we are wholly responsible for, at least when it comes to near-Earth orbit. We've done a great job of polluting the land and sea beneath the atmosphere, but unknown to many of us, we have done an equally amazing job junking the space that surrounds our planet. We humans have a propensity for creating a massive amount of debris and then without a second thought, walking away from it. And that which encircles our planet, today, for the most part remains invisible on Earth.

For me, the problem of space junk was another artistic opportunity to employ Paul Klee's dictum and use art to make visible something very real and unseen.

In 1992, I learned that the U.S. Space Command, NASA and the Naval Research Laboratory (NRL) were tracking over 14,000 pieces of orbital debris. These objects range in size from 10 cm up to large rocket bodies and satellites. Each object has a catalog number giving the date of launch, country of origin, plus a two-line element set describing the orbits of each piece. My curiosity could not be contained. But what initially arose was not just a visualization, but a listening. The images of these pieces of junk tumbling around in space was something akin to a dance. So, was there music in the way these orbital debris objects moved relative to one another and relative to various points on earth? Then out of that music came the idea of movement. Perhaps it would be possible to create a kinetic constellation sculpture without having to go into outer space. *COLLISION II* emerged.

Paris-Sorbonne University (Paris IV) composer and musicologist, Prof. Marc Battier, supported the emanation of music I had sensed. And he would eventually compose the music for *COLLISION II*, based in part on the orbital debris data from the two-line element sets supplied by the NRL. Those two-line element sets accurately described the trajectories of the earth-orbiting objects I would use to comprise the dynamic orbital debris, site-specific, artwork, called, *COLLISION II*. I took the classical approach to creating the sculpture by removing material, as one would do working with marble or stone. And like the ages of sculptors before me, the sculpture was what remained after removing the material.

Based on this concept, I set to work with the Naval Research Laboratory (NRL) in Washington DC, who created a video simulation of The Orbital Debris (OD) based on parameters I provided. I told them I wanted to eliminate only the debris objects located outside 96 and 104 degrees of inclination and an altitude of 450 to 800 km. That left 192 OD objects in sun-

synchronous orbit around the earth, from all the space-faring nations. The dance of these 192 OD objects were now an ever-shifting constellation, that choreographed themselves into the *COLLISION II* sculpture. Art making visible the very serious problem of orbital debris.

Using a massively-paralleled super computer, a CM5E Connection Machine, the NRL created a 4.5-minute video simulation during a 12-hour period that depicts;

1. A simulation of all the orbital debris at that time, (Fig. 5-3)
2. The 192 orbital debris objects color-coded by country of origin, set against a backdrop of the entire orbital debris population, (Fig. 5-4)
3. Just the 192 orbital debris objects that comprise *COLLISION II* - the orbital debris constellation sculpture, itself.
4. The NRL uses a program they developed called COMBO Calculation of Miss Distance Between Objects to produce the simulation.

As the 192 orbital debris objects dance through the simulation, a white cross flashes, every time a piece of orbital debris passes within five kilometers or less of another piece of orbital debris. Five kilometers is a relatively short distance between the orbiting objects and it's close enough to illustrate the potential for collisions. When those collisions between pieces take place, they create even more orbital debris.

COLLISION II figured prominently in the Paris exhibition, *Space Art*, at The Maison Européenne de la Photographie's Festival Art Outsiders, October 1 to November 9, 2003. Jean-Luc Soret, the curator of this exhibition, had a very special idea about how

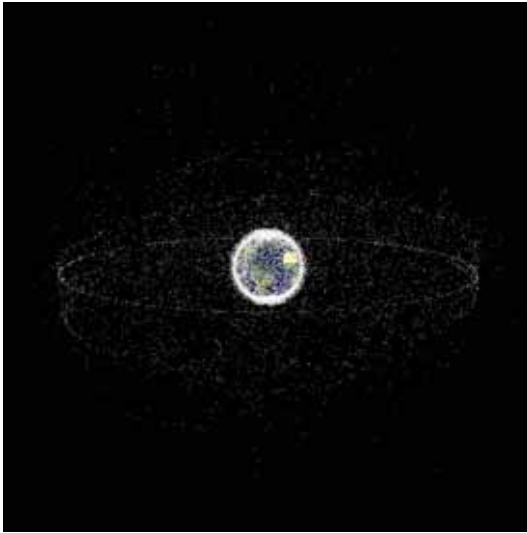


Fig. 5-3. Entire orbital debris population seen from beyond geosynchronous orbit. Credit NASA ODPO.



Fig. 5-4. *COLLISION II* orbital debris constellation sculpture in low-earth orbit, color-coded by country of origin. Image, the Naval Research Laboratory, Washington DC.

he wanted to exhibit *COLLISION II*, which required the use of a volumetric display. A volumetric display creates a holographic video image that appears to float by itself in front of an opening created in the wall, which actually contains the projection equipment. This type of display was beautifully suited for *COLLISION II*.

With the lights dimmed, a small rotating image of the earth, encircled by the 192 color-coded orbital debris objects, appears on a flat plasma screen set back inside the opening in the wall. Marc Battier's haunting musical score begins as the rotating earth accompanied by the orbital debris, slowly begins moving out into the room, growing larger. The sculpture remains in the center of the room, tilting slightly on its axis, to reveal the plane of circling objects. Then as slowly as it arrives, it retreats back inside the opening within the wall. And finally, back onto the flat surface of the plasma screen.

The programmed display would then repeat itself periodically. The curator, Jean-Luc Soret, said that the manufacturer of the volumetric display told him it was the first use of a display like this in an art museum anywhere in the world.

As a projected kinetic sculpture, *COLLISION II* was a powerful visual statement about the trashing of our world and of the space around our world. In this case again, art made visible the detritus we would rather not face and the challenge to our environment we continue to create with alarming unconscious disregard.

The Music of Neil Armstrong's Heartbeat Returns to the Moon

In August, 2015, Daniela de Paulis, Italian artist and moonbounce pioneer, presented me with a creative challenge I couldn't

refuse. She invited me to use the 25-meter Dwingeloo radio dish in the Netherlands (Fig. 5-5) to create a moonbounce artwork. The moonbounce was invented in 1940 during World War II by an engineer at the U.K. Post Office Research Station, William J. Bray. The problem was how to keep Morse coded messages from being intercepted by the Germans.

The ingenious answer was to use two radio telescopes in different locations. One would transmit the message, bouncing it off the moon, and the other would catch it on its return. The crucial factors were the moon's position relative to Earth, the location of the radio transmitter and the alignment of the receiving antenna. And with that, the dots and dashes of critical messages could be sent and retrieved without detection.

As an artist, Daniela de Paulis, recognized that while bouncing messages back and forth off the moon was brilliant technology, she began working with radio engineer, Jan van Muijlwijk to develop something more. Together, they pioneered what is now called, *Visual Moonbounce*, which allowed di Paulis to send images to the moon, and rebound them back.

For me, it was important to find a more innovative way to use the moon than just being a backboard to ricochet images back and forth. I wanted to make a more meaningful statement about the moon itself. I began researching Apollo 11 within the historic archives at NASA Headquarters. What was clear was that all of the Apollo Missions had extensive documentation along with meticulous notes taken by the astronauts during the flight and while on the lunar surface.

I then came across a nugget of pure gold when I unearthed a 2-D Electrocardiogram (EKG) of Neil Armstrong's heartbeat as he took his first step on the moon (Fig. 5-6). How cool was



Fig. 5-5. Dwingeloo Radio Observatory, The Netherlands. Photograph Jan van Muijlwijk.

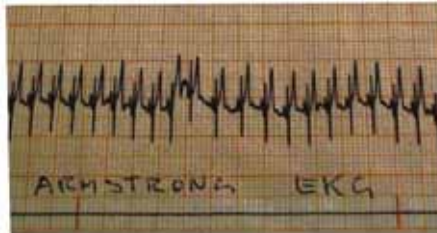


Fig. 5-6. Neil Armstrong EKG upon his first step on the moon. Photo: NASA HQ.

that? As I contemplated the waves on this historic printed EKG, my first thought was: there's music in those waving EKG lines! That was the beginning of *Giant Step*, which would be my artwork celebrating Neil Armstrong's first step on the moon.

I then reached out to Dr. Ryan Compton, currently employed by Google, whose specialty was the sonification of data. Working with the 2-D EKG, Dr. Compton created a two-minute single tone from the Armstrong EKG.

As excited as I was, I knew I needed more. For *Giant Step*, to truly exemplify this momentous occasion in human history and pay appropriate homage, I contacted, Roberto Miranda, Los Angeles double-bass jazz musician and UCLA professor. What sets jazz apart from other forms of music is its improvisational elements. I asked Miranda to use the two-minute EKG tone as a means to lift off and inspire his musical improvisation.

Within the confines of Wayne Peet's Los Angeles recording studio, Roberto recorded two soulful tracks: over Compton's single tone EKG, and Neil Armstrong's famous words: "That's one small step for man, one giant leap for mankind." And with that, Armstrong's beating, very human, heart became the representation of one of humanity's greatest achievements.

The Apollo 11 moon landing was certainly an historic first for the American space program, but Armstrong knew that stepping foot on the lunar surface was bigger than that, and the words he spoke as the planet listened were meant for all of humankind. I wanted to make sure they continued to reverberate and inspire.

On September 26, 2015, at the Dwingeloo Radio Observatory in the Netherlands, just before a Super Blood Moon was about to take place, we gathered in the control room of the Dwingeloo Radio Telescope to launch the *Giant Step* moonbounce.

Four years later, on July 21st 2019, at precisely 02:56:15 UTC, the exact time Armstrong took that first step on the moon fifty years earlier, we performed another Earth-Moon-Earth (EME) moonbounce of that Apollo 11 landing. Again, the transmission carried the *Giant Step* sound file of Neil Armstrong's words, heartbeat and the EKG tone. And as it had been designed nearly 80 years earlier, the radio telescope did its part sending

out the signal and the moon did what it does, reflecting back the rays that hit it and returning the signal back to Earth carrying both image and audio files.

Art at the Laser's Edge

In most universes, that would be enough. But at the exact moment the Dwingeloo Observatory sent off the *Giant Step* Moonbounce, 1,440 kilometers away, at the Cote d'Azur Observatory Laser-Ranging Station near Grasse, France, I had arranged for another type of transmission to take place.

Back in 1969, as Armstrong and Buzz Aldrin leapt across the lunar surface, one of the last tasks they performed before packing up and leaving the moon was to place a retroreflector on the moon's surface, in close proximity to the Lunar Lander.

A unique feature of the Apollo 11 retroreflector⁶ (Fig. 5-7) was that it caused light striking it, from any angle, to reflect back to earth in a parallel path. The scientific purpose of these retroreflectors was to enable a laser-ranging observatory to fire a laser beam that would strike the retroreflector and return a small portion of the photons from the beam back across space to its source. And even though what would be received was just a fraction of the initial output, it was enough to provide a very accurate measurement of the distance between earth and the moon.

⁶ Thomas Murphy, 'Lunar Laser Ranging', in IOP Publishing, Rep. Prog. Phys. 76 (2013) 076901, pp. 1-21, <https://tmurphy.physics.ucsd.edu/papers/rop-llr.pdf>.



Fig. 5-7. Apollo 11 retroreflector. Image credit: NASA.

With the 50th Anniversary of Apollo 11 approaching and preparations already underway in the Netherlands for the radio telescope bounce, another idea dawned on me. I could also use a laser-ranging observatory to fire its green laser at the Apollo 11 retroreflector, and have it pulse in Morse code, "That's one small step for man, one giant leap for mankind."

When it was confirmed that the concept was valid, I set out to find the best location for this green laser transmission and discovered it was from the Cote d'Azur Observatory's Laser-Ranging Station, near Grasse, France.

As with the radio telescope moonbounce, the plan was to have the laser transmission also occur at 02:56:15 UTC on July 21. In this instance, I would be returning Armstrong's words to almost the exact spot where he walked 50 years ago. It made so much sense, it was almost too good to be true. Unfortunately, because of the laser-ranging's narrow frequency band, 10 Hz, it was not possible to transmit anything other than a Morse coded message.

At precisely 02:56:15 UTC, the moonbounce commenced in Dwingeloo and the brilliant green laser at the Cote d'Azur

observatory beamed out across the heavens, marking a direct path, 238,900 miles, to the retroreflector placed 50 years previously on the lunar surface (Fig.5-8, Fig. 5-9).



Fig. 5-8. Richard Clar inside the Cote d'Azur Laser Observatory dome as green laser beam strikes the moon. Photograph Rebecca Marshall.



Fig. 5-9. Green laser beam as it strikes the moon from the Cote d'Azur Laser Observatory. Photograph Rebecca Marshall.

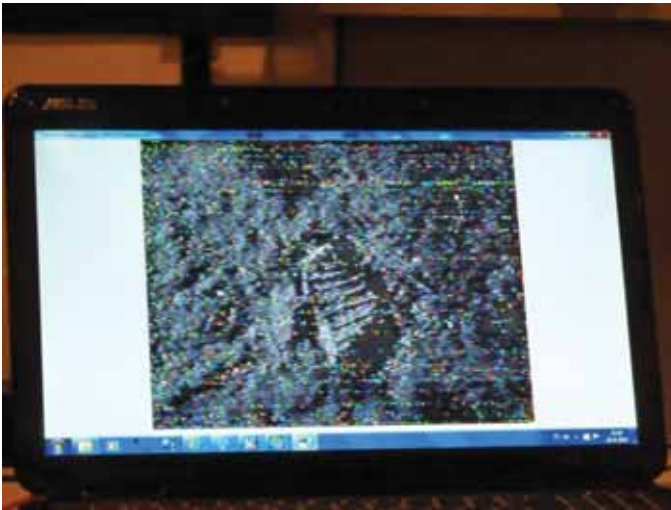


Fig. 5-10. Moonbounced photo Apollo 11 astronaut footprint. Image by Dwingeloo Radio Observatory.

Both events occurred exactly as planned. From Dwingeloo, the heartbeat sound of Neil Armstrong's EKG, the single tone created from that EKG, an image of Armstrong's footprint (Fig. 5-10), and Armstrong's resounding words were all successfully bounced off the face of the moon and back to earth. While simultaneously, 1,400 km away, the laser beam at Cote d'Azur sent out Armstrong's coded message to within feet of where he had originally spoken them.

In Closing

Art, for me, has always been a way of breaking through the limitations and boundaries of the world I encounter. Finding new space to bring people together in a positive way to celebrate that all forms of art exist. There's a word that I learned when I was studying ceramics and glaze technology, that in many ways has been a metaphor for my work in outer

space, *eutectic*. It means fuses easily. It describes a process in which certain materials melt together and combine. They actually melt at a lower temperature than the melting point of any of the individual materials that are being combined. It's almost magical, alchemical.

Art has always been my means of bringing different people together so that this eutectic process can take place. It's a place where we can all fuse easily, recognize our interdependence and join together without raising the temperature of the planet. What better job is there for an artist than that?

V-IV

SPATIAL PERFORMANCE REALITIES: SIGNATURES OF A SEA AND SPACE BODY

SARAH JANE PELL

Spacefaring has become a muse for the work of Pell. It embodies the strong continuing partnership between 'imagineering' and action. This essay provides an in-depth understanding of her pioneering work including prototypes, hypothesis, methods and emotive aesthetics uniquely created through her interdisciplinary works. Analysis of her work contributes new design insights and alternative understanding central to the (C)osmosis Art movement.

Performing Astronautics

Call me an Artist Astronaut. As an 'artist', I'm using creativity as a vehicle to space. I can bring together incredible talent and embodied tools to unlock human performance, culture and creativity in space exploration. My artistic interest in following the body's natural edge into the abyss of space is spiritual, visceral and techno-poetic. As an 'astronaut', I have a way for the artist's body to provide glimpses into the future. Spacefaring is an obvious state of art in its risk and experimentation. Even from this Earthly perspective, the promise of unique spatial performance realities challenges us to expand our psychological and imaginative limits. While I am visualising and realising pathways for a creative life in space from here on the ground, with the embodied immersive knowledge of a terrestrial visual

artist and an underwater performance artist, new senses and instruments (real/illusory) are emerging through mixed realities and material arts practices which tune into signatures of a cosmic sea and space body. I refer to this pursuit as 'performing astronautics'.

The journey of *Performing Astronautics* (2016-2018) focused on experimental performance exploration to amplify the bodily phases of astronaut training and undersea missions as basis for extreme movement. The creative research occurred by participating in space analogue training and mission scenario simulations, designing prototype performance systems, producing speculative fiction short films, proposing, reporting and producing a new work on performing astronautics. Radical ideas, compelling performances, speculative fiction, and documentation of extreme art experiences and even technical, legal and ethical recommendations resulted through creative research, training, conversation and collaboration with choreographers, engineers, scientists, designers, explorers and misfits. Other subtle and personal discovery resulted too.

By relating my investigations and investigating my relationships to the act of 'performing astronautics', my practice created a lens on broader human expression and exploration activities in extreme environments. We call them extreme because they are hostile. We must adapt, evolve, counter-measure or protect against the hostile elements to ensure an optimal range for human development¹. One tip in designing a nano-bio-info-cogno-convergence matrix, make sure you find ways connect to the environment and use your imagination to create signs of life. Right here, now, we design and prepare for

¹ Felipe Gomez, *Encyclopedia of Astrobiology*, 2014, https://doi.org/10.1007/978-3-642-27833-4_566-2.

the upgrade of Humanity 2.0. So, take a deep breath, and be open to an embodied experience. Future visions for space require us to embrace extremophilic traits.

Let's set the scene for a collective visualization. It is 2027 and Humanity 2.0 is thriving. How? Our quest for new experience (real/illusory) replaces our quest for new knowledge. Our desire for bodily control is underwritten by a desire for environmental integration (real/illusory). Subjectivity as artist-astronauts directs our purpose and meaning. We look through a collective spiritual prism into the life cycles of our evolution. We embrace liquid realities; we are fluid, expansive and unhinged. Sensory exchange within a responsive operating environment shapes our quality of life. The artist-astronaut asks new questions of the body in time/space.

Spatial Performance Environment Command Transmission Realities for Astronauts: SPECTRA 2018

In 2018, I commanded the *LunAres* MoonMars Station SPECTRA Mission in Pila, Poland: a high fidelity 15-day lunar analogue mission in total isolation and confinement of the Station, with an enclosed simulation Crater and a remote Mission Command. I architected an ambitious experiment in performing astronautics, and selected a 6-person international, interdisciplinary and intergenerational crew. Flight director Dr. Agata Kołodziejczyk and I devised a schedule to successfully complete 32 research projects with 29 international PIs and employed 100 global partners including government agencies, academia, private industry and individual stakeholders. The seven research fields and major projects that shaped the mission included: Psychology; Physiology; Microbiology, sanitation and hygiene/ Clinical and laboratory diagnostics; Operations and technology, Extravehicular and surface

activities; Biological experiments; and Art, media, communication and culture. SPECTRA converged on testing new technologies, interdisciplinary systems and crew performance. I prioritized safety, simulation, science and then societal factors. As Commander, I adopted a fluid arts-led approach to high- risk operational systems and the mission architecture, in the hope that careful orchestration and care across systems, including working with Vice Commander Samra to buffer mission support/command communications with the crew down to a need-to-know basis, embracing openness to playful improvisation and inclusion of opportunities were vital for skills transfers and new experiences, furthering innovation and discovery. Initial outcomes show support of new experimental approaches between Earth-Moon teams and insights into the spectrum of human traits essential for future lunar settlement and station management. The aim of curated arts project is in exploring the critical pathways, discourse and cultural practice surrounding space as inspiration for new works of art, and new ways of working with art and space, during a mission simulation. This included the creation of new works of art onsite, in transmission and on-line, plus new tactics for engaging space phenomena for enabling further creativity, media and aesthetics practices including rock art.

Moonhenge

Neolithic stone monuments have been culturally significant throughout humankind's history. This project created a monument using the observing technologies of Neolithic communities - a cultural heritage all humans share. The objective was to construct a stone circle on the Moon's surface, with specific regard to the location of the Earth from the location of the Moonbase. (As the Moon is in tidal lock orbit,

one side faces the Earth at all times, and hence the Earth will always be located in the sky for observers on that side.) Specific elements of the Moonhenge design were taken from common designs found in stone circles around the British Isles. The stone circle on the moon takes into account its location on its celestial body, as well as the bodies that could be observed from this different vantage point. The Moonhenge calculations and manual installation occurred over several staged EVAs under simulated spacewalk conditions and protocols with basic hand-tools, hand-signals, radio communications and handheld touches in a darkened crater.



PRODUCER/DIRECTOR: SARAH JANE PELL DESIGN: SEAN ELLIOT (ROUGH SCIENCE) CALCULATIONS/EVA LEAD: ANDREEA RĂDULESCU INSTALLATION OMAR SAMRA, MARK SPLITTGERBER PRODUCTION: JADEN HASTINGS, SIAN PROCTOR, AGATA KOŁODZIEJCZYK, BOGDAN JASIŃSKI. PHOTO BY SIAN PROCTOR: SARAH JANE PELL CENTRE STONE MOONHENG, 2018.

Loss of Crew [Moon-Earth Transmission]

SPECTRA crew staged a vignette relating to research discussion including a Loss of Crew scenario, two in meditation on EVA, and Commander Pell in the Apollo replica suit with the Lucy

Electric Emergency High Voltage Switch Trident tool. A visiting Mission Specialist (from a nearby Crater) positioned the Leica RTC360 3D reality capture solution on a tripod to document and capture in 3D the external habitat environment and the internal hanger (with simulation rater). Six main Capture scans of the crater data included: the Lucy Electric Switch, Moonhenge, Emergency Mobile Unit (Greenhab), The Legendary Rover Team vehicle, and all geological features. The LiDAR project files were transferred to MIVP with support from Harasymczuk in Mission Command and Leicar Geosystems. In less than 24 hours, Kaluza and Hamacher (MIVP) post-processed >40M points of data for optimization in the CAVE2 environment: an 84- million-pixel stereoscopic curved display cylinder with 9:1 aspect ratio and a real-time compute cluster with 100 Tflops, 4TB RAM, 240GB GPU memory. The remote MIVP Command identified potential hazards, located the fallen crew member, and EVA rescue.

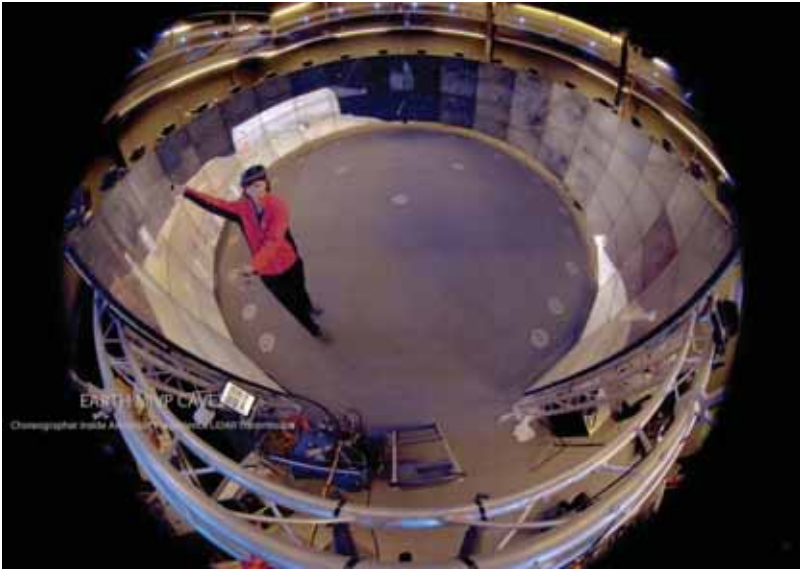


LiDAR Technician: ROBERT SZYSZKO. Project Data Processing: OWEN KALUZA, TOAN NGUYEN, ANDREAS HAMACHER. Crew: SARAH JANE PELL, OMAR SAMRA, MARK SPLITGERBER & ANDREEA RĂDULESCU. Directors/Producers (Moon) SARAH JANE PELL (Earth) DAVID G. BARNES. Thanks: JOHN POLLARD, DANIEL WAGHORN, SIAN PROCTOR, JADEN HASTINGS, MARCIN TRAPLE, AGATA KOŁODZIEJCZYK, and MATT HARASYMCZUK.

SPECTRA [Earth-Moon Transmission]

The Loss of Crew scenario LiDAR data vignette became the point of departure for an experiment exploring the remote choreographer- performer relationship. Mission Control supported the Pell with a special Moon-Earth transmission during the creative development process to understand the reception and translation of the crater data, MADA Artist-in-residence Move was asked to begin an impromptu unencumbered experimentation with the Loss of Crew environment. He had never used VR, a CAVE2 or heard of LunAres before. MIVP recorded his performance and tracked interactions to transmit an Earthly natural sensation to Pell, in this case, a dance for the dead. Move's gestures were transmitted to Commander Pell in the LunAres Airlock. She learns the dance via Move's embodied experience in VR. It is actually very emotional.

With the memory of the LiDAR data dance: the position of all the now-absent actors in the crater, and the residual VR encounter with Move's hands and head movements fresh in my bodily memory. I perform inside the Apollo replica suit for ~13 minutes in the isolated simulation Crater. It was mesmerizing. The Moon-Earth-Moon Live Performance Transmission successfully demonstrates the transfer of choreographic exploration and dance across space. The result is an uncanny dance by two artists who only experience each other through virtual presences yet could be mistaken for each other.



A collaboration between SARAH JANE PELL, DAVID G BARNES, RICHARD MOVE. Starring: RICHARD MOVE. CAVE2 Production Team: DAVID BARNES, OWEN KALUZA, TOAN NGUYEN, ANDREAS HAMACHER, JOHN POLLARD, DANIEL WAGHORN. Co-produced by Monash Immersive Visualisation Platform [MIVP].



Starring: SARAH JANE PELL.

Cameras:
Self-operated.



Starring: SARAH JANE PELL. Camera: SIAN PROCTOR Lighting: ANDREEA RADELESCU. Supported by Space Garden Company & LunAres 3 SPECTRA Crew.

Lunar Parliament, 2018

"Failure is not an option" is a famous quote from Apollo 13; however, space activities have always been plagued by errors. A mixed reality Motion-Capture Performance within the SPECTRA LiDAR Crater Data hosted by the Kosmica Parliament Space Platform, Commander Pell reports (and critiques) a loss of crew situation from the Moon. Through strategic risk-taking and experimentation, outcomes of this project help artists to visualize tasks performed in constrained spaces, under high-risk operational conditions, often alone and yet highly monitored and scrutinised. This in turn, helps engineers and architects in developing innovative approaches to creating spaces that enable artists to undertake these tasks with 'trade spaces' for design engineers to use to optimize habitable and creative

performance environments for artists to amplify their own practice and contributions too. This is a unique perspective to art-making which applies human-centred architecture and movement ability to the design, development, test, and trade analysis of spacesuits, spacecraft, habitats, tools and technologies of all kinds and includes the deeper- level psycho-social, poetic and political challenges for artists in space exploration missions. In the end, it is a human story. Lives matter.



Collaborators: SARAH JANE PELL, DAVID BARNES & DANIEL WAGHORN. Performer: SARAH JANE PELL & her APOLLO AVATAR. Score MOBI Gratis. Audio SPELLART. Live Tech: KINGSLEY STEPHENS. Asset Support: VISITOR.VISION. Photographer: Tom Mesic Travel support Monash eResearch. Devised and Co-produced with Monash Immersive Visualisation Platform MIVP for Kosmica Parliament, Error- the Art of Imperfection, 2018 Ars Electronica Festival.

Project MOONWALK, EU 2016

Back in 2016, I was Simulation Astronaut for project MOONWALK, the European Lunar Analogue EVA Simulation Human-Robotic Cooperation Undersea Trials that developed new approaches for astronaut-robotic cooperation suitable for planetary surface mission. I spent two weeks in a subsea analogue site to the Moon off the coast of Marseilles, and in preliminary tests of the Comex, S.A. pool. The trials included operating the Gandolfi-II EVA simulation spacesuit; use of

Manual tools (pantograph sampling tool and foldable pick-up claw) for geological sampling; operation of the assistant-robot (scout rover); use of the MMI robot control sub-system (gesture control) and a data interface integrated in the EVA suit (tablet); Bio monitoring (heart-rate and gate); EVA Information System (EIS) spacesuit computerization exchange with MCC using voice, text, live video, annotated imagery, telemetry, robot operations; and live voice command to Mission Control Centre, Bremen, and local CapCOMM.



Simulation Astronaut: SARAH JANE PELL MOONWALK is a consortium project comprising: DFKI Robotics Innovation Center, DE; COMEX, FR; EADS UK; LIQUIFER Systems Group (LSG) AS; Space Application Services (SAS) in BE; NTNU Centre for Interdisciplinary Research in Space in Norway, NO; Instituto Nacional de Tcnica Aeroespacial (INTA), ES.

The Agency of Human-Robotic Lunatics, AU 2017

Through the use of a recently developed autonomous subject tracking robotic camera system, the Cinema Swarm, we see my live performance blend with VR mapping of historical lunar imaging data, and augmented reality artefacts from her real

spacewalk simulation called MOONWALK. The work tells of my underwater spacesuit story and questions concepts of agency through the simultaneously complex operations and sublime imaginative landscape. As an underwater artist within the system, I was able to effortlessly harness the buoyancy to evoke qualities of the 1/6th Lunar gravity experience. I had led research to devise methods in 'Aquabatics' (a precursor to performing Astronautics). I started to build somatic or corporeal literacy of the environmental impact of outer space on contemporary performance, the challenge was to externalize how space impacts the human body/mind cadence to alter motion, rhythm, and perception of time/place/space in new ways. Essential to this, is the immersion in new worlds: worlds that we imagine, discover, inhabit, create and embody within a system. MOONWALK provided the technical inspiration and choreographic focus on Imagineering and Action. Still, *"I seek morphosis to transit from sea to summit to space fluidly, and eventually simultaneously. Will you help me? I have insurance."*



Director/Performer: SARAH JANE PELL. Cinema Swarm: JAYMIS LOVEDAY, LINCOLN SAVAGE. Visitor. Vision: CHARLES HENDEN, CRAIG BOWLER. Music: MOBI. Sound: ALISTER MORLEY. Digital Assets: NASA LOIRP, LIQUIFER SYSTEMS GROUP, PROJECT MOONWALK, SPELLART. Thanks: JONATHAN PARSONS. Photos: Campbell Harris & QUT.

V-V

UNI-VERSES

MARÍA EDWARDS

**A conversation between María Edwards
and the curator Alexia Tala**

Translated by Marcela Siri



Fig. 5-1. Constellation I, credit: María Edwards/ photo Rodrigo Barrionuevo.

The following text is an abstract of a conversation that took place at María Edwards's studio in Santiago, Chile during a sunny afternoon in October 2016.

Alexia Tala (A.T.): Your creative poetics has a lot to do with observation, experience and especially drifting and collecting objects... In this regard, I have been thinking of something that we talked about in your workshop some days ago about that third space of experience that occurs through the interaction between objects. Could you delve a bit into this?

María Edwards (M.E.): I believe that the power of something is manifested in the relationship that can be established with others. In the meeting between them, a new space is opened, new possibilities, giving another life to what seemed dead. And it is the space that appears between them as well as the void, is what finally interests me more than the things themselves. I am interested in being able to point out those spaces by the activation of the void.

A.T.: Then emptiness is a great theme in your work. But I do not see the intention to sculpt the void, but to intervene it, break it, or rather to indicate its presence...

M.E.: Yes, I think that in the end behind of what I do, there is always the intent to give space to the void, without invading it, rather letting it appear between the distances and pauses that I leave between one thing and another... Allow the air to circulate freely, as in the case of mobile constructions, where the piece can be read by observing the objects arranged in space or by traversing the empty spaces to get from one object to another. In that same way appears the process that leads to the construction of an artwork, by always starting from the parts to finally get to the whole.

A.T.: In such case, your process is one of constant learning and constant experimentation. Proust says "For beauty the secret correspondences between things and notions are essential, a correspondence that occurs over vast periods of time." How does time play a role in your work? There are several of your works that have the intentionality of measuring time through actions, especially "*1 month & 19 days before, during and after*".

M.E.: I have always had the feeling that everything happens too fast. That the minute you discover one thing it loses its state of being in force, it disappears and quickly has to go for the next one... there is little time to lose oneself and to ramble. For the same reason and against that, I decided to create works and projects that need time to be completed or "finished", although many of them do not even have an end. They are works that could be extended, as long as necessary, to allow me to live the experience of carrying them out.

Such was the case of "*1 month & 19 days before, during and after*", a project that arose from the urge to return to New York City and condense in a month and 19 days what I had lived for almost 4 years, and to do so at a pace of its own and with the necessary time to lose myself in the city, inspired, amongst other things, by the figure of the flâneur that Walter Benjamin takes from Baudelaire. To do so, I decided to take with me only the most essential and the lightest elements that could fit inside a suitcase (that would be my portable study) and that would not be much load to carry tied on my bicycle accompanying me on the trips and daily actions in the city.

I also imposed myself a series of obstructions, limits and creative exercises inspired by the Oulipo group and George Perec, to "wander" in a certain direction, but always open to what might appear on the way...

To prolong the experience, I decided to replicate the time I was staying before and after, for the previous planning and the subsequent connection of everything that had happened, had been collected and rediscovered.

A.T.: How interesting to try to compress your 4-year experience in a fraction of time by means of your bike tours. Michel de Certeau in *Practices of the Everyday*, talks about these acts of traveling “by the ordinary practitioners of the city”, which are real plots that their inhabitants weave and leave over the cities. In this creation of plots there is a psycho-geographical aspect, but also a temporal one. How do you approach it?

M.E.: I approach it with the idea of the point and the line that remain in space as a record of those routes, the arrests and moments that occur throughout such time... The line, in some cases would be the thread or wire with which I am weaving the weft; and the point, the knots, with which I mark the pauses or tie up the encounters occurred in them.



Fig. 5-2. Verse IV, 2017 Luminous points, credit: María Edwards.

In physics Aristotle poses it in a very beautiful way through the theory of the “indivisible atoms”, distinguishing between the “indivisible moments” which he calls present, and time, which would be the line that unites those indivisible moments... He also says that this line, which would be the time, and that unites the objects that keep inside those indivisible moments, saddens us because it reminds us of the inevitable end of the line.

Thus, whenever I start a project or a piece of work I do it with a thread that I put inside my pocket or that I tie on my bike and then I go out with it. In some cases I find things on my way that I tie in order to load them and if not, I simply measure the distances and count the pauses. That’s what I did during the 47 days in New York City with the thread on my bike, to later take the thread and re-extend it for a month and 19 days in my studio, in order to find the coincident constellation, guided by the knots done each day.

A.T.: What was your last project at the observatories about?

M.E.: It was the result of a prize awarded by the European Network of Digital Art and Science, consisting of a residency in search for consonances between art, science and innovation, which brought together within the project the Observatories of the Atacama Desert with the Laboratory of Innovation in Linz Austria.

Everything began with a journey to the observatories of the Atacama desert, in company with a great team of scientists and astronomers that allowed me to find great connections with the artist’s work, since both live and build from uncertainty, from observation and doubt, in a constant search to open new possibilities, to expand the limits of space

and by doing so, in some way, expand consciousness through the experience of observing.

From these walks through the desert and the observation of the sky, the work "Instrument of rope and air" arose, inspired also by the music, the mathematics, the stars and the Pythagorean myth that says that we descend from the sky and that the only way to get back up, would be by replicating the order of the Universe with the use of mathematics as music... "musical notes would fill the space between the earth and the sky with an orderly pattern that we could cross."

The intention was to build an instrument that could connect distant times and places. It consisted of 11 swings installed in 8 European countries; 3 observatories in Northern Chile; and a piano in Austria as the sounding board of this fragmented instrument. Each swing was connected with the strings of the piano to record the balance produced at a distance, translated with the 11 notes played by the piano. A project that again involved time, since the musical composition was completing itself as the swings were being installed throughout one year, leaving the (musical) result open at random.



Fig. 5-3. Mental map, credit: María Edwards/ photo Rodrigo Barrionuevo.

A.T: You have a lot of notebooks where you write down your ideas, thoughts and possible projects and their relationships with philosophy, astronomy, music and other sciences. What is the importance of writing in your process? And in what way do you generate the intersection with other sciences? Do you have other works besides *String and air instruments* that make these crosses?

M.E.: On one hand, writing helps me to remember, I have a terrible memory and I often write the ideas several times in order to record them in my head so that later, when they are necessary, they come back naturally. Many times what I write at a certain time may not have any immediate meaning or direct relationship with what I am doing, but I feel that at some point it could be useful or will connect with another idea that appears, causing both to be enhanced ... at the end, I see the act of writing similar to the action of collecting, both the notes and writings that I take (as the things that I collect) when seen isolated they are only notes and objects, but then they make sense in time when linked with others.

I believe that the way of making crosses with other sciences or disciplines outside the world of art is due to these encounters and the diversity of elements and ideas that I go collecting, making them coexist in the same "universe", this being my workshop, a suitcase, a notebook or a blackboard. Thus, ideas are linked with objects of different nature, "spreading themselves" in a way.... For example, when I use a typewriter as a paperweight so that the sheets of music do not flip or as a lectern for a book of constellations, I inadvertently discover a hidden relation between things as well as with the ideas that represent those things.... It is there where the beauty of what was not planned arises... As Lautréamont describes it: "the odd encounter of a sewing machine and an umbrella at a dissecting table".

I can also connect that with the process of writing in the creation of metaphors, but taken to the objects in space, especially to address science or certain topics that escape my understanding but not my interest. I approach those ideas through simple, everyday objects that I have at hand.

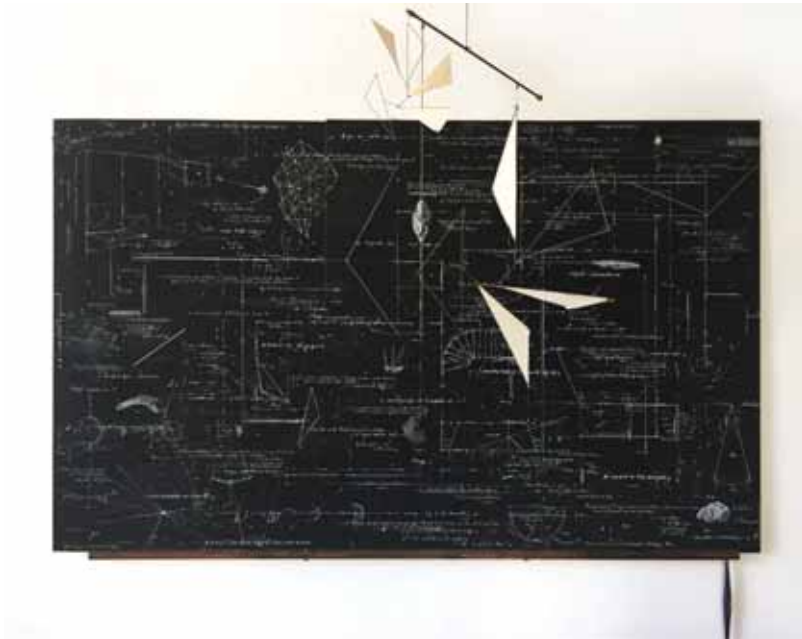


Fig. 5-4. untitled, credit: María Edwards.

A.T.: In addition, what relationship do you see in this search process with poetry and literature, which you constantly refer to in your work?

M.E: I admire the ability and freedom of poetry that can make things that seem to have no relationship live with ease in the same space, connecting them in a new universe by the mere fact of organizing words in another way to what logic

says. I like it above all because there is no established way to approach it, but many possibilities, whether as image, sound, sense or absence of it. To be able to be detached from the meaning of words and simply observe how they are organized and the place they occupy in the blank page where in most occasions there is a lot of space left empty, a space that I enjoy and feel relief to enter in. In poetry one can establish the paths at a time and pace suitable to oneself.

I think it connects with the way I organize things in space, either on my workshop's table, in an installation by suspending objects inside a weave and connecting them with a thread or wire, in the notes that I write on the blackboards, even at the moment of going out into the street and establishing my tours and recollections in it.

A.T.: Now that you say so, of course, your workshop has something that reminds me of *The way things go*, 1987, by Fischli and Weiss where everything works in a precarious way and by the gravity and interaction between the objects. But yours is a bit more esthetic and less crude, within the same conceptual idea. I see, however, a kind of archaeological search...

M.E.: Of course, there is something of archeology in this, when I see the tables of my workshop, which despite being anchored to the ground, they are another space delimited within the larger space where things are finding a place and establishing relationships. I remember the surfaces of Morandi's table from which Tacita Dean builds a fiction in *Still Life*, a table that points to a background, a picture within the frame... "The marks that have been left in the various containers become signs... the thousand and one marks inscribed on sheets of paper that Morandi left under his objects and that served him to compose his paintings in a

mathematical way, at least according to rules of perfection understandable to him, but not to u..." (excerpt from the text *Slow (E)motion*. The art of reflection according to Tatiana Dean by Elisabeth Lebovici). I think that something similar happens on the tables of my workshop and that it is also reflected on my blackboards and the walls, the floor, the ceiling and the space between them. Things are transformed into notes, suspended notes that I transfer from one space to another... what is on the tables goes to the slates, the slates to the sky, the sky to the walls... a logic of positions and movements that are recorded by the line, the string or the wire that ties them, connecting and going across the space of the workshop.

A.T.: We return then to the theme of temporality...

M.E.: There is somehow a respect or the intention to keep those "moments" intact translated into the things that I collect and take to my workshop, where they find a place, linking with each other and generating new relationships between them beyond the "moment" that is kept within each one. When they are already in place and the relation arises, a work is produced, but the combinations can be infinite, and there is always an (invisible) thread that ends up connecting them all... therefore it is sometimes difficult to know where a work begins or ends. Perhaps I refuse myself to the idea that there must necessarily be a definite beginning and end to each piece. They can be seen as a whole, as a big uni-verse made up of fragments with the possibility of being fragmented again, scattered, and spilt. To return to their original state in which they were collected, so that other relationships arise according to a certain movement, position and equilibrium in space, such as the pieces of a board game... being able to transform, to go backwards and forward, preserving within themselves the idea of the whole.



Fig. 5-5. Installation for "Impossible constructions", credit: María Edwards.

V-VI

COSMIC PERSPECTIVES

LUMEN STUDIOS

BEER, L. HUXLEY, R. KING, M. LYON, B. PRATT, H.

The Lumen Studios collective have consistently raised questions about how astronomy can alter our perspectives on a number of topics, ranging from light pollution, space exploration, ecology and spirituality. Lumen Studios have been profoundly influenced by Frank Whites' concept of "*The Overview Effect*", and this has led to the production of a number of exhibitions and events over time. In addition to this, Lumen have also curated projects, including Cosmic Perspectives, which consider how a terrestrial perspective of the night sky can engender a feeling of interconnectedness, awe and wonder.

Within this text, Lumen will draw upon their experience of curating the exhibition "*Cosmic Perspectives*", which showcased the work of 50 interdisciplinary artists. This exhibition explored the fragility and monumental importance of life on Earth, held against the backdrop of a cold and dark universe. Artists considered the concept of the "Overview Effect", and how this might alter our collective perception of ecology. Throughout the exhibition, Lumen invited participants to create a new conversation about climate change and destructive, damaging habits which impact our environment.

The exhibition highlighted the precarious nature of life, and the extraordinary set of circumstances that allow us to exist.

We will feature the perspectives of “Cosmic Perspectives” curators Becky Lyon, Hannah Pratt, Natasha Sabatini, Rebecca Huxley and Louise Beer. The curators are also artists, who share an interest in the philosophical aspects of astronomy, but express their understanding of space and astronomy with differing artist techniques.

Introduction to The Overview Effect and Cosmic Perspectives

The Overview Effect is a cognitive shift which takes place when an astronaut views the Earth from above. In 1987, Frank White published a book entitled “The Overview Effect - Space Exploration and Human Evolution” which documented the thoughts and feelings of astronauts who had experienced what it was like to leave the Earth’s atmosphere. Consistently, the astronauts’ perspective altered towards feelings of peace, an urge to protect the Earth and in some cases, spiritual enlightenment.

The “cosmic perspective” is a term which enables us to think outside of our own life-span, as it takes into account the timeline and distances within the universe. Life on Earth is rare in both time and space, and is therefore extremely precious to preserve. Discussing the Pale Blue Dot image taken in February 1990 by NASA’s Voyager 1, some 3.7 billion miles away from the Sun, Carl Sagan described the importance of such an image.

“Look again at that dot. That’s here. That’s home. That’s us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands

of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there-- on a mote of dust suspended in a sunbeam." (Sagan, 1994)

As a collective, Lumen were inspired to curate an exhibition around the concept of the "cosmic perspective" to explore how a range of different artists approached this concept. The title "Cosmic Perspectives" is pluralised to reflect the many different voices within the exhibition, which Artist and Curator Natasha Sabatini was particularly keen to emphasise. Although the intertwining narratives came from a specific western context, they were multiple, parallel, simultaneous, contrasting and colliding points of view. For Sabatini, the exhibition was a quiet way of recognising the importance of the collective efforts that need to be made to preserve the unique and precious singularity of our planet. Without converting the We into an I, or one given answer, it embraced the difficulty of divergent forces in a world dominated by a few and divided by borders.

Rebecca Huxley's research on the theme of "cosmic perspectives" employs the interscalar view (Hecht, 2018, 109-141), which Huxley uses to try and understand Earth's intertwined ecosystems, and to question how systems, borders and 'things' are organised when they are in states of flux. In her work Huxley considers how the horizon has been used as a tool in colonisation (Steyerl, 2012). From this, she explores the role observatories and astronomy may have played over time, politically and scientifically, in establishing hierarchies on Earth (Mignolo, Wynter, 2015), and gestures whether the

horizontal *Earthrise* and observatory cooperations such as Event Horizon, contribute to modes of extraterrestrial coloniality. Huxley is influenced by Wynter's analysis, that contemplates that in order to disrupt the present unequal 'order of things,' there must be a reconfiguring of what *it is* to be human 'as it is involved intimately with all other life on this shared planet' (Sharma, 2015, 180). Huxley, thinking with Wynter, suggests that these disruptions involve re-thinking of systems of classification, but also the tools and lenses used to inform these, including for, example, observatories and the land on which they reside.

Jane Bennett describes how humans and non-humans are part of an intricate network which is co-dependent. In her text, she recounts stories of encountering situations with different assemblages of matter, both organic and inorganic. Bennett hopes that the stories "highlight the extent to which human being and thinghood overlap, the extent to which the us and the it, 'slip-slide' into each other. The hope is that the stories will enhance receptivity to the impersonal life that surrounds us and infuses us, to generate a more subtle awareness of the complicated web of dissonant connections between bodies, and will enable wiser interventions into that ecology." (Bennett, 2010, 4)

Bennett's "Vibrant Matter" has influenced Melanie King's practice-based PhD research "Ancient Light: Rematerializing the Astronomical Image", which specifically looks at the interaction between distant stars and photographic materiality. Within her research the materiality of starlight is viewed through a new-materialist lens which aims to demonstrate the intimate connection between the stars, the rich biosystem of planet Earth and the complex life it holds. Light travels for thousands, if not millions of years, before reaching into Kings' camera and impressing itself within the film. The silver atoms

within the film can only have been produced within high energy activity found outside of Earth's atmosphere, such as within a supernova explosion many millions of years ago. King believes that by understanding the materiality of such processes, we can gain a greater understanding of the origin of materials, as well as where they might end up. With this in mind, King considers the ecological impact of her own artwork. She attempts to find sustainable solutions within analogue photography processes, such as using plant-based developers and rescuing silver particles from photographic fixer. King's conception of the "Cosmic Perspective" is rooted in understanding the materiality of the objects and processes she uses.



Fig. 5-1. Ancient Light, 2018. Melanie King.

Becky Lyon's work explores ideas of the animate, how we consider things as lively and how we relate to them

depending on their liveliness. Lyon believes that our treatment of these lively/non-lively things are hierarchical, based on our entrenched value and experience systems as humans. For Lyon, the cosmic perspective is a cosmic jolt from these shackling, cloudy, biases. It generates a swift and shocking re-ordering that demotes human hierarchy. For Lyon, this creates a sense of melancholy, because a cosmic perspective could be a key to repairing our detachment from nature but it is something we as a species will never be able to experience. Lyon reminds us that we can only “zoom out” from Earth in your mind’s eye. Earth can never be empirically experienced, so the concept of the “cosmic perspective” can become a brief for imagining.

A key text within the new materialism genre is “Meeting The Universe Half Way” by Karen Barad. The text has many implications, but one key section looks at how quantum physics demonstrates the lack of boundaries between the us and the universe.

“we are of the universe – there is no inside, no outside. There is only intra-acting from within and as part of the world in its becoming” (Barad, 2007, 396)

Louise Beer’s conception of the cosmic perspective is rooted within the incomprehensibly long evolutionary journey that each species and environment on Earth has taken to arrive at this point in time and space. Chiming with Lyon, Beer believes that the cosmic perspective requires the act of looking at the complexity of a non-human creature’s body, a plant’s system or the symbiosis that occurs within an ecosystem that has developed over millions of years. She urges us to look at the individual species that we have lost through human action and to think about how we treat those species that we are still sharing our environments with. She hopes that the concept of

the cosmic perspective will prompt us to protect our fragile and miraculous ecosystems.

“If I imagine Earth, I see it is a vibrant blue sphere suspended in the darkness of space. I see it’s weather systems and landscapes like an ever changing, ever-moving, fluid sculpture. It is a beam of light against a dark, uninhabitable backdrop. Looking closer, I can see the extraordinarily thin layer of atmosphere giving life to everything it contains.”
(Beer, L, 2020)

The term ‘cosmic perspective’ clarified what Beer was trying to portray with her work as well as in her curatorial practice. She believes that the term provides an all encompassing view of our pursuit to understand and value the world we inhabit and the infinite space around it and the different ways in which we each interpret it.

“In Gene Cernan’s words... You wonder, if only everyone could relate to the beauty and the purposefulness of it, the reality of the infinity of time and space, how our star moves through time and space with such logic and purpose” (White, 2014, 201)

The “Cosmic Perspectives” Exhibition at Ugly Duck, 2018

The Cosmic Perspectives exhibition was successful in using allegory to stimulate theoretical considerations through varying art practices, generating new considerations and knowledge in the form of provocations and propositions. Here we explore some of the artworks by the curators, who also select what works gave them a new perspective.

For the exhibition, Becky Lyon created a piece called ‘Transcendent Sensation’ - a series of three lightbox planet formations that became spaces for imagining. Lyon describes

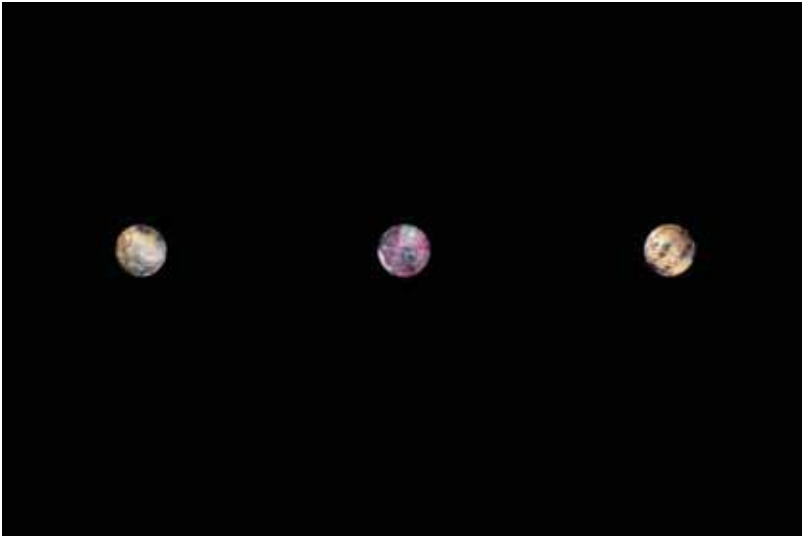


Fig. 5-2. Transcendent Sensation, Becky Lyon, 2018. Image: John Hooper.



Fig. 5-3. An Amateur Collection of Extinct Planets, Natasha Sabatini, 2018. Image: John Hooper.

these works as speculative topographies in different colours and sculpted landmass formations of a future planet Earth designed for contemplation. "Transcendent Sensation" questioned how our interactions with the 'Environment' impact the pale blue dot.

"An Amateur Collection of Extinct Planets" pushed Natasha Sabatini to imagine the past in the future. Sabatini imagined where we might be if we continued to inhabit the world the way we do. She imagined a post cosmic landscape where humans have destroyed a number of different planets as well as our own. This work has influenced Sabatini's later work, which comprises science-fictional narratives that link everyday habitual actions with the cosmos, to imagine different possibilities of connecting with ourselves and our surroundings.

Rebecca Huxley and Tom Cowell created a film that interpreted amateur astronomer's asteroid occultation data. The film imagined brief moments of a celestial object obscuring another in ubiquitous patterns of cosmic motion.

Louse Beer and John Hooper collaborated on a piece called "Preservation of Visible Starlight". The work was a response to ever increasing air and light pollution that we might see the wondrous universe through. Through the loss of natural darkness and natural starlight, Beer and Hooper believe that humans are becoming more insular as societies, more destructive and less cosmically minded. They believe that humans are losing access to the huge questions humans face as a sentient species, with untold consequences. The other side of the story is of course, the unforgivable impact humanity's actions are having on all flora and fauna and the change we are inflicting on this planet, that can never be

undone. Over the course of an exhibition, the light slowly faded until it was no longer visible.

Hannah Pratt created two paintings based on the golden record found on the Voyager Space probes and the Pale Blue Dot photograph, the farthest photograph of the earth ever taken captured by the Voyager 2 space probe on its way out of our solar system. The concept of the “Cosmic Perspective” has allowed Pratt to consider the impact of her practice on the environment. Pratt is now more likely to limit her use of plastic and tries to buy second hand equipment, in an effort to limit Pratt’s impact on the environment.

King was particularly struck by “Wanderers”, a series of photographic works by Helen McGhie. This work investigates the experience of stargazing for astronomers at Kielder Observatory. The observatory sits within a large dark sky reserve within Northumberland. McGhie asks participants to observe the sky at night, and often chooses non-male astronomers as subjects, to fairly represent leading females within the field.

Sabatini found two artworks in the exhibition which she felt conveyed the two extreme ends of the spectrum of interpretations, alerting to the factual crisis we face today. In-between there were imaginary landscapes of possible alternative futures. One extreme was an installation by Douglas Clark that read WHERE IS YOUR HUMANITY in large red neon, firing up a large basement room. The other is an installation by Plex Noir, titled Debris. This piece used a laser beam to burn through pieces of paper, visualising data of the amount of human waste in space. Both gave a sense of urgency and danger.



Fig. 5-4. Preservation of Visible Starlight, 2018. Louise Beer and John Hooper.

Beer was inspired by Lizzy Jordan's piece *Light Limbo* that used kinetic light and reflections to transform a room into an installation. The light was continuously changing and hypnotic. It articulated how the use of simple materials can create a captivating and otherworldly experience.

Huxley found Anna Gray's work mesmerising to witness. At different times of day, its formation used the light to alter its own characteristics, which she felt was a living thing in the exhibition space. Gray's practice has many fascinating thematic strands, and she has a novel way of working with scale using glass. Watching Gray install the piece with care and skill, then seeing it grow and multiply was intriguing.

For Huxley, the "Cosmic Perspectives" exhibition represented a moment of pause to 'look back in' on the enormity of what was and continues to happen on Earth. Around the time of planning the show, massive issues mainly affecting the global South were being pushed into the social consciousness of the global North. May 2018, the month during which the Cosmic Perspectives exhibition took place, was the beginning of one of the hottest summers on record that brought some of the worst forest fires seen north of the Arctic circle. Images, reports and analysis of humanity pushing Earth's ecological systems to their limit were and still are an overwhelming presence across all forms of media. Creating a space where the public can temporarily step away from the screen and explore interpretations of this situation through a theme like Cosmic Perspectives is important. Huxley believes that anthropocentric allegories in art can help open up discussion on the reality of these issues whilst, also taking a moment to appreciate the value of our environment as it exists today.

Beer grew up under an immensely starry night sky in the Southern Hemisphere. Every time she saw the Milky Way, she was electrified inside with the ideas of the vastness of the universe, and the infinite possibilities that might exist. Under that starlight, she really felt like she was collectively looking outwards, trying to unpick the mysteries of the universe and basking in its magnificence. It was clear to Beer that she was standing on an oasis of life, looking into the uninhabitable

darkness. Beer felt as if she were part of something bigger than her immediate environment. The constant reminder of the view of our galaxy, in contrast to a huge, imposing landscape, sparked Beers' interest in astronomy and a deep appreciation of the natural world. Moving on from this, Beer believes that we can only understand the value of the natural world from seeing it with an astronomical perspective, whether that is looking down on Earth as a blue marble or looking toward the glittering and endless Milky Way. She believes that is fundamentally important to continue to remind humanity that we exist in a space that is greater than our local environment. Beer sees events as entry points that offer a glimpse into another world, a place that we can all 'zoom out' and see the bigger picture in our own way.

In summary, at the time of the "Cosmic Perspectives" exhibition, there was a critical mass of exhibitions, conferences and symposia dealing with themes of environment and climate change. As a Collective, Lumen noticed that current exhibitions around ecology and the environment focused upon terrestrial discourse rather than extraterrestrial. On the other hand, traditional astronomy-themed exhibitions often disregard a connection to Earth altogether, so it was a refreshing curatorial project to bring it home.

An exhibition creates spaces to consider and become reacquainted with ideas, whilst simultaneously allowing the freedom to form your own viewpoint in the safe interiority of your mind. Events provide spaces to perform the knowledge, co-create responses and raise questions. Both spaces invite artists to co-author which in turn creates a deeper engagement and a generative environment in which to make future connections. Lumen were impressed to see the wide range of interpretations from all of the artists that reflected their experience and cultural backgrounds. It was

an open door for the audience, an offer of a place to reflect on our own place within the Universe. For Beer, the ultimate reward for co-curating an exhibition around this theme comes through conversing with the other artists and audience. It becomes clear that in some way, across cultures and borders, they were all deeply affected by the night sky and humanity's quest to understand it.

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VI

EPILOGUE

IOANNIS MICHALOU(DI)S
YURI TANAKA

Having explored, in this anthology, the nexus between art, science and technology, we have observed how diverse expressions of the cosmos are created. Such expressions may open up unique cosmic vistas, indicating a new era of human history, subtly unveiling the meaning of the fragile but precious human place in the universe. The artistic approaches in this anthology represented through cosmological myths, space exploration, space science, particle physics, and astronomy bring different perspectives.

We have also observed how the meanings of 'art' and 'the cosmos' are constructed and interpreted differently. *(C)osmosis Art* is an open-ended concept used to generate ideas and possibilities of how these two elements can co-evolve. Such a concept gives rise to hope. In the approximately 13.8 billion year history of the universe, as one species of beings, humans can make part of this history that manifests how life can aesthetically evolve in meaningful ways.

Although, to a certain extent, outer space has become more accessible for humans, the reasons for going there can always be open to debate. Surely, further exploration of

space will give rise to more questions about *why* we go to space – and not just about how we are to get there. If we wish to answer such questions, interdisciplinary collaboration is vital in order to place beauty closer to truth. Finally, what if beauty and truth are one and the same?

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CONTRIBUTORS

Ioannis MICHALOU(di)S

Born in Greece, Dr. Ioannis Michalou(di)s, has experimented with the NASA's nanomaterial silica aerogel as a sculptural medium and is the first visual artist worldwide using this ethereal material in art, choosing to hunt with it skies and dreams. Although originally designed as a space technology material to capture stardust and act as a spacecraft insulator, the artist has resituated this material into a practice which is allegorical of the creation of sky, clouds and ether.

Yuri Tanaka

Currently, a postdoctoral researcher at Tokyo University of the Arts where she received her Ph.D., a visiting researcher at Kyoto City University of Arts, a visiting scientist at CERN, and the head of the Cosmic Art Research Committee. She was a researcher in residence at Ars Electronica Futurelab in Linz, Austria in 2015. She has been pursuing to create a collaboration mediated by 'the universe' as a mutually acceptable idea among diverse experts. Her projects can be mostly found in public spaces or at art/science festivals.

Richard Clar

Los Angeles / Paris interdisciplinary artist, now living in Paris. President of Art Technologies, which Clar founded in 1987, as a liaison between the worlds of art and technology. His current work encompasses site-specific environmental issues ranging from orbital debris to water-management on Earth;

war and peace; and the Search for Extraterrestrial Intelligence (SETI).

María Edwards

Born in Santiago, Chile. Received her B.A. in Arts from the University Finis Terrae in Santiago and her Diploma in Cinema, Art Direction and Photography at the University of Chile. Emerging mathematics and physics into art, along with the inspiration from the universe, she spends her residency at the European Southern Observatory (ESO) in Chile and at the Ars Electronica, Futurelab in Linz in 2015.

Dan Goods

Born in Palmer, Alaska and was raised in Salem, Oregon. Graduated valedictorian from the graphic design program at Art Center College of Design. Visual strategist at NASA's Jet Propulsion Laboratory. Goods runs his own studio, working on everything from art pieces that speak to the discoveries that NASA makes, to working with their visionaries to help them brainstorm the missions of the future.

Sarah Jane Pell

Born in Melbourne. Artist Pell performs high-risk work as a commercial diver, alpinist and practiced-based spaceflight researcher. Her aim is to explore human behavior during extreme activities underwater and at high altitude to prepare for a future where artists may have studios in space. An expert consultant to the European Space Agency, NASA Ames, Icarus Interstellar, RMIT University, Australian Standards, Maritime Union of Australia and the Australia Council.

Charles Ross

Born in Philadelphia. Received his B.A. in Mathematics and his M.A. in Art from UC Berkeley. Using sunlight and starlight as the source for his art, Ross creates large-scale prisms to project solar spectrum into architectural spaces. For the last 40 years, he has been building the geometry of the stars into his earthwork, *Star Axis*, now nearing completion in New Mexico.

Lumen Studios

Lumen is an art collective founded in 2014, focused on themes of astronomy and light. Lumen Studios founded the Lumen Gallery Space in the Crypt of St John on Bethnal Green in 2015. Through art, exhibitions and seminars Lumen aim to raise a dialogue about how humanity understands existence, through the lens of astronomical discourse. The founders and co-directors of Lumen Studios are Louise Beer, Melanie King and Rebecca Huxley. Lumen have supported the work of over 300 artists since the collectives' conception.

Frank White

White is a magna cum laude graduate of Harvard College, a member of Phi Beta Kappa, and a Rhodes Scholar. He earned an M.Phil. in Politics from Oxford University. Frank's best-known book, *The Overview Effect: Space Exploration and Human Evolution*, is considered by many to be a seminal work in the field of space exploration. In his latest book, *The Cosma Hypothesis: Implications of the Overview Effect*, he asks the fundamental question, "What is the purpose of human space exploration? Why has the evolutionary process brought humanity to the brink of becoming a spacefaring species?"

Arthur Woods

Born in Tahlequah, Oklahoma. Studied psychology, art and literature at Mercer University in Macon, Georgia. After graduation with a B.A. and completing U.S. military service, Woods began his art career in California before moving to Switzerland where he currently lives and works. His involvement with space activities began over fifty years ago when he had an experience to personally witness the beginnings of the U.S. space program.