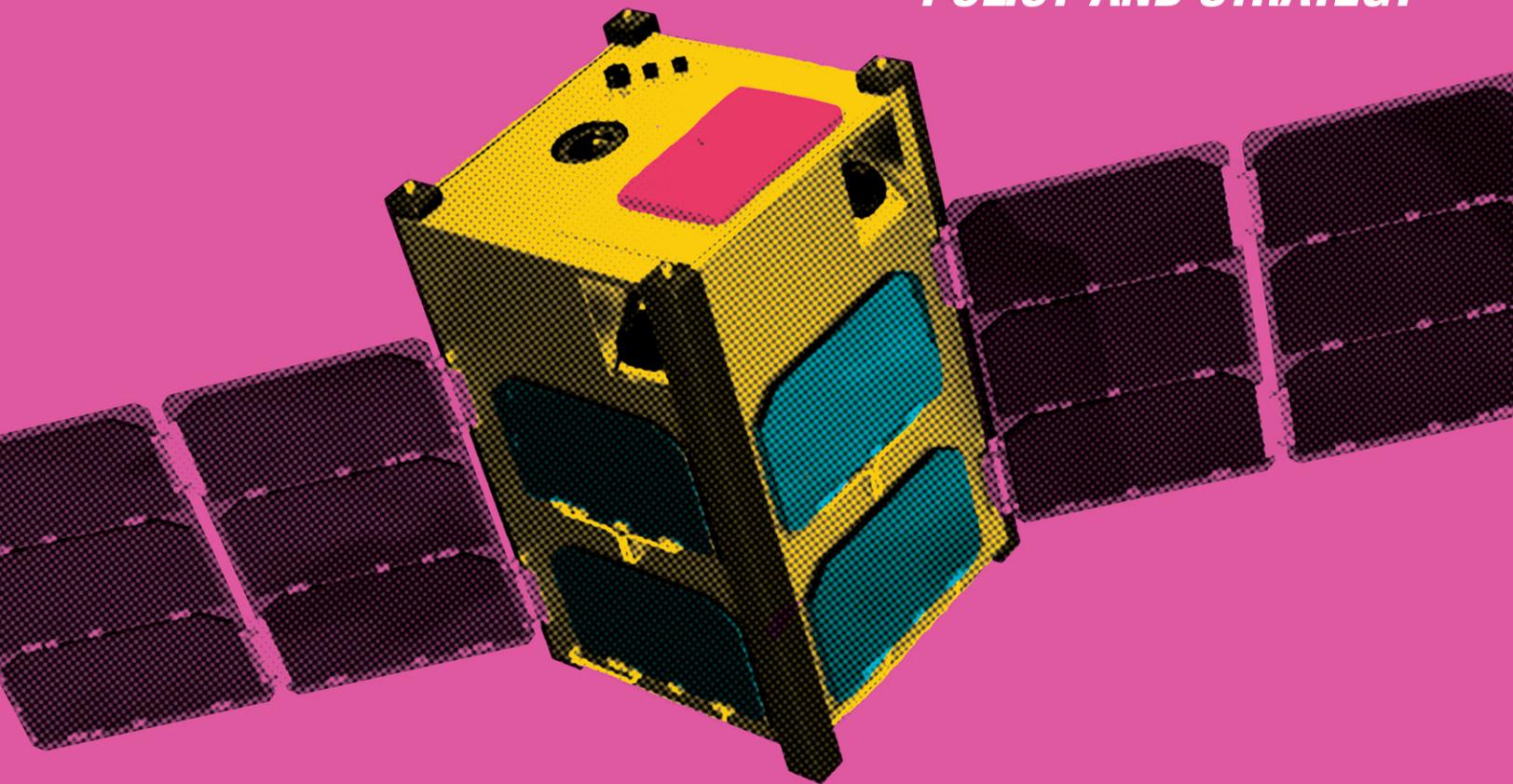


***CENTER FOR SPACE
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***SPACE AND ART:
CONNECTING TWO CREATIVE ENDEAVORS***

**WILLIAM A. BEZOUSKA
THE AEROSPACE CORPORATION**

DR. WILLIAM A. BEZOUSKA

Dr. William A. Bezouska is a project engineer at The Aerospace Corporation. Bezouska has spent the last decade at Aerospace studying international developments in space. Prior to that, he worked in the academic community on small satellites and robotic space systems at the Information Sciences Institute. He began his career at Westinghouse in the nuclear power industry. Bezouska received his bachelor's degree in mechanical engineering from the University of Notre Dame and his Ph.D. in aeronautical engineering from the University of Southern California.

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Summary

U.S. aspirations for continued leadership in space will require drawing from all sources of human creativity and inspiration. One important source is art, which can connect people and engage them in technological progress and scientific discovery. Art and space have connections going back to the early days of the space race. Creating art about space, for space, or even in space has helped propel both fields forward. This paper highlights the intersections between space and art—including some surprising ones—to demonstrate how art can be woven into U.S. space efforts for mutually beneficial outcomes.

Introduction

In 2013, the author was invited to visit the offices of Planet Labs by a colleague who had recently joined the startup company. Arrival at the nondescript San Francisco headquarters was followed with introductions to engineers, technicians, and business development staff—a surprisingly small group of people at the time who could perhaps collectively fit inside a large conference room. The next stop was an introduction to Planet Lab’s artist-in-residence who was busy drawing dreamlike monochromatic scenes that would soon be laser-etched onto the side of orbit-bound spacecraft. Traditionally, spacecraft are designed as utilitarian objects without regard for aesthetics. Here, a space company was taking the time to create not just functional satellites but ones adorned with art. This was something unexpected.

In fact, when one looks closely for intersections of art and space, examples abound in orbit, on the moon, in the halls of space organizations, in the classrooms of future scientists and engineers, and throughout the social media landscape. The motivations are similarly diverse: public engagement, creative inspiration, pure artistic

expression, even propaganda. As fundamentally creative efforts, space and art are siblings. Furthermore, though space development rests on creations of technology and science, it is ultimately a human endeavor. Art helps to shape human perspectives, focus effort, and form a shared culture. This paper surveys the field in hopes of surfacing examples of art intersecting space, both historical and contemporary. The examples explored seek to inform future U.S. efforts to foster this connection. The paper concludes with suggestions for paths forward, including creative ways for the space community to further art.

Art in Space

During the early days of the space race, as the United States and the Soviet Union competed for technological primacy, art captured and encouraged the spirit of the age. Soviet and American artwork depicted the creativity, bravery, and perseverance of the people taking part in this competition. More generally, art was an essential component of the human engine driving unprecedented development in space. During this period, art drew from well-

known and resourced funding like the Apollo Art Program or the Artists' Union of the USSR. One small but representative example of art's early role in space is a small aluminum figurine known as *Fallen Astronaut*, which remains today on the surface of the moon. Secretly left by the crew of Apollo 15, the figurine is intended as a memorial to

those who have died during the space race (see Figure 1). One could argue that the markings in the lunar regolith left by the astronaut hands that placed the statue—markings that persist in time due to lack of surface wind—add to the physical manifestation of this work.



Figure 1: *Fallen Astronaut* by Paul Van Hoeydonck, placed on the lunar surface by the Apollo 15 crew on August 1, 1971. (Credit: NASA)¹

Since that time, art has been a regular traveling companion on many crewed missions, both in the United States and internationally. For example, in the 1990s, the Russian space station Mir hosted a free-floating sculpture known as *Cosmic Dancer*.² The International Space Station (ISS) continued in this vein by hosting many examples of art, from fine art oil paintings to contemporary street art (see Figure 2). The Japan Aerospace Exploration Agency (JAXA) even sponsored the creation of innovative musical instruments designed for weightlessness, which were launched in 2011 to the ISS and played on orbit.³

Art in the form of poetry has also made its way to space. Astronauts from JAXA authored some of the first poems written in space. In 1998, Chiaki Mukai wrote the first few lines of a poem (“weightlessness /

repeating summersaults in space / as many times as I like”) while onboard space shuttle mission STS-95 and then asked the public to complete the poem; over 144,000 entries were submitted.⁵ In 2009, astronaut Wakata Koichi authored additions to a poem chain (*renshi*) while onboard the ISS.^{6,7} Poetry remains an important part of art in space. Less than ten years later, in 2018, a Long March rocket in China launched the HY-2B mission into orbit from the Taiyuan Satellite Launch Center; onboard were 50,000 audio poems recorded by users throughout the world.⁸ In 2020, China announced that the upcoming Mars mission and all future planetary exploration missions will be named Tianwen after a poem titled *Tianwen*, or Questions to Heaven, by ancient Chinese poet Qu Yuan. Clearly, art serves as inspiration for these space missions in China.

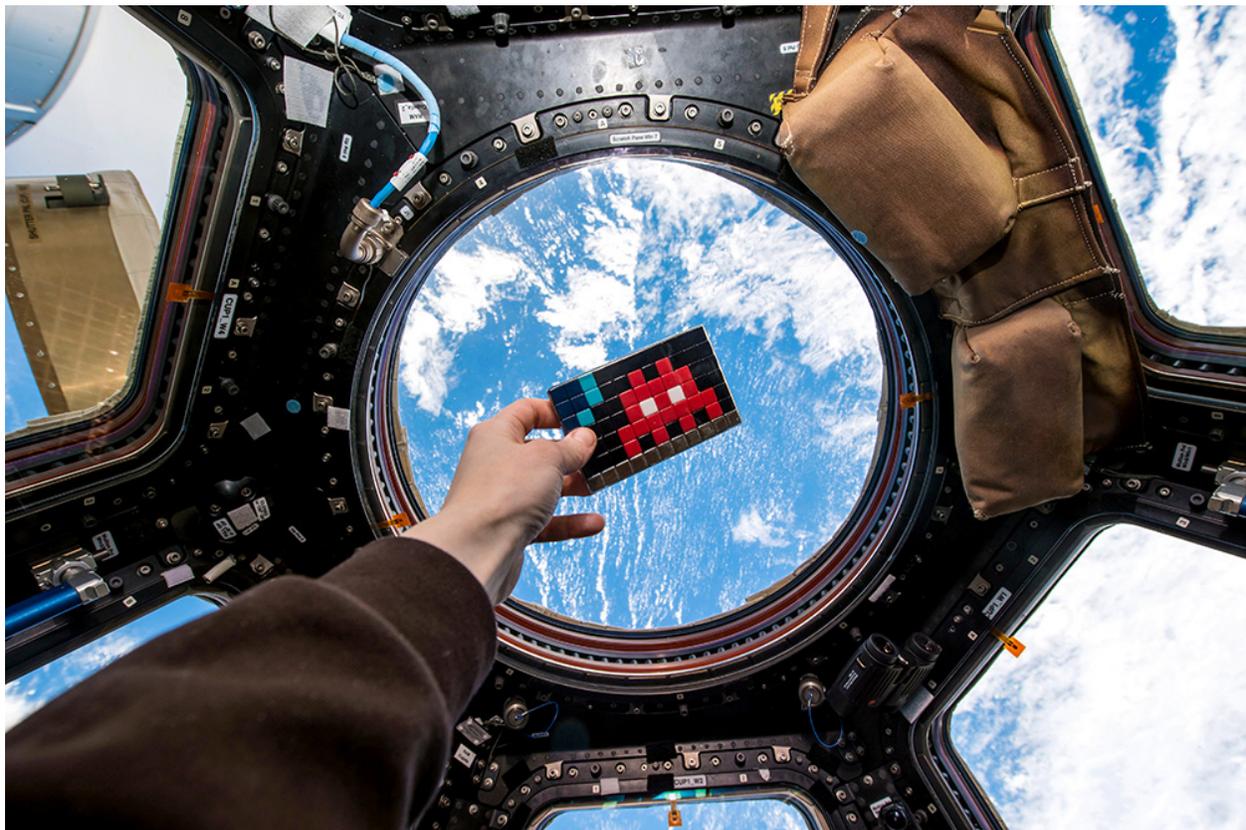


Figure 2: Street art far above the streets; mosaic art piece by French artist Invader on the International Space Station. (Credit: ESA/NASA)⁴

In addition to crewed space flight, other types of satellites have incorporated art. Early examples include the placement of a specially designed sculpture of aluminum known as *Space Visitor*, or *Weltraum Visitor*, on the TerraSAR-X radar imaging satellite. In 2011, JAXA launched an entire microsatellite dedicated to art known as ARTSAT, which included an onboard algorithmic generation of music, poems, and voices, as well as transmission of images to and from the ground. JAXA followed this with a secondary free-flying art payload for the Hayabusa-2 mission to deep space known as *DESPATCH*, which included an undulating 3D-printed sculpture (see Figure 3). *DESPATCH*, which is currently in the Sun’s orbit “as a gift to the future of mankind” according to its creators,⁹ joins the two Voyager spacecraft—each containing a golden record with 90 minutes of worldwide musical

selections—as hosts in deep space for humanity’s artistic creations.

Art in space is not limited to government-funded missions. Increasingly, private companies are directly sponsoring art for inclusion in their commercial missions. As mentioned in the introduction, Planet Labs has an artist-in-residence program that, among other things, has produced original art placed onto the sides of more than 250 satellites in orbit (see Figure 4).¹¹ In supporting such endeavors, the company states, “We bring together art and science to build a culture of creative entrepreneurship and innovation at Planet.” Blue Origin, another space startup, has also incorporated art into its space activities. For example, the 2019 launch of the company’s New Shepard launch vehicle contained several art payloads, including

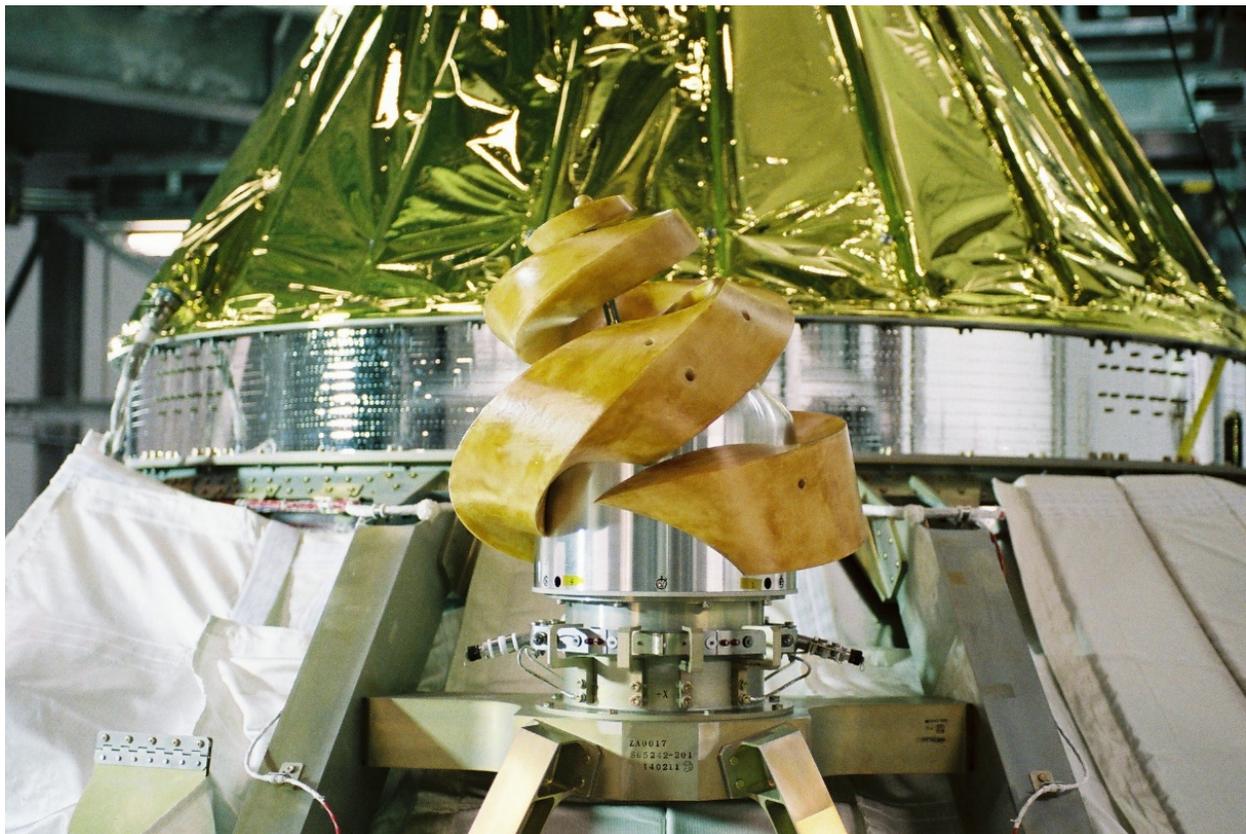


Figure 3: JAXA art mission *DESPATCH* attached as a secondary payload to the Hayabusa-2 spacecraft prior to launch. (Credit: JAXA, used with permission)¹⁰



Figure 4: Art at Planet Labs. (Credit: Planet Labs, used with permission)¹²

strips of painted canvas created prelaunch by patients at a children’s hospital in Houston and then incorporated postlaunch by artist Edgard Medina to complete the artistic collaboration titled *Mission Art*.^{13,14} Blue Origin also partnered with the American rock band OK Go to host an art proposal contest with the two winning submissions hosted on a Blue Origin rocket launch. One of the winning submissions, aptly named *Dark Origin*, was an evolving sculpture of magnetic debris meant to invoke the formation of the cosmos.^{15,16}

Perhaps the final frontier for art in space is the creation of dedicated large-scale structures or artistic works that can be seen by audiences on the ground directly, ideally with unaided eyes. In 2018, SpaceX launched an artist-designed secondary payload consisting of a microsatellite that would deploy a 100-foot-long balloon, which would be as visible as some of the brightest stars in the sky.¹⁷ A Japanese company, Astro Live Experiences, has explored creating artificial meteor showers viewable on the ground via pellets released from low-altitude satellites; although a prototype version was launched into orbit in 2019, technical difficulties prevented correct operation.¹⁸

Large on-orbit projects are controversial, however, for several reasons. First, due to their size and visibility, they have the potential to disrupt ground-based astronomy by becoming unwelcome intruders into natural night skies. Second, these art installations are typically uncontrolled objects, which potentially contribute to space debris and collision concerns. Art always has the potential for controversy—even in space.

Space Development Leveraging Art

Art can be part of the process of space development, not just an activity existing in its own separate creative domain. NASA and the European Space Agency (ESA) have been at the forefront of harnessing artists and creative thinkers to further

their missions of scientific exploration. For example, art can serve as a wellspring of ideas and inspiration for technical personnel working in space development. Around 2001, ESA launched an initiative to survey science fiction, art, and literature—both past and present—to identify and assess innovative technologies, concepts, and designs with potential for future development into space applications. This effort produced over 250 ideas for follow-on analysis.¹⁹ More recently, The Aerospace Corporation invited creative thinkers like science fiction authors to take part in the company’s Strategic Foresight initiative, providing insight for U.S. space leaders on what space technologies or space concepts might be coming next.²⁰

Art has also helped facilitate transition from ideation to design. Art can serve as a tool during the design process for space systems. For example, an artist can provide tangible visualizations of designs and scenarios as well as mediate and integrate multiple scientific viewpoints during collaborative work.²¹ In the words of David Raitt from ESA, art can “give form to developing technologies.”²² At the Jet Propulsion Laboratory (JPL), a team of designers and artists known as *The Studio* serves the artistic needs of the organization, including helping scientists to “think through their thinking.” According to its website, the artists “organize their information and ask them questions that their peers do not ask, with the hope that it will help them see their incredibly complicated ideas in a new way.”²³

Sometimes art serves a dual purpose for satellite missions by simultaneously providing artistic expression and technical function. A wonderful example is the inclusion of an original art piece by contemporary artist Damien Hirst on the Beagle mission launched to Mars in 2003. The artwork, a collection of brightly colored dots on a brushed metal surface, was designed as a calibration reference for onboard cameras; the pigments were

specifically chosen to withstand the Martian environment.²⁴ Another form of art that is leveraged for space is data visualization that supports interpretation of scientific information. NASA has established the *Scientific Visualization Studio* at Goddard Space Flight Center to promote greater understanding of the scientific results of NASA research by using state-of-the-art animation tools to

visualize scientific information collected from orbiting spacecraft (see Figure 5 for a notably artistic example).²⁵

Art can also provide solutions in the form of architecture and industrial design to produce environments specifically designed for human interaction, both on the ground and in space. Space

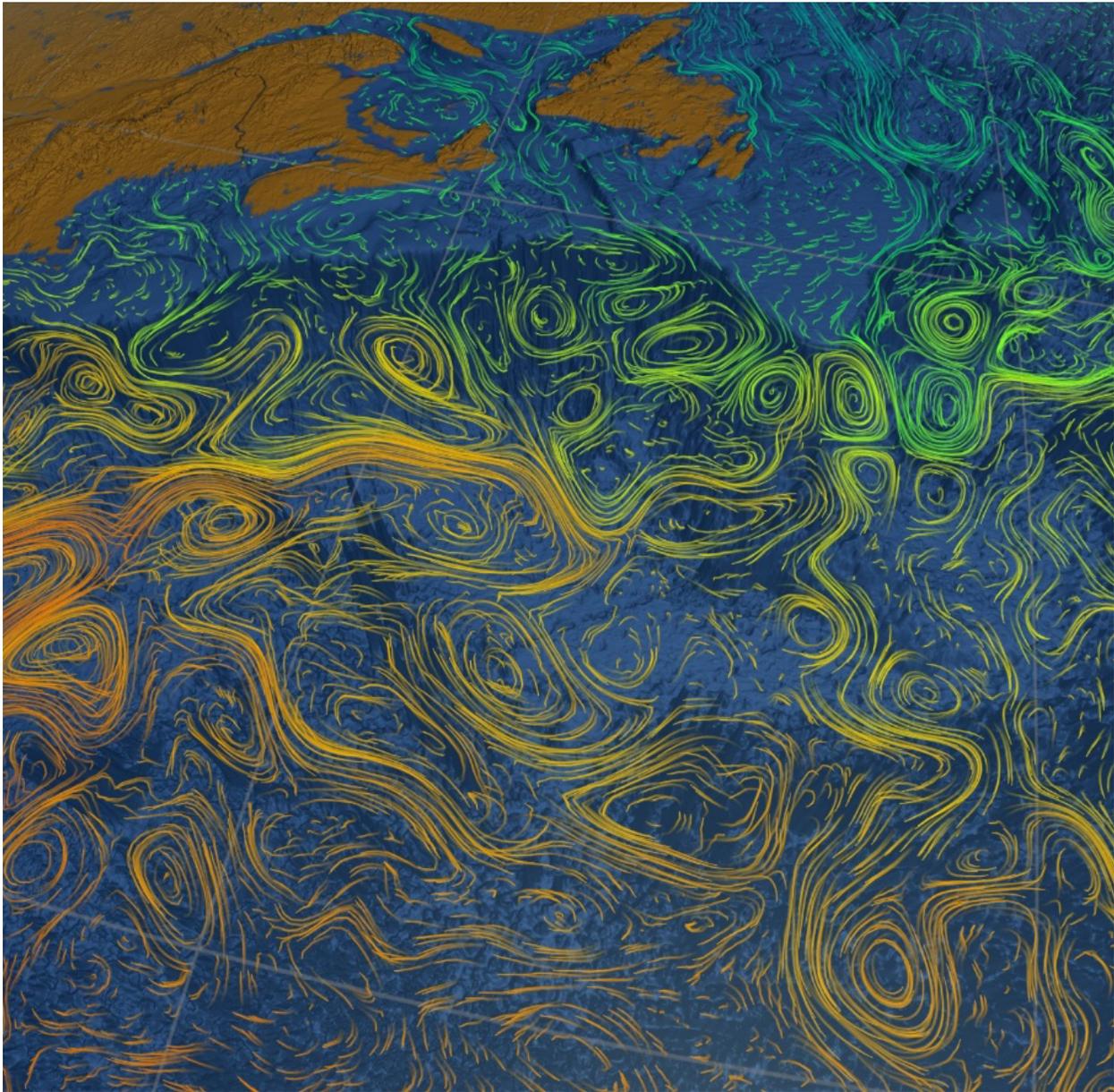


Figure 5: NASA data visualization of ocean flows and sea surface temperature data. (Credit: NASA).²⁶

art, for example, has been employed for the design of lunar habitats and the ISS, including emphasis on tactile surfaces, color selection, and even soundscape design, to produce an optimal environment for future astronauts.²⁷ Art also can play a role in the design of space facilities on the ground. For example, a researcher looking retrospectively at the architecture of Cold War-era command and control centers has posited that these utilitarian facilities were designed to tell a larger story to assuage a worried American populace and deter an aggressive Soviet bloc.²⁸ As the United States Space Force “organizes, trains, and equips space forces in order to protect U.S. and allied interests in space,”²⁹ considered approaches to the visual impact and aesthetics of the facilities (for example, space operations centers, command centers, space launch locations, and ground communications stations) could enhance the perception of strength in space.

Space Exploration, Technology, and Development as the Subject of Art

Space development has certainly made a new location and medium accessible for artists. However, space development *itself* has imbued artists with new tools, thoughts, and methods for expression. This comes from the technology, scientific artifacts, materials, and experiences that are by-products of space development and space exploration.

One way that space sparks artistic works is by exposing the artists themselves to the space development process. ESA has created artist residencies that place the artists in the center of mission development so that they can create works

inspired by their experiences at important European space locations.³⁰ Sometimes, scientists and engineers are artists as well. During the height of the Cold War space race, The Aerospace Corporation established a gallery for its employees to exhibit original art created in the midst of participating in the development of U.S. space capabilities.³¹ Finally, a very select set of artists are quite literally eyewitnesses to space exploration as astronauts. Soviet cosmonaut Aleksey Leonov, who took the world’s first spacewalk, was an amateur artist and used these talents to depict his time on orbit—even drawing a depiction of the sun rising over Earth’s horizon using specially built color pencils brought onboard the Voskhod 2 spacecraft.³² Apollo astronaut Alan Bean, after retiring from NASA, pursued painting full time and has incorporated lunar dust and other space ephemera into the artworks themselves.^{33, 34} The tradition of artist-astronauts continues to the present; in 2009, U.S. astronaut Nicole Stott became the first person to paint with watercolors on orbit during a mission to the ISS inspired by views of the Earth’s surface.³⁵

Art based on the materials or products of space exploration and space development is another active area. For example, Vargas-Suarez Universal is an artist who draws upon spaceflight and space development from countries across the world to produce large-scale geometric and abstract works like murals, paintings, visualizations, and installations; his artwork even incorporates the materials used for satellites, including solar panels, aluminum, and insulation. (See Figure 6, which was created during a 2014 residency at NASA Ames Research Center.)³⁶

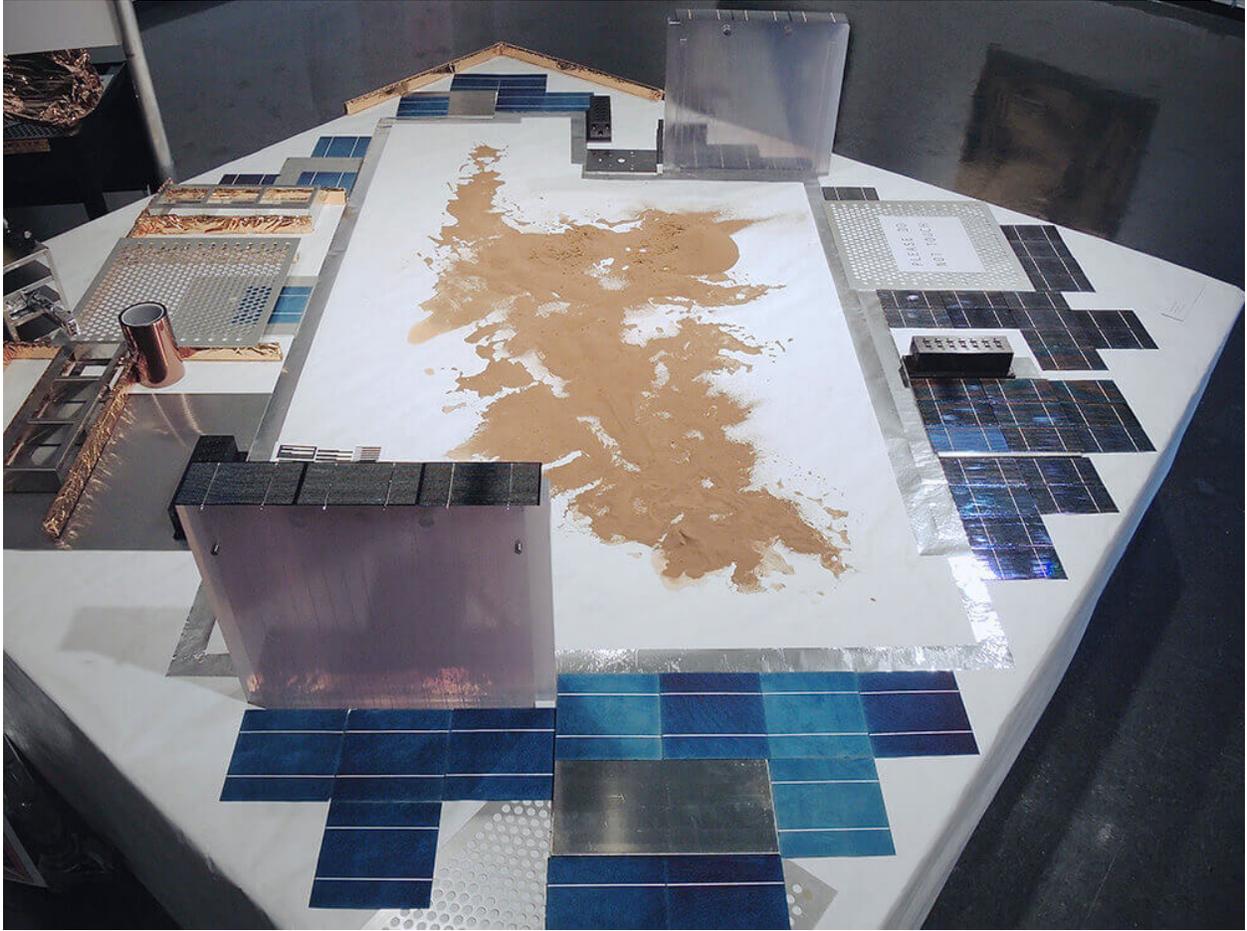


Figure 6: Vargas Suarez Universal, Cosmos Codex, 2014, MACLA, San Jose, California, USA. (Credit: Collection of the artist, image courtesy of Vargas-Suarez Universal studio, New York, New York, used with permission)

Emerging space technology is inspiring artists as well. When scientists at Surrey Nanosystems invented a new carbon nanotube coating used for the baffles of star trackers and as blackbody calibration sources, artists saw a unique and unearthly black material destined for use in artwork (see Figure 7). The Aerospace Corporation recently curated a collection of images generated by its scientists and

engineers related to space technology development, including microscopy of space materials, remote sensing data products, and computer-aided design of structures and electronics (gallery available online);³⁸ some of the products, if left uncaptioned, mimic abstract artistic works or colorful landscapes (see Figure 8 and Figure 9).



Figure 7: Art using carbon nanotube black material, Vantablack, originally produced for space applications. (Credit: Surrey Nanosystems, used with permission)³⁷

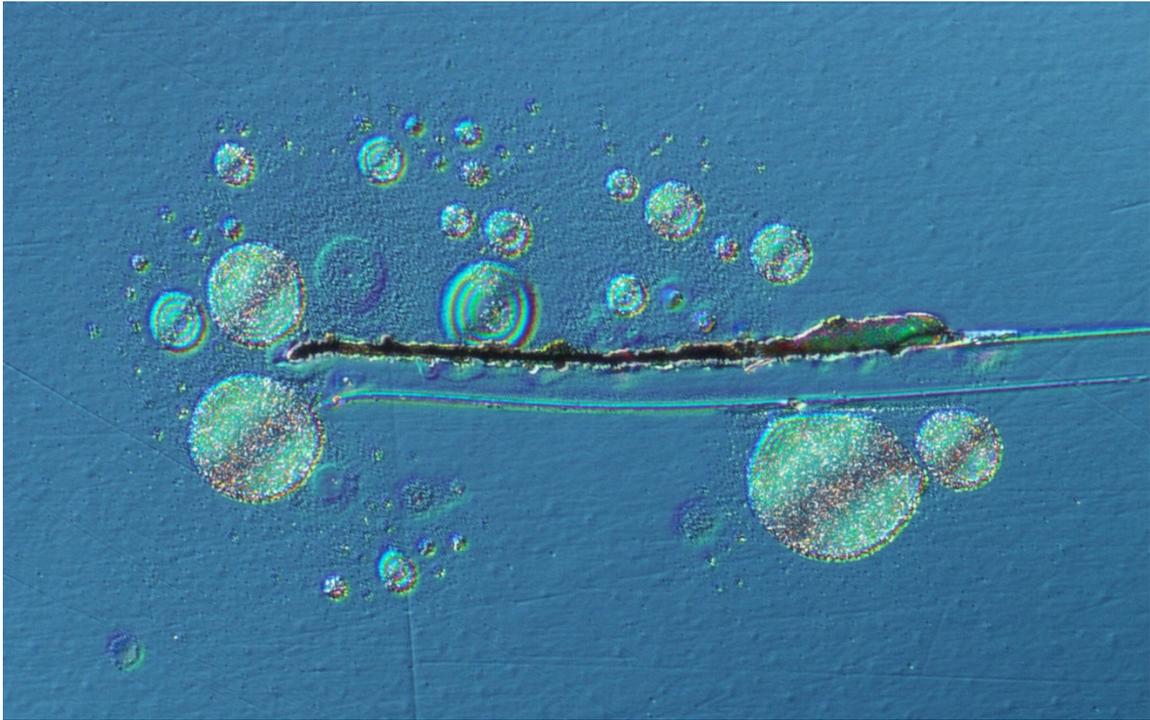


Figure 8: Scratching and circular corrosions on the surface of a silver mirror coating.

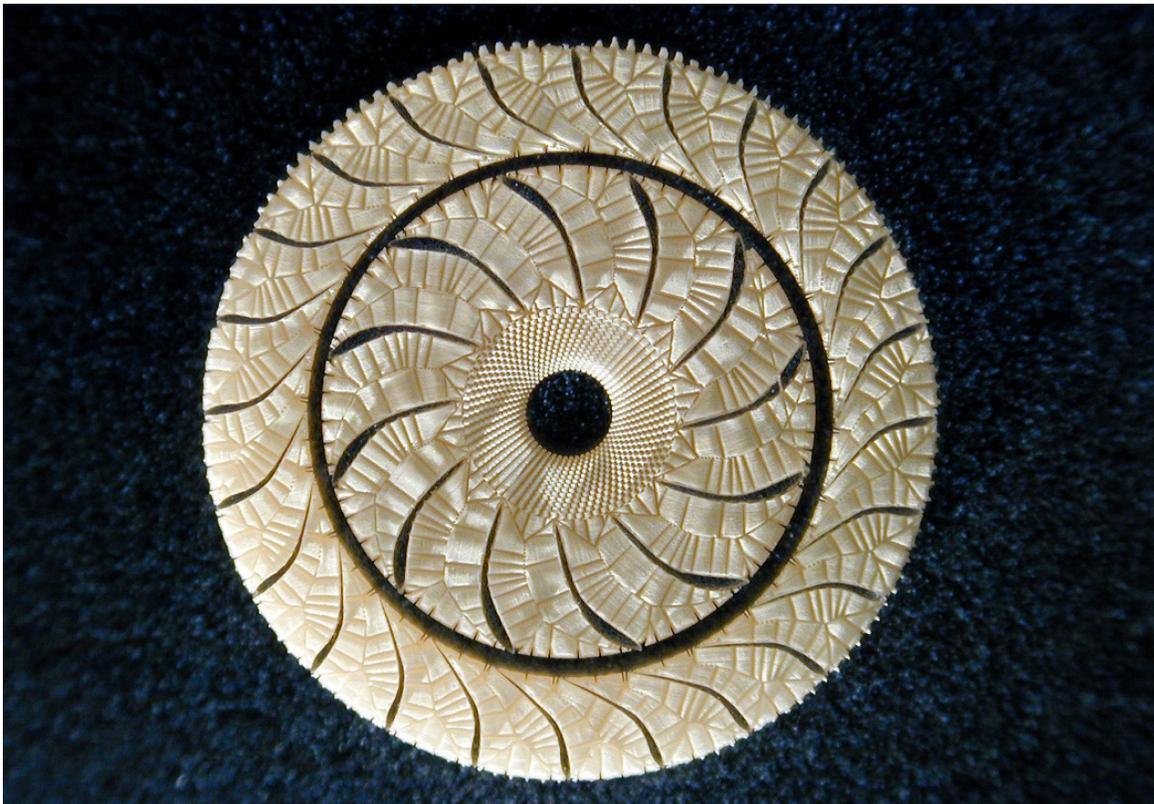


Figure 9: A counter-rotating turbine fabricated in photostructurable glass ceramic material using a novel laser machining technique.

Space in Film

The film community has continued to embrace space as a subject, with movies like *Gravity*, *Interstellar*, and *Ad Astra*. Some movies such as *The Martian* and *Hidden Figures* go so far as to dramatize even esoteric technical topics like orbital mechanics. The connection between space and film is even more interesting considering the close geographic proximity between the early U.S. aerospace industry and Hollywood.³⁹ These connections endure today. For example, SpaceX's factory floor in Southern California played the role of a weapons research laboratory in *Iron Man 2*. And more recently, reports have surfaced in the press that actor Tom Cruise is working with SpaceX and NASA on developing a film that is not only set in space but *filmed* in space.⁴⁰ Filming in space would require technology development and partnerships between the film industry and the space industry—furthering the natural connection between the two.

Interest in space for cinema is not limited to Hollywood, of course; movie studios in other spacefaring countries have recently released big budget films portraying space with an emphasis on national space capabilities. China's film industry released *Wandering Earth* in 2019, portraying a rescue of Earth from an expanding sun and it became the country's third highest grossing film of

all time. In this movie, set 30 years in the future, China and its space capabilities are the only hope to save the world.⁴¹ China released guiding policies in the mid-2020s for science fiction films like this focused on cultivating Chinese innovation, furthering Chinese values, and raising the spirit of scientists.⁴² Such emphasis from the Communist Party of China highlights the perceived influence of the genre specifically and the cinematic art form in general.

India's Bollywood industry produced several films focused on Indian space capabilities and satellites, including the 2019 *Mission Mangal*, based on the Indian space agency's real-life successful Mars Orbit Mission. The film foregrounds female leadership and participation in the mission.⁴³ Space has long been a theme in the film industry of the countries of the former Soviet Union. The popularity continues to this day with several big budget commercial movies in recent years—some with state funding—that dramatize some of the momentous events of the U.S.S.R. space program (*Salyut 7*, *The Age of Pioneers*, *Gagarin: First in Space*). Due to the simultaneous growth in international space endeavors and movie audiences, it seems likely that film will continue to be a popular medium for space art.

Public Engagement

For art associated with specific government-funded space efforts, public engagement is often the *raison d'être*. Art enables sharing of the human experience of space and offers a universal entry point that facilitates reaching the public at large.⁴⁴ Public engagement also builds support for what an organization is doing. Examples of engagement include educational outreach, art-based contests, and campaigns to raise awareness of ongoing missions.

Major space agencies have typically dedicated a portion of their funding toward educational outreach. For example, NASA, the Canadian Space

Agency (CSA), and ESA all have online resources to support educators to address space in the classroom.^{45,46,47} Art furthers this mission by providing an accessible medium with which to approach the subject of space. CSA provides artistic classroom posters that depict complex systems like radar satellites in a student-friendly manner (see Figure 10).⁴⁸ ESA offers a teacher's guide to create space-themed “pixel art,” including a collaboration with the artist known as Invader; pixel art has even started appearing on ESA buildings (see Figure 11).⁴⁹ In India, an artist-led workshop involving scientists and engineers from the Indian



Figure 10: Classroom poster from CSA on radar satellites. (Credit: CSA)⁵⁰



Figure 11: Mosaic pixel art on ESA's Redu Center in Belgium. (Credit: ESA)⁵¹

Space Research Organisation's (ISRO's) lunar mission was held for children who lived near the build site for India's lunar spacecraft, Chandrayaan-1. The science/art workshop was viewed as a "vehicle through which the cultural dimension of the mission could find a space to be articulated," according to its organizer.⁵² In the United States, undergraduate animation students joined scientists from the Fermi Gamma-ray Space Telescope in animating astronomy topics.⁵³

Art contests are one way to encourage both connection with space efforts as well as generate artwork that offers broad engagement. For example, SciArt Exchange, a nonprofit entity that works with NASA and others, offers "multi-disciplinary art contests, artwork events, consulting, training and community resource services to support science and technology education, collaboration, and innovation," according to its website.⁵⁴ A recent example is the *Project Mars Competition* that

included both films and posters and brought in astronauts, rocket engineers, science fiction writers, and photographers to act as judges.⁵⁵ Contests are a popular engagement method internationally as well. Each year, China organizes a poster contest in celebration of its national Space Day. The winning poster from the 2019 contest was chosen from 658 submissions and depicts the goddess Chang'E (the namesake of China's lunar spacecraft) reaching out to touch hands with an astronaut and includes motifs from China's past and present such as the Great Wall, the Silk Road, and the Tiangong space station.⁵⁶

Sometimes, space organizations directly support artists to engage with the public. *The Studio* at JPL, mentioned previously, led the development of futuristic travel posters to real-world planetary destinations with a hope to inspire future space innovators (see Figure 12).⁵⁷



Figure 12: Futuristic travel posters to promote planetary exploration. (Credit: NASA/JPL)⁵⁸

The Studio also created an immersive sculpture where the audience can “hear” orbiting spacecraft as they pass overhead (see Figure 13). Roscosmos, the Russian space agency, has released artistic images on its website that include drawn overlays of mythical creatures on real images of space exploration, adding an element of the fantastic to

already remarkable photographs.⁵⁹ Roscosmos most recently created an online digital art project titled *In Space We Trust*, depicting the first 100 years of international space exploration.⁶⁰ It is worth noting that much of the artistic output of these agencies is now “born digital” as websites, social media posts, or streaming videos to connect with the public.

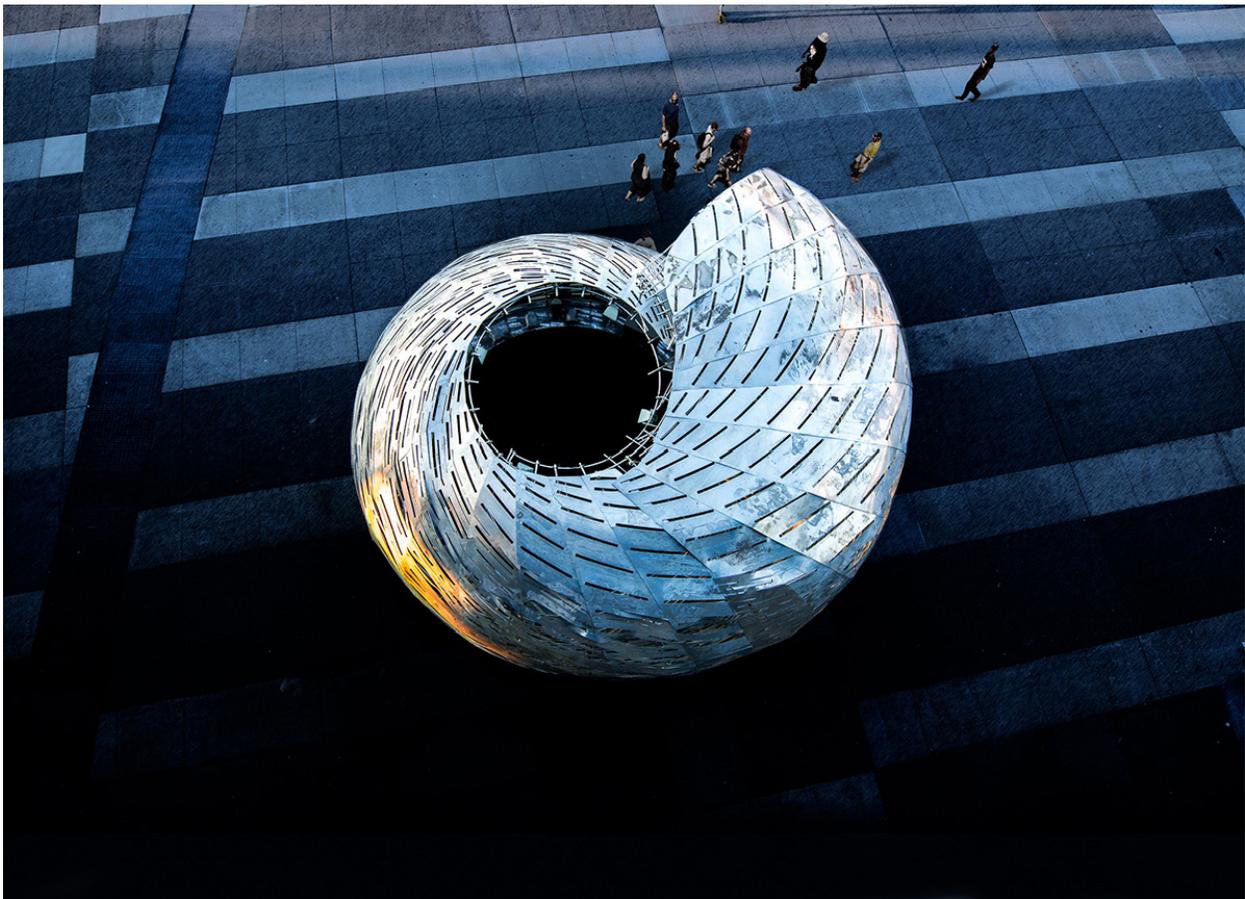


Figure 13: JPL Studio's Orbit sculpture. (Credit: NASA/JPL)⁶¹

Advertisement, Marketing, and Branding

Closely related to public engagement are the domains of advertisement and branding. Art plays a key role in these areas as well, promoting commercial enterprises as well as providing a unifying touch point for government efforts. Though the world is yet to experience orbiting soft drink billboards (although Pepsi did pay \$5 million to float a can on the Mir space station in 1996⁶²), commercial advertising has made progress in space. A surreal example is the paid placement of logos on Russian, previously Soviet, rockets during the mid-1990s, including Pizza Hut in 1999.⁶³ The contemporary situation is just as intriguing; take, for example, SpaceX's placement of an entire Tesla Roadster automobile in orbit.⁶⁴ Is this advertisement for Tesla, branding for SpaceX, post-modern sculpture in space, or all of these things?

A specific and familiar example of branding in space is the design of logos and patches for missions. These provide a visual cue and focal point for a mission. Even highly classified missions without names have patches—providing a touchpoint for the wider world. There is a universality that emerges when looking at logos for space organizations; for example, logos for the national space agencies of the United States, Russia, China, and India all prominently include a delta wing, as does the recently unveiled U.S. Space Force logo (see Figure 14). Logos use visual depictions to efficiently communicate larger messages. The logo for China's Lunar Exploration Program is a blue semi-circular swoop identifiable

with a crescent moon within which lie two gray footprints reminiscent of the lunar surface. The overall logo further resembles the first character of the Mandarin word for moon (月亮).⁶⁵ Logos are also a tool for further public engagement with a mission; in 2008, a 12-year old child from Moscow won the patch design contest for the Soyuz TMA-14 mission to the International Space Station.⁶⁶

Branding extends to commercial companies who build space capabilities as well. During the Cold War, as defense companies like North American Aviation and Ramo-Wooldridge competed for top talent, one of the tools was advertisement. Print advertisements of these companies from the 1950s and 1960s are awash with elements of abstract expressionism, pop art, and the science-fiction-inspired space art of earlier decades.⁶⁷ Branding continues into the present day with rich multimedia campaigns from both established aerospace companies and new startups.

Path Forward for the United States

Art and space have had interconnections throughout the decades of space development, both in the United States and internationally, and, as noted herein, contemporary examples abound led by civil space agencies and, increasingly, private space startups like SpaceX, Planet Labs, and Blue Origin. This section provides ideas for how the U.S. government may further foster the connection of space and art. Ideas include providing funding, increasing access, fostering partnerships, and encouraging research.



Figure 14: Logos for space organizations, from left to right: NASA, Roscosmos, ISRO, China National Space Agency, and the U.S. Space Force.

Just like space development, creating art requires resources. In the most straightforward scenario, U.S. space organizations could provide resources directly in the form of grants or other direct funding mechanisms. Alternatively, collaborations with existing government art funding lines (such as the National Endowment for the Arts) or private foundations may be an option. U.S. space organizations may look for synergistic opportunities to share resources to foster art toward mutually beneficial goals, like public engagement, and inspire the next generation of creative minds to build U.S. space capabilities. Efforts that combine art, space, and education, may be especially fruitful collaborations for this purpose. The United States could consider creating a consortium of organizations (military, civil, commercial, nonprofits, etc.) interested in sponsoring or enabling art related to space.

In addition to funding, U.S. space organizations can offer entry points for artists into existing space infrastructure and activities. In some cases, this would involve little or no cost. For example, artists could be offered access to facilities like operations centers or events like space launches to provide inspiration, insight, and ideas, which can resonate with the artist and re-emerge in creative artwork. A step further would be to provide artist residencies, something that NASA has done for some time.⁶⁸ It would be interesting for the new U.S. Space Force to examine the feasibility of such an arrangement, including artists in uniform; the U.S. Army has done something similar in the past.⁶⁹ Finally, U.S. space organizations can offer access to something few others can: orbital platforms for artwork. Art can be

included in existing space missions for a modest cost thus literally “elevating” artistic achievements related to space. The United States could establish a hosted *artwork* payload program; art could be drawn onto the side of spacecraft, launch vehicles, or stored digitally onboard. Much can be done without increasing risk or cost for these missions.

Against the backdrop of supporting art related to space, the United States could also foster research on how art improves space development. For example, insomuch as it is possible, objective analysis on the impact of art would be a useful tool in justifying expenditures related to art; studies could explore how artistic efforts aid the creation of new technologies or inspire students to pursue schooling and careers that help U.S. space capabilities. Another area of research could be using art as a lens for international comparison. This is something that has been done, mostly in retrospect, by looking at the contrast between Soviet and U.S. artwork during the Cold War.⁷⁰ A comparison of art among major spacefaring nations (the United States, China, Russia, and Europe) and new entrants (India, North Korea, Pakistan, and Iran) has not appeared in the literature. Finally, although there are many works examining the intersection of art and space,^{71,72} there is a lack of focus on the specific intersection between art and *military* or *national security* space. For example, during the Cold War, U.S. intelligence agencies used artwork to express the potency and immediacy of the threat of Soviet space capabilities (see Figure 15). What is an analogous use of art today? This may be a valuable area for researchers to explore.

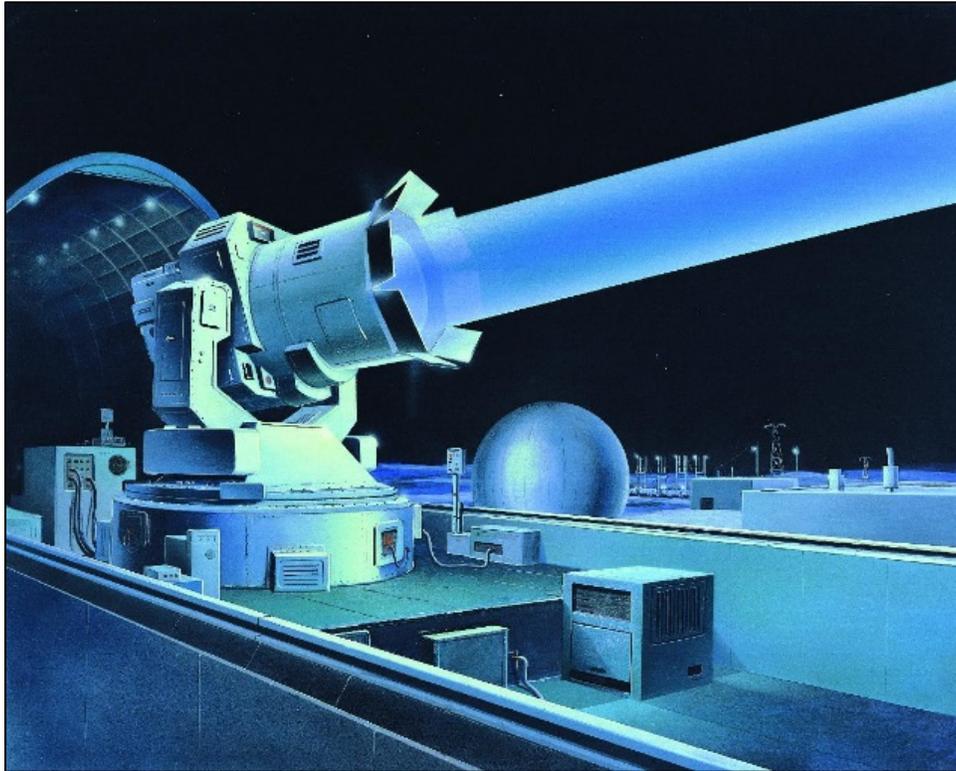


Figure 15: U.S. paintings depicting Soviet space development. (Credit: Defense Intelligence Agency)⁷³

Conclusion

The proposal for a 2016 call for artists-in-residency at ESA states, “Art and scientific research are often driven by a similar spirit: investigating the nature of our being in the world, pushing boundaries in knowledge and technology, venturing into the domain of the unexplored.” The world abounds with tangible examples of this spirit in the work that connects art and space, from cases as simple as launching art into orbit to cases as complex as integrating artistic processes into the development of new space technologies. Space organizations that seek to identify and foster these connections may find benefits across the spectrum of space activity while at the same time supporting one of the most fundamental human activities: creating art.

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