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The Astronomical Realists: The Social Mechanics of Visual Documentation, Art, and the American Space Age, 1944 – 1987

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Astronomical Realism and the Social Mechanics of Visual Documentation: Art, Illustration, and the American Space Age, 1944 – 1987

By

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University of California, Berkeley

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Abstract

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This dissertation examines how the practice of astronomical illustration changed and expanded over the course of the twentieth century Space Age. In the United States, the post-war period transformed outer space into a geopolitically significant environment, reorienting the authoritative picturing of space from a practice housed primarily within European astronomical observatories to one with commercial viability in American science and popular culture.

In the absence of cameras capable of rendering the space environment, individual illustrators filled in pictorial gaps by hand. Between the years of 1944 and 1987, illustrators developed an aesthetic of neutrality that visually signaled the scientific accuracy of their work. This aesthetic privileged a style of representation that mirrored the technical impartiality of cameras, collapsing distinctions between "most realistic" looking with "most photographic." The visual clarity of photographic resolution became the standard for the most successful illustrations, even though most subjects depicted required a degree of artistic license to be made visible at all. This dissertation examines the visual techniques developed to reproduce photographic-looking illustrations of unphotographable places.

The status of these images as utilitarian was negotiated via a complex web of group consensus and proximity to places like NASA, educational programming at planetariums, and public television. Examining midcentury astronomical illustration as a cultural product instead of neutral technical output offers a new entry point into the visual culture of the Space Age in the United States. This study underscores the way in which socially constructed expectations about the space environment were coded into objective-looking images

Dedication

This project is dedicated to my father, Ben, who was always my biggest champion. Thank you Dad, for filling our home with books and spurring a love of history from the very beginning.

Acknowledgements

I was an intern at NASA's Ames Research Center for two years before starting graduate school, during which I longed for a book that could explain the incredible paintings and illustrations that hung in the History Office archive. The bulk of the art was commissioned to circulate in print, but in person the framed originals resembled the stately oil paintings of a museum exhibit. The paintings, which mostly depicted the interplanetary satellite missions conducted with Ames in the 1970s, were remarkably realistic looking. It was difficult to shake the urge to call them "photographic-looking," even though they couldn't have been based on photographs of interplanetary encounters. What followed was a near-decade long preoccupation with defining the realism of scientific illustration.

I am eternally indebted to the people who helped me grapple with this question and wrangle it into written form. I'd like to thank Yvonne Clearwater for bringing me into the fold at NASA, offering indispensable mentorship, and encouraging me to continue my education. At Ames I'd also like to thank April Gage for tolerating my frequent use of the archive doorbell, and Luke Idziak, who continues to serve as a valuable collaborator and friend.

I spent an incredible year with the Space History Division at the Smithsonian's National Air and Space Museum, an experience that simultaneously sharpened my scholarship and deepened my love of the space program. At NASM I'd like to thank Matthew Shindell for serving as my mentor and entry point into the world of space history. I'd also like to thank Emily Margolis for serving as the scholarly model I aim to emulate still to this day, and for her wonderful baked goods. The entire curatorial team was remarkably generous in supporting my scholarship, and I'd especially like to thank Martin Collins, Mike Neufeld, Valerie Neal, Margaret Weitekamp, David DeVorkin, Paul Ceruzzi, Tom Crouch, Carolyn Russo, Allan Needell, Jim David, Teasel Muir-Harmony, Matthew Sanders, and Diego Jauregui. No mention of my time in Washington D.C. would be complete without Pete Daniel and everyone who still regularly convenes at Kelly's Irish Times. I cherish the community I have found within Space History as a field of interest, and would also like to thank Ingrid Ockert, Peter Kleeman, Samantha Thompson, Elizabeth Kessler, Lisa Ruth Rand, Eleanor Armstrong, and Jordan Bimm for their collegial support and generosity.

This project would have been impossible without access to both archival material and the stories that helped me make sense of it. I'd like to thank Elizabeth Borja of the National Air and Space Museum Archives, and Mariecris Gatlabayan at Vulcan LLC. Ron Miller and Melvin Schuetz were tremendously helpful in guiding my project towards the appropriate materials. The late Paul Allen was also a critical help, without whom the Bonestell papers may never have been preserved at all. For help with the career of Patricia Bridges I'd like to thank Kevin Schindler and Lowell Observatory for enabling online access to material during a global pandemic. For help with the NASA Art Program, Paul Fjeld and James Dean were indispensable. At the International Association of Astronomical Artists, I'd like to thank Michael Carroll, Kara Szathmáry, Aldo Spadoni, Carter Emmert, Marilynn Vicary-Flynn, and Pamela Lee. Special thanks to Jon Lomberg, William Hartmann, Louis Friedmann, Don Davis, Rick Sternbach,

Joel Hagan, James Dean, Pamela Lee, Louis Meisel, Paul Fjord, and Gunny Scarfo for sharing their stories with me over the phone and in person.

Just as invaluable to this process was my advising committee—Cathryn Carson, Massimo Mazzotti, Daniel Sargent, Patrick McCray, and Jacob Gaboury. Their thoughtful comments shaped this project in ways I couldn't imagine, and I'm grateful for all I've learned from them. I'd also like to thank the Department of History at U.C. Berkeley, especially Erin Leigh Inama and all of the administrators that help guide us through the doctoral process.

A special place will always be reserved for my cherished graduate student colleagues, who made me a better scholar (and person!) over the course of our time together. Simon Brown, John Handel, J.T. Jamieson, Sophie Fitzmaurice, Eva Villaincourt, and Elizabeth Hargrett offered brilliant feedback in writing, over the course of our seminars, and most importantly in their capacity as friends. Camillo Lund, and Peter Vale offered me refuge from the psychological horrors of the year 2020, and a second graduate degree in domestic bliss. The regular attendees of Craft Night, a pandemic fixture of our household, helped me explore the material dimensions of my work and maintain my sanity in the dissertation process' final months.

Maria Reis, Claire Wrigley, and Natalie Quinn continue to serve as an incredible support structure both emotionally and intellectually. No written words can adequately express my graditude for their friendship. The same goes for Grace Goudiss, my work wife, my forever accountabilibuddy, and my best friend from orientation onward.

Finally, this project would not have been possible without the continued support and encouragement of my mother, Diana, my step-father Loreto, and especially my sister Amanda. Banana—thank you for always reminding me that the future is bright!

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Introduction

In October of 1987, the International Association of Astronomical Artists traveled to Moscow to display their artwork at the Soviet Space Future Forum. It was a high-profile exhibition—the forum was to bring together well-known space dignitaries from around the world for the commemoration of Sputnik's thirtieth anniversary. Space scientists from the United States, frustrated by the post-Apollo slowdown of American space activities, organized the conference to celebrate the higher levels of interplanetary exploration maintained by their Soviet counterparts.[1] The conference was a sign of an uncertain space future, but also of thawing political tensions between the United States and Soviet Union. Because of the event's collaborative nature, the display of art commemorating humanity's expansion into space was deemed an appropriate part of the event's programming. The IAAA, as the International Association of Astronomical Artists were colloquially known, was invited to show work alongside space art produced by the Soviet Union of Artists, a parallel guild they considered their Eastern Bloc equivalent.

The art exhibition at the Soviet Space Future Forum brought together two groups of artists that had cultivated independent aesthetics over the previous thirty years. Both the Soviet artists and their American counterparts developed a visual grammar for their work that responded largely to their respective space programs. Despite the similar subject matter, the two artistic approaches represented drastically different artistic philosophies. The Americans preferred a highly technical style that obscured the artist's hand, while the Soviets embraced dramatic brushwork, fluid shapes, and emotive colors. Interpretations of space as a topography also differed. One of the IAAA's most popular subjects, the arid rocky landscapes of neighboring planets, clearly recalled nineteenth-century paintings of the American West. The Soviets preferred paintings of cosmonauts swirling through a hazy universe, opting for a more symbolic take, and often shirking the idea of a concrete landscape. The divergence that prompted the most reflection, however, was the Soviet accusation that the Americans' fixation on accuracy could be described as overly materialistic. How could one claim to see the surface of another planet with any degree of certainty? Besides, the interpretation of an artist was itself a form of documentation. Producing an image truthful to one's experience was more honest than an image masquerading as a window on reality. The art exhibition at the Soviet Space Future Forum prompted serious reflection. How could the pursuit of truthful representation produce such distinct approaches? Members of the IAAA were so awed by the split that they likened the meeting to first contact between indigenous peoples and Europeans in the Americas.[2]

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1. Louis Friedman, *Planetary Adventures: From Moscow to Mars* (Kindle Locations 116-118). Page Publishing, Inc. Kindle Edition.

2. It's unclear which group was supposed to represent who, but the IAAA maintained that the impressionistic approach cultivated by the Soviets was due to the CCCP's unwillingness to share scientific data. It's possible that this was used as a metric by which to judge artistic sophistication, and that the IAAA considered themselves a civilizing force. William Hartmann, Andrei Sokolov, Ron Miller, and Vitaly Myagkov, *In the Stream of Stars: The Soviet/American Space Art Book* (New York: Workman Publishing, 1990).

This dissertation examines the history of astronomical illustration in the United States. I focus on how certain pictorial conventions came to read as more accurate than others, and why American space art looked so different from its Soviet counterpart in 1987. The convergence revealed two different systems for visualizing outer space, offering each group a fresh alternative with which to make sense of their own approach. These differences were historically contingent, cultivated over the course of the post-war Space Age, a period between the conclusion of the Second World War and the fall of the Soviet Union when technological expansion spurred by competing superpowers underwrote the work of both the IAAA and the Soviet Union of Artists. Over the course of five chapters, I explain how photography shaped expectations for pictorial accuracy in the United States, and how looking "realistic" become functionally synonymous with "photographic." I argue that fixation on the production of trustworthy images was what spurred American astronomical illustration's preoccupation with impartiality, and that this resulted in the recycling of images of the American west as a stand-in for space. Landscapes of the west carried metaphorical weight, but more importantly, they were immediately visible to the naked eye.

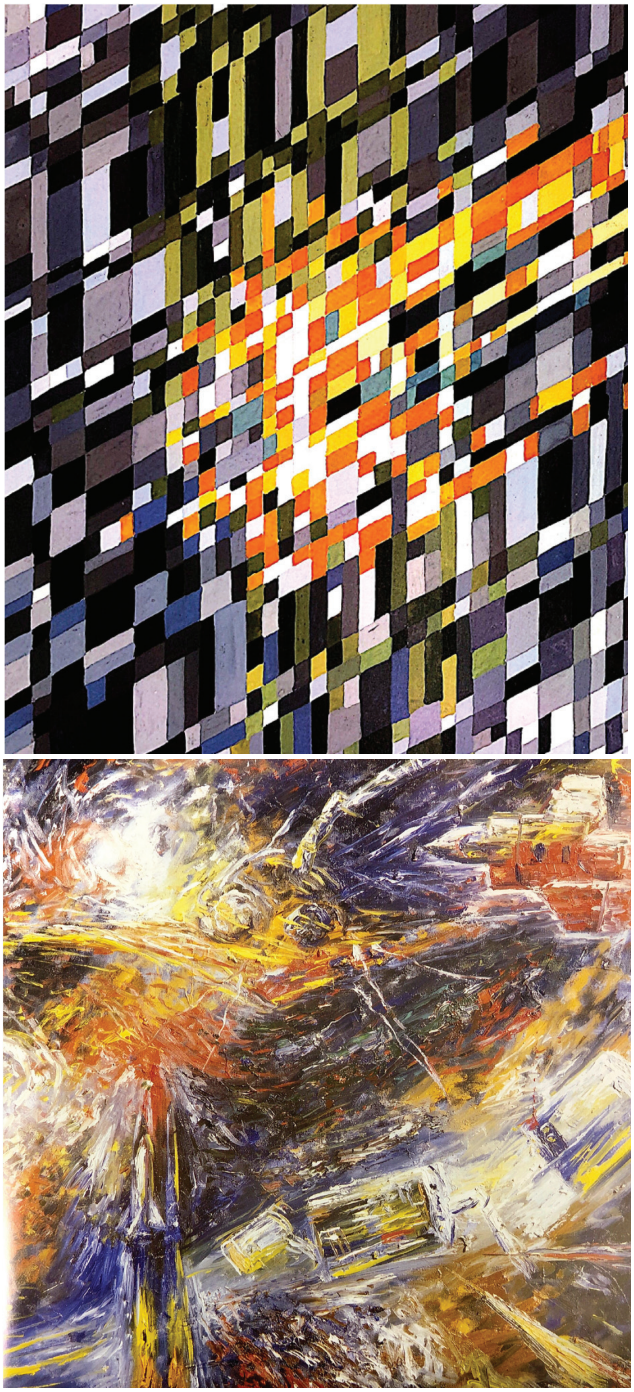

Figure 5.17 — Left: Anatoly Paseka, *Sunlight*. Right: Rafik Karaev, *Progress*.

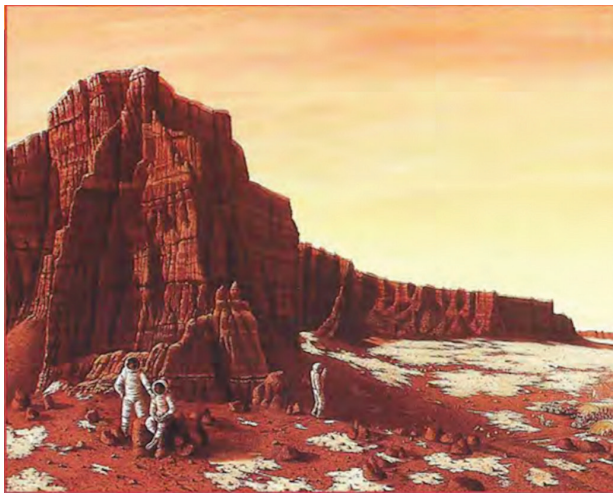

Figure 5.2 - Left: *Descent to Valles Kasai,* painting by Rick Sternbach and Don Dixon. Depicts an aerocapture technique used to slow a descending spacecraft headed for the Martian surface. Craft was to use the upper atmosphere as a breaking device. Right: *Polar Outpost Pioneers,* painting by Marilyn Vicary. Image depicts thin sheets of ice forming at Martian poles. Because Martian settlers would require usable water, the planet's frozen poles are depicted as a primary site of investigation. *The Planetary Report*, Vol VII Number 1, January/February 1987, pgs. 12 - 13.

I. Summary of Argument

Even by the late 1950's, the quickest way to produce a high-resolution image of outer space was to have someone paint it by hand. By this time, the conquest of space and the global visibility of such an achievement was a serious political priority, and illustrators produced images of space where cameras could not. Though these artists were framed by scientific collaborators as passive vessels transmuting astronomical information into images, they exerted far greater agency over the popular space imaginary than is typically acknowledged. The subsumption of an individual illustrator's identity into the anonymizing category of "artist's rendering," was a convention used to emphasize the neutral utility of a given image. In this formulation, these depictions were not art, but something more grounded in the representation of fact. This practice helped astronomical illustration cohere into a viable genre but also prevented the influence of these artists from being fully explored in the historiography of the American Space Age.

The actors in this story were paid illustrators, but they evaluated their contributions to astronomical illustration in terms of their artistic dexterity. Some of them described the act of scientific visualization as a type of high realism consistent with the history of representation in Western art, even though they weren't producing what galleries or museums considered art objects. To circumvent technical distinctions between art and illustration, I use Michele H. Bogart's historical definition of illustration as a professional occupation in the twentieth century. In Bogart's explanation, art and illustration don't represent static categories, but rather function as historicizeable practices that changed because of external historical conditions. In this view, twentieth century technological advancements in print culture and television expanded the terrain of art practice, but this proliferation prompted a narrowing of fine art's

Figure 5.16 and Figure 5.2—Left: Andrei Surovtsev, "Memory." Right: *The First Great Steps,* Michael Carroll. Illustration depicts a Soviet and American astronaut sharing the honor of being the first humans to walk on Mars. The landing craft is shown in the background, set down in the Valles Marineris canyon of Mars.

ideological borders. While the act of artmaking expanded for commercial reasons, the definition of "fine art" solidified around a specific set of objects.[3]

This is a story about how a group of people professionalized around a set of practices, but also how the perceived superiority of the photograph was integrated into the illustration process. Over the roughly thirty-year period between 1944 and 1987, the camera prevailed as the most trustworthy form of image-making, setting a pictorial standard of resolution for artist's attempting to mimic mechanical sight.[4] The most common tool deployed in the replication of photographic clarity was to deploy a stand-in for the otherwise unpicturable environment. The development of physical proxies for alien surfaces—either models or sufficiently similar geological formations on Earth—allowed artists to render minute details with high degrees of resolution. For the artists in my story, the American West represented a seeable landscape uncovered by trees or grass, where geologic formations that likely existed elsewhere in the universe could be closely examined. By the 1980s, frontier landscapes were codified as a natural stand-in for outer space. An examination of the professional lives of astronomical illustrators and the standards of accuracy negotiated by and around them reveals the cultural contingencies of their otherwise neutral-looking art.

II. Chapters and Methodology

This project traces major developments in Space Age astronomical illustration between the years of 1944 and 1987. I begin with the publication of Chesley Bonestell's first work of astronomical art and conclude with the travel of the International Association of Astronomical Illustrators to Moscow in 1987 for the thirtieth anniversary of Sputnik. In between, I trace the professionalization of astronomical illustration into

3. Michele H. Bogart, *Artists, Advertising, and the Borders of Art* (Chicago: The University of Chicago Press, 1995), pg. 4.

4. The periodization of this paper starts with the publication of Chesley Bonestell's TIME Magazine paintings of Saturn and concludes with the IAAA's visit to the Soviet Union in 1987.

a bounded discipline, as well as the tensions inherent in differentiating scientific image-making from fine art.

Chapter One follows the career of Chesley Bonestell, widely considered to be the father of astronomical illustration in the United States. This chapter explains how the practice evolved from one cultivated inside nineteenth-century European astronomical observatories into one with a commercial market in the United States. Bonestell's training as a Hollywood matte painter and architectural renderer established the standard of photographic clarity for later illustrators who claimed to be working in the Bonestellian tradition. Bonestell's later illustrations were often produced in conjunction with well-respected men of science and demonstrate how "accuracy" was a category contingent on group consensus.

The second chapter examines how the creation of the National Air and Space Administration and the build-up to Project Apollo helped systematize distinctions between fine art and astronomical illustration. In 1962, NASA administrators created the NASA Artist's Cooperation Program, in hopes that fine artists could help capture the cultural significance of the space program. This chapter centers the tension inherent to art as a form of documentation, and the mercurial meaning of "worthy" expenditures of taxpayer money. I contextualize the NASA Art Program in the history of military painting in the United States rather than the expansion of arts funding associated with the increased social spending of the 1960s. Many participating artists were funneled directly from the U.S. Air Force Art Program, a collection of painters charged with depicting and memorializing the aircraft that won the Second World War. The Air Force Art Program also prompted a visual treatment of sunlight on metal that would reappear later with the emergence of Photorealism as a coherent genre. Parts of the story overlap in 1976, when both the collection of the NASA Art Program and a collection of Photorealist paintings were shown at the newly opened National Air and Space Museum. The chapter ends with Laurie Anderson's ill-fated 2005 artist-in-residency, which resulted in a congressional amendment prohibiting art residencies at NASA, illustrating the complex relationship between art, illustration, and monetary value.

While Chapter Two explores NASA's foray into the fine arts, Chapter Three focuses explicitly on the production of strictly utilitarian images during roughly the same decade. The third chapter follows Patricia Bridges, who trained a cohort of illustrators hired by the United States Geological Survey's Brach of Astrogeology. Like the NASA Artist's Cooperation artists, who were integrated primarily for their interpretive value, these artists were hired to see what otherwise couldn't be pictured, and to translate this information into a two-dimensional representation. While art commissioned for the NASA Art Program emphasized the identity of the individual artist, large hand-drawn Moon maps subverted the identities of participating artists entirely. The USGS lunar illustrators were treated as a mechanical process within a larger institutional seeing apparatus. By comparing Patricia Bridges lunar illustrations with the detailed drawings of artist Vija Celmins—images resulting from remarkably similar approaches—this chapter complicates distinctions between art and technical illustration. The chapter concludes with Don Davis, Patricia Bridges' protégé, who took the techniques he learned from Bridges and applied them to much more speculative works of illustration. Davis was able to cultivate a reputation for accuracy that stemmed

from his training at the USGS.

The fourth chapter picks up in the post-Apollo moment, characterized by unmanned probe and satellite exploration as well as broad government disinvestment from space activities. This chapter examines how astronomical illustration helped second-wave space boosterism circulate in the 1970s by offering an overview of the commercial market for depictions of space during this period. This period also reflects a broader shift in American aerospace, one characterized less by large unified federal efforts, and more by splintered efforts across a public-private divide. As opposed to the centralized efforts of the NASA Art Program, astronomical illustration in the 1970s served a variety of needs and functions. Its status as a genre of image making that functioned as legitimately utilitarian meant NASA project managers did not need to justify it as a frivolous expenditure, even if the illustration's intended purpose was largely promotional. This market also expanded beyond NASA, expanding into science fiction, public television, and popular print.

Chapter Five follows the development of the International Association of Astronomical Artists, a professional guild of astronomical illustrators formed in 1981. Over the course of the 1980s, the IAAA codified their professional identity, borrowing techniques from both the USGS lunar illustrators as well as Chesley Bonestell. They also organized workshops throughout the American West, using plein-air painting of geological formations as fodder for commercial illustrations. The chapter concludes with the group's 1987 trip to the Soviet Union, during which a completely different visual grammar for depicting space was discovered.

III. Historiography

For much of the 1980, seminal works in the history of science focused on the political context of the Cold War.[5] These histories, like Walter McDougal's *The Heavens and the Earth* and John Logsdon's *The Decision to Go to the Moon,* explained why humanity went to space in the twentieth century by locating the answer in the political goals of the United States and Soviet Union. As the Apollo program faded from living memory, focus shifted to the coproductive relationship between popular culture and the space program. Howard McCurdy's 1991 *Space in the American Imagination* charts the importance of social forces in the achievement of human spaceflight, pointing to works of science fiction, amusement parks, television, and other forms of popular culture as critical to understanding the Apollo program's success. McCurdy describes Chesley Bonestell's space age illustrations, discussed in Chapter One, as a cultural product critical to motivating space exploration. McCurdy, however, never parses the tension between the status of Bonestell's images as art objects and scientific objects, treating them as both simultaneously. In McCurdy's view, Bonestell's images were so accurate they had predictive value, but remained imaginative and awe inspiring at the same

5. John Logsdon, *The Decision to Go to the Moon: Project Apollo and the National Interest* (Boston: MIT, 1970).

time.[6]

This framing treats astronomical illustration as something more accurate than art, but more meaningful than technical illustration. In most cases, the differentiation from art objects was largely superficial. My intervention begins with Chesley Bonestell's position in the history of the Space Age, which set the tone for works of astronomical illustration that came later in the twentieth century. McCurdy's reading of Bonestell's work stems from descriptions perpetuated by Bonestell's space advocate collaborators, who benefitted from promoting his illustrations as more "realistic" than artistic depiction. Werner von Braun and Willy Ley's attempts to wrest spaceflight from the realm of science fiction has been well-explored by the historiography, but the consequences of this framing on Bonestell's work have been underexplored. As a result, historians of the space age have continued to evaluate Bonestell's illustrations as both scientifically accurate as well as artistically significant.[7] As with McCurdy's analysis Catherine Newell applies the same categorical ambiguity to Bonestell's work, declaring his early architectural renderings a form of art, while maintaining that his astronomical illustrations—which deployed a nearly identical methodology—were more scientifically informed.[8] This contradiction is avoided if we explore the aesthetic of scientific accuracy as a set of visual conventions that can operate independently of scientific knowledge.

Bonestell's categorization is important because it set the tone for the professional illustrators who cast themselves in the same professional light. Works produced by the artists that would eventually form the IAAA should be understood as a kind of pictorial craftsmanship with its own distinct epistemology. This guild of artists function as a twentieth-century version of the nineteenth-century atlas-makers in Lorraine Daston and Peter Galison's *Objectivity*—they cultivated a specific form of pictorial expertise by developing their own techniques for the creation of trustworthy images.[9] Unlike the scientific illustrators in Daston and Galison's story however, these artists weren't displaced by the camera. Rather, they incorporated it as a tool in the illustrating process, simulating a camera's clarity in depictions of unphotographable places.

The case of midcentury astronomical illustrators can also be situated in conversation with recent works on the relationship between images and scientific knowledge. In *Observing by Hand*: *Sketching the Nebulae in the Nineteenth Century,* Omar Nassim explains how the process of hand-drawing helped nineteenth-century astronomers concretize their visual observations.[10] Janet Vertesi's *Seeing Like a Rover:*

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6. Howard McCurdy, *Space and the American Imagination* (Washington DC: Smithsonian Institution Press, 1997), pg. 33.

7. Jared Buss's biography of Willy Ley engages Bonestell's work in a similar tone, relying on a biography compiled by Frederick C. Durant III, Bonestell's late art dealer. Jared Buss, *Willy Ley: Prophet of the Space Age* (University Press of Florida, 2017).

8. Catherine Newell, *Destined for the Stars: Faith, the Future, and America's Final Frontier* (Pittsburg: The University of Pittsburgh Press, 2019).

9. Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2010).

10. Omar Nassim, *Observing by Hand: Sketching the Nebulae in the Nineteenth Century* (Chicago: University of Chicago Press, 2013).

How Robots, Teams and Images Craft Knowledge, describes how images of Mars are mediated through complex social channels as well technological ones.[11] Lisa Messeri's *Placing Outer Space: An Ethnography of Other Worlds,* examines the various processes by which planetary scientists make other worlds legible.[12] For Messeri, the work of "placemaking" coheres disparate forms of information about an exoplanet into a localized picture of place. This is also the job of the astronomical illustrator—imagining planets from the vantage point of an individual standing on their surface, rather than viewing them remotely. The synthesis of information about foreign planets into the simulation of a photograph or naked eye view formed the core of the IAAA's professional identity.

As historical studies of spaceflight have continued to proliferate, so have discussions about the visual culture of space and its unshakeable invocations of American Manifest Destiny. Elizabeth Kessler's 2012 *Picturing the Cosmos* argues that the astronomical sublime represented by Hubble Space Telescope photography was greatly influenced by the nineteenth-century landscapes of the Rocky Mountain School and used the visual iconography of frontier landscapes as a visual metaphor to make space legible.[13]

Rather than identify similarities between two moments nearly a century apart, a close look at the practice of picturing outer space in the midcentury helps explain why the American West persists as the most realistic looking stand in for space. The appropriate vehicle for this question is an examination of what makes an image believable looking or realistic in the first place—the rise of Rocky Mountain School coincided with the commercialization of photography and a radical transformation of what trustworthy image looked like to the average consumer. Paintings of the American West were sometimes held to similar standards of accuracy as the astronomical illustrators working over the course of the Space Age. A critic of Albert Bierstadt once decried his 1864 painting, *Rocky Mountain's Lander's Peak*, for forming a misleading picture. "The whole science of geology cries out against him… juxtapositions may be in accordance with the artist's recipe for the picturesque, but they are a heartless violation of nature."[14]

To compare contemporary depictions of space frontiers with nineteenth century ones, we must first understand the visual conventions that make an image look like a replication of reality. When compared to the Soviet depictions of outer space, American space art was clearly fixated on the comprehension of space as a type of landscape. Even more prominent, though, was its fixation on pictorial accuracy. Decoupling the "look"

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11. Janet Vertesi, *Seeing Like a Rover: How Robots, Teams and Images Craft Knowledge* (Chicago: University of Chicago Press, 2014).

12. Lisa Messeri, *Placing Outer Space: An Ethnography of Other Worlds* (Durham: Duke University Press, 2016).

13. Elizabeth Kessler, *Picturing the Cosmos: Hubble Space Telescope Images and the Astronomical Sublime* (Minneapolis: University of Minnesota Press, 2012), pg. 20.

14. Nancy K. Anderson, "Curious Historical Artistic Data" *Discovered Lands, Invented Pasts: Transforming Visions of the American West* (New Haven and London: Yale University Press, 1991) pg. 12.

of accuracy or realism from the subject depicted can help us understand the visual conventions we have learned to read as trustworthy.

By focusing on the methodology of astronomical artists working in the twentieth century, we can begin to denaturalize the casting of outer space as a type of western frontier. This project centers the techniques and practices of artists working to create accurate depictions of space. I rely primarily on analysis of reference material deployed in the visualization process—places or structures on Earth intended to stand in as an observable counterpart to space—as well as oral histories with living members of the space art community. Individuals are important to this story. One of the conventions inherent to the practice of scientific illustration is the anonymization of the artist, a strategy that emphasizes the subject matter over the individual's interpretation, similarly to the way a textbook might deploy the third-person tense in its descriptions.

Astronomical realism straddled the line between scientific visualization and artistic intervention. As a case study, it skirts semantic debates that have prevented scholars from seriously analyzing space age astronomical illustration. For historians of science these illustrations aren't considered close enough to the knowledge-production apparatus to be accounted for as material evidence of the scientific process.[15] For art historians, they're too derivative of other image-making techniques to function as an interpretive artistic contribution. Astronomical illustration in the mid-twentieth century sits most squarely at the intersection of these two fields, and tools from each are necessary to understand how artists conceptualized their own work. I maintain that astronomical illustrators cultivated and maintained real purchase over the space imaginary in the United States over the course of the twentieth century. The pictorial record they produced was a cultural product. By taking seriously their efforts, we can uncover the material links between outer space as a scientific subject and a cultural one.

15. Studies of astronomical illustration don't typically stretch into the twentieth century. This is largely because the status of an illustration produced in conjunction with an observatory is much more easily recognized as a scientific product. As space exploration moved beyond the purview of the observatory, many more types of people and tools were enlisted in the visualization process, making category "astronomical illustration" a more loosely bounded one. For more on astronomical illustration in the nineteenth-century, see Omar Nassim's *Observing by Hand: Sketching Nebulae in the Nineteenth Century* (Chicago: The University of Chicago Press, 2013).

Chapter 1 — America's Astronomical Illustrator: Chesley Bonestell and the Problem of Seeing Outer Space

I. Seeing with a Human Camera

"Chesley Bonestell's paintings should not be considered 'artist's conceptions' in the customary sense of the phrase." The opening chapter of *The Conquest of Space,* written by German American rocketeer Willy Ley in 1949, explained to readers that the publication's lavish illustrations were closer to a photographic view of other planets than the product of artistic imagination. Bonestell's rigorous methods, in Ley's explanation, made his depictions of space utilitarian. They combined near-mechanical trustworthiness with a sensible aesthetic touch, like "a picture which you might obtain if it were possible to get a very good camera." But there was also an element of professional artistic judgment, as though the images were shot "with perfectly color-true film into the proper position and… manned by a good photographer who could use just the right exposure."[16] Though *The Conquest of Space* was a book about the plausibility of space travel, the opening pages of the best-seller focused explicitly on Bonestell's credentials as an illustrator.

The conflation of Bonestell's aptitude with mechanical forms of image making was central to the text's success. A now canonical work of space boosterism, *The Conquest of Space* framed space exploration as a feasible possibility, if not an imminent reality, by explaining how the emerging field of rocketry would carry humanity across a new cosmic frontier. Ley's goal was to make the technical side of space exploration intelligible to a broad public audience, so that it might finally be wrested free from the realm of science fiction. By framing Chesley Bonestell's illustrations as empirically grounded foils to the typical "artist's conception," Ley distinguished *The Conquest of Space* from the types of space-faring science fiction his audience was more familiar with. In Ley's description, Bonestell's paintings weren't just art, they were something closer to real science. *The Conquest of Space* made the science and engineering of space travel seem like a complete and neatly bounded body of knowledge; the only thing left to do was to simply realize these goals with the appropriate levels of political mobilization.

Despite the success of Ley's framing, Bonestell's illustrations had little to do with his study of astronomy, and much more to do with his understanding of photography's visual authority in the mid-twentieth century. His professional reputation was codified at a moment in history when outer space emerged as a high-stakes political arena accessible only via fledgling technologies. As with the mapping efforts of Old-World colonization efforts, picturing this new frontier was a necessary precursor to its conquest, and by the late 1940s, a new market opened for "realistic" images of outer space. For advocates making arguments about the plausibility of human spaceflight, Bonestell's photograph-like illustrations provided a useful tool. His colorful images helped otherwise dry publications circulate in popular channels without diminishing their credibility. While the language of truth and realism was frequently invoked by Bonestell's contemporaries to explain the pictorial clarity that famously characterized

16. Willy Ley, *The Conquest of Space* (New York: The Viking Press, 1949), 9 - 12.

his work, they explained this as a function of his rigorous study of astronomical principles. However, I argue Bonestell's work wasn't successful because he passively reconstituted astronomical knowledge into the form of an image, but rather because he convincingly simulated the trustworthy pictorial grammar of a photograph.

I contend that a realistic depiction of outer space is one that is necessarily constructed. Since humans lack the basic sensory apparatus for making sense of the size and spectral composition of the universe, comprehensible representations are constructed using broadly legible pictorial conventions that signal to viewers how the image should be read. We have historically understood the cosmos as a traversable realm that parallels terrestrial landscapes, and this impulse remains even with the availability of new picturing technologies. Elizabeth Kessler's work on Hubble Space Telescope photography demonstrates the extent to which astronomers draw on this pictorial framework to make their images both legible and attractive to lay audiences. The celestial subjects of the Hubble Space Telescope's lens, which are first translated into data and then later reconstituted into coherent images, are consciously given landscape orientations, and colored using earth-tones that register as a physical horizon.[17]

Bonestell's paintings made the space environment legible by replicating the direct observation of a camera, and mimicking the same pictorial conventions associated with objective images. His artistic practice is the central focus of this story, in conjunction with three main bodies of evidence: the full arc of Bonestell's professional life; the techniques he developed to bolster the photographic qualities of his illustrations; and how the branding of his work as "scientifically accurate" evolved as new technologies for imaging distant places developed. Bonestell was celebrated by his space booster collaborators for disappearing from his paintings, obscuring his brushstrokes, and replicating for viewers the sensation of direct observation. However, this effect was highly contingent on the specific skill set Chesley Bonestell cultivated over the course of his long career. By the time Bonestell arrived at the practice of astronomical illustration, he was already fifty-eight years old and had worked full-time as both an architectural draftsman and Hollywood special effects artist. It was in these professional settings that Bonestell mastered the principles of perspective and developed techniques for producing hand-painted backdrops that looked continuous with film footage of human actors. His architectural work, matte paintings, and astronomical illustrations all looked identical from a technical perspective, and if the rubric of scientific accuracy can't be applied to his commercial art, then its application to his astronomical paintings should be reconsidered.

Chesley Bonestell's appearances in the historiography of the Space Age are often colored by the way he shaped his own identity. Bonestell actively cultivated his reputation as a type of astronomical expert, capitalizing on the difficulty of photographing remote space landscapes. The creation of this new category of pictorial expertise was contingent both on his maneuvering as well as an amenable contextual

17. Elizabeth Kessler, *Picturing the Cosmos: Hubble Space Telescope Images and the Astronomical Sublime* (Minneapolis: University of Minnesota Press, 2012), 61-63.

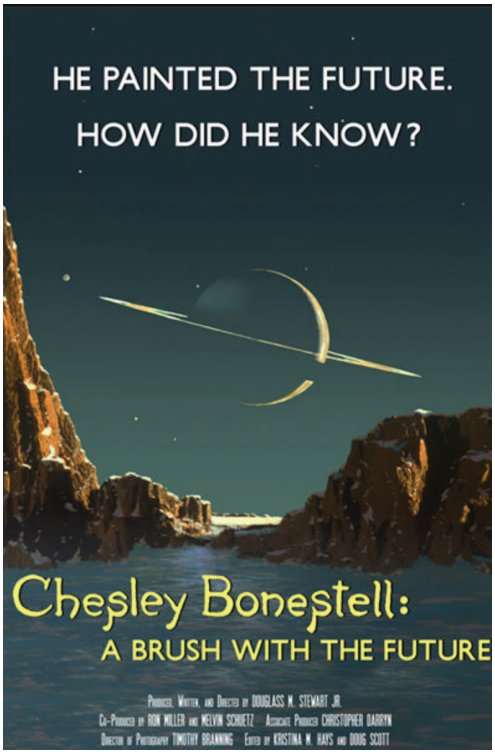

Figure 1.1— Poster, *A Brush with the Future* (2018). The tagline of the film, "He painted to future. How did he know?" draws an explicit connection between Bonestell's adherence to scientific accuracy and his subsequent predictions of the look of distant space landscapes.

moment. This framing resulted in a reputation that hinged on objective representation, which was spun over time into a type of prescient knowledge about the true look of distant planets. The claim that Bonestell operated with scientific accuracy chiefly in mind, and occasionally predicted the look of future space landscapes is one largely upheld in historical scholarship addressing his collaborations with space boosters.

By the end of the 1950s, a press release from the Boston Museum of Science celebrated Bonestell as "America's foremost astronomical illustrator." This did not exist as a professional category the decade prior and elevated the role of commercial illustrator to one imbued with technical expertise. To reinforce the viability of his reputation, Bonestell actively performed his devotion to scientific accuracy, cementing his image as a twentieth-century astronomer-artist. He wasn't shy about expressing this view, and reportedly kept the motto "Let them be right, you be rich" posted in his studio.[18] I argue that Bonestell's position as a commercial illustrator vested him with a similar set of professional interests to the enterprising young Galilei—he encouraged his portrayal as a human camera because this helped his images sell, and this commercial success further bolstered his reputation.[19]

Bonestell benefited commercially from the image he created for himself, and this framing still lingers in the way his contributions to the early space age are remembered. Catherine Newell's 2019 book *Destined for the Stars* examines the extent to which twentieth-century space boosterism relied on the cultural saliency of Manifest Destiny in American intellectual life. *Destined for the Stars* upholds Bonestell's work for its scientific accuracy, but also actively contends that his illustrations were rooted in visual tropes associated with frontier expansion; the tension between Bonestell's paintings as objects of science and culturally mediated interpretations of space landscapes goes

18. Ron Miller and Frederick Durant III, *The Art of Chesley Bonestell* (London: Paper Tiger Books, 2001), pg. 23.

19. Bonestell's approach to self-fashioning can be compared to Mario Biagioli's Galileo in *Galileo Courtier,* as well as a host of other characters in the history of science that actively constructed their professional image. As Biagioli points out, Galileo framed his talents in a way that suited the landscape of available patronage in the court of the Medicis Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993).

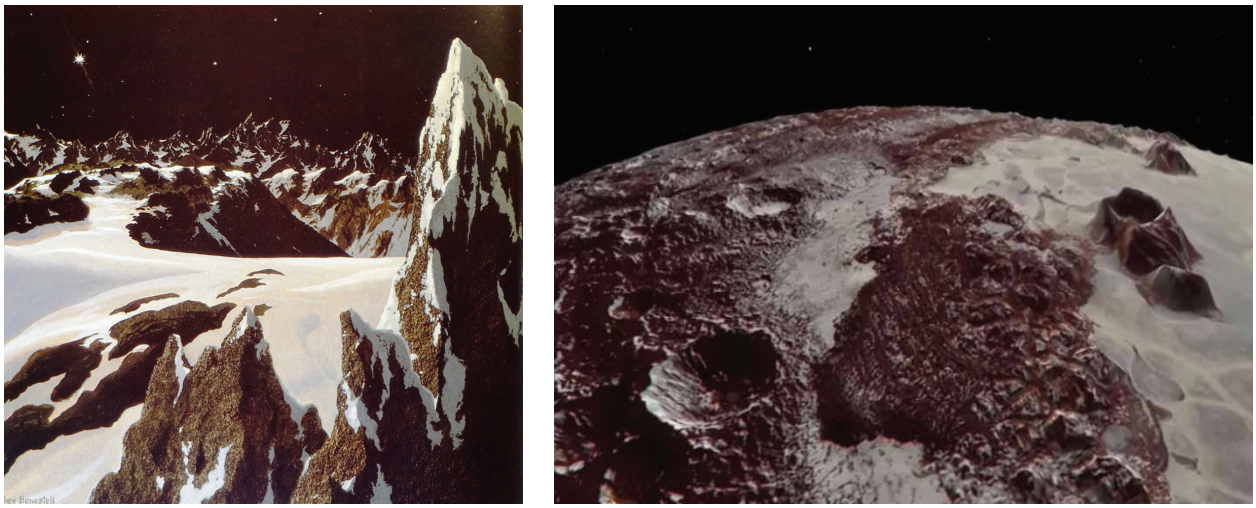

Figure 1.2— Left: Bonestell's *Pluto,* (1948). Reproduced courtesy of Bonestell LLC. Right: 2015 image of Pluto taken by NASA's New Horizon's Team. The 2018 documentary, *A Brush with the Future,* suggests to viewers that Bonestell's depiction of Pluto was confirmed by the New Horizon's spacecraft.

largely unaddressed in Newell's analysis.[20]

Descriptions of Bonestell's work as broadly "accurate" have contributed to a tautological mythology—Bonestell was so committed to scientific accuracy in his visual practice, that some of his images predicted the look of distant celestial bodies. Howard McCurdy's 1997 *Space and the American Imagination* points out that images returned to Earth by the Apollo 8 astronauts affirmed Bonestell's views of the lunar surface, painted nearly twenty years prior.[21] A 2018 documentary about Bonestell's career as an astronomical illustrator concluded on this very note, suggesting to viewers that a painting of Pluto produced in 1949 accurately predicted the look of its surface.[22] The film showed photographs taken by the *New Horizon* spacecraft alongside Bonestell's painting, pointing out similarities in the look of the topography.

Reframing Bonestell as an artist who lent his interpretations to a particular cultural moment doesn't diminish the sophistication of his contributions. Rather, it opens room to examine his career as more than just a passive compilation of astronomical knowledge. In his writing on the emergence of international rocket societies in the 1930s, Asif Siddiqi points out that these organizations did critical work by "dressing science fiction in the language of modernity."[23] According to Siddiqi, rocket

20. Catherine Newell, *Destined for the Stars: Faith, the Future, and America's Final Frontier* (Pittsburg: The University of Pittsburgh Press, 2019).

21. Howard McCurdy, *Space and the American Imagination* (Baltimore: Johns Hopkins University Press, 1997).

22. *Chesley Bonestell: A Brush with the Future,* dir. Douglas M. Stewart Jr, (2018; Los Angeles: DMS Production Services, Inc, 2018) DVD.

23. Asif Siddiqi, "Making Spaceflight Modern: A Cultural History of the World's First Space Advocacy Group" (*Societal Impact of Spaceflight*, edited by Steven J. Dick and Roger Launius, Washington, D.C.: National Aeronautics and Space Administration Office of External Relations, History Division, 2007), Pg. 536.

societies lifted spaceflight from the realm of the fanciful by applying the principles of science and technology. This reworking made spaceflight seem plausible, and kickstarted a process that would ultimately conclude with the physical exploration of space. Bonestell served a similar purpose, but his contribution was visual and not literary. He borrowed images from science fiction and applied the visual language of cameras and film to make his views seem comparatively naturalistic.

Bonestell's biggest contribution to the visual culture of the early space age was the apparent photographic realism of his work.[24] Attributing the success of Bonestell's images to a faithful devotion to scientific accuracy glosses over their value as historical artefacts. His work was celebrated because it managed to look "real" at a time when realistic images of outer space were in demand. The mechanics of Bonestell's pictorial accuracy constituted a distinct form of professional visual expertise. And, just as we understand the development of linear perspective as a contribution to pictorial technology, we should understand Bonestell's work as a kind of image-based craftsmanship with its own epistemology. This is Bonestell's true value to the historiography of space science; his work made a largely unobservable topography legible to a broad audience. Just as Janet Vertesi and Lisa Messeri have pointed out how the extensive technological mediation of images of foreign planets necessitates human interpretation, Bonestell helped create a localized identity for the surfaces of other worlds. Visual representations of outer space often collapse the complex chain of human and machine collaboration essential to the visualization process. I argue that a critical examination of Bonestell's working process illuminates how his brand of scientific accuracy was legitimated, and functions as a useful record in the history of space as a legible realm.

II. The Creation of a Technical Credential

In 1958, an exhibition of Bonestell's work at the Stanford Research Institute described him as an architect, astronomer, and artist. "A native of the San Francisco Bay Area," the release continued, "his background in astronomy began when, at 10, he read Laplace's nebular hypothesis."[25] Appearing in several different press releases over the course of the 1960s, this was one of the stories often coaxed from Bonestell's prehistory to explain his later success as an astronomical artist. A similarly demonstrative biographical account that often circulated alongside Bonestell's work claimed that after seeing Saturn for the first time through the lens of a telescope at the Lick Observatory,

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24. The term "photographic realism" here is meant to denote the reading of a painting or illustration as photographic looking. I explain astronomical illustration's relationship to Photorealism, an artistic movement associated with the 1970s and 80s, in Chapter Two.

25. Many of the advertisements circulated for Bonestell's exhibits over the course of the 1960s included this anecdote about Laplace. One of Bonestell's biographical notes often included was signed by astronomer Robert S. Richardson, though the text was likely written by Bonestell himself. This is a great example of how Bonestell fashioned his own identity with help from people with professional scientific credentials. "Viking Press and Stanford Research Institute, 1958," Correspondence Series: Bill Estler, Box 16, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

the young artist was so moved that he immediately went home to paint its likeness.[26] These vignettes testified to Bonestell's lifelong devotion to astronomical subjects—and were dutifully incorporated into the mythology that emerged after his success as an astronomical illustrator. Even though Bonestell was never formally trained as an astronomer, this later biographical framing offered a life-history that validated his work as a trustworthy scientific image maker.

Because Bonestell's successes informed much of what was written about him in the second half of the twentieth century, it's difficult to view his early career independently of the reputation he cultivated as an astronomical illustrator. A closer look at Bonestell's early life makes clear he had an interest in art and representation that extended far beyond images of the cosmos. It also reveals a consistent desire to monetize his practice into a stable form of income. Examining how Bonestell's approach to art making was shaped by commercial viability helps explain his arrival at astronomical illustration in a way that skirts some of the mythology baked into his later biographies.[27]

By the time Chesley Bonestell arrived at the practice of astronomical illustration, he had cultivated two very full careers as both an architectural draftsman and Hollywood matte painter. For Bonestell's collaborators, that he was trained as an architect frequently served as a skill set commensurate with scientific training. They often emphasized that Bonestell's training in architecture enabled him to mathematize perspective and paint with a technical rigor that was, in their view, largely absent from impressionistic fine art practices popular at the time. While Bonestell's training helped his later framing as a human visualization tool, the reasons why he arrived at these practices were the products of historical contingency rather than a philosophical devotion to empirical representation. In this section I hope to demonstrate that Bonestell's contemporaries cherry-picked parts of his prehistory to craft a narrative about his professional life that was largely teleological.

Born in San Francisco on New Year's Day in 1888, the relationship between art and financial stability influenced Bonestell's trajectory from the very beginning. Chesley's grandfather, Louis H. Bonestell ran a wholesale paper company in San Francisco that sold paper to various stationery stores in the area.[28] Chesley was expected to learn the family trade but didn't enjoy the work and lacked enthusiasm for business. Much to the frustration of the elder Bonestell, Chesley began taking evening art classes at the Hopkins Institute on Nob Hill and participating in the Bohemian lifestyle of

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26. That Lick Observatory embarked on a campaign to draw in tourists in the 1910s is also never noted, instead suggesting that the young Bonestell was drawn to this institution purely by his own volition. "Lick Observatory 1894 and Undated," Posters and Illustrations 1835 – 1985, Box 76, Lick Observatory Records: Lick History. UA 36 Ser.8. University Archives, University Library, University of California, Santa Cruz.

27. For example, Bonestell was born in San Francisco in 1888. The earthquake and subsequent fire that tore through the city in 1906 destroyed all his earliest artworks. This gap in the pictorial record of his early life was seized on by his later biographers, who lamented the loss of the great artist's first space paintings. Miller and Durant, *The Art of Chesley Bonestell,* pg. 10.

28. Miller and Durant, *The Art of Chesley Bonestell,* pg. 12.

San Francisco.[29] Chesley wanted to make art his full-time job and began illustrating so-called tailpieces for *Sunset Magazine* while he was still living in the city.[30] However, his grandfather maintained a low opinion of artists and insisted that his grandson pursue a more respectable occupation. As a member of the Board of Trustees of the Unitarian Church, Louis Bonestell knew several prominent San Francisco architects, and considered architecture an appropriate alternative to the practice of fine art. In the end, this was an attractive compromise for both parties—Chesley later admitted he had a girlfriend who was planning to attend Boston Normal Arts School, and that for this reason he convinced his grandfather that the architecture program at Columbia University was the best in the country. Chesley reportedly also feared that the math classes at MIT would prove too difficult, and that Columbia felt a more suitable option.[31] Bonestell enrolled at Columbia in 1907, where he worked under Frank Dempster Sherman. Though Sherman is now best remembered for his poetry, the mathematized approach to perspective drawing that he championed while a professor at Columbia had a significant impact on Bonestell's career. While working with Sherman, Bonestell learned how to calculate visual perspective, and gave his later collaborators an element of personal history they could bill as a technical credential. Sherman, who Bonestell later described as both a "poet and mathematician," instructed his students in "perspective, shades and shadows and stereotomy."[32]

Bonestell's descriptions of his tutelage under Sherman frequently emphasized the rigorous mathematical difficulty of his approach to technical drawing. In one example, an anecdote later incorporated into the standard retelling of his early career, Bonestell was expected to demonstrate his mastery of perspective by drawing the reflection of a chair tilted against a mirror that was leaning against a wall at a different angle.[33] Despite the consistent emphasis on the mathematical dimensions of Bonestell's training, the visual aspects of architectural practice proved much more immediately useful. The math classes necessary to complete the architectural degree at Columbia eventually proved too difficult, and in 1910 Bonestell moved back to San Francisco to find work as an architectural draftsman.

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29. "Chesley Bonestell at Ninety-One." Pamphlet for exhibition held at the Palo Alto Medical Center, March, and April 1979. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

30. *Sunset* was a periodical headquartered in Oakland. Tailpieces were small drawings that would conclude an article or story that appeared in print. For his efforts, Bonestell was paid in railroad passes, which he eventually used to travel to Mount Hamilton to visit the refracting telescope at Lick Observatory. Miller and Durant, *The Art of Chesley Bonestell,* pg. 10.

31. Richard Reis and Alexander Bruan. "Beyond Our Time: Interview with Artist Chesley Bonestell" *The Mercury News,* San Jose, California. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

32. In technical drawing, stereotomy is the practice of turning three dimensional shapes into two dimensional representations. Ley, *The Conquest of Space,* pg. 11.

33. The example is listed in Willy Ley's introduction to the *Conquest of Space but* appears in many later descriptions of Bonestell's training. *Conquest of Space,* pg. 11.

By 1910, the parts of San Francisco destroyed in 1906 were not yet fully rebuilt.[34] The earthquake and fire that destroyed the city opened many opportunities in the field of architecture, and Bonestell had little trouble finding work upon his return to California. In 1911 Bonestell joined the American Institute of Architects, codifying his new professional identity as an architect. While Bonestell worked as a draftsman for several different San Francisco architects, his time with Willis Polk was most formative. Willis Polk was a prominent fixture in the city's architectural community, and Bonestell contributed to several well-known pieces of Bay Area architecture while a member of his firm. Bonestell produced renderings and designs for the Hobart Building and Insurance Exchange Building in downtown San Francisco, designs for the Filoli Estate in Woodside, and the road layouts at Pebble Beach that would eventually become 17 Mile Drive.[35] There were also personal projects; In 1914, Bonestell built a house for his childhood sweetheart Mary Hilton and their daughter Jane across the bay in Berkeley. The small family lived in Berkeley until Chesley and Mary's separation in 1918, when Bonestell moved to New York to work with several East Coast architects.[36] According to a later interview, New York was "the place to be" for architecture in 1918.[37]
When considered in the context of his later work, Bonestell's time as an architectural draftsman was the beginning of a much larger preoccupation with the visualization of non-observable structures. In the case of Bonestell's architectural drawings, the images he produced were intended to clearly picture the look of buildings that had not yet been constructed. The "realism" of these images was functional; in Willy Ley's later analysis of Bonestell's architectural work, the primary task of the draftsman was to convince prospective customers "that the architect will really build something for their money." This was a function that defined their future collaborations, and the production of otherwise unobservable views was a consistent thread that spanned the bulk of Bonestell's working life.[38]

Bonestell's time as an architect was critical for the cultivation of his later identity as a sort of image technician, but it was also contingent on a set of historical conditions.

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34. A letter from Hulda Bonestell, Chesley's third wife, to the wife of Edward J. Boxer Jr, says this explicitly. Of Polk's legacy, she wrote: "The earthquake and fire of 1906 offered Polk and other architects in San Francisco an unusual opportunity to construct or reconstruct many buildings, and quite a number of Polk buildings still stand…" Hulda Bonestell to Mrs. Edward J. Boxer Jr, May 23rd, 1979. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

35. The Filoli Estate became well-known in the 1980s, when it was selected as the primary filming location for the television series *Dynasty*. "Chesley Bonestell at Ninety-One," Palo Alto Medical Center, 1979.

36. Between 1918 and 1921, Bonestell worked with Bertram Goodhue on the construction of several buildings at the California Institute of Technology in Pasadena, collaborated on a mural with Rockwell Kent, and worked with Thomas Hastings on the construction of the Cunard Building in New York. "Chesley Bonestell at Ninety-One," Palo Alto Medical Center, 1979. pg. 2.

37. Irene Gaasch, "World Creator Chesley Bonestell" *The Carmel Pinecone,* April 21st, 1977. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

38. Ley, *Conquest of Space,* pg. 11.

His departure from Columbia coincided with a building boom in San Francisco that allowed him to return home and work as an artist while still generating a steady income. His separation from his first wife and relocation to New York also seemed to reflect a larger cultural moment—1918 marked the beginning of a new phase of Bonestell's life that harkened back to his youth as an artist in what he described as the bohemia of San Francisco. He left for New York to continue his work as an architectural draftsman, but only for a short while longer.

In 1922, Chesley met and married his second wife, a small-time English concert singer named Ruby Helder. Known on stage as the "the girl baritone" for her uniquely deep voice, Ruby convinced her new husband to relocate with her to Europe, where the two worked enough in their respective capacities as artists to support their travels.[39] Between 1922 and 1927, Ruby and Chesley split their time between London and Florence—Ruby performing in operas and Chesley producing commercial illustrations for various periodicals whenever possible. Despite the building boom that initially lured him to New York, Bonestell spent the next five years producing commercial illustrations and moving around Europe.[40]

Though the period that Bonestell spent in Europe is frequently glossed over when his career is recounted, it sheds a great deal of light on his attitudes towards commercial art and illustration. He spent the bulk of his time illustrating a range of subjects for the *Illustrated London News,* a swath of other London papers, candy advertisers, and the occasional restaurant.[41] As a result, the portfolio of subject matter he circulated professionally, expanded to include illustrations that weren't necessarily architectural. While many of the friends the Bonestells made while travelling in Europe believed that commercial illustration was beneath Chesley's talents as a painter, he countered that his "American" attitude preferred solvency.[42] Bonestell's indifference to the monetization of his work signaled a view of image-making that emphasized the practical and utilitarian over the conceptual.

This was part of a broader attitude towards fine art that would define Bonestell's relation to the art world for the bulk of his career. Even after his successes as an astronomical illustrator earned him a high degree of celebrity in communities of space enthusiasts, his work was rarely shown in fine art museums or galleries unrelated

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39. Ron Miller "Chesley Bonestell: The Fine Art of Space Travel" in Melvin Schuetz *Chesley Bonestell: A Space Art Chronology* (Universal Publishers, 1999), pg. xvi.

40. James Sweeny and Thecla Fabian. "Chesley Bonestell Exhibit Opens" *Spaceflight,* Vol. 23, 3, March 1981. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

41. Advertisement for Maison Lyons Turkish Delight, 1922 – 1936. Articles and Illustrations from Country Life Magazine, 1922 and 1926, Oversized Graphics Materials Series, Box 20, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

42. "I have to attribute this to my American aggression, as my friends seemed to feel it was better to maintain some sort of dignity than lose face peddling their wares around town, even if it kept them in financial bad health." "Chesley Bonestell, Space Artist" Personal Profile, *Spaceflight Magazine,* 1969. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

to astronomy or science. This was largely because of Bonestell's adherence to a style of representation that was largely unfashionable in the mid-twentieth century, but also because he actively disdained the type of non-representational work produced in contemporary art circles. In an interview given in 1977, he explained that his abstinence from the larger arts community was because he had "a very poor opinion of the modern artist."[43] Citing a man "who took his nude model and rolled her around in a paint soaked blanket and used the result as a painting," he explained that he thought most contemporary artists were "frauds who move in because they find they can make a mess of color."[44]

Bonestell's personal views on what counted as quality art or not greatly complicates how he himself is categorized. For his space enthusiast collaborators, he was an adept astronomical illustrator whose work was quality because it was faithful to its scientific subject matter; for them, this was what they meant when they described Bonestell as a "great artist," and the words "artist" and "illustrator" were not incompatible.

Openly disdainful of much contemporary art, Bonestell traced his approach to illustration through representational movements in western art history. He celebrated the pictorial clarity of painters like Diego Velasquez and Michelangelo, the latter especially since he was also a "good architect."[45] For Bonestell, good art was decidedly representational, and its quality could be measured by its expression of technical aptitude. "I believe that to be a good artist, you first have to be a good draftsman and a few of them are draftsman at all. They should be able to draw… But today's artists won't learn to draw. And, of course, the critics will talk a lot of double talk about what they see just to confuse the public."[46] While Bonestell's later collaborators considered him a great artist because of his apparent scientific fidelity, Bonestell himself thought of his work as consistent with the traditions established by canonical European painters. The contemporary art world of the 1940s however, likely wouldn't have considered Bonestell a fine artist at all. Rather, he was a commercial illustrator producing images that were largely derived from external reference material that—when compared to the conceptual art popular during the same period—contained little interpretive contribution. Bonestell's views of the art world anticipated the later views of Louis Meisel and the Photorealist painters of the 1980s, discussed further in Chapter Two.
Distinguishing Bonestell as either a fine artist *or* an illustrator is a fruitless task, but his categorization helps explain why his work was shown predominantly in science museums, and how he came to be understood as a sort of astronomer-artist constructing

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43. "Chesley Bonestell" *Mercury News,* May - June 1977. Biographical Series, Box 1, Interviews, 1977 – 1986, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

44. It's likely that Bonestell was referring to Yves Klein's 1960 work *Anthropométrie de l'Époque Bleue [Anthropometry of the Blue Period] (ANT 82)*. In the work, Klein used nude women as human paint-brushes to combine painting with performance art.

45. "Chesley Bonestell Interview (1983)," YouTube Video, 1:06:00/1:15:20, posted by John Mosley, January 19th, 2017. https://www.youtube.com/watch?v=aooXKr8VC4c

46. "Chesley Bonestell" *Mercury News,* May - June 1977, Bonestell LLC.

scientifically valid images. It also helps explain why his work has been largely ignored by the field of art history, despite recent efforts to better understand the visual culture of scientific disciplines.[47]

While traveling in Europe with his second wife, Bonestell encountered the work of Thomas Simeon Scriven Bolton, and by extension, the European practice of astronomical illustration. Bolton and Bonestell both worked as illustrators for the *Illustrated London News* in the 1920s, where Bolton, an amateur astronomer from Leeds, specialized in illustrations of the surface of the Moon. Though Bolton was employed at the publication as an illustrator, he was much more taken with the practice of astronomy. He set up a 10-inch reflector telescope next to his family home, and eventually upgraded to a 26-inch when they moved to Bramley. When compared to Bolton, who was a member of the Leeds Astronomical Society, the Royal Astronomical Society, and the British Astronomical Association, Bonestell's status as an amateur astronomer appears flimsy. Bolton actively participated in the astronomical community by publishing the observations he made with his personal telescope in a variety of journals.[48]

Bolton was employed at the *ILN* as an illustrator for fifteen years, and over that period circulated many drawings he made of his personal observations. An admirer of English amateur astronomer James Nasmyth, Bolton adapted a technique Nasmyth developed in the nineteenth-century to sharpen the accuracy of his lunar drawings. After making his telescope observations of the Moon's surface, Bolton built physical models of the topographical features he saw. Then, he would photograph the models, and use the photographs to inform the drawings he did of the lunar environment. Bonestell was impressed by the technique Bolton developed, but thought he lacked the draftsmanship necessary to execute a successful image.[49] Bonestell was by this point already familiar with the utility of model building in producing convincing images.

In 1917 he authored a segment on architectural rendering in a publication called *The Architect*. The article, which focused on the utility of black and white drawing on the production of clarity, makes no mention of mathematical calculations in the

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47. Additional studies on the investigation of the intersections of art, science, and visual perception include Pamela Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004); Barbara Maria Stafford, *Artful Science. Enlightenment, Entertainment, and the Eclipse of Visual Education* (Cambridge, MA: MIT Press, 1994); Paolo Rossi, *Philosophy, Technology, and the Arts in the Early Modern Era* (Harper & Row: 1970); Svetlana Alpers, *The Art of Describing: Dutch Art in the Seventeenth Century* (Chicago: University of Chicago Press, 1983); Jutta Schickore, *The Microscope and the Eye: A History of Reflections, 1740-1870* (Chicago: University of Chicago Press, 2007); Julia Voss, *Darwin's Pictures: Views of Evolutionary Theory, 1834 - 1874* (New Haven: Yale University Press, 2012); Michael Baxandall, *Patterns of Intention: On the Historical Explanation of Pictures*, (Oxford University Press: 1985); Catherine A. Jones and Peter Galison, *Picturing Science, Producing Art* (Routledge: 1998).

48. Davenhall, Clive. "The Space Art of Scriven Bolton." eds. Nicholas Campion and Rolf Sinclair, *Culture and Cosmos*, Vol. 16 nos. 1 and 2, 2012, pg. 385-392. www.CultureAndCosmos.org

49. Davenhall, Clive. "The Space Art of Scriven Bolton." http://www.cultureandcosmos.org/pdfs/16/Davenhall_INSAPVII_Scriven_Bolton.pdf

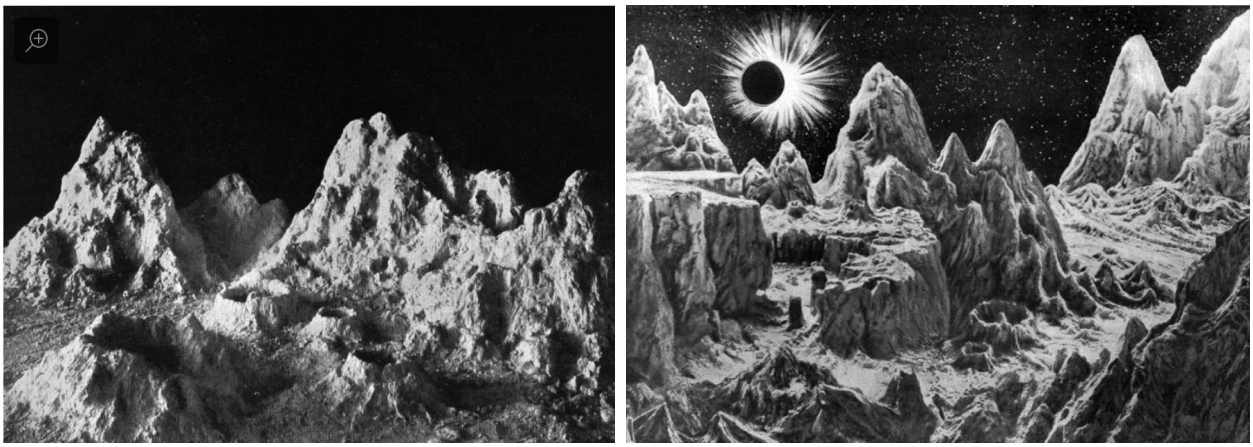

Figure 1.3— Left: Scriven Bolton's model of the lunar surface. Right: illustration of the lunar surface Bolton produced for the *Illustrated London News*.

cross-checking of accuracy. Instead, Bonestell emphasized the utility of model building in the production of realistic-looking images. Bonestell explained that the malleability of models built out of materials like plasterine, which wouldn't harden while the structure was still being formed, was invaluable for studying the designs of certain constructions. He also clarified that this was one was one way to ensure that the final drawing looked sufficiently life-like: "Not only is it convenient for studying, but it makes a most convincing illustration of the finished product, for by photographing it in the sunlight with the lens of the camera at the level of the would-be observer's eye, or, in other words, an inch and a half from the base line should the model be made at quarter scale, it is possible to get a very fine realistic effect."[50] The "realistic effect" Bonestell describes is achieved by generating visual reference material, not vetting the accuracy of a representation with mathematical calculations.

It's unclear if Bolton's working process inspired Bonestell to combine his interest in astronomical images with the process of model building, but it's undeniable that Bonestell's later models bore a striking resemblance to the ones Bolton constructed in the 1920s. One of the reasons why Bolton's working process likely isn't well-remembered when the story of astronomical illustration in the twentieth-century is recounted, is because he died in 1929 at forty-six years old.[51] His untimely death likely didn't affect Bonestell—in 1927, after five years in Europe, Bonestell and his wife Ruby were lured back to New York's bustling architectural firms to get in on "the huge building programme" then underway.

Bonestell's return to architecture was fruitful for the first few years. In the years between 1927 and 1930, he worked on several iconic buildings, including the Supreme

50. Chesley Bonestell, "Architectural Rendering: Part One: Black and White" *The Architect,* Vol. XIII, No. 3., March 1917. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

51. Bolton died on Christmas Day 1929 from complications related to influenza. Davenport, pg. 390. According to Ron Miller, a lecture series at the University of Leeds was established in Bolton's memory after his death. Miller, "The Forgotten Pioneer of Space Art." *Gizmodo,* 2013.

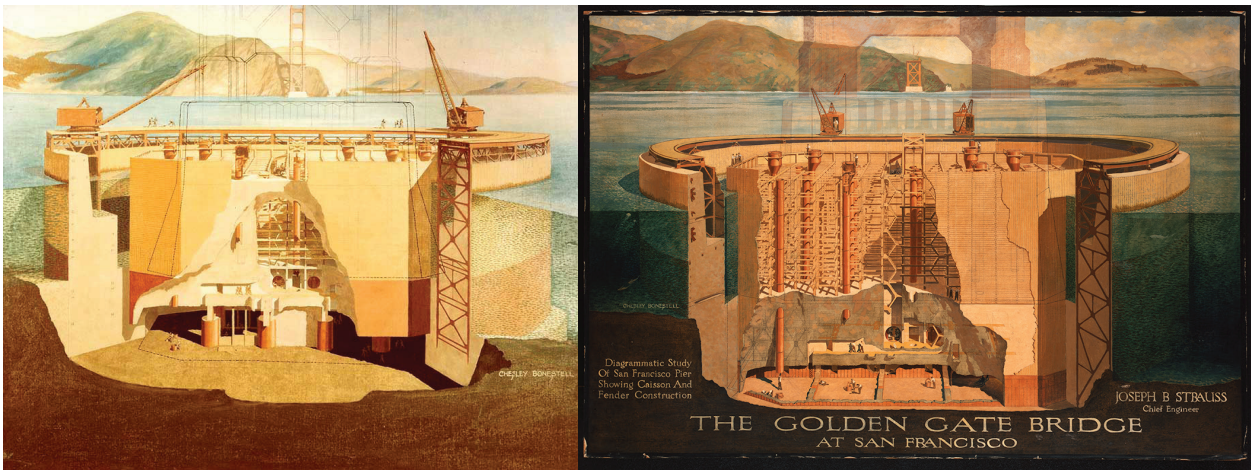

Figure 1.4— Bonestell's architectural drawing depicting the interior of the Golden Gate Bridge.

Court of the United States, the Biltmore Hotel in Los Angeles, and the Plymouth Rock Memorial established in Massachusetts. He also designed the four gargoyles that adorn the corners of the Chrysler Building in Manhattan.[52] Unfortunately, the steady stream of work did not last long. When the stock market crashed in October of 1929, the bottom quickly fell out of the industry that had kept Bonestell employed for the better part of two decades. The economic rupture prompted Bonestell to move back to California in 1931, where he worked odd jobs around San Francisco for roughly six years. While working on color schemes at the Opera House and Veteran's Building in San Francisco, Bonestell was approached by Joseph Strauss, the chief engineer overseeing the construction of the Golden Gate Bridge. According to Bonestell, Strauss "had trouble explaining to the directors (who were businessmen and could not read plans) how money allocated each month was to be spent."[53] Strauss hired Bonestell to draw cut-away sections showing how each portion of the bridge was to be constructed, giving viewers a clearer sense of the engineering's complexity. The line between functional and promotional was a thing one, and in 1939, Bonestell's experience illustrating the bridge led to work designing explicitly promotional materials for the Golden Gate International Exposition, held on Treasure Island through 1940.

Bonestell's illustrations of the Golden Gate Bridge were remarkably consistent with the types of work he would produce as an astronomical illustrator. Conceptually, the tasks were identical: use technical information to complete a view that was not otherwise physically observable. In the case of the bridge, this was because it had not yet been constructed. In the case of Bonestell's later space landscapes, it was because they were too remote to see. In both instances, Bonestell extrapolated a complete image from a set of technical parameters, deploying a pictorial style that made it appear as though

52. "Chesley Bonestell—A Chronology Prepared by Hulda von Neumayer Bonestell" in "Chesley Bonestell at 91," Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

53. "Chesley Bonestell, Space Artist" Personal Profile, *Spaceflight Magazine,* 1969. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

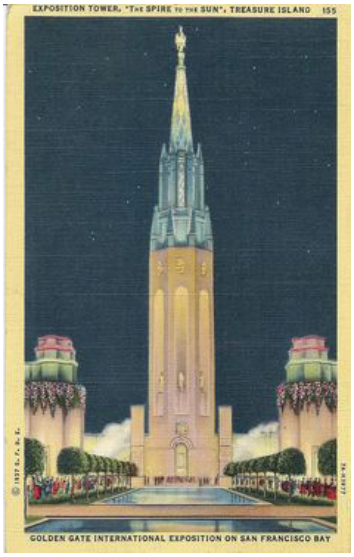

Figure 1.5— Bonestell's designs for the 1939 Golden Gate Exposition.

he had observed the scene himself. There was also the sense that Bonestell was acting as a sort of translator, turning difficult-to-understand technical information into easily legible images.

Even though Bonestell was able to secure meaningful work in the field of architecture at a time when the construction industry had largely ground to a halt, by the late 1930s he pivoted to a line of work that was well-funded despite the national economic Depression. He made the transition when William Van Alen, one of the architects Bonestell worked with in New York, visited California and suggested Bonestell move to Hollywood to work on motion pictures. Advancements in film technology and the establishment of a studio system contributed to the dynamism of the new medium, and by 1927 sound had been introduced to a previously silent format. The confluence of these elements made it a robust and visible industry in the 1930s, despite the floundering national economy. Van Alen, who oversaw Bonestell's work on the Chrysler building, wrote Bonestell a letter of introduction, and by 1937 Chesley had relocated to Hollywood to find work. By 1938, he'd secured employment with RKO Pictures as a special effects artist—or "matte painter" in industry language. The next year, Ruby Helder Bonestell, "the girl-tenor" died, and Chesley remarried his first wife, Mary Hilton Bonestell. This reportedly caused a rift with Van Alen, who objected to the speed with which Chesley remarried. The relationship between the two of them was reportedly never the same again.[54]

Despite this fact, Chesley was now comfortably installed in a new industry that was remarkably well-suited to his skill set. Just as Bonestell's architectural drafting hinged on the production of convincing illustrations of non-existent structures, his task as a matte painter was to manufacture views the film studio couldn't otherwise capture.

54. Chesley Bonestell to Bill Estler, February 11th, 1967. Correspondence Series: Bill Estler, Box 16, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

Matte painting was developed early in the history of the film industry to create the illusion of a particular environment or setting. Sets that were too large or too expensive to be constructed by movie studios were instead painted and combined with film to produce believable backdrops against which certain scenes could be filmed. Artists used thin layers of oil paint to create scenes on panes of glass or smooth-painted Masonite, and a camera would shoot actors through pieces that were left transparent. The layering of these painted foregrounds and backgrounds with live action footage created the illusion of a coherent plane on film. Matte painting required photographic realism to mimic the rest of the camera's footage and produce a continuous shot with live actors. A strong sense of perspective, a functional understanding of color, and a control of fine motor skills were needed to create sufficiently convincing landscapes.
Mark Cotta Vaz and Craig Barron have pointed out that matte painting was an "invisible art," because when it was carried out successfully, no one realized it was there.[55] Bonestell's training as a draftsman made it easy for him to master necessary techniques, and he was soon one of Hollywood's most in-demand special effects artists. His first film was Errol Flynn's *The Adventures of Robin Hood* (1938), quickly followed by *The Hunchback of Notre Dame* (1939). Bonestell's paintings of the hunchback seated on a gargoyle—not unlike the ones he designed for the Chrysler building some years prior— drew directly from his architectural training. Bonestell would later claim that he was the only painter at Warner Brothers who could paint Notre Dame. This was a skill he capitalized on frequently—in the 1949 adaptation of Ayn Rand's *The Fountainhead,* Bonestell designed many of fictional architect Howard Roark's buildings, and then executed the matte paintings that realized them. He was included in Byron Haskin's roster of top Hollywood matte artists and was soon making roughly $1,500 a week.[56]

While Bonestell's architectural training gave him a novel approach to matte painting, the technique in turn heightened his sensitivity to photographic-looking representations. While working in Hollywood, he learned how to apply camera angles to paintings, framing his landscapes so that the imagined viewer was gazing out at the vista at roughly a 40-degree angle. According to Bonestell, this was the angle that film cameras used to simulate the experience of looking out across a topography first-hand, making the views that appeared on-screen look more natural to the human eye. This was one of the pictorial techniques Bonestell applied to his later astronomical illustrations. It's likely that when viewers described his paintings of other planets as "realistic," they were remarking partially on Bonestell's ability to recreate what a camera would capture were it to land on a foreign planet. As with his early architectural drawings, the matte paintings Bonestell produced in Hollywood were a functional type of art, the success

55. Vaz, Mark Cotta, and Craig Barron, *The Invisible Art: The Legends of Movie Matte Painting* (San Francisco: Chronicle Books, 2002), pg. 22.

56. Byron Haskin was the head of special effects at Warner Brothers, and eventually went on to direct *War of the Worlds*. Vaz and Barron, *The Invisible Art,* 115. Chesley also reportedly turned most of his earnings over to a stockbroker friend who compiled a portfolio of blue-chip investments. According to Ron Miller, astronomer Robert S. Richardson recalled that Bonestell would accept assignments from educational institutions at a moderate price, but gouge commercial outfits—movie studios included. Miller and Durant, "*The Art of Chesley Bonestell,"* pg. 36.

Figure 1.6— Matte paintings for *The Swiss Family Robinson* (1940). Bonestell is shown with two of his paintings and a Mahl stick, used to stabalize the hand when working close to a painting's surface.

of which was contingent on his ability to seemingly "disappear" from the image. Brush strokes were carefully blended into the image, and the layers of paint on the smooth surface were kept as thin as possible.[57]

The purpose of Bonestell's work was to be illusionistic, and to convince his viewers that the subjects they were looking out on existed. Or at least that it was possible for them to be physically manifested. As a result, Bonestell and others like him often conceptualized of these images not as paintings, but as "problems," that needed to be solved with technique. There were learnable methods a painter could deploy to make his image simulate a real, physical view. This attitude was also something that Bonestell's later collaborators seized on and conflated with scientific rigor. For them, Bonestell's attention to the appearance of angles and distances between celestial subjects was evidence of the artist's commitment to astronomical principles. However, Bonestell's illustrations weren't realistic looking because he studied the science of astronomy, but

57. In an interview with *Spaceflight* magazine in 1969, Bonestell detailed some of the technical concerns relevant to the working artist. "The technique demanded of a matte artist calls for photographic realism. The paintings used are made on glass, smooth-painted masonite or mounted photographs, depending on the problem. Turpentine with about one-third linseed oil and a bit of drier is the medium and the dry the painting is sprayed with shellac and then delicate glaze applied, also stippled and blended. The wax in shellac turns yellow with age, so for permanent work the artist should avoid using it. There are other expensive spirit varnishes that will take a glaze. A fine sense of values, a knowledge of perspective and a good colour sense, as well as fine draftsmanship, are necessary to be successful in this work, and of course it, like the camera, must be in fine detail." "Chesley Bonestell, Space Artist" Personal Profile, *Spaceflight Magazine,* 1969. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

Figure 1.7— Matte painting used in *Citizen Kane* (1941). Everything included inside the red trapezoid is hand-painted, while everything outside of it—including Orson Welles' frame inside of the doorway—is live-action film footage. Bonestell's work as a matte painter was predicated on his ability to paint with photographic levels of resolution. His final paintings needed to look continuous with film footage of human actors if the desired illusion was to translate on-screen.

rather because he understood the techniques necessary for producing a convincing image on a two-dimensional plane.

Bonestell mastered mathematical perspective as an architectural draftsman and borrowed techniques from the Hollywood film industry to apply angles to his subjects that mirrored a naked-eye view. He also learned how to paint with oils in a way that looked continuous with film footage of human actors, opening the door for photography as a tool in the production of "realistic" looking illustrations. This specific skill set was critical to Bonestell's later success as an astronomical illustrator, but he'd learned how to manipulate his images while working as a commercial artist in fields entirely unrelated to the practice of astronomy. His collaborations with science writers over the course of the 1950s drew from conventions in astronomical illustration established a century prior, but his training as an architect, and later as a Hollywood matte painter, sharpened his sensitivity to mathematized perspective and photographic-looking surfaces. His ability to manufacture scenes that mimicked or extended what a camera could produce greatly impacted the perception of his later paintings as scientifically authoritative, while his training as an architect and his experience as a Hollywood matte painter functioned as a technical credential that science writers respected.

Because of Bonestell's instinct to obscure visible paint strokes and painterly interpretation, he was compared to a camera or other piece of impartial recording equipment. This photographic style of representation was coupled with the scientific authority of professional astronomers (or science popularizers, who were not necessarily

professional scientists), to produce images that were categorically different from those billed as science fiction. He didn't necessarily know more about astronomy than other painters, but he had a photographic style and technical credentials that served science popularizers and the arguments they were trying to make about the plausibility of spaceflight.

III: "America's Foremost Astronomical Illustrator"

In May of 1944, Chesley Bonestell published a set of illustrations that would set him on an entirely new professional trajectory. The illustrations, accompanying a brief article in *LIFE* magazine about Saturn and its various moons, showed the planet from the vantage point of its various satellites. Bonestell's views of Saturn were printed in color alongside a set of photographs taken by E.C. Slipher of Lowell Observatory in the years between 1912 and 1941. Slipher's photographs were arranged chronologically, highlighting the increase in clarity of the newer images. However, even the clearest of Slipher's photographs appeared blurry when compared to Bonestell's carefully rendered color paintings, which began on the next page. The effect suggested that the paintings were simply the next installment in the sequence of increasingly clear views of Saturn. The second of Bonestell's illustrations clearly used Slipher's 1941 photograph as a reference, lending the images in the article a sense of continuity.

Bonestell's paintings of Saturn greatly expanded on Slipher's photographs and were clearly influenced by his experience in the Hollywood special effects industry. By 1944, he was under contract with several different production studios, and enjoying the fruits of a well-established reputation. This was clearly the professional identity from which he was operating—the *LIFE* Magazine article billed him as a "Hollywood miniature set-designer and amateur astronomer."[58] The images themselves retained a cinematic quality, showing Saturn growing in the distance as though the viewer was approaching it by way of each of its moons. Bonestell later explained that his illustration of "travel" from satellite to satellite was inspired by the principles of camera angling he learned from film production. The angle of the painting was roughly 38 degrees, which Bonestell considered the angle of "normal human vision," and the angle at which a camera would capture a given view when pointed straight ahead.[59] His goal was to show Saturn "exactly as it would look, and at the same time [add] interest by showing inner satellites or outer ones on the far side of Saturn, as well as the planet itself in early phases."[60] In each illustration, the viewer is standing on the hard terrestrial surface of one of Saturn's satellites, gazing out at the planet as it looms over the horizon. This added a first-person narrative quality that Slipher's images lacked. Instead of a

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58. "Solar System," *LIFE* Magazine, May 29th, 1944, LIFE Magazine Online Archive, 1944 – 1949, Google Books, https://books.google.com/books/about/LIFE.html?id=N0EEAAAAMBAJ

59. "Chesley Bonestell Interview (1983)," YouTube Video, 27:23/1:15:20, posted by John Mosley. January 19th, 2017. https://www.youtube.com/watch?v=a0oXKr8VC4c

60. "Chesley Bonestell, Space Artist" Personal Profile, *Spaceflight Magazine,* 1969. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

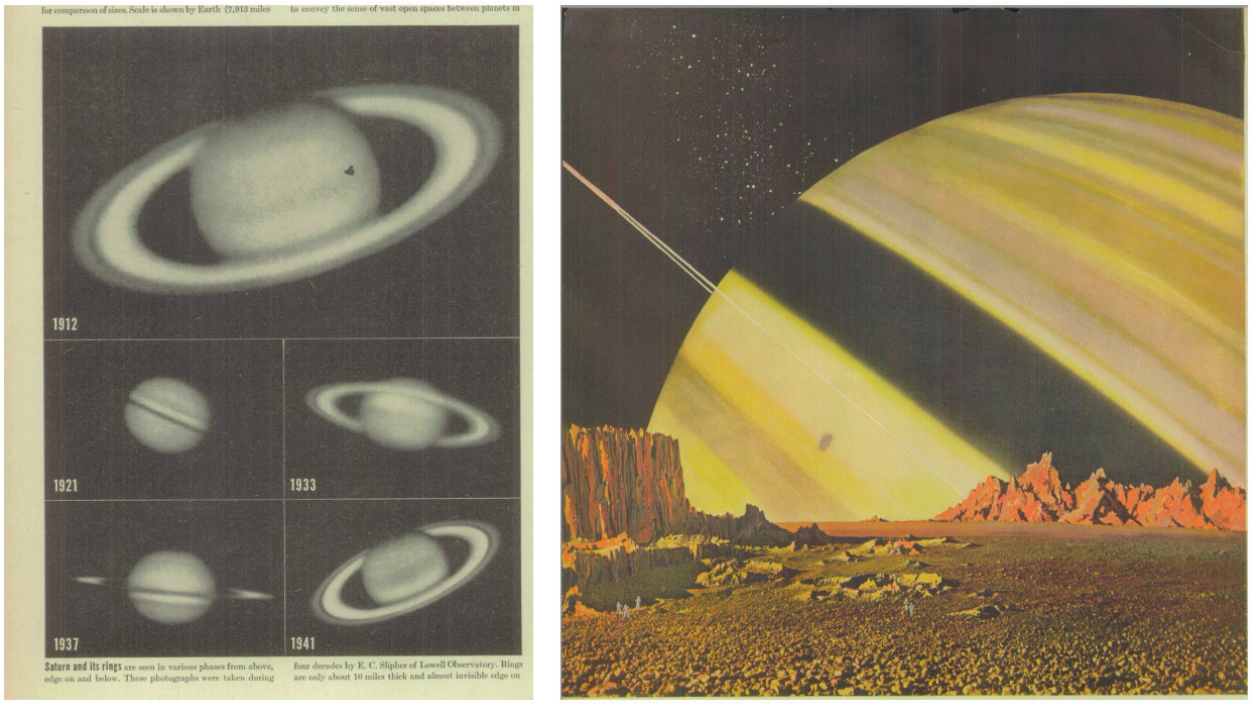


Figure 1.8— Left: E.C. Slipher's photograph's of Saturn, published in *LIFE Magazine*, 1944. Right: *Saturn as Seen from Mimas,* (1944). The caption printed in the original *LIFE* article pointed out for viewers that the shadow laying across Saturn's surface was cast by its rings. It also acknowledges the tiny figures Bonestell included in the foreground, but explained them as a functional part of the image: "Shadowy figures on Mimaas are purely imaginary, put in to give scale."

blurry telescope image, Bonestell's illustrations collapsed the chain of technological mediation to give viewers the sense that they were looking at Saturn directly. This visual context, which also scaled Saturn relative to its various satellites, offered much more in the way of an experience of Saturn, rather than a distant view. As Lisa Messeri has pointed out in her work on placemaking in contemporary exoplanet research, calibrating discrete data points into a coherent "picture" of a world is a serious conceptual challenge. How do you envision the experience of a truly alien world, if all the information you know exists at the scale of the planetary? Bonestell's views of Saturn included a first-person interpretation of the landscape that recalled photography, but that was not yet photographable.[61]

In addition to their cinematic narrative quality, Bonestell's illustrations also

61. Building on Daston and Galison's descriptions of mechanical objectivity as a late-nineteenth century product, Messeri points out that "as techniques and instruments have changed, the locus of objective measurement has transitioned from the astronomer's body (specifically his or her eye) to the increasingly mechanized telescope." This progression has informed the vocabulary of "seeing" stars and planets, even though our mechanical sensing capacities now extend far beyond the visible light spectrum. For contemporary space scientists, making sense of exoplanets in these new terms is often done through analogy—data about distant planets is compared to the more tangible example of Earth and its immediate neighbors. This is the process Messeri refers to as the work of "placemaking." Abstract data sets about a vast and distant subject are reworked into a comprehensible picture. Messeri, *Placing Outer Space: An Earthly Ethnography of Other Worlds* (Durham and London: Duke University Press, 2016), pg. 123.

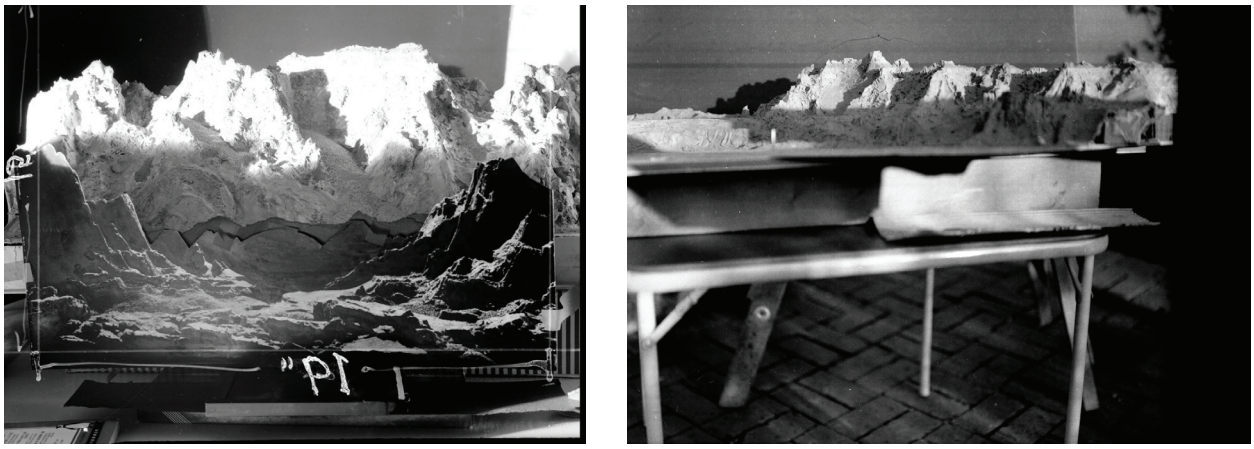


Figure 1.9— Left: image showing how Bonestell set up the photographs of his models. Right: one of Bonestell's model's sits on a table outside, using the sun as a light source to examine different shadows. Once his models were constructed, he'd photograph them with varying intensities of light, and then incorporate them into his paintings.

contained a level of fidelity not possible with the photographic techniques available to astronomers at midcentury. The images were immediately a huge success, and *LIFE* was reportedly inundated with requests for reprints. The clarity of Bonestell's images was striking to many, and his illustrations were frequently described as more "real-looking" than those already in circulation. This was because the images were real, in a sense, and not painted from imagination. Bonestell adopted Scriven Bolton's method of building physical models and photographing them to generate reference material. In this case, the constructed models stood in for distant celestial bodies. When incorporated into the final image, Bonestell's topographies appeared as though they were the product of direct on-site observation.

While Bonestell's approach to modeling the landscapes he illustrated was heavily informed by Scriven Bolton's methods, it was ultimately closer to Hollywood set building in practice. While Bolton—and, by extension, James Nasmyth's—process was contingent on naked eye observations of the lunar surface, Bonestell used the models he constructed to stand-in for the surfaces of completely different bodies. For instance, a strikingly similar model to the one Bonestell built to illustrate the surface of Iapetus in 1944 was used as a painting of the Moon in *The Conquest of Space* five years later. The exact same model reappeared in a painting used as the cover for *Fantasy and Science Fiction* magazine in November of 1954, and again in *Beyond the Solar System* (1964) as a view of the bright red supergiant Antares *[Figures 1.10 - 1.11].* This is a critical departure from the method Nasmyth and Bolton used—Bonestell's model landscapes weren't a tool for sharpening his own telescope observations, but rather a way to bolster the realism of a subject with no other available sources of reference material. In this way, his models of foreign stars and planets were much closer to the models he built as an architectural draftsman, combined with his training as a Hollywood matte painter. *Saturn as Seen from Titan,* produced for the 1944 *LIFE* Magazine article, became one of Bonestell's best-known images. Arguably the most famous work of astronomical art Bonestell ever produced, it came to be known as "the painting that

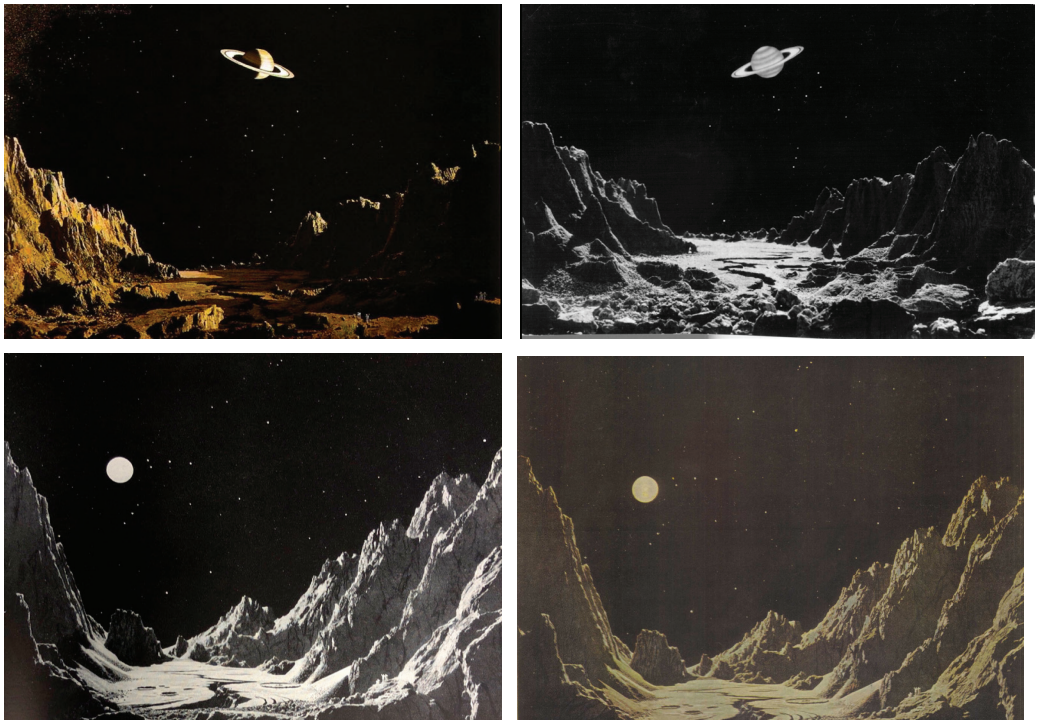


Figure 1.10— Top left: painting of Iapetus Bonestell circulated in LIFE Magazine in 1944, which incorporated a photograph of the reference model. Top right: the model Bonestell constructed, with a painted backdrop. Bottom left: nearly identical model used as the surface of the Moon for the 1946 article "Trip to the Moon." Printed again in *The Conquest of Space,* 1949.

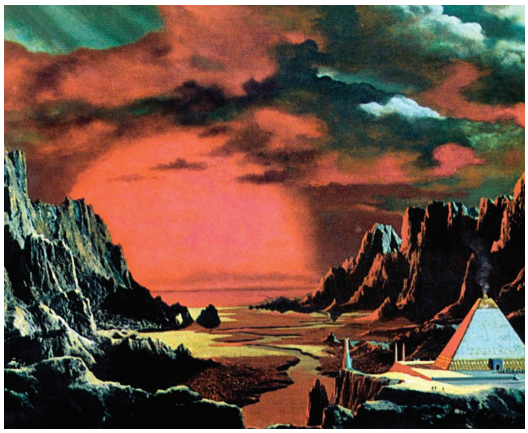
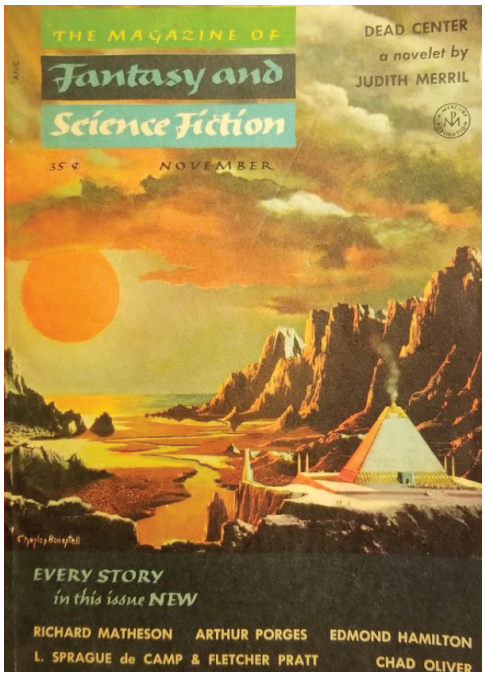


Figure 1.11— Left: model similar to the ones above used for a view of the supergiant Antares in *Beyond the Solar System*, 1964. Reproduced courtesy of Bonestell LLC. Right: a version of the same model appeared on the 1954 cover of *Fantasy and Science Fiction*.



launched a thousand careers" for its impact on budding space enthusiasts at a critical moment in the history of spaceflight.[62] When Bonestell's career is referred to today, *Saturn as Seen from Titan* is the image most commonly reproduced.[63]

That *Saturn as Seen from Titan* is most often coupled with retellings of Bonestell's career that emphasize his scientific accuracy is fascinating when considered in the context of his actual working process. The way Bonestell materialized the image was not very different from his earlier architectural or special effects work, and yet it is still frequently upheld as an example of scientific accuracy in illustration.

The original *Saturn as Seen from Titan,* like many of Bonestell's other works, was produced using a model and is technically a photomontage. Bonestell built the model of Titan from dirt dug up around his home in Los Angeles, photographed it from various angles, and painted the rest of the image over the printed photograph *[Figure 1.12]*.[64] The view of Saturn was likely informed by Slipher's photographs, but the physical landscape that framed it was largely imaginative. The painted portions of *Saturn as Seen from Titan* can be described as "photorealistic" because they intentionally mirrored the same level of pictorial resolution as film.[65] Many scholars have pointed out the way that the style of space landscape that Bonestell helped standardize is reminiscent of the pictorial trope of the American frontier—in this case, Bonestell's

62. Kim Poor, an astronomical artist and art dealer working in the 1980s, lent this title to Bonestell's painting. Poor was a member of the International Association of Astronomical Artists, which fashioned itself in the "Bonestellian" tradition. Poor referred to the painting's impact on his own profession, but also to the numerous scientists and engineers that cited Bonestell as an early catalyst for their interest in space. Ron Miller, "To Boldly Paint What No Man Has Painted Before," *Invention & Technology: The Magazine of Innovation,* Vol. 18, Issue 1, Summer 2002.

63. Bonestell recognized the popularity of the image immediately, and he repainted it several times over the course of his career. The original was given as a gift to Willy Ley and donated to the Adler Planetarium in Chicago upon Ley's death in 1969. Miller and Durant, "The Art of Chesley Bonestell," pg. 38.

64. Miller and Durant, "The Art of Chesley Bonestell," pg. 38.

65. "Photorealism" is a term that's often applied to Bonestell, but which can be confusing if not specified. In Bonestell's case, what's usually meant is that the way he painted certain subjects resembled a photographic output. His working process, however, was very different from the Photorealists, a school of painters that emerged in the 1980s. Bonestell's attempts to simulate photographic resolution was informed by his Hollywood training, which necessitated the imitation of film's pictorial qualities. The photorealists were guided by a different set of conceptual interests, but their commitment to the recreation of photographic views with paint is similar to some of Bonestell's visual concerns.

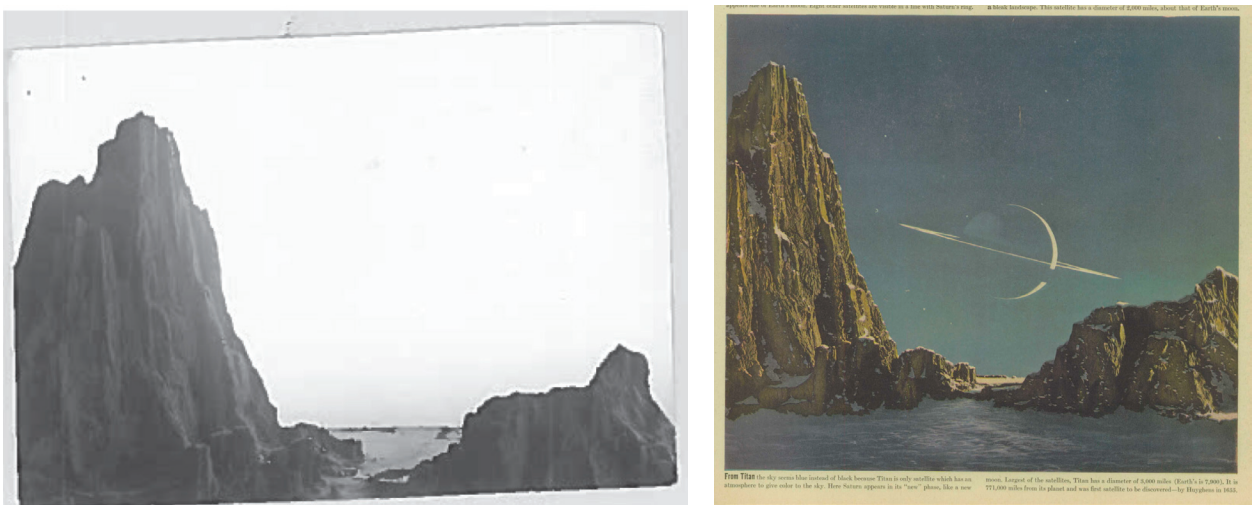


Figure 1.12— Left: the model Bonestell built for *Saturn as Seen from Titan*. Reproduced courtesy of Bonestell LLC. Right: the final photomontage, with the view of Saturn painted on top of the photograph of the model.

Titan is literally made from the same material as the American West.[66]

Later in his career, Bonestell's paintings of Saturn were heralded as his return to astronomy—rather than an arrival outright. In an interview conducted in 1983, Hulda Bonestell, Chesley's then-wife, clarified for interviewers that Chesley didn't "get to know many astronomers until he himself became known for his space art."[67] In the same interview, when asked which astronomers Chesley worked with over the course of his career, he stated that "Robert S. Richardson was the first." A letter from Robert S. Richardson to Fred Durant dated July 25th, 1980, stated that he and Chesley "became friends sometime in 1945, and continued steadily until his move from Altadena to Carmel."[68] The mid-1940s marked Bonestell's expansion into astronomy in a serious way, and the beginning of his collaborations with astronomers and observatories. It was

66. It's undeniable that the tradition of western landscape painting influenced the pictorial grammar to Bonestell's imagined environments. Elizabeth Kessler argues that the visual tropes of frontier expansion in the nineteenth-century gave Bonestell a visual formula for signaling to his audiences that these places needed to be explored; Catherine Newell maintains a similar interpretation, arguing that Bonestell channeled the religious fervor that fueled Manifest Destiny into a type of faith in the scientific process that would carry America to outer space. The material links between Bonestell's working process and the traditions of American landscape painting have been somewhat more difficult to locate. In a photograph of Bonestell's studio collected in his personal papers, a copy of *Keith: Old Masters of California* can be seen on a table. William Keith was a Scottish-American painter affiliated with the Barbizon school, who became well-known for his work on California missions. The photograph is undated, so it's unclear whether Bonestell sourced the book because of his own interest in California missions, or if Keith was a wider influence. Photographic Sleeve, Binder Series no. 8, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

67. "Chesley Bonestell Interview (1983)," YouTube Video, 17:20/1:15:20, posted by John Mosley. January 19th, 2017. https://www.youtube.com/watch?v=a00XKr8VC4c

68. "Robert S. Richardson, 1980 - 1984" Subject File Series, Box 5, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

Bonestell's work as a commercial illustrator that led him to the practice of astronomical illustration, not the practice of astronomy.

Bonestell's budding status as an astronomical illustrator was amplified in 1945, when he met science writer Willy Ley. Born in Berlin in 1906, Ley was a scientific polymath with a range of interests, but space exploration was chief among them.[69] The two were a timely match—in 1944, as Bonestell circulated his images of Saturn in *LIFE* Magazine right as Ley published *Rockets: The Future of Travel Beyond the Stratosphere Rockets*. The book coincided with V2 attacks on both London and Paris, and ultimately capitalized on a surging interest in rockets as a developing technology. Ley's *Rockets* quickly became a hit, going through twenty-one different printings and four revisions before 1968.[70] It's unclear how Bonestell and Ley were first connected, but their utility to each other was immediately apparent. Bonestell's striking images *looked* real and were fitting perfect accompaniment to Ley's claims that space travel was a real possibility. In September of 1945, Ley and Bonestell published what was the first of many collaborations, an article for *Mechanix Illustrated* titled "Rocket to the Moon"[71] The article explored the "ever-fascinating problem of space travel to the moon," examined "factually and scientifically by expert Willy Ley, and illustrated with full-color paintings by Chesley Bonestell." Ley was billed as a "Charter Member of British Interplanetary Society" while Bonestell was listed as "a noted Hollywood artist specializing in educational material."[72]

The *Mechanix Illustrated* article also emphasized that Bonestell collaborated with Mount Wilson Observatory in the production of his illustrations. It's unclear what kinds of materials Bonestell sourced from Mount Wilson, but there is evidence Bonestell began cultivating relationships with astronomical observatories after the publication of the 1944 *LIFE* Magazine illustrations. In 1949, Bonestell sent a letter to the director of the Lick Observatory C.D. Shane, asking for 8x10 glossy prints of Venus, Mars, and Jupiter: "Mt Wilson is in some sort of process of affiliating with Caltech and so for the present my usual source of such material is cut off."[73] Regardless of where the images Bonestell used came from, the fact that reference material he sourced could be cited as the product of an astronomical observatory helped bolster the scientific credibility of his illustrations. This, coupled with Ley's branding as a scientific expert,

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69. Jared Buss, *Willy Ley: Prophet of the Space Age* (Gainesville: University Press of Florida, 2017). Pg. 63.

70. Eugene Emme, "Space, Past and Future" Review of *Rockets, Missiles, and Men in Space,* by Willy Ley, *Science,* Vol. 161, No. 3844, August 30th, 1968. https://science.sciencemag.org/content/161/3844/874.1

71. "Personal Profile: Chesley Bonestell, Space Artist," *Spaceflight,* 83.

72. "Mechanix Illustrated, 1945 and 1947," Books and Periodicals Series, Box 26, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

73. On May 20th, 1949, Shane responded in the affirmative. "In view of your very great contributions towards stimulating public interest in astronomy, as well as your past favors towards us, there will be no charge." Subject File Series, Box 4, "Lick Observatory, 1946 – 2000," Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

helped make "Rocket to the Moon" seem more plausible. The article helped reframe rockets as a positive tool for scientific exploration in a new postwar moment, instead of as frightening wartime weapons. Ley and Bonestell's partnership would prove to be mutually beneficial; Ley schooled Bonestell on the basics of rocketry, while Bonestell was able to add a near-photographic dimension to the drawings Ley envisioned. The visual signaling of scientific verisimilitude was important to Ley because he wanted to distinguish rocketry from fictional depictions of spaceflight.

Willy Ley fled his native Germany for the United States in 1935 to resettle as a writer, but his primary interest was the use of rocketry for space travel. Hermann Oberth's 1923 *Die Rakete zu den Planetenräumen* was a significant influence, and Ley was fascinated by the book's suggestion that rockets could be used to reach outer space. He believed the science contained in the book was valid, but that the technical information it contained was inaccessible to a broad audience. Oberth's book generated a swell in publishing on the topic, prompting Ley to try to translate the ideas he found so compelling in a way that was more accessible. [74] In 1926 Ley published *Die Fahrt ins Weltall* (Travel in Outer Space), the first of many books attempting to sell a broader readership on the possibilities of rocket travel. He continued to cultivate his interests in rocketry over the course of the next decade, but the political stakes of the topic came to a head in 1933. After Hitler's rise to power, Ley was told he could no longer publish on the topic of rocketry outside of Germany.[75] This signaled an important geopolitical shift with lifelong ramifications for Ley; rocketry was developing quickly as a technology, but first as a weapon and secondarily as a means for exploration.[76] If the utility of the rocket as a scientific tool was to be fully realized, then the basic mechanics of space exploration needed to be explained. Only then would rocket travel be fully reclaimed from the genre of science fiction.

Ley left Germany, eventually settling in the United States, and churning out roughly one book a year until the 1970s. The *Mechanix Illustrated* article he produced with Chesley Bonestell article was a popular contribution to the type of space boosterism that was quickly becoming its own genre in the years following the conclusion of the war. There was a clear market for this type of material, and in 1946 Bonestell submitted a new set of illustrations to *LIFE* Magazine. These new paintings, a reprisal to the images of Saturn he circulated two years prior, clearly evidenced the impact of his new collaborator. The 1946 paintings were printed alongside an article titled "Trip to the Moon," and showed a manned rocket flying at a high altitude above the Earth. The rocket gets farther and farther away, eventually descending onto the lunar

74. Newell, *Destined for the Stars,* pg. 100

75. Newell, pg. 102

76. Ley was a member of the Nazi Party from 1925 to 1928, and there is evidence he generally supported they party's platform. While, as Jared Buss points out, it's difficult to judge the extent to which Ley was involved, there are intellectual continuities between his brand of scientific Romanticism and the German nationalism that underpinned movements within Naturphilosophie. Buss, *Willy Ley,* pg. 34 – 35.

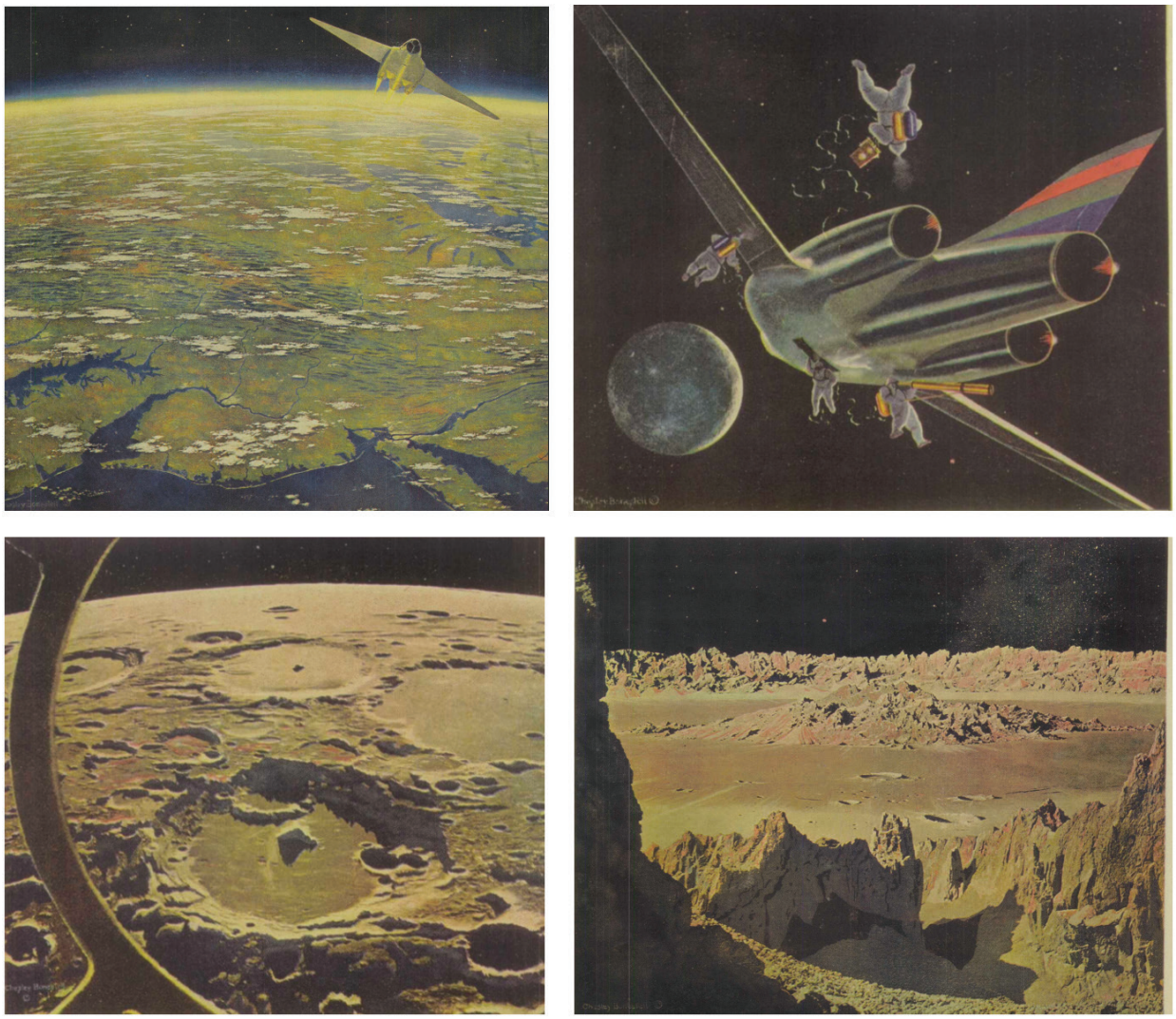

Figure 1.13— Illustrations circulated alongside the 1946 LIFE Magazine article "Trip to the Moon." As with the illustrations of Saturn Bonestell circulated two years prior, "Trip to the Moon" provided images that envisioned lunar travel. Reproduction courtesy of Bonestell LLC.

surface.[77] The illustrations featured cinematic "travel" just as his images of Saturn had, with each image getting sequentially closer to its far-off destination. The 1946 *LIFE* Magazine article still billed Bonestell as a "Hollywood Special effects artist and amateur astronomer," but this would only be the case for a short while longer.

By 1949, the contract Bonestell held with the various film studios he'd been working on—which included Fox, MGM, Warner Bros., and Columbia Pictures—expired. He continued painting space scenes for Paramount Pictures intermittently, but the bulk of his time was spent illustrating images for the space popularizers who were impressed by their photographic quality. In 1949, he and Ley published *The Conquest of Space,*

77. "Trip to the Moon," *LIFE* Magazine, April 3rd, 1946, LIFE Magazine Online Archive, 1944 – 1949, Google Books, https://books.google.com/books/about/LIFE.html?id=NoEEAAAAMBAJ

which reprinted many of the space paintings Bonestell had already circulated in various publications. The book combined well-known works of Bonestell's art with Ley's characteristic flavor of space boosterism in a publication more substantial than a magazine article.

Between 1944 and 1949, Bonestell's identity transitioned from Hollywood special effects artist to trustworthy astronomical illustrator, and by 1950, his status as an expert on the surfaces of alien worlds was mostly complete. The film industry played a significant role in this process. According to Fred Durant and Ron Miller, the 1945 *Mechanix Illustrated* article convinced movie producers Irving Block and Jack Rabin to make a film demonstrating the plausibility of manned spaceflight. Bonestell produced several storyboards for the film—which made sense considering he was a recognized Hollywood professional—but the project was abandoned when it became clear that George Pal was undertaking a project of the same subject.[78] Pal's film however, which materialized in 1950 as *Destination Moon,* would also rely heavily on Bonestell's unique category of expertise.

In what was likely the most remarkable act of reframing of Bonestell's career, he worked on the project as a "consultant on the lunar surface." Bonestell was brought onboard the project not as a special effects artist—which is exactly what he had been doing in Hollywood since 1938—but as an expert on the appearance of the lunar surface. As with Ley's efforts to sell space exploration as a real activity, George Pal wanted to market his film as distinct from works of science fiction by emphasizing its accuracy. By positioning Bonestell as a type of technical expert, and not an ordinary matte painter, Pal imbued the look of his film's moonscape with a higher level of authority. Robert Heinlein, a science fiction author well-known for combining fictional narratives with scientific principles, was also hired as a consultant to monitor the accuracy of film. Heinlein's descriptions of Bonestell did much to frame him as a technical expert with respect to astronomical subjects. Writing in *Astounding Science Fiction* after *Destination Moon's* release, Heinlein wrote that Mr. Bonestell knew "more about the surface appearance of the Moon than any other living man." Heinlein suggested the crater Aristarchus for the film's backdrop, but Bonestell vetoed this suggestion claiming that the shape and position of Harpalus was better. According to Bonestell, Harpalus's high northern latitude would allow the Earth to appear down near the horizon of the set's landscape, where the camera could pick it up. This was important, so that "Earth would appear in the conventional and recognizable schoolroom-globe attitude," and thus familiar to viewers.[79] Heinlein's descriptions of Bonestell's working process are remarkable, because they emphasize the technological rigor of his methods without tying any part of it back to the practice of astronomy. According to Heinlein, Bonestell began the visualization process by using a reference photo sourced from Mount Wilson to build a model of the crater on his dining room table out of plasticine, tissue paper, paint, and "anything at hand." The model was combined with other materials and

78. Miller and Durant, *The Art of Chesley Bonestell,* pg. 51.

79. Robert A. Heinlein, "Shooting Destination Moon" *Astounding Science Fiction,* July 1950, Subject File Series, Periodical Covers 1925 – 2002, Box 8, Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

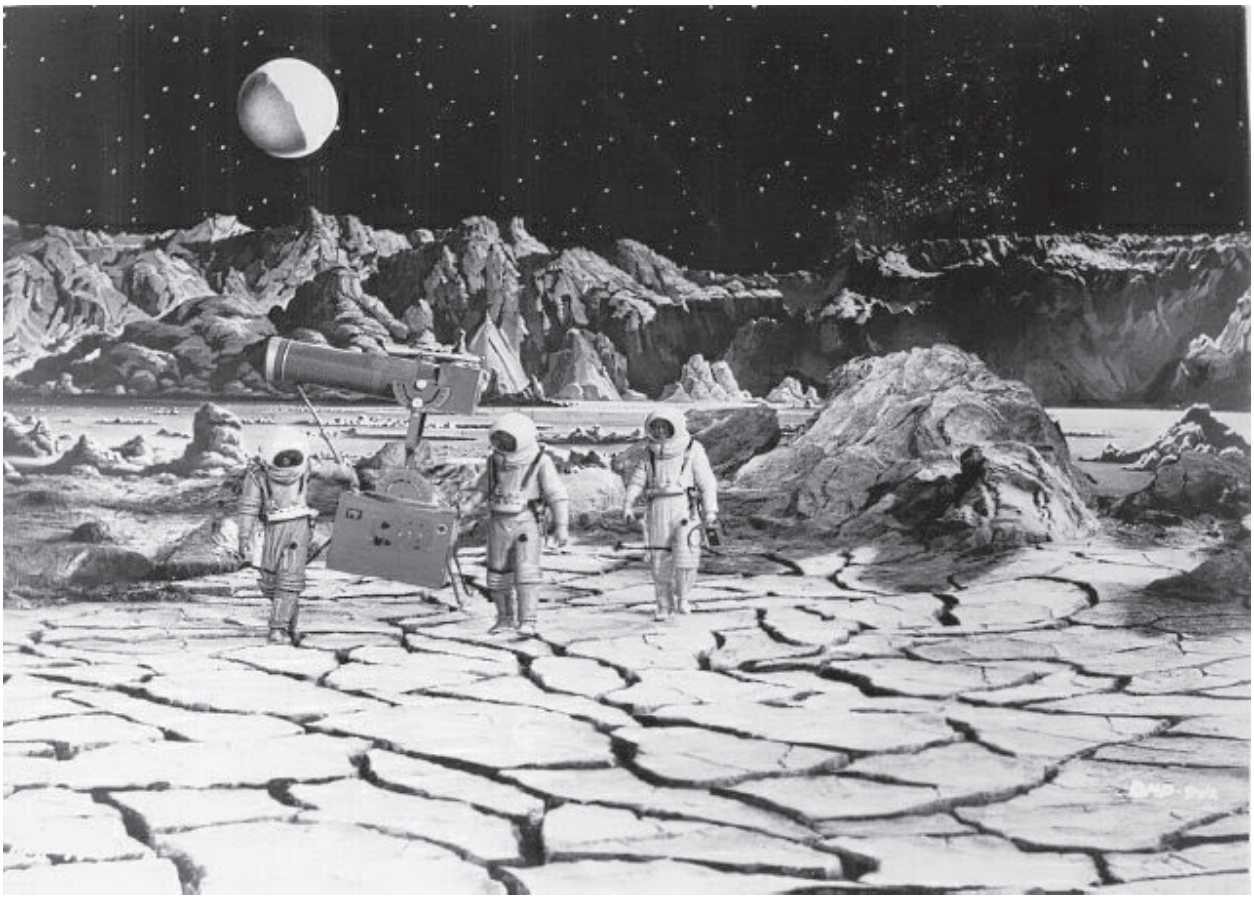

Figure 1.14— Set for George Pal's film Destination Moon, 1950. The dry lake bed effect was added to compensate for the size of the set. The dramatic foreshortening of the cracks made the mountains in the distance appear further away.

pinhole camera projections to produce blown-up views of the Moon that were then painted into a usable set.

Heinlein clarified that, even though the set was produced by the art department as a team of people, *Destination Moon's* lunar surface "looks like a Bonestell painting because it *is* a Bonestell painting—in the same sense that Michelangelo mural is still the work of a master even though a dozen of the master's pupils may have wielded the brushes." Heinlein's emphasis suggests that by 1950, Bonestell was famous enough that audience members would recognize his approach to space landscapes as "a Bonestell." It also combines Bonestell's status as technical expert and fine artist in a fascinating way; Heinlein emphasized Bonestell's model-building as part of an otherwise deeply rigorous materialization process that ensured that his view of the Moon was scientifically accurate. However, he also compared him to Michelangelo—creating an image of an artistic genius orchestrating the materialization of a vision only he could create. No mention is made in Heinlein's account of the fact that Bonestell's model-building was a borrowed technique that could be traced back through the history of astronomical visualization.

Chesley Bonestell's status as a space age booster further solidified in 1951, when Cornelius Ryan, assistant editor of *Collier's* magazine, asked him to

Figure 1.15— Photograph of (left to right) Rolf Klep, Willy Ley, Heinz Haber, Werner von Braun, Fred L. Whipple and Chesley Bonestell.

attend a conference convening in San Antonio on Medicine and Physics of the Upper Atmosphere. *Collier's* had recently started covering scientific breakthroughs and was interested in producing a spread on the plausibility of space exploration. The "Upper Atmosphere" the conference titled referred to was a euphemism designed to attract both military personnel as well as advocates of manned spaceflight. Wernher von Braun, the German rocket scientist who developed the V2 rocket in Peenemünde during World War Two, was now shepherding the U.S.'s intermediate-range ballistic missile program. In his biography of the von Braun, historian Michael Neufeld describes him as a twentieth-century Faust, bargaining with the devil for knowledge that would eventually carry mankind to outer space.[80] Von Braun was just as preoccupied as Ley with using rocket technology to reach the Moon, and quickly accepted Ryan's offer to participate in a *Collier's* publication. Von Braun's introduction to Bonestell would prove to be just as fruitful of a collaboration as his work with Willy Ley. For Bonestell, his affiliation with one of America's best-known men-of-science helped cement his reputation as more than just a commercial artist. By the end of the 1950s, Bonestell had become "America's Foremost Astronomical Illustrator," a category that hadn't existed in such terms the decade prior.[81]

In March of 1952, Collier's magazine launched an eight-part series detailing Wernher von Braun's plans for the future of manned spaceflight.[82] The series was

80. Michael J. Neufeld, *Von Braun: Dreamer of Space, Engineer of War* (New York: Vintage Books, 2008), pg.5.

81. "Panorama of the Moon," Press Release from the Boston Museum of Science, March 29th 1957, Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

82. Neufeld, *Von Braun*, pg. 259.

Figure 1.16— Covers of the *Collier's* series, started in 1952. Both covers on the left were painted by Chesley Bonestell. The cover on the right was painted by Fred Freedman, one of the other artists hired to help produce art for the series. Freedman's "cutaway" style was useful for showing the various components of hardware featured in the articles, and he later produced work for the NASA Artist's Cooperation Program.

designed for broad dissemination and aimed to capture the public's attention. Each installment consisted of several articles peppered throughout an issue of *Collier's,* each penned by a different expert. The first installment, titled, "Man Will Conquer Space Soon: Top Scientists Tell How in 15 Startling Pages," contained contributions from von Braun himself; fellow Operation Paperclip defector, Heinz Haber; the chair of the Harvard astronomy department Fred Whipple; then-UCLA physicist Joseph Kaplan, and Willy Ley. The art for the project was divided up between Chesley Bonestell, technical illustrator Rolf Klep, and "cutaway" artist Fred Freeman.

The eight-installment spread was wildly popular and inspired several other projects. Most immediately was Walt Disney's television programs, "Man in Space," "Man in the Moon," and "Mars and Beyond." Disney reportedly came across the *Collier's* collection on spaceflight and reached out to both Ley and von Braun. Von Braun and Haber ended up collaborating with Disney on the programming, appearing on-screen alongside animated explanations of rocket technology and the projected impacts of space on the human body. Eventually, the aesthetic cultivated over the three-episode installment would inform the physical design of Disney's Tomorrowland.[83]

While Bonestell never worked directly on the project Walt Disney materialized over the course of the 1950s, he helped shape the visual aesthetic Disney adopted and catapulted into mainstream visual culture. The rocket designs used in "Man in Space," and the sleek shapes that characterized Tomorrowland's brand of futurism were heavily influenced by von Braun and Bonestell's collaborations. After the *Collier's* series concluded, Bonestell, von Braun, and Ley went on to publish several books on the topic of space exploration with Viking Press. Bonestell himself became an in-demand fixture of space age consumerism, combining attractive images with the authority of scientific plausibility.

83. . Neufeld, *Von Braun,* pg. 285.

Figure 1.17— Reproductions of Bonestell's planetarium panoramas, produced for the Griffith Observatory. The hand-painted panoramas were printed on film and projected on top of the Zeiss starfield inside the planetarium's dome. The effect was an immersive experience that gave viewers the sensation they'd been transported to a distanct celestial body.

Bonestell's approach to the space landscape combined a near-photographic style of painting with a reputation legitimated by famous engineers, scientists, and science writers. In addition to commissions from publishing houses and films, Bonestell's work took on an educational flavor in the 1950s; his work could be coupled with pedagogical material related to space exploration, without diminishing its credibility as fanciful. This was especially useful for planetariums, which straddled the line between education and entertainment. Over the course of the 1950s, Bonestell was commissioned to produce several panoramas for different planetariums, including one at the Griffith Observatory in Los Angeles, and the Hayden in New York. Bonestell painted his landscapes on long pieces of illustration board, photographed them at an angle, and then planetarium staff would project the panoramas over the starfield of the planetarium's main projector. Audiences would then be given the sensation that they had been dropped right into the center of one of Bonestell's paintings—a space designed both to dazzle and instruct.

IV: Art Object or Scientific Image? A Lunar Case Study

In March of 1957, just eight months before the launch of *Sputnik I,* the Boston Museum of Science unveiled a sweeping new mural of the lunar surface. Installed in the Astronomical Exhibits lobby in front of the Hayden Planetarium, the painting enveloped viewers in a detailed ten by forty-foot recreation of the Moon's topography. Titled *A Lunar Landscape,* the mural was a fitting accompaniment to the other pedagogical objects on display: several illuminated transparencies donated by the wife of Percival

Lowell, and a 295lb iron meteorite from Arizona.[84] The mural was described to visitors as the product of careful astronomical calculation. A label on the wall next to the mural broke down the scientific information instantiated in the oil paint's smooth layers: an imagined spectator stands on the lunar surface at the top of an interior crater wall soaring 1,300 feet above the pit's floor, seven degrees from the moon's north pole, and five degrees to the left of the centerline of the earth-facing lunar disc. Thirty miles in the distance, the opposite wall of the crater can be made out against a jet-black sky—an observable consequence of the moon's thin atmosphere. The rest of the lunar horizon is illuminated by the glowing coin of the Earth's western hemisphere, sixty times as bright as the light from the full moon. In this snapshot of the lunar surface, it is 3:00PM on a summer day in Boston.[85]

Rather than existing in the museum as an anonymous scientific illustration—a typical convention in the display of scientific images—the mural was attributed to "America's Foremost Astronomical Illustrator," Chesley Bonestell.[86] The mural was the largest painting Bonestell ever produced, designed to immerse viewers in a simulated view of the Moon's surface. Painted at his studio in California, Bonestell created the mural in three large panels, and then flew to Boston for their installation. The panels were aligned and smoothed over by the artist once they were in place. Three smaller paintings by Bonestell were displayed alongside the mural. One painting of a double-star system, one of the planets in relation to the sun, and one demonstrating the lifespan of the Earth from its probable origin in a cloud of cosmic dust "to its probable dissolution" upon the death of our solar system's star.[87]

Despite all the efforts to signal the mural's grounding in astronomical knowledge, *A Lunar Landscape* marked the beginning of Bonestell's transition back into a fine artist. The launch of *Sputnik* accelerated the U.S. government's efforts to reach outer

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84. When *A Lunar Landscape* was installed in the Boston Science Museum, Bonestell's version of the Moon was understood to be a sufficiently rigorous one. The mural was considered a scientific object and displayed alongside other scientific objects in an exhibit on astronomy intended to educate the public about the field. It featured moon craters, the moon at last quarter, Halley's Comet, the world's largest telescope at Palomar, the Great Spiral Galaxy in Andromeda, star spectra, etc., and a 295lb iron meteorite from Arizona. "Panorama of the Moon," Press Release from the Boston Museum of Science, March 29th 1957, Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

85. The curatorial label displayed next to the mural noted: "The time is toward the end of June on the Earth---which can be seen in the sky above the lunar horizon. The Earth's western hemisphere faces the Moon and it is 3PM in Boston." Museum visitorship often increased in the summer months. It's possible this configuration was chosen with summer visitors in mind. *A Lunar Landscape by Chesley Bonestell.* Museum label, Boston Museum of Science, posted 1957. Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

86. Panorama of the Moon," Press Release from the Boston Museum of Science, March 29th 1957, Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

87. "Panorama of the Moon," Press Release from the Boston Museum of Science, March 29th 1957, Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

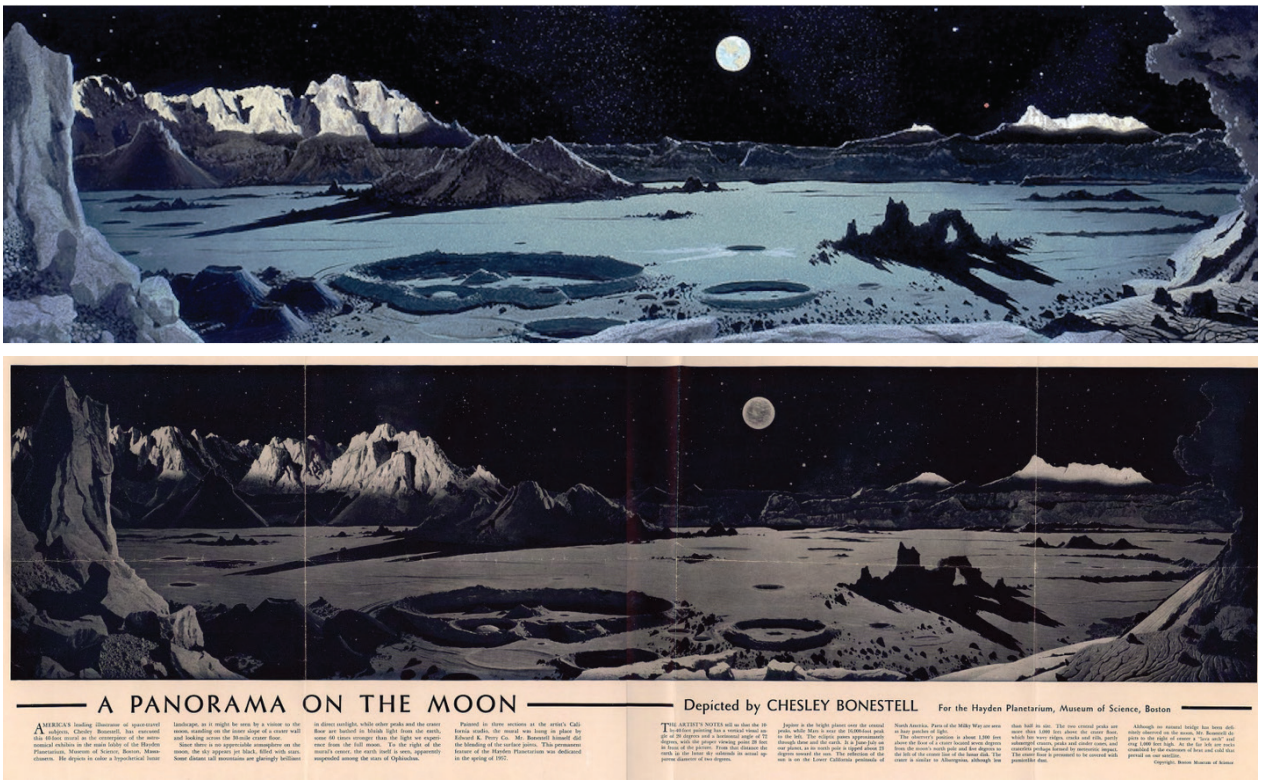

Figure 1.18— Top: study produced for the mural, which was painted in three large panels and then shipped from California to Boston. Bottom: photograph of the mural circulated in a newspaper article about its installation.

space, culminating in 1963 into a decision to visit the lunar surface. In 1957, *A Lunar Landscape* functioned as an object of science—by 1969, the first-hand view Bonestell created could be cross-checked with photographs taken by Apollo astronauts. The differences between the two views prompted a recategorization of Bonestell's mural as an art object with historical significance.

The history of *A Lunar Landscape* demonstrates the extent to which the authority of Bonestell's illustrations was socially constructed. Bonestell helped shaping of the "look" of space landscapes in the 1950s hinged on his new status as an expert. His work was not circulated as an artist's conception, but rather as an informed view of astronomical subjects. As a result, his work served as reference material for others who wanted to illustrate outer space "realistically." *A Lunar Landscape* was remarkably like the lunar panorama Bonestell produced for George Pal's 1950 film *Destination Moon*—where he was billed as an "expert on the lunar surface." Between 1950 and 1957, Bonestell painted the surface of the Moon several times for planetariums around the country—but the version of it he painted was largely the same. While Bonestell's pre-Apollo conception of the Moon changed very little in the years between 1946 and 1957, the image's conceivability increased with his rising popularity. By the time Apollo photography finally countered Bonestell's illustrations, it was lamented by his

Figure 1.19— Left: portion of the mural where Bonestell included evidence of volcanic formation. Right: a photograph of the same volcanic process, as it manifests itself on Earth. Iceland, 1977. Photo courtesy of Ron Miller.

proponents that his view was what the Moon "ought to look like."[88] That the Moon's less dramatic topography was seen as a slight disappointment reveals the nostalgic attachment many developed to Bonestell's style.

The photographs produced by Apollo 11 astronauts in 1969 offered a first-hand account of the lunar surface that countered the dramatic topography Bonestell described in *A Lunar Landscape*. Rather than confirm Bonestell's high-drama version, Apollo 11 photographs revealed a lunar landscape that was largely flat and only occasionally punctuated by sloping hills. The contrast was stark; Bonestell included mountain ranges in his mural with peaks as high as 16,000 feet, along with many examples of volcanic activity.[89] However, the moon's topography wasn't a completely foreign sight by 1969. NASA's Lunar Orbiter and the Apollo 8 mission sent back images of the lunar surface that added detail to the telescopic images astronomers were already familiar with. However, these images were still taken at a distance, and it wasn't until Apollo 11 provided viewers with images of the moon's surface from the ground. In an

88. Chesley Bonestell to Frederick C. Durant III, letter dated May 20th, 1976. Chesley mentions a letter he'd received two years prior from Brad Washburn, director of the Boston Museum of Science: "'I know they took it down from the wall of the Planetarium entrance hall at Boston after the astronauts landed. Brad Washburn wrote me about two years ago saying it might go to your museum, and promised to keep in touch, but I haven't heard from him. 'Now historic' he called the mural, and said the moon OUGHT to look like that and he couldn't understand why it didn't." Bonestell Folder, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

89. There are mountains on the moon taller than this, but they don't occur with the frequency Bonestell predicted. Mons Hugyens (mon is the latin word for single mountain) is roughly 18,000 feet high. It was named by the IAU in 1961. Bonestell expressed his surprise that the surface of the moon wasn't covered in dramatic mountain peaks, but soft rolling hills— "like the Berkeley Hills"—after all. Miller and Durant, *Worlds Beyond*, pg. 12.

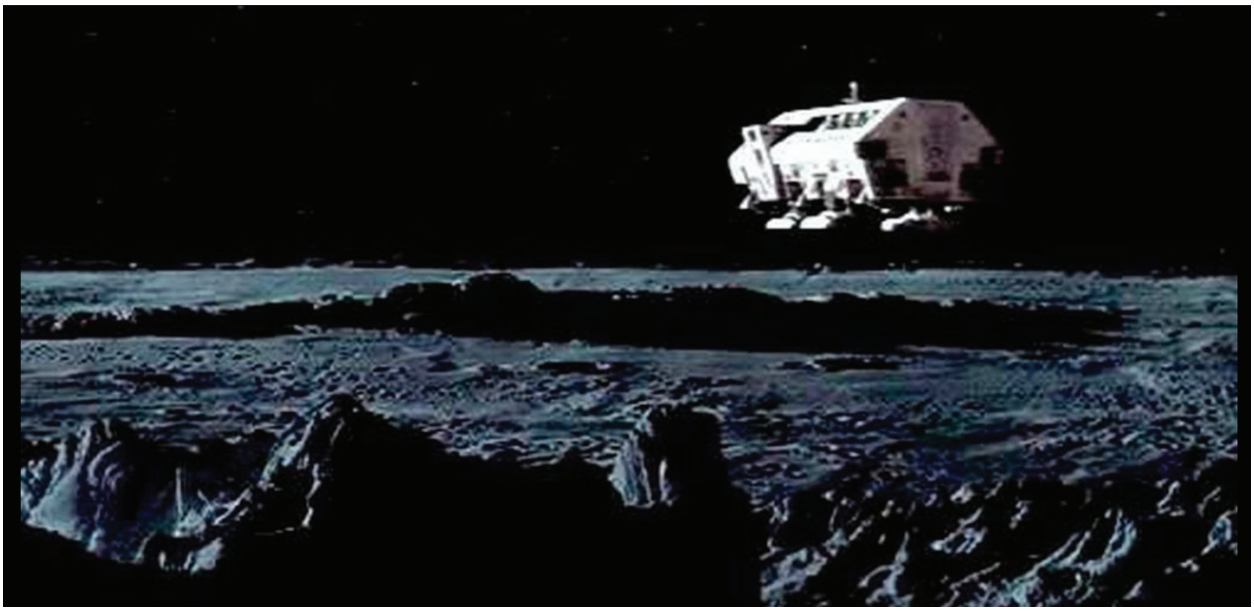

Figure 1.20— The Moon Bus, as shown in Stanley Kubrick's *2001: A Space Odyssey* (1968). According to Douglas Trumbull, one of the special effects artists employed on the set, Kubrick wanted a dramatic "Bonestellian" moon, over one that featured softly rolling hills.

interview about Bonestell's impact on popular conceptions of the lunar surface, Douglas Trumbull, a special effects artist who worked on *2001: A Space Odyssey,* recounted Stanley Kubrick's deliberations on what the lunar surface should look like. According to Turnbull, Kubrick actively rejected the inclusion of softly rolling hills in favor of Bonestell's more pointed ones—even though the smoother topography was likely to be the more accurate.[90] Even by 1968, Bonestell's version of the moon was still the one that looked most identifiably as "the lunar surface," more so than the mechanically produced photographs taken by NASA orbiters.

This was most likely because NASA's Orbiter images were black and white, and individual photographs needed to be overlapped if they were to read as a coherent landscape. The result was an image that still resembled an abstract artwork that a photograph of a legible topography. More importantly, they lacked the firsthand perspective that Bonestell so consciously lent his landscapes. The "38-degree angle" he applied to his illustrations were meant to simulate normal human vision—a trick he picked up from Hollywood camera angling—that created the sense that one was looking out across the landscape themselves. The Orbiter photos lacked the same degree of legibility.

In July of 1969 however, Neil Armstrong and Buzz Aldrin snapped photographs of the lunar surface that didn't need to reconstruct the pictorial conventions of first-hand observation. The photographs they took showed the surface of the moon, scaled to the human observer exploring its surface in actuality. This posed a unique problem for the Boston Science Museum; Bonestell was at the height of his repute as a working

90. This is peculiar considering Kubrick's preoccupation with the scientific accuracy of the representations of spaceflight in 2001. Kubrick's appeals to scientific expertise are detailed in David Kirby's book *Lab Coats in Hollywood: Science, Scientists, and Cinema* (Cambridge: MIT Press, 2011), Chapter One.

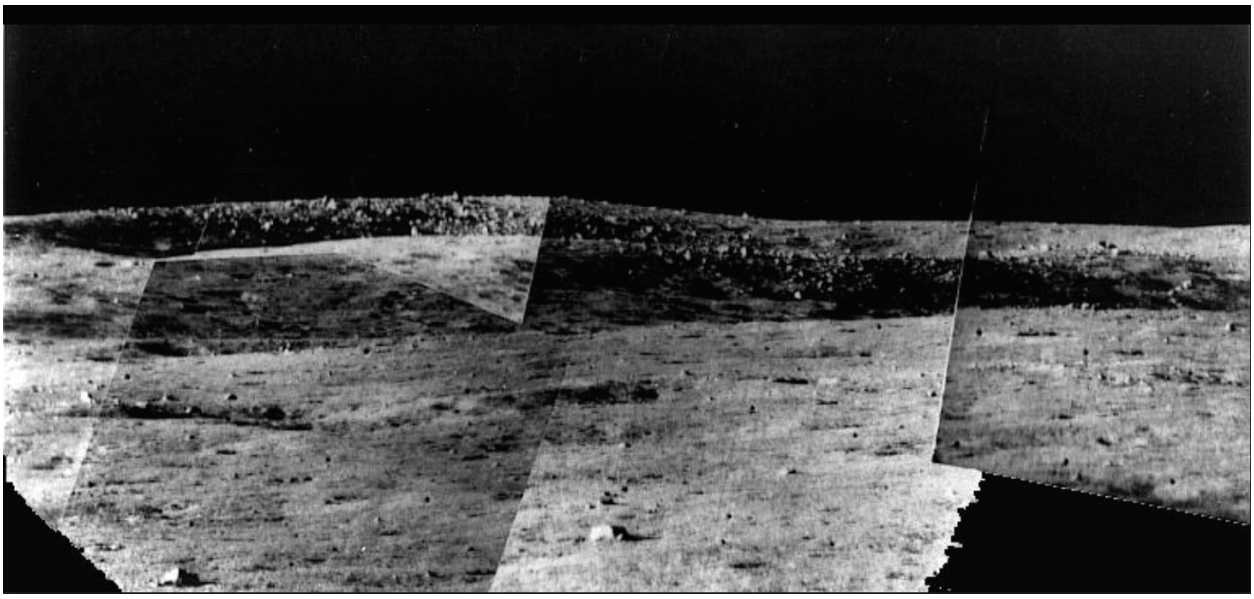

Figure 1.21— Image of the lunar surface produced by Surveyor 6, 1967. Kubrick would have had access to images that displayed the surface of the moon more accurately, but he still chose to feature a craggy moon—much more similar to the way Bonestell painted it throughout the 1950s.

astronomical artist when he painted the mural, and at 10 by 40 feet it was without question the largest of his astronomical paintings. Because of the mural's significance, museum staff was unsure what to do with it once it could no longer be hung as a scientifically authoritative view of space.

In 1970, just a year after the Apollo 11 moon landing, *A Lunar Landscape* was removed from the wall inside the Boston Museum of Science and replaced with Apollo mission photography. That same year, Roman Romach the museum's Curator of Collections, explained that "the mural was removed from exhibition in 1970 because it was felt that it did not represent the moon's surface accurately enough."[91] The museum tried to sell the mural, but when that proved unsuccessful, donated it to the Smithsonian's new Air and Space Museum.

In a coincidence that borders on the symbolic, Michael Collins—the Apollo 11 astronaut who piloted *Columbia* while Armstrong and Aldrin explored the lunar surface—was appointed the new Air and Space Museum's director. In March of 1976, Bradford Washington, Director of the Boston Museum of Science, wrote to Collins about the donation of the mural: "Based on our knowledge of the moon at the time, the mural was an outstanding exhibit. When you and your colleagues went to the moon, however, and we all learned what the surface really looks like, the Museum felt an obligation to remove the mural from display."[92]

The Air and Space Museum, which was about to open on the National Mall for

91. Roman Romach to Michael Collins, October 29th, 1975. "Moon Mural Acquisition," Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

92. Bradford Washington to Michael Collins, March 4th, 1976, "Moon Mural Acquisition," Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

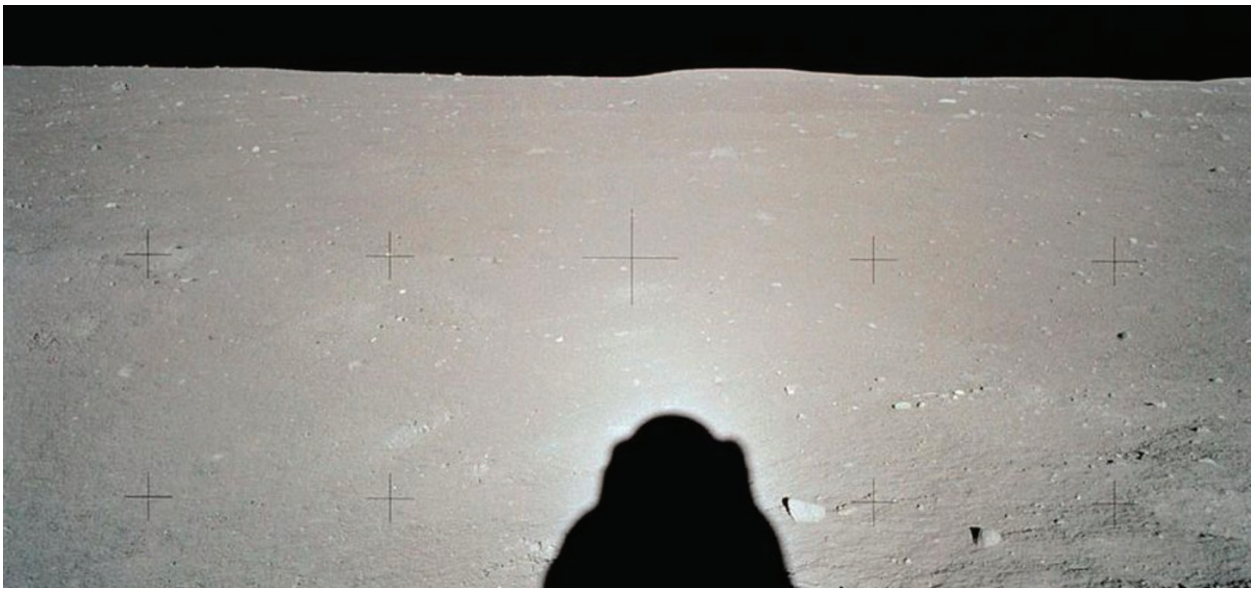

Figure 1.22— Buzz Aldrin's shadow on the lunar surface, 1969. The photographs produced by the Apollo 11 astronauts added a human dimension to photographs of an otherwise alien body. Viewers were given a visual scaled to human perception—an element that Bonestell needed to simulate in his illustrations over the course of his career.

the nation's bicentennial, accepted the mural but couldn't install it because of the large restoration costs. When the mural was installed in the Boston Science Museum, it was done so in panels and then the visible joints were smoothed over with paint. It was badly damaged in the deinstallation process and estimates to repair it were judged to be too costly to justify before the museum's opening. Aside from the mural's condition, curators at the Air and Space Museum shared some of the Boston Science Museum's apprehensions about displaying an image that presented a view of the moon that had been shown to be inaccurate. An internal museum memorandum circulated in 1980 on where the mural could possibly be shown concluded: "the best case would be as near to the Art Gallery as possible… The issue has also been raised that were it put on display in a non-art environment that the visitor could construe this depiction as reality as opposed to something rendered in the 50's."[93]

What was billed as a scientific image in 1957 was no longer by 1976, and the National Air and Space Museum was reluctant to display the mural in a "non-art" environment. Another suggestion, for "the most logical and perhaps the only place to display it" was on the wall behind the museum's lunar lander. However, "since most visitors approaching the Lander would perceive this painting as our attempt to depict the lunar landscape, we would need to disclaim this by explaining it is actually an artist's 'pre-space' interpretation. Although this would not be hard to do, it puts us in the position of prominently displaying a rather mediocre, inaccurate painting, and

93. Bill Good to Noel Hinners through Walt Boyne and Ed Bedno, "Concerning: Bonestell mural," December 3rd, 1980, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

then explaining why it is a mediocre, inaccurate painting."[94] The labeling of Bonestell's painting as "mediocre" was a value judgement made in the same spirit as earlier celebrations of him as a great artist. It referred less to the painting's execution or merit as an art object, and more to Bonestell's earlier successes with a particular type of pictorial realism. When his paintings were finally proven to be speculative—by visiting the celestial body in question—they could less easily be described as "real-looking." Despite Bonestell's acknowledged significance to the history of the early space age, it was determined that the mural would not be restored and displayed.[95]

The fate of *A Lunar Landscape* demonstrates the shortcomings of conventions that legitimized astronomical art as scientifically authoritative. In 1957 Bonestell's pre-Apollo images had nothing to be compared to, and so from a scientific vantage point, were as well-informed as possible. By 1969, the Apollo astronauts had experienced the surface of the moon first-hand, and the photographs documenting their experience showed a flat lunar landscape that looked very different from the dramatic mountain peaks peppered throughout Bonestell's mural. The Boston Science Museum mural was a tangible casualty of readjusting bodies of information, plainly revealing the ways in which knowledge gaps were filled in via extrapolation and legitimated through social channels.[96]

Bonestell's interpretation of the lunar surface was obviated by first-hand experiences of the moon. This is what makes it such an interesting case study in the larger context of his body of work as an astronomical illustrator—none of his other views of the solar system have been traversed by human astronauts capable of generating visual material in the first-person. Most of the illustrations Bonestell created are still too remote to be observed by the unaided human eye, and at times are still discussed as scientifically plausible.[97]

Bonestell was not a machine compiling astronomical data into a mirror of the cosmos, but like a forensic artist translating known features of a suspect's face into a coherent portrait. In the case of forensic art, the success of each depiction can only be

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94. Ed Bedno to Noel Hinners, Bill Good. "Subject: Disposition of Bonestell Mural," February 12th, 1981, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

95. However, this is no longer the case. The mural has been fully restored and is now in display in the National Air and Space Museum's *Destination Moon* gallery, chronicling the history of Project Apollo.

96. In 1982, the museum received a request from Frank Awbrey, a professor of biology at San Diego State University. Awbrey was working on an article for a journal that published critiques of creationism and was interested in *A Lunar Landscape* as an image that typified what the moon was believed to look like in the 1950s. "I have found this to be very effective for people who do not understand radiometric dating. Everyone can see the difference between what scientists thought the moon would look like and how it really does look. Most also understand how old the moon must be for its surface to be so eroded by micrometeorites and charged particles of the solar wind." In this instance, Bonestell's mural was determined to be a useful historical artefact as opposed to just a significant one. Frank T Awbrey to Bill Good. April 8th, 1983, "Moon Mural Acquisition," Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

97. The 2018 documentary, *A Brush with the Future,* suggests to viewers that Bonestell accurately predicted the look of Pluto.

judged when the suspect is apprehended and observed directly. To apply the analogy to Bonestell, in 1969 his subject—in this case, the lunar surface—was "apprehended" when astronauts produced photographs of the lunar surface. Bonestell's paintings deployed a. Like our hypothetical police sketch artist, Bonestell didn't know any more about a given suspect's face than other working artists, but he was considered by his contemporaries to be the best at producing convincing faces overall.

Considering Chesley Bonestell's body of astronomical illustrations as relevant documents in the history of objectivity opens a new set of questions. If Bonestell's working process as an astronomical illustrator was virtually the same as his earlier draftsmanship, why aren't the images he produced over the course of his first two careers understood as "scientific"? The answer has been skewed by the way Bonestell is typically remembered—which often borrows the language of his contemporaries. To date, the most rigorous accounts of his career have been produced by other space artists who situate their own work in a "Bonestellian" tradition, and collectors who recognize him as the father of the genre.[98] Historians have broadly gestured to Bonestell's importance to early space popularization, but their lauding of the artist's representational skills frequently echoes the reverence held by his contemporaries in an uncritical way. There is a wide range in the scope of these evaluations: some claim that Bonestell's art simply helped space exploration look possible at a time when it was difficult to imagine, while others have gone as far as to suggest that this reframing was critical to the creation of a national space program in the United States.[99] Because Bonestell's collaborators consciously deployed his images in their campaign for manned space exploration, celebrating his images as authoritative helped strengthen their cultural purchase. However, the rubric of scientific accuracy they applied to Bonestell's work still lingers in scholarship evaluating his contributions.[100]

What's missing from these accounts is how and why the aesthetic he developed was conflated with authoritative views of space. His paintings were celebrated for being impartial pictorial calculations, careful and diligent extrapolations of known data. But they were also loved for capturing the cosmic grandeur of space in ways that were distinctly human. This is the underexplored paradox central to the way Bonestell's work is typically categorized: it is objective and impartial astronomical illustration, but also

98. For the most thorough account of Bonestell's early life see Miller, Ron, Fred Durant III with Melvin Schuetz, *The Art of Chesley Bonestell* (New York: Sterling Publishing Company, 2001). For a catalogue of Bonestell's known works see Melvin Schuetz, *Chesley Bonestell Space Art Chronology* (Universal Publishers, 1999).

99. Howard McCurdy's *Space and the American Imagination* (Washington DC: Smithsonian Institution Press, 1997) is the most general history of space and popular culture to consider Bonestell's impact on mid-twentieth century space exploration. McCurdy argues that the ability to picture space exploration was a necessary imaginative precursor to realizing it as an actual activity.

100. This likely also has to do with the availability of Bonestell's personal papers. Most historical scholarship on Bonestell has used correspondence housed in the archival repositories of his collaborators, most often Willy Ley and Wernher von Braun. Bonestell's personal papers were purchased by the late Paul Allen and are now housed in Vulcan's private archive as part of Bonestell LLC.

compelling and interpretive art.[101] That Bonestell's illustrations were deployed by a community of people actively professionalizing a new scientific discipline is necessary context for understanding his contributions to the space age.

If any single document can be said to capture Bonestell's framing as a scientific image maker, it's Willy Ley's "On Chesley Bonestell," published in the *Conquest of Space* in 1949. In Ley's description, he notes that the types of images Bonestell painted required a great amount of astronomical knowledge, and an entire life history of special studies. The qualifications listed to support Ley's claim about Bonestell's unique painterly talents focus on his empirical attitude towards image production. The way Bonestell's attitude towards image production is described mirrors late nineteenth century attitudes about paintings as experiments—or "problems" in representation. Bonestell's paintings weren't framed as artistic expressions, but rather as rigorous empirical descriptions of visual subjects and mathematical perspective. Therefore, he could produce, in Ley's view, images that were objective representations of subjects that had never been observed by the naked human eye. Bonestell framed his images as problems that could be either correct or incorrect. These problems were interior to the image however, and less a question of accurately transmuting external information into a visual format. Bonestell's images weren't reference material the way botanical or anatomical illustrations were. Scientists didn't "use" them, and he didn't intend for them to function that way.

Bonestell's working process informed his new identity as an astronomical illustrator and contributed greatly to the brand of scientific image-making he helped inaugurate. He turned a set of nineteenth-century practices into something appropriate for the needs of the twentieth century, opening room for later generations of astronomical illustrators to produce images that functioned as scientifically valid. This took on a new urgency in the 1970s, when NASA pivoted to unmanned robotics missions. In this new technological context, working in the "Bonestellian tradition" meant applying incoming astronomical data to illustrations of space subjects that could still only be mechanically observed. In this way, the astronomical illustrators who came after Bonestell can be understood comparatively as more "Bonestellian" than the man himself: they had a vastly expanded palette of astronomical information to work with regarding distant space subjects and refined several new techniques for vetting the scientific accuracy of their illustrations. Adopting the mantle of the Bonestellian tradition was an explicit strategy for astronomical illustrators over the next several decades. It helped the International Association of Astronomical Artists—discussed in Chapters four and five—make sense of the visual history of their field.

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101. In *Space and the American Imagination,* McCurdy never parses the tension between Bonestell's images as art objects or science objects. He compares Bonestell's work to Thomas Moran or Albert Bierstadt for its ability to "exaggerate features in such a way as to create a sense of awe and splendor" (pg. 45), but also describes them as sufficiently objective as to have predictive power later. In McCurdy's view, Bonestell's various moon illustrations were affirmed by Apollo 8 photography. This is unsurprising since the Apollo 8 photographs didn't differ wildly from telescopic views available at the time and reveals the mercurial descriptions characteristic of evaluations of Bonestell's work. Elizabeth Kessler's work is similar in its analysis, noting the resemblance of his images to Romantic painting. However, like McCurdy, forgoes discussion of the conventions that helped the images read as scientifically authoritative.

Bonestell's other major contribution came in the form of his reluctance to engage with the fine art world, complicating the status of astronomical illustrations as art objects even when they were finally recognized to be speculative. *A Lunar Landscape* was installed in a pedagogical space as an image derived from astronomical observation. Even after it was shown to be an interpretive representation however, it was still unclear whether it should be categorized as an object of fine art. This was a tension that existed in Bonestell's work for the rest of his career—he began showing in art exhibitions over the course of the 1960s and 70s, but they were almost always hosted in science museums or spaces with an explicitly pedagogical bent.

As a result, later astronomical illustrators produced work they categorized as functionally distinct from fine art. This gulf was further amplified when NASA established its own Artist's Cooperation Program in 1963, which hired artists to produce fine art to capture the cultural significance of its technological work. When examined side by side, sometimes the fine art produced in conjunction with the NASA Artist's Cooperation Program was difficult to distinguish from the astronomical illustrations produced at roughly the same time. The categorical boundaries between these two genres, however, were actively defended by NASA as an institution. Chesley Bonestell is largely responsible for making scientific illustration a category of image making legible in the mid-twentieth century.

Chapter 2 — Bearing Eyewitness to Space: The NASA Artist's Cooperation Program

On March 13th, 1972, Chesley Bonestell sent a letter to the director of the NASA Art Program, James Dean, thanking him for his complimentary copy of *Eyewitness to Space*. The book—a hefty volume filled with 258 paintings, drawings, and prints—was a survey of artwork produced for the NASA Artist's Cooperation Program between 1964 and 1969. As the title suggested, the program emphasized the direct "eyewitness" observation of important milestones in the space program's development. Though Bonestell never participated in the NASA Art Program, he was recognized by its leading contributors as the "old master" of space painting.[102] His *Surface of Mercury*, produced more than twenty years before its circulation in *Eyewitness to Space*, was positioned in the book as a precursor to the entire collection, endowing it with a history that sat at the intersection of fine art and the envisioning of space.

If Bonestell showcased the way artistic representation could be deployed in the service of space boosterism prior to the development of a national space program, the NASA Artist's Cooperation Program represented the agency's institutionally mediated continuation. This body of artworks developed on the periphery of the fine art world, working out its own historical legacy and relationship to realistic depiction. There were also important continuities with the brand of astronomical illustration championed by Werner von Braun and Willy Ley—in an echo of these collaborations, the NASA Art program purportedly invited artists to produce work in any style or medium but demonstrated a clear preference for pictorial realism. Bonestell identified the artists that could paint the most accurately, in his view, as the most talented of the art program's roster of participants. "Paul Calle, in my judgement, bears the palm," he wrote, and "although his work is new to me, his draughtsmanship is both beautiful and delicate… He will go far in this business and I would like to see him move into the field of astronomy."[103] Bonestell also pointed to "a brilliant painting" by Robert McCall, and noted that his work was encouraging to see, especially at a time when "so many 'artist' frauds succeed."[104] There was a clarity in the pictorial style of this work that resonated

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102. H. Lester Cooke, Chief Curator at the National Gallery of Art and one of the NASA Art Program's most important collaborators, described Bonestell this way to William Estler in 1969. Cooke wanted to make sure Bonestell was represented in a 1969 exhibition, *The Artist and Space*. Letter, H. Lester Cooke to William Estler. November 17th, 1969, Correspondence Series: Bill Estler, Box 16: "Chesley and Hulda Bonestell, 1964 – 1980," Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

103. Chesley Bonestell to James Dean, March 13th, 1972. Correspondence Series: Bill Estler, Box 16: "Chesley and Hulda Bonestell, 1964 – 1980." Chesley Bonestell Archive (1863 – 2002), Bonestell LLC, Seattle, Washington.

104. Bonestell's analysis of the work of other artists was not always so charitable. Of Norman Rockwell's contributions to *Eyewitness to Space*, he wrote: "Here is an artist who is superb in picturing the uncultured mediocrity of America but is in deep quicksand, in fact has sunk, when it comes to space. He depicts a crescent earth (pl. 227) where the sun obviously must be below the horizon while he lights the moon by a sun obviously high in the sky, showing that he is incapable of using his head in dealing with problems of space, and should confine his efforts to the field where he is appreciated." Chesley Bonestell to James Dean. March 13th, 1972. Correspondence Series: Bill Estler, Box 16: "Chesley and Hulda Bonestell, 1964 – 1980." Bonestell LLC Archives, Seattle, Washington.

with Bonestell, even if the subject matter diverged from the astronomical subjects for which he was known.

Supporters of the program framed artwork as a form of trustworthy documentation, capable of capturing what cameras couldn't. On the administrative side, the NASA Artist's Cooperation Program represented an amplification of Bonestell's attitude towards photographic clarity and realism—that an artist-interpreter could make unseeable subjects visible. This was more complicated for participating artists however, who didn't necessarily mimic photography to signal their value as a form of documentation. Rather, they used photography as a tool, and maintained that a successful artwork should be more real than what a camera could produce on its own. This recentered the artist as author of an image, bolstering the quality of the work precisely because of the individual's interpretive intervention. Unlike the scientific illustrator, who was usually anonymized in the circulation of a scientific image, a fine art program creating art about science explicitly emphasized the identity of individual artists and attempted to bolster their celebrity. Paintings were referred to as "McCall's" or "Calle's" instead of as whatever subject was depicted. This shift helps explain why the proliferation of astronomical art seen in the post-Apollo period, detailed in Chapter Four, occurred mostly via private channels. It also resulted in a continued emphasis on astronomical illustration as a functional form of utilitarian image-making, by emphasizing it as categorically different from fine art about space exploration.

Despite this renegotiated relationship to authorship, the NASA Artist's Cooperation Program never neatly aligned with the broader machinations of the fine art world. As a historical case study, it can be best understood in the aesthetic genealogy traced in the last chapter—a particular type of realism that functioned as trustworthy documentation of an unpicturable subject. In the case of the astronomical illustrator, this was a scientific subject, and for the NASA fine artist, it was the cultural significance of the U.S. space program. The difference in subject matter further codified astronomical illustration and fine art about space as distinct categories serving different functions. The next two chapters will show that despite significant conceptual overlap, artists and illustrators cultivated dramatically different identities within NASA.

The NASA Art Program is an example of shifting attitudes about government funding of the arts in the 1960s. The program prompted questions about what constituted a worthy expenditure of taxpayer money, leading inevitably to attempts to quantify the monetary value of commissioned work. This dynamic played out at largely the same time that the fine art world pivoted to non-representational modes of image making, pushing the boundaries of what constituted "fine art" at all. In order to skirt associations with the contemporary art world, the NASA Artist's Cooperation Program was modeled on the U.S. Air Force Art Program, which offered a political foil to the left-leaning Works Administration Program of the 1930s. When contextualized this way, NASA's Artist Cooperation Program can be situated in a much longer history of military painting, rather than the big state-sponsored art initiatives of the 1960s.

This chapter follows two members of the NASA Art Program who participated in the Air Force Art Program, Robert McCall and Paul Calle, to examine the relationship of participating artists to photographic documentation, the meaning of realism, and artistic representation. McCall and Calle were two of the program's best publicized

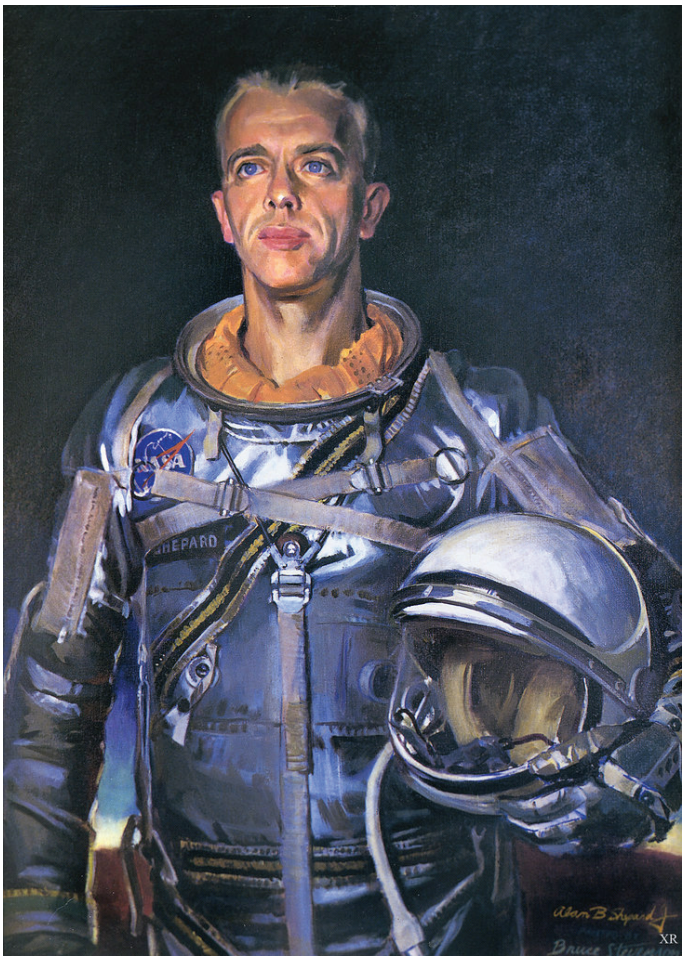

Figure 2.1— Bruce Stevenson, *Alan Shepard*. Oil portrait, 1962. Courtesy of the Smithsonian's National Air and Space Museum.

artists, and their output represented the type of art NASA administrators deemed most valuable. The program culminated with a show called "Eyewitness to Space," which emphasized the artist's role as documentarian throughout the Apollo program. This philosophical framing was crucial to the project's justification, which attenuated over the course of the 1970s. The chapter concludes with Laurie Anderson's 2006 NASA artist residency, an episode that illustrates how the characterization of the commission of art as a wasteful expenditure culminated within the program.

I. The Creation of the NASA Artist's Cooperation Program

On March 16th, 1962, almost a month after John Glenn's historic orbit around Earth, NASA Director James Webb prompted his staff to consider how the agency might deploy artists in the commemoration of its work.[105] Just four years after the agency's creation, the idea for a formalized mechanism for the commission of art emerged when Webb encountered an oil portrait of Mercury astronaut Alan Shepard. Webb was struck by the way the portrait captured Shepard's dignified likeness and envisioned a group of portraits of the Mercury astronauts that would signal the collective effort necessary for success in human spaceflight.[106] NASA's successes hinged largely on their visibility over the course of the Cold War, and Webb saw fine art as a way to shape popular narratives about the achievements of the space program.

105. James Webb to Hiden Cox, March 16th, 1962. Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

106. The collection of portraits was deemed too expensive to commission, though the idea of incorporating artists into the documentation of space activities stuck. Surprisingly little has been written about the NASA Art Program aside from agency publications. For more on how the NASA Art Program was considered part of a larger trend in government spending on the arts, see Anne Collins Goodyear's, "NASA and the Political Economy of Art, 1962-1974," in *The Political Economy of Art: Making the Nation of Culture,* ed. Julie F. Codell (Madison: Farleigh Dickinson University Press: 2008), 192.

Figure 2.2— James Wyeth, *Gemini Launch Pad*, 1964. Watercolor on paper. In the early days of manned spaceflight, technicians responsible for a launch worked in a domed, concrete-reinforced blockhouse, protected from accidental explosions. Although surrounded by cutting-edge technology, the technicians relied on a bicycle for check-up trips to the launch pad. Courtesy of the Smithsonian's National Air and Space Museum.

Webb, who came to NASA after careers at both the Bureau of Budget and the State Department, was an expert in running large government organizations, but was especially familiar with the psychological elements of warfare and their utility in the Cold War conflict. During his tenure as Undersecretary of State, Webb brought together a network of academics to think through the barriers of the United States' Cold War information campaigns.[107] At NASA, Webb was interested in exploring the commission of fine art as a form of documentation with more lasting power than traditional press coverage. NASA was an expensive midcentury institution with scientific objectives that were unclear to most of the public. It received plenty of press coverage, but this type of documentation didn't always signal the groundbreaking nature of its technological

107. Audra Wolfe, "Project Troy: How Scientists Helped Refine Cold War Psychological Warfare. *The Atlantic,* December 1st, 2018. https://www.theatlantic.com/science/archive/2018/12/project-troy-science-cold-war-psychological-warfare/576847/

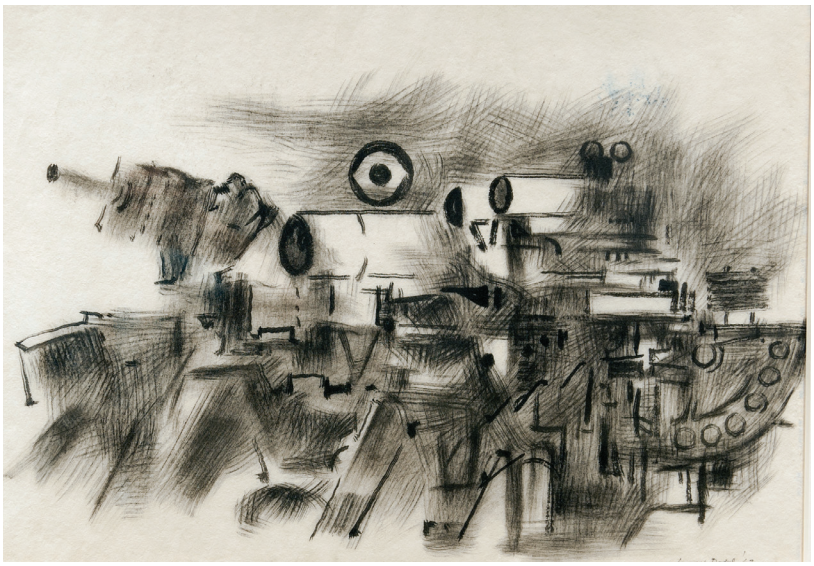

Figure 2.3— Lamar Dodd, Watching (CBS CAMERA SETUP), Ink on Pellon, 21 x 30", 1961. Courtesy of the Smithsonian's National Air and Space Museum.

endeavors. In Webb's estimation, fine art could showcase the cultural meaning of the space program by using artists as pictorial translators for lay audiences. [108] Unlike the Soviet space program, which developed a reputation of secrecy and covert operation in the 1960s, its American counterpart would demonstrate the superiority of democratic systems by remaining transparent and accessible to taxpayers.[109]

The deployment of artistic interpretation as a cultural tool was very much in line with state-held attitudes about the power of fine art to demonstrate American intellectual freedoms at home and abroad.[110] The integration of art and the expression of soft power developed over the course of the 1950s as Cold War conflict took on increasingly global dimensions. Whereas Harry Truman decried modern art as the "vaporings of half-baked lazy people," his successor Dwight Eisenhower considered it to be a pillar of liberty demonstrating "healthy controversy and progress in art." Eisenhower's interpretation was intended to contrast with artmaking in a politically tyrannical environment, where artists were made "slaves and tools of the state."[111] The government funding of abstract art was still occasionally lambasted as a waste of taxpayer money, but the freedom to produce inscrutable art was the message

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108. This relative opacity was seen in stamps and postcards celebrating the Soviet space program—which featured designs largely invented by the artists. None of the actual hardware designs were known to artists, and if their approximations came too close, they risked government censure. James T. Andrews and Asif A. Siddiqi, *Into the Cosmos: Space Exploration and Soviet Culture* (Pittsburgh, PA: University of Pittsburgh Press, 2011), pg. 72-73.

109. The framing of the US Space Program as a transparent foil to the Soviet Space Program was only partially forthcoming since NASA participated in the development of much clandestine military hardware. For more on the transfer of NASA technology to US military forces fighting in Vietnam, see Neil Maher, *Apollo in the Age of Aquarius* (Boston: Harvard University Press, 2017), 54 – 92.

110. The New York Museum of Modern Art was heavily involved with CIA efforts to use abstract art as a symbol of artistic freedom. This was intended to contrast with Soviet encouragement of Socialist Realism. Russel H. Bartley, "The Piper Played to Us All: Orchestrating the Cultural Cold War in the USA, Europe and Latin America." *International Journal of Politics, Culture, and Society*. Spring 2001, Vol.14.

111. Lucy Levine, "Was Modern Art Really a CIA Psy-Op?" JSTOR Daily, April 1st, 2020, https://daily.jstor.org/was-modern-art-really-a-cia-psy-op/ .

emphasized by fine art's champions in government.[112]

Figure 2.4— Mitchell Jamieson, *First Steps*, 1963. Acrylic, gauze, and paper on canvas. In a silver-colored spacesuit, astronaut Gordon Cooper steps away from his Mercury spacecraft and into the bright sunlight on the deck of the recovery ship after 22 orbits of Earth. Mitchell Jamieson documented Cooper's recovery and medical examination and accompanied him back to Cape Canaveral. Courtesy of the Smithsonian's National Air and Space Museum.

The NASA Artist's Cooperation Program was a product of the Cold War's political environment, which was both a benefit and constraining factor. In 1963, Webb delegated the inauguration of a formal art program to NASA's Director of Educational Programs, who recognized that not everyone would see the value in adding the commission of fine art to the agency's long list of technical objectives. More importantly, by the 1960s the fine art world was seen as one of the places where communist sympathies were likely to abound.

The depression-era Federal Art Project of the Works Progress Administration is typically positioned as the most relevant historical precursor to the government sponsorship of the arts that took place in the 1960s.[113] Stylistically, the bulk of the work produced for the Works Progress Administration maintained a Social Realist style depicting the conditions of labor in America. The social realists associated with the WPA, like Diego Rivera and Alice Neel, were sympathetic to communist movements abroad.[114] This identification took on a new radicalism after the 1939 Nazi-Soviet Non-Aggression Pact, which split supporters into either self-proclaimed Stalinists or Trotskyites. By the time the United States entered the conflict, New York had replaced occupied Paris as the center of the art world, and Abstract Expressionism had emerged as the cutting edge of the Avant-Gard.[115]

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112. "Your Money Bought These Paintings," *Look Magazine*, 1947. Quoted in Lucy Levine, "Was Modern Art Really a CIA Psy-Op?," JSTOR Daily, April 1st, 2020, https://daily.jstor.org/was-modern-art-really-a-cia-psy-op/ .

113. Anne Collins Goodyear, "NASA and the Political Economy of Art, 1962-1974."

114. Christine Sylvester, "Picturing the Cold War: An Art Graft/Eye Graft," (*Alternatives: Global, Local, Political*, Vol. 21, No. 4 Oct.-Dec. 1996), pg. 398.

115. The shift away from social realism was so dramatic that Alice Neel reportedly purchased back several of her WPA canvases that had been sold to a junk dealer for four cents apiece. "They just sold them as spoiled canvas to wrap pipes with. Phoebe Hoban, *Alice Neel: The Art of Not Sitting Pretty* (New York: David Zwirner Books, 2021), pg. 176.

Despite the departure from overt support of communist politics abroad, the modern movements that displaced social realism still maintained a left-leaning orientation. Clement Greenberg, an avid promoter of Abstract Expressionist art decried "mass art" as a function of the industrial revolution and fascist control.[116] In his view, the tastes of the of the masses could *only* be elevated under socialism, because it allowed for a system of artistic production that didn't hinge on monetization or commodification.[117] In 1957, just five years prior to the NASA Art Program's establishment, an exhibition of American Art in the Twentieth Century scheduled to travel abroad was cancelled after ten artists were accused of being pro-Communist.[118]

Regardless of these hesitations, the CIA was an avid supporter of Abstract Expressionism as a symbol of the freedom of American thought and democracy. On the cultural front of the Cold War, the New York Museum of Modern Art, the movement's largest institutional supporter, functioned as a "minor war contractor" organizing several shows abroad.[119] Working in tandem, the CIA and MOMA funded the cultural projects necessary to "sell the rest of the world on the benefits of life and art under capitalism."[120]

While U.S. government was open to enlisting the avant-garde as an example of artistic intellectual freedom, it did so under covert channels and in conjunction with private art institutions. Agencies that answered directly to congress needed to be more careful. To avoid the thorny political dynamics of the contemporary art world, the NASA Artist's Cooperation Program's proponents sought out affiliations with old, well-respected institutions. At the suggestion of David Findlay of the Fine Arts Commission, the program allied with the National Gallery of Art in Washington D.C., and sourced artists with a track record of government service.

Hereward Lester Cooke, a senior curator at the National Gallery of Art, was contracted into NASA to help compile a list of reputable artists. The son of a Princeton physicist, Cooke was an attractive choice because he was both an artist and had served as a pilot and intelligence officer during the Second World War. James Dean, a talented watercolorist and NASA employee was appointed the program's director. To bolster the program's respectability, Cooke and Dean worked together to model the architecture of the NASA art program after the U.S. Air Force Art Program, which selected artists

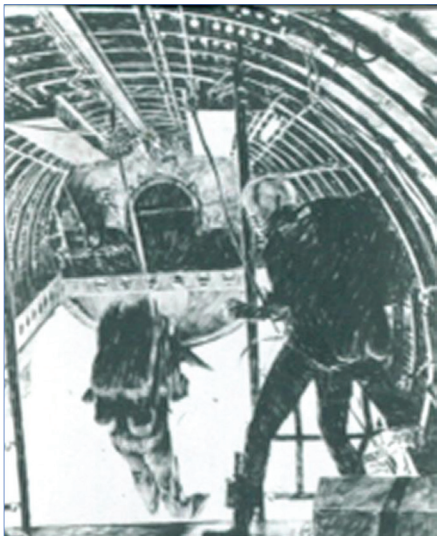
116. "The masses must be provided with objects of admiration and wonder… And so we find Mussolini announcing a "new imperial style." … Today we no longer look toward socialism for a new culture—as inevitably as one will appear, once we do have socialism. Today we look to socialism simply for the preservation of whatever living culture we have right now." Clement Greenberg, "Avant-Gard and Kitsch," in Art and Culture: Critical Essays (Boston: Beacon Press, 1961), pg. 21.

117. Phoebe Hoban, *Alice Neel,* pg. 178.

118. Christine Sylvester, "Picturing the Cold War: An Art Graft/Eye Graft," pg. 408.

119. Eva Cockcroft, "Abstract Expressionism, Weapon of the Cold War," *Artforum* 12, no. 10 (June 1974), pgs. 39 – 41, quoted by Christine Sylvester, "Picturing the Cold War: An Art Graft/Eye Graft."

120. Eva Cockcroft, "Abstract Expressionism, Weapon of the Cold War."



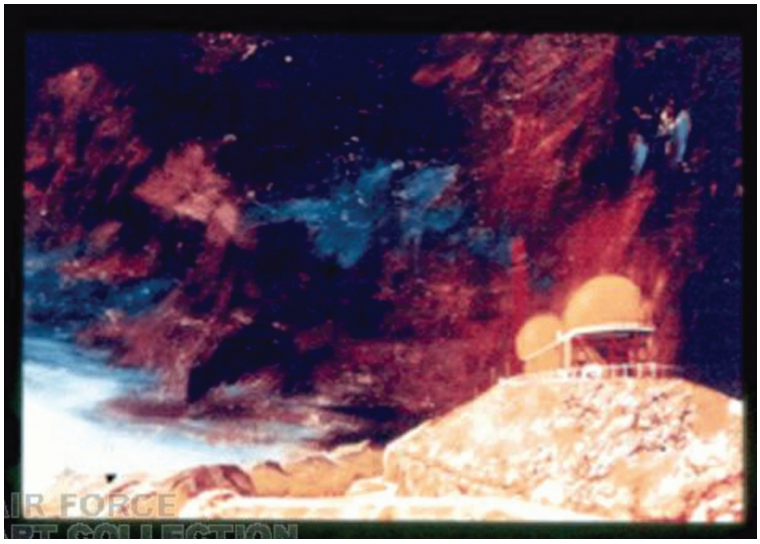


Figure 2.5— Left: *The Jump,* showing a pararescue team jumping from a C-97. Paul Calle, US Air Force Art Program, Catalogue #1966.020. Right: *Majorca Radar Tower,* painted during a trip to Torrejon Air Base, outside of Madrid, Spain. The storm seen coming in behind the tower was meant to emphasize the "great lonely beauty that exists along with this vital and seemingly isolated duty." Paule Calle, US Air Force Art Program, Catalogue #1962.068. Courtesy of Chris Calle.

in conjunction with the Society of Illustrators.[121] The Air Force Art Program was an excellent model for embedding artists within larger institutions, and no one could reasonably claim that affiliated artists were part of some radical leftist syndicate.

The NASA Artist's Cooperation Program reserved the right to make all selections, but it used the U.S. Air Force Art Program roster to inform its invitation pool. Rather than situate the NASA Artist's Cooperation program in a civilian tradition of arts commission, like that established via the Works Progress Administration in the 1930s, the program was justified in the broader historical context of military painting. In fact, the NASA Artist's Cooperation Program may have even served as a model for how government could sponsor art without promoting anti-democratic ideologies. A review of the National Gallery's first show of NASA art program work was quoted in the congressional record by senator Claiborne Pell, in supporting legislation for the establishment of the National Endowment for the Arts. Pell reportedly quoted the positive reviews as being a good first step by the government in its relationship with artists and that perhaps it offered an instructive format.[122]

In a drafted press statement, NASA's Office of Education explained the invitation

121. In a NASA Headquarters Memorandum, Shelby Thompson noted: "Chairman David E. Finley let off [sic] the discussion by saying he supposed NASA wanted to do something similar to the program carried on by the Armed forces during WWII. I replied that we had no fixed preconceptions but were planning to meet with the officer in charge of the Air Force program (one in which artists do representations of Air Force events and scenes without charge and present the product to the Air Force) to learn more in detail about it." Shelby Thompson, NASA Headquarters Memorandum, July 6th, 1962. Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

122. James Dean, Interview by Nicole Buccino, June 20th, 2008, in Alexandria, Virginia, transcript, NASA History Office, pg. 15.

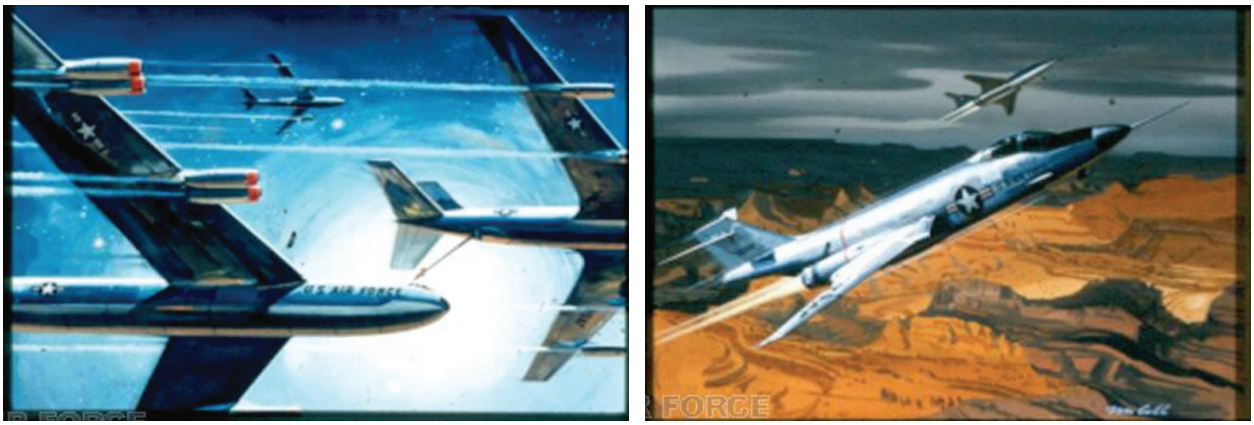


Figure 2.6— Left: *B52 Aerial Reference*, Robert McCall, US Air Force Art Program, Catalogue #1956.094. Right: *Flight of F-101S*, Robert McCall, The United States Air Force Art Collection, Catalog# 1956.033. Courtesy of Catherine McCall and mccallstudios.com.

of artist-observers into the agency by framing their work as an American tradition, but not one that included the WPA. "Such eyewitness records were first used in the United States during the Revolutionary War, Civil War, World War I and II, and in a post-World War II official U.S. Air Force Program."[123] Many of the Art Program's first participating artists were connected to the military in some capacity, and despite the emphasis on unconditional support of a participant's artistic expression, final selections underscored a clear preference for representational art. An internal document introducing NASA's first cohort of artists focused especially on these qualifications. Robert McCall, a leader of the Air Force Art Program had a full security clearance and was billed as America's top aerospace illustrator. Peter Hurd, it was noted, served with the 8th Air Force during the war and then went on to start a successful career as a realist painter. Paul Calle had worked with the Air Force Art Program already, and Mitchell Jamieson led the Navy's art program during the Second World War.[124] Participating artists with no military training were celebrated for their contributions to realism in art, or for their celebrity status. Willem de Kooning and Edward Hopper reportedly expressed interest in the program but later declined. Andrew Wyeth, "America's top realist painter" was also among the first consulted, and George Weymouth, one of Wyeth's students, was invited on his recommendation. Wyeth himself ultimately declined the invitation, but his son Jamie Wyeth accepted and visited the Kennedy Space Center twice.[125]

123. Shelby Thompson, Press Release Draft, June 20th, 1963, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

124. Hereward Lester Cooke to Shelby Thompson, RE: NASA Art Program, undated, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

125. James Dean and Thomas Crouch, *NASA/ART: 50 Years of Exploration* (New York: Abrams, 2008), pg. 9.

Figure 2.7— Peter Hurd, *Maintenance Hangar at Night*, US Air Force Art Program, Catalogue #1956.047

Figure 2.8— Peter Hurd, *B-24 Maintenance,* depicts night maintenance on a B-24. US Air Force Art Program, Catalogue #1956.040

II. Tensions Between Realism and Interpretation

The NASA Art Program's relationship to naturalistic representation can be traced through its relationship to the U.S. Air Force Art Program, and the broader trend of inviting artists into institutions to function as a type of documentarian. Balancing a realistic-looking image with artistic interpretation was a tension for much of the art program's existence. In the few histories of the NASA Artist's Cooperation Program that currently exist, the program is typically explained as a part of the same expanding liberal state that underwrote midcentury institutions like the National Endowment for the Arts.[126] While the spread of government-funded programs and initiatives contributed to a historical climate amenable to the patronage of art, we can understand the early years of the program as philosophically closer to the types of astronomical illustrations that characterized the 1950s.

Art Program administrators justified the financial expenditure by gesturing specifically to the history of military art. As a genre of painting, the documentation of heroic performance on the battlefield and the drama of war is well-patronized. These images served a specific cultural function, helping shape narratives about the course of empire. Panoramas of famous battles, like Robert Barker's *Lord Howe's Victory and the Glorious First of June,* took a well-known English sea battle and depicted it at such a large scale that it immersed viewers in the legendary scene. Many of these artworks were tremendously popular—Kerr Porter's nineteenth century battle scenes drew in record numbers, as did the wave of battle scene art inspired by the

126. The NASA Art Program predated the NEA by a full two years. Anne Collins Goodyear, "NASA and the Political Economy of Art, 1962-1974." *The Political Economy of Art: Making the Nation of Culture*, ed. Julie F. Codell (Madison: Farleigh Dickinson University Press:2008), 192.

Napoleonic and Franco-Prussian wars.[127]

In the United States, "Special Artists" were sent on behalf of magazines like *Harper's Weekly* to document battles and life in a soldier's encampment.[128] Though the Civil War was one of the first American conflicts documented with photographs, the wet-plate collodion negatives used at the time required five to twenty seconds of exposure time. This made action shots of conflict impossible to capture, giving the working draftsman a clear documentary purpose.

By World War I, despite improvements to photographic methods, artists were still being integrated into military forces and received varying degrees of support for much of the century.[129] As with written dispatches from the field, it was thought that paintings and drawings could capture the human experience of war in addition to logistical information. Despite the inclusion of humanized interpretation, emphasis on unmediated first-hand accounting persisted throughout the genre. When asked in 2010, a member of the Marine Corps combat art program explained that the group's work was not promotional, but rather a form of record-keeping: "What we are sent to do is to go to the experience, see what is really there and document it as artists." As with representations of unseeable space environments, first-hand depictions of combat were thought to recreate an otherwise unpicturable environment.

The Stuart M. Speiser Collection of Photorealism, housed at the National Air and Space Museum alongside most of the work produced for the NASA Artist's Cooperation Program, helps illustrate the connections between the U.S. Air Force Art Program and realistic-looking artwork. The NASA art program was largely modelled off the Air Force's older version and incorporated many of the same ideas about the value of representational art early on. The story of the Stuart M. Speiser Collection helps explain the variety of realism championed by institutions like NASA, and why one of the country's most complete collections of Photorealist art was given to the National Air and Space Museum and not one of the many art museums on the National Mall.

Stuart Speiser, the collection's namesake, was a bomber pilot in the Second World War. He turned to aviation litigation after the war's conclusion, where he amassed a significant amount of wealth over the course of his law career and used his resources to commission works of art. Speiser remembered the careful aircraft paintings that characterized much of the Air Force Art Program's output in the wake of WWII—paintings meant to commemorate the hardware that helped hasten the end of the conflict. Speiser was awed by the clarity of these paintings, particularly the treatment of reflective metal, and in 1973 set out to commission a set of Photorealist paintings of aircraft. He approached the genre's preeminent New York gallerist, Louis K. Meisel, who

127. Oliver Grau, *Virtual Art: From Illusion to Immersion* (Cambridge, The MIT Press, 2003), pgs. 90 – 96.

128. Harry L. Katz, Vincent Virga, and Alan Brinkley, *Civil War Sketch Book: Drawings from the Battlefront* (New York: W.W. Norton and Company, 2014).

129. Carol Kino, "With Sketchpads and Guns, Semper Fi," *The New York Times,* July 14th, 2010, https://www.nytimes.com/2010/07/18/arts/design/18marines.html.

Figure 2.9— Richard Estes, *Alitalia,* 1973. Model airplane visible in lower right hand corner. Gift of Stuart M. Speiser to the Stuart M. Speiser Photorealist Collection, National Air and Space Museum. Courtesy of Louis Meisel.

claimed to have coined the word "Photorealism" in 1969. Meisel convinced Speiser to sponsor a set of artworks that simply alluded to aviation, rather than depict airplanes outright, to which Speiser eventually agreed.[130]

Meisel assembled a roster of artists now considered progenitors of the genre. Richard Estes painted a New York City office window with a model airplane in the window. Robert Bechtel painted a yellow Chevy parked at San Francisco International Airport. Tom Blackwell painted an airplane engine; Charles Bell painted a seaplane in a bathtub; Audrey Flack painted a toy airplane nestled among cosmetics and paint jars.[131] The collection was composed of twenty-two paintings, which was a large feat considering that most photorealists produced one painting per year on average. Meisel, who opened his first gallery in Manhattan in 1969, was invested in bolstering the reputation of the genre he had supported for several years. As part of the agreement, Meisel also stipulated that Speiser pay to send the works on tour to various national

130. Louis K. Meisel, "Curating the Stuart M. Speiser Collection," Stories, Louis K. Meisel Galleries, https://www.meiselgallery.com/story/curating-the-stuart-m-speiser-collection/

131. Louis K. Meisel, "Curating the Stuart M. Speiser Collection."

Figure 2.10— Left: Audrey Flack, *Spitfire,* 1973. Acrylic on canvas, 73 x 110.5 inches. Right: Charles Bell, *Seaplane in Bathtub,* 1973. Gift of Stuart M. Speiser to the Stuart M. Speiser Photorealist Collection, National Air and Space Museum. Courtesy of Louis Meisel.

art museums and university galleries. Meisel understood the collection would benefit from the cultural prestige of these exhibitions, and now he could sweeten the deal for participating institutions by offering to cover all shipping and exhibition fees. This was just as beneficial to Speiser as it was Meisel. According to Meisel, although Speiser was very rich, he was from the Bronx, and "yearned to be a member of high society" like the Fords, Mellons, or Guggenheims. Meisel encouraged him that the art world was an excellent entry point.[132] As a result of the five-year tour, the Speiser collection helped define the genre of Photorealism, and establish its main players.[133] Once the tour was done, Speiser was unsure what to do with all twenty-paintings, and at Meisel's encouragement, donated the complete collection to the Smithsonian Institution in Washington D.C. For his generosity, Speiser was awarded the Smithsonian Gold medal, and even better, reportedly invited to a celebration party held by Blanchett Rockefeller.

Administrators at the Smithsonian determined that, because of the collection's emphasis on aerospace, it should be accessioned by the soon-to-open National Air and Space Museum. The NASA Art Program's biggest exhibition, *Eyewitness to Space,* was also gifted to the Smithsonian in 1975, and both collections were shown in the museum's art gallery shortly after the museum opened. Both collections eventually ended up at the National Air and Space Museum, but the biggest similarities between the two bodies of work laid with their connections to the U.S. Air Force Art Program and the political attitudes it represented.

Louis K. Meisel's later writing on Photorealism's relationship to the art world helps solidify the genre as a culturally conservative moment in this history of art.

132. Louis K. Meisel, phone interview by Lois Rosson, Berkeley, California, April 4th 2022.

133. Louis K. Meisel, "Curating the Stuart M. Speiser Collection"

Beyond its connections to the American military, the genre itself represented a return to more traditional designations of artistic value. Meisel described the Photorealists as carrying on older practices central to the art of Western cannon—the Photorealists deployed the camera as a tool for seeing just like the "Renaissance genius" Leonardo da Vinci and the Dutch Golden Age master Johannes Vermeer. The contemporary art world, in his view, was degenerated by the "communism, socialism," "ugly multiculturalism," and "political correctness" that he identified as causes of the left.

This was a problem he attributed to misguided cultural hegemony: "In the liberal, left-leaning universities it was deemed to be politically incorrect and a suppression of multiculturalism to attempt to teach—and to require artists to study—the standards of what was then, as now, considered to be a white-heterosexual-male-oriented, Western-dominated way of thinking about and creating art. In addition, the traditional methods of art instruction were just too difficult and tedious, and they required skills and discipline that very few had or were willing to exert and assert." Meisel's insistence on Photorealist approaches as more inherently valuable than abstract expressionism reveals a coded frustration with the women and minorities who gained traction in the art world over the course of the twentieth century. The conservatism of Photorealist painting isn't explicitly political, but it does shed light on how the cultivation of a narrow and technically demanding style of representation was seen as the domain of "white-heterosexual-male-oriented, Western-dominated way of thinking about and creating art."[134]

That this style of painting was the kind also championed by scientific institutions in the twentieth century should not be overlooked. Photography is a form of capture and commodification of a fleeting moment in time. The painted simulation of photographic vision similarly commodifies the subject with a truth claim: this is a *real* depiction of the subject. As later chapters in this dissertation will explore, visual truth claims about space landscapes functioned as a form of settlement in much the same way as imperial map-making in previous centuries.

Artists selected to work with the NASA art program were there to add to the photographic coverage of the buildup to the Apollo moon landings. Despite their status as cultural arbiters, they adhered to a predominantly representational style that would be legible to broad audiences. The status of their work as something more real than photographs was compounded by insistence that these were not utilitarian "illustrations," but squarely works of "fine art"—despite being sourced in conjunction with the New York Society of Illustrators.

I argue that the selective deployment of these categories performed a specific type of work and can be best understood as historical artefacts rather than as a universally stable taxonomy. The NASA Artist's Cooperation Program blurred distinctions between fine art and illustration in practice while simultaneously establishing them as oppositional categories. The conceptual similarity between the astronomical illustrator and the NASA fine artist is that both were asked to picture the unseeable subjects in a way that would be legible to other viewers. At the core of both practices was the question of how to represent these subjects realistically, which often engaged the practice of photography

134. Louis Meisel, *Photorealism* (New York: Abrams, 1989), introduction.

as an objective mode of seeing and image-making.

"Realism" a loaded term in art historical contexts, regardless of if it's applied to fine art or illustration. To address this distinction, however, I use Michele H. Bogart's historical approach to writing about illustration in the twentieth century. In Bogart's view, art and illustration aren't distinct a-historical categories, but historically contingent practices that changed over time. In her explanation, twentieth century technological advancements in print culture and television expanded the terrain of art practice, but this proliferation prompted a narrowing of fine art's ideological borders. In other words, while the act of artmaking expanded for commercial reasons, the definition of "fine art" solidified around a specific set of objects.[135] This happened while the sciences in the United States professionalized into established disciplines with clear contours, further ossifying distinctions between art and science that were fungible in earlier centuries.

As to the multiple meanings associated with the term "realism," I contend that the form of visual fidelity that motivated the actors in my story is simply one form among many. There is a smattering of terms that refer the impulse to index reality in Art History. All are useful for historicizing scientific representation. The first, oldest, and most complicated is "realism" which refers both to an impulse to paint a given subject with high levels of fidelity, and a specific movement in art that took place in France in the second half of the nineteenth century.[136] The French Realists were interested in giving a more truthful, objective, and impartial representation of the real world, but this was as much a philosophical goal as an optical one. Reacting to the idealized history paintings of European Classicism, the Realists were interested in depicting merchants, workers, and peasants going about their everyday lives. Direct observation was a central requirement; The Realists insisted that only the contemporary world was a suitable subject for the artist since it was the only truly knowable one.[137]

Despite the historical specificity of the term "Realism," its sensitivity to the production of a truthful representations of life remained a stable facet of the term's meaning. The emergence of Photorealism in the postwar period represented the coupling of this impulse with photography, a technology designed to help capture and stabilize human vision. The Photorealists of the 1960s integrated photography into the painting process in ways that foregrounded the camera's observations; photographs of complex subjects, like the glass panes of a storefront or the reflective paint of a car in a parking

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135. Bogart, *Artists, Advertising, and the Borders of Art* (Chicago: The University of Chicago Press, 1995), pg. 4.

136. The term naturalism is closely related to "realism" and its historical roots. Like Realism, it was a major trend in the nineteenth century that emphasized depicting the world as it really was. It is often associated with plein air paintings, or observations of the outdoors made with the naked eye and then recorded in paint. Linda Nochlin, *Realism: Style and Civilization,* (New York: Penguin Books, 1971), pg.20.

137. "The art of painting can only consist of the representation of objects which are visible and tangible for the artist,' and the artists of one century were basically incapable of reproducing the aspect of a past or future century." Gustav Courbet, as quoted in Linda Nochlin, *Realism: Style and Civilization,* (New York: Penguin Books, 1971) pg.25

lot, would be carefully copied in paint onto canvas.[138] Visual information captured and frozen by the camera could be transmuted by hand into an entirely new medium. The subject of the painting could be considered the photograph just as much as the object depicted.[139] This unselfconscious privileging of machine vision was precisely why the movement was lambasted by art critics. In their view, the Photorealists were incapable of achieving any greater aesthetic value than the middle-class consumer products they typically depicted.[140]

Photorealism should be interesting to historians of science and technology because of its privileging of the photograph as an especially accurate measure of reality. "Realism" and "photorealism" are often collapsed in popular parlance, underscoring long-held assumptions about the impartiality of photography in capturing true forms. This is even more confounded by the term "hyperrealism," which is often used interchangeably with photorealism and suggests that reality can be captured in varying degrees; the more detailed an image, the more presumably "real" it becomes.

This belief in the neutrality of machine output is mapped in Lorraine Daston and Peter Galison's 2007 *Objectivity,* which locates its origins in the nineteenth-century development of scientific photography.[141] Daston and Galison outline truth to nature, mechanical objectivity, and professional expertise as three different forms of objectivity that emerged in response to the development of the scientific photograph. In their story, illustrators that cultivated their own methods for signaling the accuracy of their images were obviated by the development of the camera. Photography eradicated the potential biases of the human observer, allowing scientists to replicate images instantly, even if it meant sacrificing pictorial legibility. By the end of the nineteenth century, proximity to professional expertise emerged as a dominating factor that informed the trustworthiness of scientific images. In other words, images produced or interpreted by certified experts was established as a solution to the pictorial ambiguity of scientific forms.

The competing realisms of the twentieth century, a response to the meaning of mechanical reproduction, illustrate that the three methods of establishing pictorial objectivity described by Daston and Galison are not exhaustive. Different forms of realism in the art historical context—French realism, socialist realism, photorealism, hyperrealism—all refer to a particular epistemological strategy for the documentation of truth. For the fine artists working with the NASA art program, the quality of their work hinged largely on their artistic reputation, functioning here as a form of expertise cultivated in a professional capacity. This only increased over the course of the 1960s, as the program attracted celebrity artists like Robert Rauschenberg and Andy Warhol. This contrasted with the treatment of astronomical illustrators working over the course of the

138. Because Photorealism wasn't considered a proper movement in art for much of its existence, academic studies of it are scarce. For a recent overview, see Bridgit Elizabeth Gilman, "Re-envisioning Everyday Space: Photorealism in the San Francisco Bay Area" (Ph.D Dissertation, University of Michigan, 2013).

139. Louis Meisel, *Photorealism* (New York: Abrams, 1989), introduction.

140. Gilman, "Re-envisioning Everyday Space," pg. 4.

141. Daston and Galison, *Objectivity* (New York: Zone Books, 2010).

same period, who were typically anonymized in the display of their work. Astronomical illustrations were often categorized as "artist's renderings," without specifying an individual. This helped solidify the image as the visualization of scientific knowledge, rather than the product of an individual's interpretation.

III. Fine Art Over Photography

In a 1963 memorandum issued to the NASA Art Program's first cohort of participating artists, Hereward Lester Cooke—the program's art world shepherd—took the opportunity to emphasize the importance of the work undertaken. "When a major launch takes place at Cape Kennedy more than two hundred cameras record every split second of blast off. Every nut, bolt and miniaturized electronic device is photographed from every angle. The artist can add very little to all this in the way of factual record. But, as Daumier pointed out about a century ago, the camera sees everything and understands nothing. It is the emotional impact, interpretation, and hidden significance of these events which lie within the scope of the artist's vision. An artist may depict exactly what he thinks he sees, but the image has still gone through the catalyst of his imagination and has been transformed in the process."[142] The value of the participating artist was their pictorialization of the human experience of the space program.

This was not a view that was universally shared. When asked to participate, American painter Thomas Hart Benton said he put the invitation out of his mind. "What can I do to make a painting of a damn rocket? You'd show it better in a moving picture. It doesn't mean that I don't have the highest respect for the achievements and intelligence of the people involved. But this is checked by the intuition that man doesn't escape his environment."[143] Benton was not convinced the space program would be successful, and beyond that, he was unsure how artistic contributions could be meaningfully integrated.

In Cooke's descriptions, artists served as eyewitnesses to the space program, and were valuable precisely because they captured a subjective experience that cameras could not reproduce. None of the paintings or sketches the program collected were to be judged or juried by administrators. The only requirement of the participating artist was that the materials used be of an archival quality, so they could survive to be viewed by future generations. This was also a key component of arguments that rationalized expenditures on the program. "NASA is anxious to document the space effort in every way possible. The expenditure of public money on this art program is justified because NASA has a mandate to keep the public informed about the space program, and a work of art can have meaning to a segment of the public not reached by other means."[144]

Despite this emphasis on subjective interpretation, there was a clear preference

142. Hereward Lester Cooke, NASA Art Program Memorandum, April 15th, 1963, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

143. James Dean and Thomas Crouch, *NASA/ART: 50 Years of Exploration* (New York: Abrams, 2008), pg. 9.

144. Cooke, NASA Art Program Memorandum, April 15th, 1963.

Figure 2.11— *The Space Mural - A Cosmic View*, Robert McCall, 1976. Courtesy of the Smithsonian's National Air and Space Museum.

for representational artwork. The value fine art added was precisely this translation of an individual's perception of an event into a two-dimensional representation, the so-called human element that cameras lacked. If the work was to function as a form of documentation however, it needed to be articulated in a visual language that was legible to other people. Abstract art was not explicitly avoided—in fact Lester Cooke emphasized to artists that they could paint whatever they liked—but artists with a realistic style were purposely selected. This was evident from the first roster of selected artists. Cooke explained the decision in a newspaper interview, claiming that administrators felt space travel was already abstract enough, and that the body of images should be legible to members of the lay public.[145]

Cooke's statement also represents a deeper tension between artistic freedom and perceptions of meritorious artwork. While Cooke and others emphasized the freedom of artists to paint however they'd like, he was sensitive to perceptions that the commission of art was a frivolous expenditure. By June of 1963, Cooke had considered following a suggestion to rename the Artist's Cooperation Program to the "Graphic (or Artist's) Documentation Service," or to a title that suggested that the purpose of the program was

145. Goodyear, "NASA and the Political Economy of Art, 1962-1974," 193.

Figure 2.12— Study, *The Space Mural - A Cosmic View*. Courtesy of Catherine McCall and mccallstudios.com.

Figure 2.13— Left: *Flight of the B52s*, Robert McCall, U.S. Air Force Art Program, Robert McCall, Catalogue #1955.020. Right: *Flight of F-102R*. Robert McCall. The United States Air Force Art Collection Catalog# 1956.032. Courtesy of Catherine McCall and mccallstudios.com.

largely informative, rather than to create imperishable art monuments."[146]

Robert McCall and Paul Calle were two of the NASA Artist's Cooperation Program's first participants, and their work typified the way Cooke hoped artistic interpretation would be reconciled with realistic depiction. Both McCall and Calle deployed photography in their working process but maintained that the outcome was a clearer form of vision that what a camera could produce. Though this was in line with Cooke's idea of the value of eyewitnessing, both artists were occasionally celebrated for their photographic clarity, and likened to machines of representation.

Robert McCall's relationship with the NASA Artist Cooperation program helped cement his status as an aerospace artist over the course of the 1960's and 70s. Born in Columbus Ohio in 1919, McCall was one of three Ohio high school students to win a scholarship to the Columbus Fine Arts School. After working several different advertising jobs as a student, he joined the Air Force in 1942. McCall initially wanted to serve as a pilot but discovered via Air Force testing protocols that he was colorblind and was assigned to duty as a bombardier.[147] This was a fortuitous turn, since McCall was especially taken with the clear aerial views afforded by the observation bubble at the front of the bomber and found the airborne vantage points ideal for sketching different aviation scenes.[148] After leaving the Air Force, McCall approached *Life* Magazine with an offer for his services, and secured work illustrating an article on the future of space travel. Stanley Kubrick saw the images while preparing the concept for *2001: A Space*

146. Cooke, Memo to Shelby Thompson, June 6th, 1963.

147. Robert McCall, Biographical Interview, Archive of Visual Arts MS 001, Box 14 Folder 135, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

148. Even though he's now best known for his colorful representations of outer space, McCall remained active in the field of aviation painting for much of his life and eventually helped found the American Society of Aviation Artists. Robert McCall, Biographical Interview.

Figure 2.14— Robert McCall, *Gemini Recovery,* 1963. The Gemini V crew, Gordon Cooper and Charles Conrad, bob in a life raft beside their spacecraft as a helicopter comes to the rescue after their Earth orbital mission, which took place August 21-29, 1965. It was the longest manned flight to date -- 7 days, 22 hours, and 55 minutes. McCall documented the return of the crew from the recovery ship USS Lake Champion in the Atlantic Ocean. Image Credit: Robert McCall. Courtesy of the National Air and Space Museum.

Odyssey and approached McCall about creating promotional artwork for the film.[149] McCall produced four paintings for Kubrick at the same time he joined the NASA Artist's Cooperation Program, one of which eventually ended NASA Art Collection, hanging in Daniel Goldin's office for the duration of his tenure as NASA administrator.[150]

McCall's biggest work was a mural he painted inside the National Air and Space Museum for the museum's opening in 1976. In an interview with *Outré Magazine*, McCall claimed that mural was his favorite work of his own art, mainly because he achieved a clarity he described as different from the photographic. "I loved the central figure, the American astronaut with the flag. A major fear for me was that he would look like a blown-up photograph that I had copied… With the exception of research, and understanding what every part of that suit meant, I avoided any kind of projection of a photograph onto the canvas, which I had done in the past for aircraft and such."[151]

Aside from the perception that copying a photograph's visual interpretations meant a reduction in artistic merit, the problem with photographs was that they could be too descriptive and drown out the potential for narrative in a deluge of competing visual information. Though trained as an illustrator, for McCall this represented the difference between art and illustration: "Illustrators put in the details because their clients want it. They want to see every nut and bolt. Yet great art often is not concerned

149. McCall's work was a central part of Metro-Goldwyn-Mayer's extensive advertising campaign. In each of the eight cities where the film was premiered, MGM ran four full-page color advertisements featuring his work—appearing together as an insert or as single full-page ads—on successive Sundays in leading newspapers. That McCall served as "official artist for NASA" added to the marketability of his paintings. Press Release from Metro-Goldwyn-Mayer, undated, Archive of Visual Arts MS 001, Subseries A: Box 1, Folder 1, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

150. The painting showed the film's Pan Am shuttle departing a toroidal space station. Interview with *Outré Magazine,* Archive of Visual Arts MS 001, Box 14 Folder 138, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

151. Interview with *Outré Magazine,* Archive of Visual Arts MS 001, Box 14 Folder 138, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

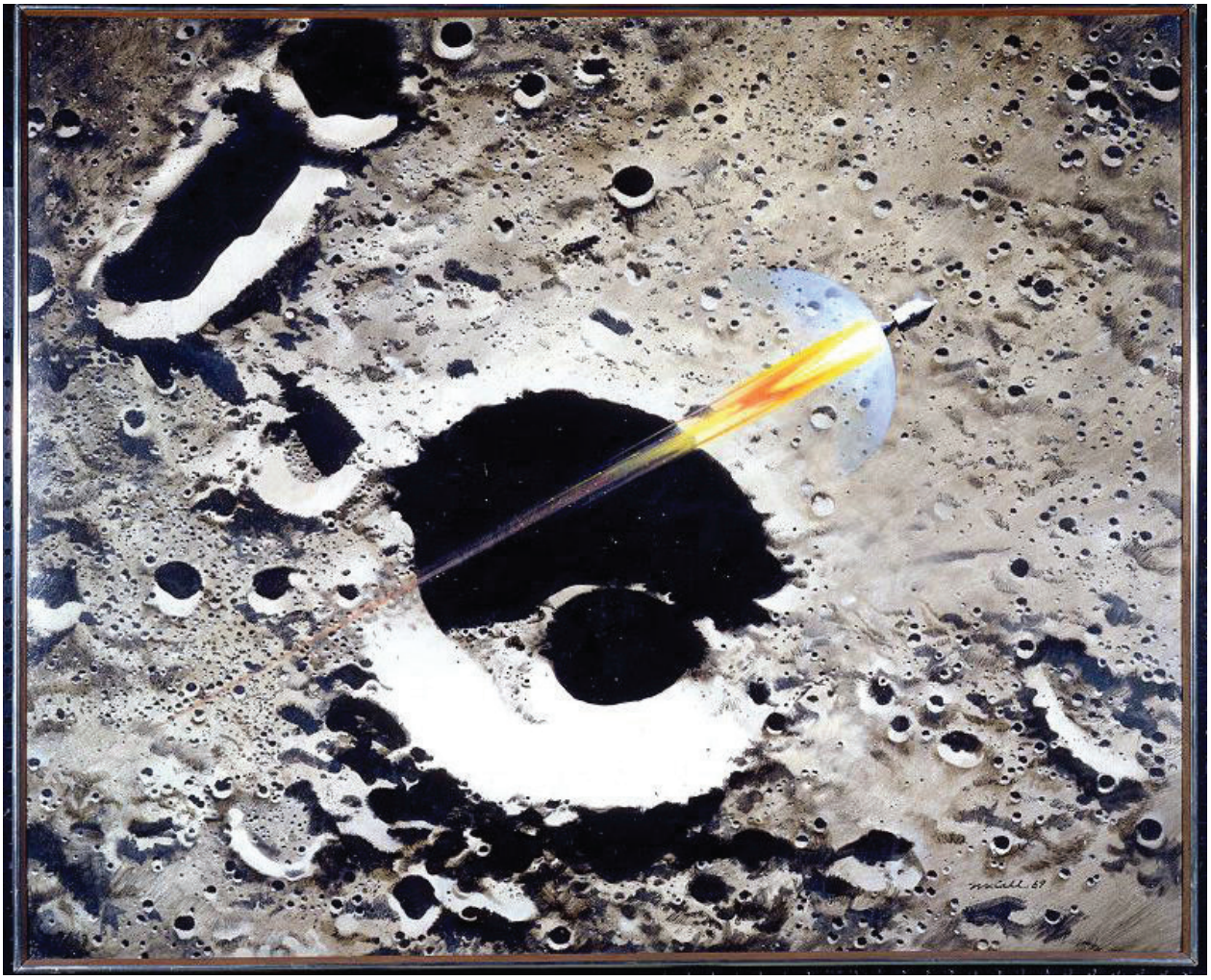

Figure 2.15— Robert McCall, *Apollo 8 Coming Home*, 1969. McCall imagines the sight of the rocket engine firing to propel the spacecraft out of lunar orbit for its return to Earth. Courtesy of the Smithsonian's National Air and Space Museum.

with all the details. It's the impression. It's the symbolism, and a lot of other more esoteric aspects of art that are more important." The production of a successful work of art was a balance of accuracy and the recognition that "as an artist… you can tell the story with even greater success …when you are not too limited or too constrained by including every detail."[152]

Despite maintaining that the artistic process could ultimately produce something more meaningful than photography, the photograph was often still the visual standard against which the quality of his work was judged. In a pamphlet advertising an exhibition at the Phoenix Art Museum, his work stood in for photographs that were impossible to materialize. Of McCall's work, Lester Cooke wrote: "First, he has a profound respect for the facts of space technology. Aeronautical experts admire his work as much as art

152. Robert McCall, Biographical Interview, Archive of Visual Arts MS 001, Box 14 Folder 134, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

editors. He may be in outer space but his feet are on the ground, technically speaking. A surprising number of space projects have ended up looking very much as McCall predicted they would look many years in advance. Second, he has the quality and scope of imagination to travel in space, and carry us, the spectators, along with him in full confidence that we are in the hands of a competent guide. Many of his pictures portray events which man never could see or photograph and which, without his talents, would remain in the realm of words, mathematical formulae and tapes electronic signals."[153] Cooke shared McCall's view that the working artist could use artistic dexterity to produce an image that was more meaningful that a photograph and conveyed arguably more information. This distinction was often collapsed into simply looking photographic. Isaac Asimov, with whom McCall had collaborated with on *2001,* wrote: "Robert McCall shows you the future! Robert McCall knows the real future and can show it to you so realistically that you are made to feel as though you have actually seen it before it existed in fact; and your children and grandchildren who will see it in "real life" will seem to have no advantage over you at all… It is clear as photography, except that photographs cannot be taken of things that do not exist at this now-moment of time. It is as sharp as photography, except that McCall's artist's eye arranges the balance and composition to make it mean more in beauty and excitement than a mere listing of objects within the frame can manage. It is as true-to-life as photography, except that the truth is to a life that your children will see and not yourself."[154] Asimov continues, explaining that McCall's work was meaningful because his optimistic images represented a future that had solved the problems of a cramped and resource-depleted Earth.

While McCall believed that the simple replication of photography was not an artistically meritorious, he also entertained the notion that there was a correct way to render the subjects he depicted. While helping document Apollo 11, Rauschenberg was making sketches from a large television monitor in mission control. Because of the distance between Earth and the Moon, there was a short gap of about three to five seconds from the moment anything occurred on the Moon to the time when the image was received and materialized on the television McCall was observing. McCall was working on a sketch of the lunar lander's ascent stage, depicting the moment when the Apollo 11 astronauts departed the Moon to return to orbit and rendezvous with the command module. "The sketch that I made, which was done in real time, real fast, fast sketch, Chris Kraft came by … and made some kind of a comment of an error in the way I viewed it. He said, 'Let me play that back for you…' I had seen it in real time, and I saw this blast of fire from the base of the ascent stage, and I had depicted it in a certain way that he thought was not correct. He said, 'Now, watch very closely and we'll replay this, and we'll replay it in slow motion,' and he did. And I felt real special that the director of the center was aware enough of this artist milling around and making these drawings, and cared enough to make this point. So, he played it back and I could see that he was

153. Art Exhibition Pamphlet, *Robert McCall: Space Artist,* Phoenix Art Museum, November 18 – December 31, 1972, Archive of Visual Arts MS 001, Box 28, Folder 365, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

154. Art Exhibition Pamphlet, *Robert McCall: Space Artist,* Phoenix Art Museum.

Figure 2.16— Left: Paul Calle, *Michael Collin*s, 1969. Felt tip pen on paper. Right: Paul Calle, *Suiting Up,* 1969. Pencil sketch. Courtesy of Chris Calle.

correct and that I had made an error. So, I made some changes."[155]

Though known in aeronautics circles, Robert McCall never achieved the same level of fame as other, later participants in the NASA Art Program. Despite this fact, he was one of the program's most long-standing participants, and his affiliation with NASA cemented his reputation as an artist of space subjects. His work was imaginative enough to signal its status as fine art but technical enough to be respected by more traditional standards of art evaluation.

Paul Calle, born in New York in 1928, was well-versed in government collaboration. A member of the New York Society of Illustrators, he worked with the U.S. Air Force Art Program and the National Park Service's Artist Program before joining NASA. He was one of the first participants in the NASA Art Program's first cohort of artists, eventually producing a set of postage stamps commemorating Apollo 11. Along with Robert McCall, Lamar Dodd, John McCoy II, Peter Hurd, Robert Shore, George A. Weymouth, and Mitchell Jamieson, Calle traveled to Cape Canaveral to sketch scenes from Gordon Cooper's flight aboard the Mercury Atlas-9. Artists were encouraged to produce preliminary drawings on site and return to their studios for more detailed rendering. Paul Calle's from-life sketches however, characterized his best-known works for the program.

As with Robert McCall's work, administrators emphasized that he was able to record the event in a way film could not, rendering ordinary gestures with a heroism that signaled their significance to viewers. Calle's drawings were monochromatic and gestural but embraced the same type of realism encouraged by NASA art program administrators. He described himself as both reporter and interpreter, "documenting

155. Robert McCall, Biographical Interview, Archive of Visual Arts MS 001, Box 14 Folder 134, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

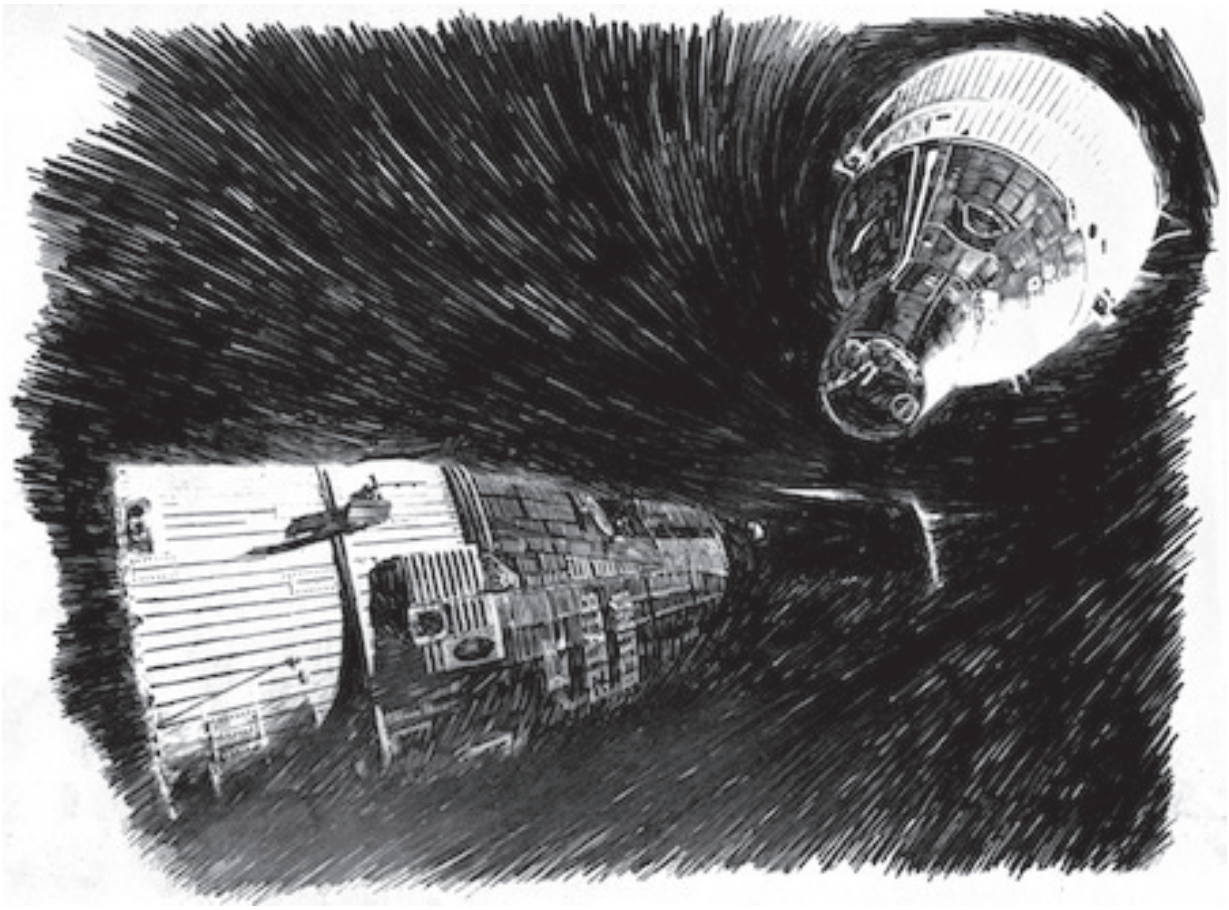

Figure 2.17— Paul Calle, *Gemini Capsule*. Courtesy of Chris Calle.

the historic journey into space."[156] His sketches functioned as documentation produced in person, reminiscent of courtroom drawings.

As with McCall, Calle believed that photography could be integrated into the drawing process in a way that produced an image that was more real than anything a camera could replicate. Calle felt that photographs included too much information, and that the key to a compelling image was selectivity in composition. Though famous for his pencil drawings, he worked in pen and ink to prevent himself from getting overly fixated on irrelevant details when working in person.[157] In his view, the camera was a tool to be integrated into the drawings process, but that the "slavish" copying of photographs was

156. Paul Calle, *The Pencil* (Cincinnati: North Light Publishers, 1974), pg. 89.

157. Calle did most of his work with an HB pencil but would occasionally use a 2H or a 4H for lighter areas. Pencil weights are understood on a scale arranged from hardest to softest, with the softest, darkest, greasier pencils assigned a B, and harder lighter pencils assigned an H. HB is in the middle of the scale, with 2H and 4H increasing in hardness, and better for achieving lighter, finer lines. Calle reserved the harder pencils for rendering subjects in the distance that still needed a great deal of detail. The rest of the variation was created by varying pressure on the HB. He also used a kneaded eraser, which could be molded into a fine tip, and didn't produce eraser crumbs that risked smudging. Pgs. 21 – 27.

Figure 2.18— Paul Calle, *Neil Armstrong*. Courtesy of Chris Calle.

a waste of effort.[158] This was an important distinction for Calle's working process, and he vehemently defended the incorporation of photographic material. Writing in 1971, he explained that the condemnation of the deployment of photography in the artistic process was in some cases justified. "However, with the discovery and realization that many painters, including Thomas Eakins, Cézanne, Degas, Lautrec, Picasso, and Shahn, have utilized photography in their work in some way, and with the respectability of the meticulously rendered projected photographic transparencies of the current American photorealism school, a re-evaluation is taking place in the attitude towards artists who utilize photographs."[159] The invocation of canonical western artists helped Calle justify his point—the photograph allowed artists to capture fleeting details that could be recomposed with artistic dexterity back in the studio.

While most of his sketching was supplanted by the additional use of the camera, he also emphasized the importance of learning how to draw basic forms to perceive the pictorial distortions sometimes introduced by photographs. [160] In Calle's philosophy, like McCall's, drawing was a process with correct and incorrect approaches. In discussing a portrait of Barye Phillips, the president of the New York Society of Illustrators, Calle explained that his process was oriented around solving the "inner problems" of the portrait study, "chiefly the general form, the middle-grays, the blacks, and the ever-important direction of all areas of line."[161] He framed the successful rendering of forms in terms of solutions to a problem, to which there were many possibilities in terms of content and composition." His typical procedure was to make several "thinking" sketches for his own use and then develop several visual possibilities he felt came closest to solving the "problem" he identified.[162]

After the completion of the Apollo program, Calle went on to paint mountain men and scenes of the American frontier. In his view, this was a conceptual complement to his depictions of American astronauts, who he viewed as heroic explorers charting difficult new landscapes. "The exploration of the vast frontiers of space by the United States will undoubtedly be recorded as one of the most significant events in the history of man since creatures left the oceans and sought to change their environment…." The significance of this task also elevated the status of the working artist: "I believe that H. Lester Cooke, Curator of Painting at the National Gallery of Art best summed up the

158. Even when I must work from a specific photograph, my objective is never to strive for a photographic rendering but to interpret, to add, to give it additional dimension." Paul Calle, *The Pencil*, pg. 33.

159. Calle, *The Pencil,* pg. 71.

160. "Draw from the human figure as much as possible. Only through repeated practice will you be able to understand the basic structure of the body. As you draw, you will also be constantly forced to make visual measurements, comparing the length of an arm with the torso, the upper leg versus the lower leg, the width of the hips compared to the shoulders… It is important to master drawing from life or from casts [physical models used for reference] before you start working with photographs which can greatly distort the proportions. This drawing is the only method which will enable you to gain a visual understanding of the volume of the figure. Reduce it to its simplest elements." Calle, 49.

161. Calle, pg. 45.

162. Calle, pg. 46.

aspirations of all who have taken part in this program when he wrote at its inception, 'perhaps this project will help to prove to future generations that the United States in the sixties produced not only engineers and scientists capable of shaping the destiny of our age, but also artists worthy to keep them company.'"[163]

In 1965 the National Gallery of Art organized a show titled *Eyewitness to Space*, which was understood to be one of the most successful in the museum's history. According to one account, turn-out for the show was second only to the museum's display of da Vinci's Mona Lisa.[164] Viewership of the exhibition wasn't just restrained to the District of Columbia, either. After its closing at the National Gallery, the show was packed up and sent to various institutions around the country for display. In 1969, the National Gallery of Art prepared a second exhibition in tandem with the NASA Art Program, titled *The Artist in Space*. Designed to coincide with the Apollo 11 Moon Landing, the show was likewise sent around the country once it finished in Washington.

Eyewitness to Space represented the culmination of the NASA Artist's Cooperation Program as it existed throughout the buildup to Apollo. It also represented a marked shift in how the art program was rationalized as an expenditure. Once the reasons for displaying American technological might began to fade, so did the reason for the Art Program. Once the agency's annual overall budget declined from $5.2 billion in 1965, to approximately $3 billion in 1972, it became much more difficult to justify spending on the arts.

At its inception, Hereward Lester Cooke anticipated a more robust budget for the commission of fine art. The original set of Mercury astronaut portraits, however, was estimated to cost around $22,500 and was ultimately abandoned because of the price tag.[165] The costs for fiscal year 1963 were reduced to $7,600 in total, by paying each of the seven initial participants $800. Mitchell Jamieson was paid $1,600, and $400 was budgeted for compensating any delays.[166] A tally made in December of 1970 concluded that seven years of funding the art program cost roughly $54,350.

Spending on the art program was always modest, compared to what participating artists were paid by private collectors. For their participation in the program, artists were to receive an $800 honorarium, regardless of the amount or quality of work produced. In Mitchell Jamieson's case, the initial 800$ wasn't even enough to cover

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163. Calle, pg. 105.

164. Anne Collins Goodyear, "NASA and the Political Economy of Art, 1962-1974," pg. 201.

165. Hereward Lester Cooke's assembled roster of potential portrait artists included Ian Hoowij, Gardner Cox, Willard Cummings, William F. Draper, and Franklin Watkins. Cox's proposed portrait of John Glenn fetched a $7,000 sum, and the $22,500 total didn't yet include a budgeted amount for a portrait of Gus Grissom. Anticipating the sticker shock, Cooke explained in his memo, "the portrait painting by America's leading artists is well organized, and although I believe it might be possible to have these artists paint the astronaut's portraits for sums less than those indicated here, I do not believe we will be able to reduce this figure by much." Hereward Lester Cooke, Memo to Shelby Thompson. Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

166. NASA Art Program Budget Breakdown, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

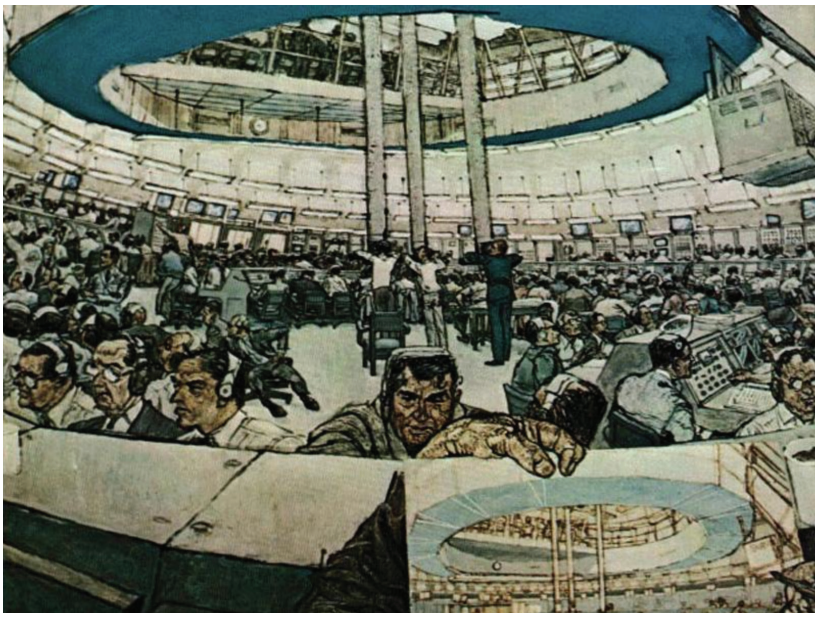

Figure 2.19— Fred Freeman, *Saturn Blockhouse*, 1968. Acrylic on canvas. As a participant in NASA's art program, Fred Freeman gained unlimited access to space facilities during missions. Courtesy of the Smithsonian's National Air and Space Museum.

his travel expenditures. To offset the imbalance, artists were encouraged to write off finished paintings as donations to the space program. If a painting was appraised at a certain dollar value, then that amount could be claimed on the artist's taxes.[167]

Despite efforts to run the program as efficiently as possible, NASA's changing funding climate made the procurement of consistent support a challenge. In 1974, the same year that *Eyewitness to Space* was published as a book documenting the work of the NASA Art Program, James Dean sent a frustrated memorandum to NASA's Assistant Administrator for Public Affairs. Citing a lack of institutional support for the Art Program he'd spent a decade cultivating, Dean recommended, with "extremely great regret," that the collection be given to the newly built National Air and Space Museum. There, he noted, it could be properly stored and cared for. No new art program activity would be started, "and," he continued, "if this decision cannot be reversed, we should not prolong its agony – and mine – any longer."[168] Dean's request was taken to heart, and later that same year he left his position at NASA to shepherd the collection as the National Air and Space Museum's chief curator of art. While the NASA Art Program was eventually reimplemented under a new director, it never enjoyed quite the same level of activity or access as during the buildup to Apollo. The art collection's move to the National Air and Space Museum signaled its new status as an object of the past.

The move to the Smithsonian also furthered the NASA Artist Cooperation Program's parallels with forms of military art. The museum was initially conceptualized by the Smithsonian Institution as a National Air Museum, to celebrate the hardware many perceived as hastening the end of the war.[169] Development plans had been in motion

167. Hereward Lester Cooke, NASA Art Program Memorandum, April 15th, 1963, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

168. Memo from James Dean to the Assistant Administrator of Public Affairs, "Subject: Expanded Art Program Coverage," January 24th, 1974, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C

169. F. Robert van der Linden, "Building a Collection" in *Smithsonian National Air and Space Museum: An Autobiography* (Washington D.C.: National Geographic, 2010).

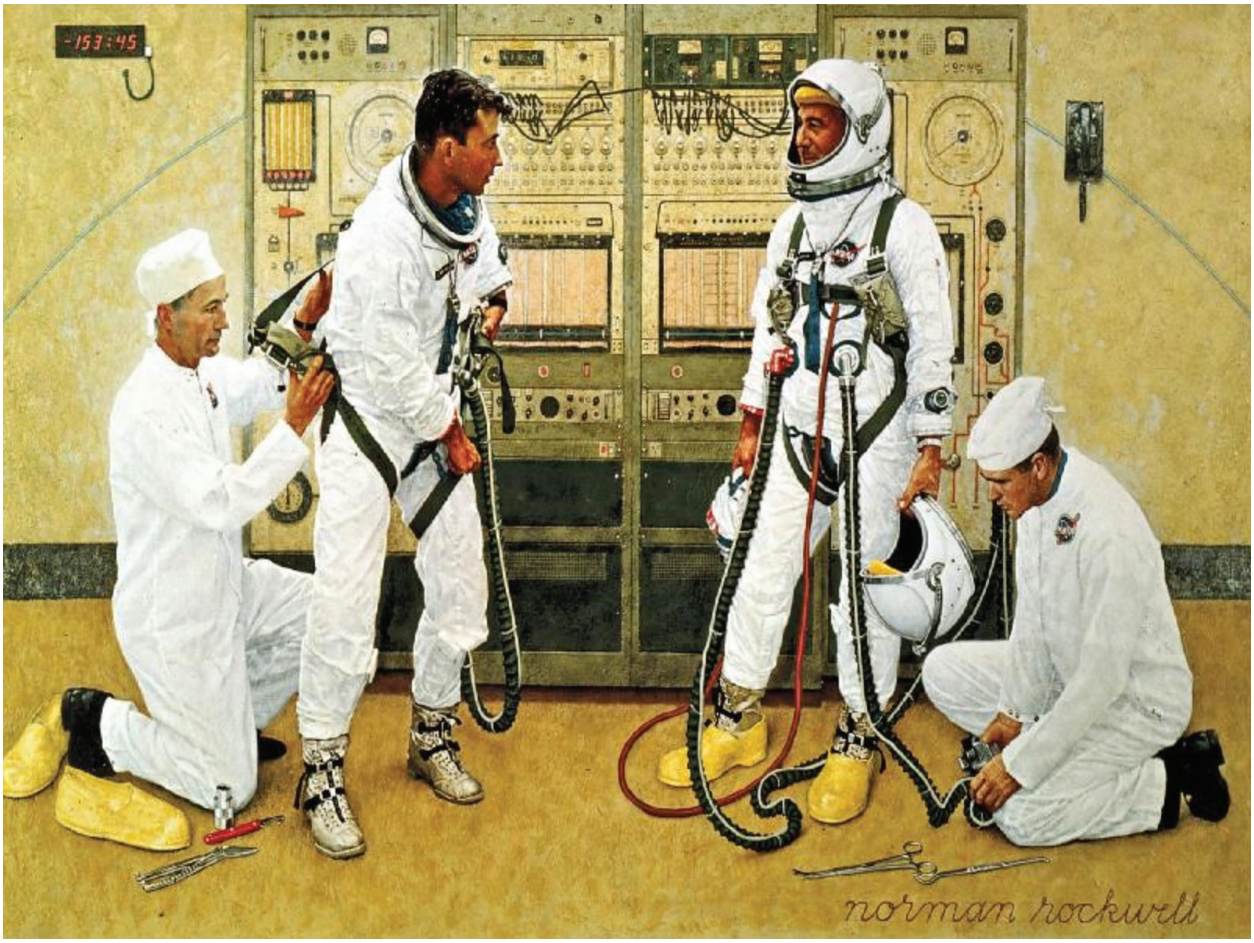

Figure 2.20— Norman Rockwell, Grissom and Young Suiting Up, 1965. Astronauts John Young and Gus Grissom are suited for the first flight of the Gemini program in March 1965. NASA loaned Norman Rockwell a Gemini spacesuit in order to make this painting as accurate as possible. Courtesy of the Smithsonian's National Air and Space Museum.

for the museum since 1955, but the launch of Sputnik catalyzed perceptions that space hardware was an innovation in the preservation of democracy. It soon became clear that the new museum would have to include spaceflight in addition to aeronautics, and the collection that eventually became the National Air and Space Museum sprouted from the National Air Museum's collection of war-time aviation.[170] Despite later efforts to reorient the museum's purpose towards an apolitical memorialization of nonpartisan scientific advancement, it was still the product of a temporary union between government national security interests and space science.

The display of aircraft was meant to celebrate the hardware in much the same way the paintings of the U.S. Air Force Art Program had. After the conclusion of World War II, military aircraft were systematically gifted to the Smithsonian in hopes of memorializing the aviation technology credited with helping win the World Wars. In 1946,

170. Joanne Gernstein London. "A Modest Show of Arms: Exhibiting the Armed Forces at the Smithsonian Institution 1948 – 1965" (Doctoral dissertation, George Washington University, 1999).

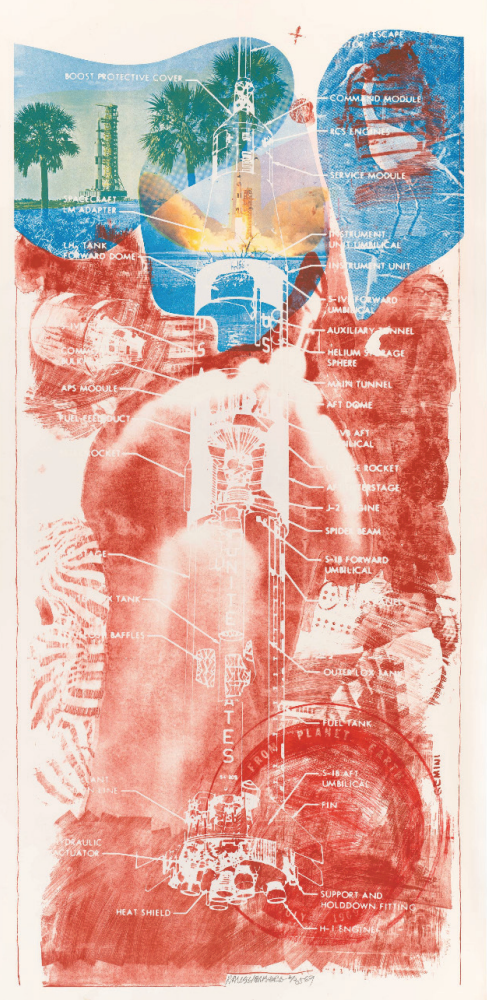

Figure 2.21— Robert Rauschenberg, *Sky Garden (Stoned Moon),* 1969. Lithograph and screenprint. Credit: Collection SFMOMA Gift of Harry W. and Mary Margaret Anderson. Copyright © Robert Rauschenberg Foundation and Gemini G.E.L.

legislation was passed to formally establish the National *Air* Museum on the National Mall, but the collection quickly outgrew the physical spaces allotted to it—even the Quonset hut erected by the War Department behind the Smithsonian Castle—and it was understood that the objects would eventually require their own building.[171] In 1966, when Lyndon Johnston changed the name of the National Air Museum to the National Air and *Space* Museum, it was to pivot the collection away from its predecessor's overt militarism; however, after the museum's collections were expanded to include artifacts relevant to the pursuit of space, an Army Jupiter-C satellite launcher, a Navy Vanguard satellite launcher, and a Navy Polaris A-3 missile were among the first objects added.[172]

When funding was finally granted to the National Air and Space Museum for the construction of a new building in 1971, Smithsonian administrators were sensitive to accusations that they'd installed a war museum in the nation's capital. Because the presence of such a museum in a space as heavily self-curated as the National Mall was a poor way to counter the United States' growing international reputation as a belligerent nation, Smithsonian administrators insisted that the museum emphasize NASA's distinctly civilian orientation.[173] One of the reasons it was so hard to make the National Air and Space Museum seem like a civilian enterprise however, was because the history of the space program itself was at times indistinguishable from that of the American military. [174]

171. London, "A Modest Show of Arms," pg. 30.

172. London, pg. 115.

173. London, pg. 125.

174. A good example of the Air and Space Museum's struggle to maintain a civilian status is the controversy over the Enola Gay, the aircraft that dropped an atomic bomb code-named "Little Boy" on the Japanese city of Hiroshima. A group of veterans lobbied to display the aircraft in the museum, and in 1995, the nose and cockpit of which were exhibited for the bombing's 50th anniversary. The controversy over the display, which critics claimed lacked appropriate historical context with respect to the devastation wreaked on Hiroshima, was so acrimonious that the exhibition was cancelled, and the director of the museum forced to resign. Otto Mayr, "The 'Enola Gay' Fiasco: History, Politics, and the Museum" (*Technology and Culture,* Vol. 39, No.3, July 1998).

By the time construction was completed on the Air and Space Museum's new building in 1976, the political tensions that characterized the previous decade had started to wane. In other words, the Cold War motivations that married government resources with a civilian space program were dissipating, and in the wake of the Apollo moon landings, NASA struggled to define its long-term purpose. The agency's budget, which had grown to over four percent of federal spending in 1967, was cut down to less than one percent by 1978, and as a result, many of the projects envisioned for the post-Apollo space program were reduced in size or eliminated altogether.[175]

This period in the history of NASA as an organization was characterized by budget reductions across the board, and this dynamic was reflected in the agency's pictorial output just as it had been in the decade prior. The NASA Artists Cooperation Program was a centralized mechanism for the commission of fine art, and it functioned as evidence of an agency with a large budget and clear unified goal. The smaller unmanned missions of the 1970s were often administered at different NASA facilities, and occasionally competed for funding. As a result, images commissioned to help publicize individual projects and scientific objectives were often commissioned by individual research centers.

Just as the Apollo Program opened a need for artistic interpretation of difficult-to-picture concepts, the pivot from manned spaceflight to unmanned robotics missions in the 1970s resulted in a need for illustrations that visualized distant and sometimes unseeable scientific subjects. For example, over the course of the 1970s, Don Davis was hired to produce art for several projects managed out of NASA's Ames Research Center in northern California. The art he produced for the Pioneer Project Office was used in several NASA press kits and helped envision what spacecraft might look like when operating in their respective research environments. NASA Ames was also home to the famous 1975 Space Settlement Design Study, produced in conjunction with Stanford University and Princeton physicist Gerard O'Neill. The space settlement paintings made for the study—produced mostly by Don Davis and fellow California artist Rick Guidace—are discussed at length in the next chapter.

The NASA Art Program waned in the post-Apollo years but took on a new—if reduced—momentum during the development of the space shuttle in the 1980s. The art program continued throughout the 1990s, commissioning works from a range of different artists, but moved more gradually into the realm of non-representational art. The move away from the types of realism described in this chapter, seen in conservative institutional circles as the most valid form of artmaking, made it increasingly difficult to justify expenditures to skeptics that had lived through the culture wars of the 1980s.

Art at NASA received renewed scrutiny in 2003, when Laurie Anderson became the National Aeronautics and Space Administration's first, and last, "official" Artist-in-Residence.[176] She was paid $20,000 for two years of participation in the program,

175. Howard McCurdy, *Inside NASA* (Baltimore: Johns Hopkins University Press, 1993), pg. 50.

176. Anne Hull, "Moon and Stars Align for Performance Artist," *The Washington Post,* June 30th, 2004, https://www.washingtonpost.com/archive/politics/2004/06/30/moon-and-stars-align-for-performance-artist/aa5e411d-1a85-4865-a696-07ff9e97d9a6/.

during which she traveled to different NASA research centers compiling material for a 90-minute monologue. The resulting performance piece was met with mostly favorable reviews from critics, many of them surprised by Anderson's unlikely patron.

The collaboration was short-lived. Seemingly in step with the surprise expressed at NASA's unexpected encouragement of artistic interpretation, Congress eliminated the Artist-in-Residence program shortly after Anderson completed her contract.[177] In 2006, Christopher Chocola, a Republican member of the House of Representatives, spearheaded the motion to eradicate spending on the arts from NASA's budget.[178] He characterized Anderson's appointment as clear fiscal mismanagement:

> "This is really about prioritizing spending and fiscal responsibility. Over the last two years, NASA has spent $20,000 for an artist-in-residence program. My amendment is designed to prevent that practice in the future. Nowhere in NASA's mission does it say anything about advancing fine arts or hiring a performance artist… $20,000 may not seem like much in the Halls of Congress; but to the average American family, it is a significant amount of money. I wish I could say that NASA is boldly wasting taxpayer money where no agency has wasted it before, but I am afraid that the artist-in-residence program is just a symptom of a bigger problem."[179]

Alan Mollohan, a Democrat present for the vote, responded:

> "I rise not in opposition, I am going to agree to the amendment, but I would like to have some comment before I do… First of all, it involves an awfully little bit of money. Secondly, I think it sends a bad signal. One of NASA's missions is to inspire; and it has had an arts program, a very small arts program, since 1962. It is a worthy program. There is no reason to believe that this initiative, which is so modest in nature, would do anything but further enhance the arts program at NASA. Again, it is so small that it is just minuscule. I am afraid the amendment

177. Keith Cowing, "NASA's First and Last Artist in Residence?" NASA Watch, June 21st, 2005.

178. "Chocola amendment… prohibits the use of funds by NASA to employ any individual uner the title, "artist in residence." The amendment was adopted by a voice vote. "Appropriations Bills Monitored by the Committee on Science," H.R. 28262, *United States House of Representatives Legislative Calendar,* One Hundred Eighth Congress, Committee on Science, pg. 209.

179. Amendment No. 1 Offered by Mr. Chocola, Congressional Record Excerpt, *Science, State, Justice, Commerce, And Related Agencies Appropriations Act, 2006,* House of Representatives (June 15, 2005): H4530.

really represents more art-bashing than it does good fiscal policy."[180]

The exchange between Chocola and Mollohan—indicative of much deeper misgivings about the relationship between art and government spending—provides a useful illustration of the thin line that existed between utility and waste when determining monetary value from an institutional standpoint. When compared to James Webb's petitions for an art program in 1962, the rhetorical shift in the characterization of Anderson's work as frivolous looks more surprising. Just forty-four years before the hearing on the Laurie Anderson's unbefitting residence, NASA administrators and their political supporters used a wide gamut of impassioned speech to argue that fine art was necessary in making the work of the space program legible to taxpaying audiences.

180. Conservatives hailed Chocola's intervention as a responsible one, and characterized Mollohan's position as out-of-touch. "So long as veteran lawmakers such as Mollohan and Jackson Lee see nothing wrong in funneling taxpayer dollars to such bizarre ends-This is how artist Laurie Anderson described her taxpayer-funded film: "It begins with this idea of stuttering and how difficult it is to start things. And it's connected to the rocks in many ways"-efforts to shrink the federal behemoth will flounder." Michael Franc, "Legislative Lowdown—Week of June 27th," Heritage Foundation Commentary, June 27th, 2005, https://www.heritage.org/commentary/legislative-lowdown-week-june-27th.

Chapter 3 — Making the Space Environment Visible: The Utility of Astronomical Art in the Apollo Period

In an interview with *Missiles and Rockets,* Walter "Wally" Schirra explained a problem he hoped to address over the course of the Gemini program. "The best films and hand-held cameras have consistently failed to record precisely some unexpected things seen from orbit." But, Schirra explained, this problem sometimes also extended to human vision. In the article, the Project Mercury astronaut cited a controversy started when Gordon Cooper claimed he saw buildings and possibly smoke on the Himalayan Plateau. Optical experts were convinced this was beyond the capabilities of human vision at such a great distance and must have been a form of visual hallucination. Other astronauts however, reported seeing aspects of the Earth's surface that technically should not have been visible. Schirra himself reported seeing the wake of a water skier on the Salton Sea, and John Glenn claimed he saw the faint tracing of dirt roads while flying over Mexico.

To settle the debate, Schirra suggested astronauts be given crayons to record what they saw, so that their visual observations could then be crosschecked back down on Earth. In addition to clearing up whether or not these sights were beyond the capabilities of the human eye, he provided *Missiles and Rockets* with a list of visual phenomena that cameras could not capture anyway: the color-change of planets as they sunk through bands of visible light at the horizon; "Moonset," which produced a bright halo film never recorded; and so-called "red-arcs," an ionization phenomenon that occurs at an altitude of about 150 miles.[181]

Wally Schirra's proposal, which suggested integrating visual documentation into the labor of spaceflight, represents a familiar solution to a common problem in the history of the exploration: using humans to document what technology could not yet render. Because of the rapid progression of Project Apollo's advancements into space, technological solutions for many problems of visualization did not yet exist. This chapter explores the ways in which artists were treated as a type of professional expert in matters of the visual, and how this contribution was understood within NASA. While Chapter Two focused on how fine art functioned as a form of cultural documentation, this chapter focuses on its conceptual complement—artists rendering supposedly objective visual information for use in large technical systems. Instead of emphasizing the identity of the individual artist, these illustrators were anonymized to bolster the impartial status of the images produced. According to institutional narratives, these were not art objects, but something more functional.

This chapter explores the hazy boundaries between fine art and illustration by exploring the ways in which astronomical illustration was differentiated from work produced in places like the NASA Artist's Cooperation Program. The types of problems Wally Schirra described, ones in which a professional was needed to make visible phe-

181. Because of the challenges inherent to oil paint and other wet materials, commercially available crayons were considered the best possible material. Russell Hawkes, "Astronauts May Become 'Artists," *Missiles and Rockets*, date unknown, Artist Files, Aeronautics Department, Smithsonian's National Air and Space Museum, Washington D.C.

nomena legible to others, ultimately created room for radically different forms of artistic work within the same institution. By the 1960s, artists able to depict what cameras couldn't were fully integrated into Project Apollo. This chapter follows the careers of Patricia Bridges and Don Davis, both employed as astronomical illustrators, to demonstrate how social mechanisms reinforced certain images as utilitarian and obscured their artistic interventions.

Patricia Bridges was an artist hired to produce lunar illustrations for the USGS's Office of Astrogeology in Flagstaff, Arizona. Unlike Chesley Bonestell or members of the NASA Artist's Cooperation Program—artists who actively cultivated their celebrity as artists associated with the sciences—Bridges, and the illustrators she helped train, were dissolved into the broader institutionalized "seeing" apparatus deployed to make the lunar surface legible. Their careful drawings of the lunar surface were treated as the mechanical transcription of visual information, cementing their status as a form of utilitarian image making and distinct from the artwork being produced by the NASA art program. Despite efforts to distinguish technical forms of illustration from fine art, Bridges' technique of carefully reproducing elements of lunar photography gained traction in the fine art world at roughly the same time. Her career is one that showcases the difficulty in establishing fine art and illustration as cleanly oppositional categories, as opposed to labels coproduced between artists and their audience.

Don Davis, Bridges' protégé at the Office of Astrogeology, demonstrates how the techniques Bridges developed were metabolized into astronomical illustration as a practice and carried over into the next decade. Davis' career, which grew from illustrating hard-to-see phenomena to representing phenomena-that-did-not-yet-exist, represents how the visual needs of space science changed in the post-Apollo period. Rather than serving as a pictorial stopgap in the way flagged by Wally Schirra and carried out by Patricia Bridges, Davis deployed his technical precision to make ambitious space hardware of the future appear as plausible as possible.

I. Patricia Bridges: Techniques for Sharpening Clarity

In 1960, Gerard Kuiper, a planetary scientist at the University of Arizona, concluded that he needed an artist. Kuiper was working on a lunar atlas to help the United States map logistics for an eventual Moon landing, and though he was able to compile a robust portfolio of images from several astronomical observatories, the maps needed a higher degree of pictorial clarity.[182] As discussed in the previous chapter, in the early days of the Space Age the quickest way to sharpen resolution was by hand, using different drawing techniques to clarify fuzzy or ambiguous forms. Kuiper was a committed visual observer of the Moon via telescope. He believed it was impossible to interpret the

182. In 1960 Kuiper established the Lunar and Planetary Laboratory at the University of Arizona, where lunar work required interpretation of Ranger and Surveyor probe results. Kuiper published *The Orthographic Atlas of the Moon* the same year and immediately began work on the *Rectified Lunar Atlas*. Observations made in between revealed many more concentric basins on the lunar surface, which needed to be rectified with histories of early lunar impact. Dale P. Cruikshank, *Gerard Peter Kuiper: A Biographical Memoir* (Washington D.C.: National Academy of Sciences, 1993), pgs. 275 – 276.

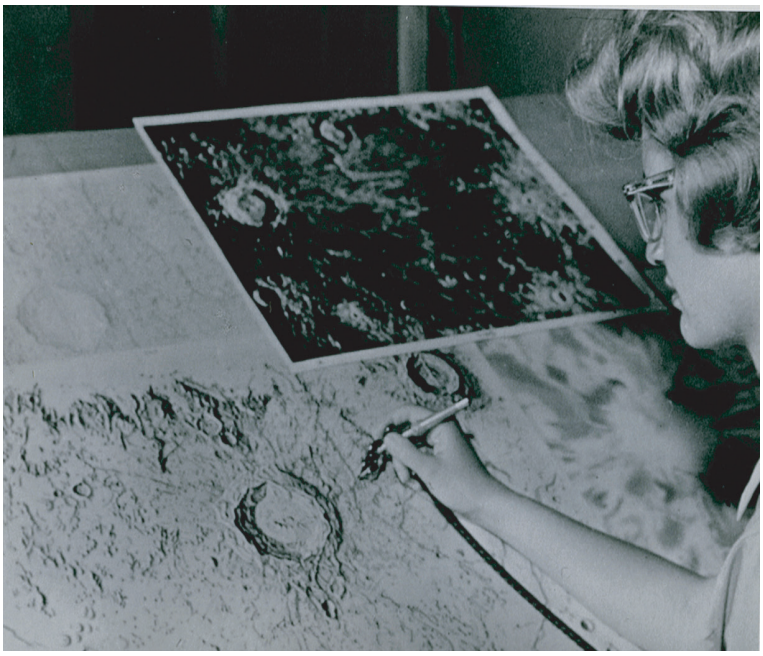

Figure 3.1— Top: "Pat Bridges creates a lunar map," Lowell Observatory's Lunar Legacy. Bottom: Patricia Marie Bridges at her drawing table, working with airbrush and air compressor. Courtesy of Lowell Observatory.

structure of lunar topography using photographs alone because the human eye could perceive so much more information.[183]

According to lore that recalls Pliny the Elders' recounting of Zeuxis's feats of pictorial mimesis, Kuiper reportedly filled this position by supplying several artists with a lunar photograph and asking each of the contenders to replicate the image.[184] He hired the artist who produced the most natural looking replica, a twenty-eight-year-old art school graduate named Patricia Marie Bridges, née Mitchell. Bridges had worked briefly restoring murals in government buildings in St. Louis, but when the project concluded she took up a job at the U.S. Air Force Aeronautical Chart and Information Center nearby.[185] At the ACIC, she was hired to add shaded relief to topographic contour maps of different landscapes in the United States. As a function of her time in terrestrial mapping, she learned how to use an air-brush to sharpen the resolution of topographical information, making her exactly the type of candidate Kuiper was looking for.

In Bridges' version of the story, in 1960 a special project came across her desk from the ACIC Development

183. Z. Kopal and R.W. Carder, *Mapping of the Moon: Past and Present,* Vol. 50, Astrophysics and Space Science Library (Boston: Reidel Publishing Company, 1974), pg. 147.

184. Donald Davis, interviewed by author, May 26th, 2020, transcript of phone interview, pg. 15.

185. Interview with Patricia Marie Bridges by Gerald G. Schaber, April 12th, 2001, USGS Open-File Report 2005-1190, transcript, pg. 43.

Figure 3.2— Pictured (left to right) are Eugene Shoemaker, James Lovell, Neil Armstrong, Arthur Adel, Charles Conrad, Frank Borman, and John Young studying a lunar map drawn by Patricia Bridges. January 17, 1963. Courtesy of Special Collections and Archives at Northern Arizona University.

Office—a set of photographs from Kuiper's lunar atlas that required the same level of visual clarity she had been coaxing from Air Force maps. The ACIC office's cartographic resources had recently been contracted by NASA to produce a set of maps of the lunar surface, so it made sense that Kuiper's atlas images should reach one of the Chart Center's illustrators.[186] Regardless of whether Bridges actively competed with other artists for access to the project, the Kuiper photographs marked the beginning of her work with telescopic observations.[187]

NASA, interested in mapping the lunar surface in preparation for the Apollo Moon landings, was impressed by the first two lunar charts and requested the ACIC work with Lowell's 24-inch refractor telescope to map the entire Apollo zone. Though the scale of the project was large, it was initially estimated that the job could be done with just two observers and one full-time illustrator in residence at Lowell Observatory. The ACIC office at Lowell was formally established in an old wood-frame building on the

186. Interview with Patricia Marie Bridges, pg. 44.

187. Z. Kopal and R.W. Carder, *Mapping of the Moon: Past and Present* (Boston: Reidel Publishing Company, 1974).

Figure 3.3— Patricia Bridges working on a lunar map in her office at Lowell Observatory.

observatory grounds in September of 1961, and staffed by cartographers Bill Cannell, James Greenacre, and the freshly minted lunar illustrator Patricia Bridges. The flow of labor early on was such that Cannell and Greenacre produced the observations, while Bridges would render the relief drawings.

The story of Patricia Bridges' selection for the lunar mapping project via competition in mimetic replication is very much in keeping with the way her work was made legible to scientific institutions. Most accounts of the ACIC's Moon mapping project at Lowell emphasize Bridges ability to draw impartially. In Z. Kopal and R.W. Carder's 1974 *Mapping of the Moon: Past and Present,* Bridges was selected not because of her adjacency to ACIC mapping projects, but because of her "intense interest in the Moon and her exceptional ability to interpret the lunar forms and render them with an airbrush."[188] In Kopal and Carder's account, one of the most comprehensive overviews of

188. Kopal and Carder, *Mapping of the Moon,* pg. 151.

Bridges' lunar mapping efforts to date, her drawings were characterized as entirely "free of interpretive style," imparting on the viewer a "convincing impression of realism" with respect to the shape and character of lunar features. As with Bonestell's collaborations with Willy Ley, which emphasized the neutrality of his interpretation and likened him to a human camera, Bridges' drawings were compared to lunar photography—the standard of resolution to which her images were held.[189]

The naturalism ascribed to Patricia Bridges' work really referred to an adeptness at replicating photographic resolution—in the much same way Chesley Bonestell's work did. Both Bonestell and Bridges can be thought of as twentieth century examples of much older practices in scientific visualization. As with the medical or botanical illustrations of previous centuries, a gap in science's ability to record observation was filled-in by a trained artist whose expertise and impartiality was emphasized in a way that makes their images read as authoritative representations.

In Daston and Galison's *Objectivity,* the scientific illustrator was eventually displaced by the camera, a mechanical tool seen as free from human fallibility. In this mid-twentieth century version of the story, photography became a benchmark by which to judge illustrations. Photographs were incorporated as a tool in a process that upheld mechanical vision's epistemological dominance. In other words, while the lunar surface proved difficult to photograph clearly, photographs were still privileged as the most "objective" type of image possible. However, as Daston and Galison have shown, the epistemological status of the camera can be best understood as the product of anxiety surrounding human bias, rather than photographic technology's unique ability to inscribe reality.[190] Bridges' anonymity was one of the tools that signaled the empiricism of her lunar illustrations. Whereas Bonestell was celebrated by his collaborators as having a singular talent for painting accurately, Bridges was entirely subsumed in the visualization process, becoming a mechanical component herself.[191]

Recasting Bridges' work as active perception coupled with a highly cultivated professional dexterity—as opposed to the unthinking duplication of visual information—helps clarify the extent of her contributions to the picturing of space. Comparisons of Bridges' illustrations to the output of a camera cemented her as an infallible visualization tool in the ACIC's lunar mapping process. This framing functioned to assuage anxieties about the accuracy of hand-made images, but it is also reminiscent of the way women "computers" hired to perform astronomical calculations in the eighteenth centu-

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189. Kopal and Carder, *Mapping of the Moon,* pg. 152.

190. If several photographs were made of a single subject with stable lighting and from the same perspective, but different camera formats were used—say a daguerreotype, a calotype, a polaroid, or even a high-definition digital camera—the final set of photographs would contain several images that looked very different from one another. Each of them would differ from the view of the naked eye. In this scenario, none could necessarily be said to be a "more" objective view than the other, but rather, each image could be described as having its own subjective mechanical interpretation. Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2010).

191. Bridges subsummation into an institution's work mirrors the plight of women computers in the 19th and twentieth century. Computer programming, work that is now viewed as warranting professional expertise, was thought of as mindless and mechanical enough it could be performed by women.

ry were integrated into larger systems of observation.[192] Their labor was seen as mechanical instead of cognitive, a process more akin to transcription rather than interpretation. However, as Lisa Messeri has pointed out in her work on placemaking in contemporary exoplanet research, calibrating discrete data points into a coherent "picture" of a world often poses a serious conceptual challenge. If information about an alien landscape only exists in an incoherent patchwork of observation, then the process of excavating what the experience of this place is like requires a significant amount of gap-filling.[193]

The work of "placemaking," according to Messeri, happens when abstract data sets about a vast and distant subject are reworked into a comprehensible picture. A "place" exists in abstract terms and is "made" once those abstract terms are reconstituted into something we can recognize as a type of knowable topography.
Though Patricia Bridges' work was viewed as the nonparticipative replication of topographical information, she can be easily recast as an active process in the Apollo program's placemaking efforts. There is also a political dimension to this type of work—if maps are how landscapes are made legible to the nation-state, then Bridges' work can be seen as an important step in U.S. expansion onto the lunar surface.

Bridges' contemporaries emphasized her role as a passive vessel for astronomical knowledge to bolster her credibility. This framing, however, erases the technical strategies she developed to replicate photographic clarity. Between 1961 and 1964, Bridges developed a set of techniques for airbrush use that became standard for illustrators employed by the ACIC at Lowell Observatory. The airbrush at the center of Bridge's practice was the Paasche AB, a precision instrument powered with compressed gas. Though already capable of rendering extremely fine detail, Bridges learned to sharpen the needles for even finer forms of mark-making. Airbrushes, which don't resemble typical paintbrushes so much as gun-shaped ink pens, work by passing paint pigment onto paper via a high-pressure stream of air. The paint is atomized into tiny droplets onto the surface of the image, producing an effect like that of a miniature spray can. Because of the nature of the soft-edged lines made by an airbrush, hard-edges needed to be produced using stencils, necessitating a level of image planning largely absent in oil painting. The trade-off for Bridges was a much higher degree of control.

To produce a drawing, Bridges would start by spraying paint onto the paper's surface but leaving blank the areas meant to function as highlights.[194] She formed lunar craters by contrasting light and dark shapes to suggest the appearance of physical depth. Occasionally, airbrush overspray would creep into the white space that meant to read as reflected light, which Bridges addressed by developing a rotating mechanical eraser

192. For more on the use of women in computing in early astronomy, see David Alan Grier, *When Computers Were Human,* (Princeton: Princeton University Press, 2007). For analysis of the gender dynamics that affected the early history of computing, see Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and List its Edge in Computing* (Boston: The MIT Press, 2018).

193. Lisa Messei, *Placing Outer Space: An Earthly Ethnography of Other Worlds* (Durham and London: Duke University Press, 2016.) Pg. 123.

194. Donald Davis, interviewed by author, May 26th, 2020, transcript of phone interview, pg. 14.

that could lift pigment off the map. This gave the artists an even higher degree of control over highlights and shadows. The maps were then reproduced at a 1:1 scale from the original art, meaning the final product handed over to the USGS was the same size as the drawings Bridges created.[195]

Bridges was also responsible for incorporating naked-eye views of the lunar surface into her illustrations. The ACIC office was placed three-hundred feet from Lowell's 24-inch refractor telescope.[196] A telephone was installed between the telescope and the office, and while Greenacre or Cannell looked at the Moon, Bridges would sit in the office working on a drawing of the topography under observation. On occasions when conditions were especially clear, or a particular lunar feature was illuminated, Bridges was called up to examine the telescope herself. When Bridges was not present, Greenacre and Cannell attempted to record their observations by drawing sketches of what they saw or annotating preexisting photographs.[197]

To her collaborators, Patricia Bridges' work was a neutral transcription of scientific knowledge and ultimately a passive form of labor. However, if her work is viewed in the context of map-making as a strategy for rendering landscapes legible to political bodies, then Bridges' work can be seen as a substantive contribution to the midcentury project of making the Moon a more clearly legible surface. In other words, Patricia Bridges helped the United States "see" the Moon and Mars more clearly and passed these techniques onto a protégé that capitalized on astronomical illustration's status as a form of legitimate scientific image making. Bridges' work is also a case study in the perception of photographic levels of pictorial resolution as the most accurate form of visual information possible. If contextualized in the history of scientific photography, then Bridges' "impartial" illustrations reinforce the theory that eradicating the visual traces of an artist's hand was an effective strategy for assuaging fears about the fallibility of human perception. Though Bridges herself did not consider the drawings she produced for the ACIC to be viable art objects, considering them as such helps recenter her agency as an image maker.

The other way to Bridges' work can be reframed as an intellectual contribution is by comparing her lunar surface drawings to similar-looking works produced in the fine art world at the same time. This can be done most directly by comparing Bridges' work on ACIC charts to Vija Celmins' detailed drawings of the lunar surface. Vija Celmins, a Latvian artist awarded both a Guggenheim and MacArthur fellowship over the course of her career, was explicitly celebrated for many of the same reasons Patricia Bridges was considered a type of pictorial automaton.[198] Some of Celmins' careful graphite drawings were based on photographs of lunar topographies, and the finished products look very much like Bridges final maps. These drawings, categorically "fine art," are a telling

195. Donald Davis, interview, pg. 15.

196. Kopal and Carder, *Mapping of the Moon,* pg. 155.

197. Ibid., 156.

198. Roberta Smith, "Deep Looking, with Vija Celmins," review of retrospective at the Met Bruer, *The New York Times,* September 26th, 2019.

Figure 3.4— Left: Vija Celmins, *Moon Surface (Surveyor 1),* 1971–72. Graphite on acrylic ground on paper, 14 x 18 1/2 in. Right: Source photograph for *Moon Surface (Surveyor 1)* with masking tape added. The Museum of Modern Art, New York, Gift of Edward R. Broida © 2009 Vija Celmins. Photo, McKee Gallery, New York.

conceptual foil to the ACIC map making process.

Beginning in the 1960s, Celmins echoed early photorealistic painters by deploying photography as a central tool in the artistic process.[199] By the early 1970s, she focused her large-scale monochrome graphite drawings on images of flat and barren landscapes, like deserts, oceans, and starfields.[200] In the same period, Celmins incorporated Lunar Surveyor photography—the same types of orbital photographs used in Lowell's lunar mapping efforts—to produce detailed drawings of the Moon's surface.[201]

Art critics and historians made sense of Celmins work as something explicitly more than simply copying the visual information of a photograph, even if the artist herself claimed the images were meaningless. Writing in 2010, London Tate curator Stephanie Straine reluctantly characterized Celmins as a realist, though admitting that Celmins' working process was fundamentally "an image-based, photographically-assisted practice." Despite similarities to Photorealists like Chuck Close and Richard Estes, Straine quickly reminded readers that Celmins' work "evolved beyond the basic conceit of copying a photograph." In Straine's explanation, "the absurd level of detail registered via the photographic structure" disrupted "the standard creative 'inventiveness' of drawing." Celmins' graphite drawings, like Bridges' maps, were not "brought forth from

199. She cited Chuck Close as an influence as well as Richard Estes a, one of the Photorealists included in the Stuart M. Speiser Collection of Photorealism, discussed in Chapter Two.

200. Stephanie Straine, "Dust and Doubt: The Deserts and Galaxies of Vija Celmins," *Tate Papers,* no. 14, Autumn 20210, ISSN: 1753-9854. https://www.tate.org.uk/research/tate-papers/14/dust-and-doubt-the-deserts-and-galaxies-of-vija-celmins#footnote-25

201. Celmins could also be said to be working in conjunction with a larger scientific institution. "The galaxy image, specifically of the Coma Berenices constellation, is a general reference source found by the artist in the bookshop of the California Institute of Technology in Pasadena." Strain, "Dust and Doubt."

the recesses of the artist's consciousness or worked out from a direct life encounter; they simply filter through from photograph to graphite form, broken down into small particles as they are deposited on the paper." For Straine, the displacement of artistic intervention this was precisely what made Celmins' drawings profound. While the replication of photographic material appears, on the surface to be a rigidly anti-subjective approach, it also represented an act of "letting go" within the activity of drawing.

In this context, a fine artist's "copying" of a photograph of a space subject can be explained as a substantive meditation on the nature of representational art. Just as Patricia Bridges wrote off her own work as fundamentally technical, Celmins speaking about her drawing *Untitled (Desert–Galaxy)*, explained, "It really has no meaning. These images just float through from my life; they have no symbolic meaning …"

Straine's interpretation, that Celmins' radical decentering of her role as an artist in the drawing process made her something more than a Photorealist, was shared elsewhere. Writing about Celmins' "Cyborg Eye" in *American Art,* Cécile Whiting described the artist's lunar drawings, the ones that bear the greatest conceptual similarity to Bridges' work, as especially profound. Whiting describes the drawings as "a collaboration between body and machine" that made "details of the alien lunar landscape visible to the human eye."[202] For Whiting, Celmins' intervention were explicitly feminist. Celmins adopted the cyborg body of remote vision, but without taking on an "implicitly masculine perspective." Rather, "she explored and defined a form of embodied vision that avoided binaries, whether between human and machine, or between masculine and feminine."[203] She had inserted herself, a woman, into the cold unfeeling technical apparatus of the space program.

Bridges' and Celmins' working methods, which centered photographs of remote topographies, shared a similarly technical style. It is difficult to describe Celmins' artistic interventions, especially those described by Straine and Whiting, without extending the same insights to Patricia Bridges. In Bridges' case, the fact that her work was seen as an extension of a larger technical apparatus was precisely why her drawings were characterized as categorically different from artistic practice. She was copying information, not creating it, and this was what subsumed her into the anonymity of scientific image making. In fact, her approach to "seeing" the lunar surface and transmuting visual information into two dimensions was so disembodied, that she was able to abstract the practice and teach it to other people, establishing for the group a sort of neutral non-style. In Celmins' case, her collaborations with mechanical hardware were what elevated her work above the elemental "copying" of photography.

The double life lunar drawings lead in the realm of fine art can help tease out the social dynamics that flattened Patricia Bridges into the hardware of the Space Age.

It's not as though Vija Celmins somehow became aware of Patricia Bridges' work and copied it in an artistic context. Rather, the context in which Celmins' work is read gives her working process—one she largely shared with Bridges'—elevated meaning.

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202. Cécile Whiting, "It's Only a Paper Moon: The Cyborg Eye of Vija Celmins," *American Art,* Vol. 23, Number 1, 2009. Pg. 37 – 55.

203. Whiting, "It's Only a Paper Moon," pg. 53

Suggestions that Celmin's work was brilliant because she managed to remove herself from the art she produced are still valid. The same interpretive lens, however, can also be used to make sense of why Patricia Bridges drawings were conceptually important.

By 1964, the Moon mapping project had grown significantly, and the ACIC began contracting personnel at Lowell to help with the endeavor's growing scale. Lowell Observatory's director, John Hall, eventually suggested that a motion picture camera be used to supplement the visual record produced by human observers. A motion picture camera allowed many photographs to be taken at once, increasing the chance that a particular area would be captured while stationary. The ACIC installed a 35mm motion picture camera on the telescope and expanded its contract with Lowell to include a new darkroom for developing film.[204]

Photographic methods for capturing lunar details caught up with the need for Moon maps as early as 1964. Bill Cannell used the Naval Observatory's Flagstaff Station to produce long exposure photos during a full Moon, producing images the organization deemed fantastically sharp. The ACIC was also very interested in the Ranger 7 photos produced the same year, the first images of lunar features produced so close to the Moon's surface.[205] By 1966, there were only seven of the commissioned forty-four lunar charts left to complete, and NASA was preparing to launch a new set of orbital satellites. The first three of this series—referred to as Lunar Orbiters—were launched in 1966 but had little influence on the mapmakers' visual observations. The Orbiters circled the Moon's equator, while the lunar regions left to map were located at the poles. The fourth Lunar Orbiter mission however, made lunar mapping observations via telescope virtually obsolete. The satellite returned complete photographic coverage of the near side of the Moon, as well as a significant portion of the far side. By 1967, Orbiter IV's high-resolution photographs were used to finish the ACIC's remaining lunar charts.[206]

This improvement of photographic methods for picturing the lunar surface over the mid 1960s demonstrates the photograph's epistemological supremacy in picturing distant landscapes. No matter how technical the drawing, the photograph would always function as the more trustworthy representation. However, while it's easy to think of the Orbiter missions and increased photographic capabilities of telescopic vision as technologies that displaced illustrators, the process that legitimized them as a part of the visual transcription process reemerged in the early 1970s with efforts to map Mars, and again in the 1980s to help guide the Voyager spacecraft's trajectory.[207] By 1971, Patricia Bridges and many of her lunar mapping colleagues were back at work compiling tiled Mariner images into coherent landscapes. The working process was largely the same, but this time a satellite orbiter's images functioned as the baseline body of reference material. Bridges took the tiled Mariner images and smoothed them into a legible landscape scientists could use in the mission planning process.

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204. Ibid., 154.

205. Ibid., 164.

206. Kopal and Carder, *Mapping of the Moon,* pg. 164 - 165.

207. Patricia Marie Bridges, interview transcript, pg. 45.

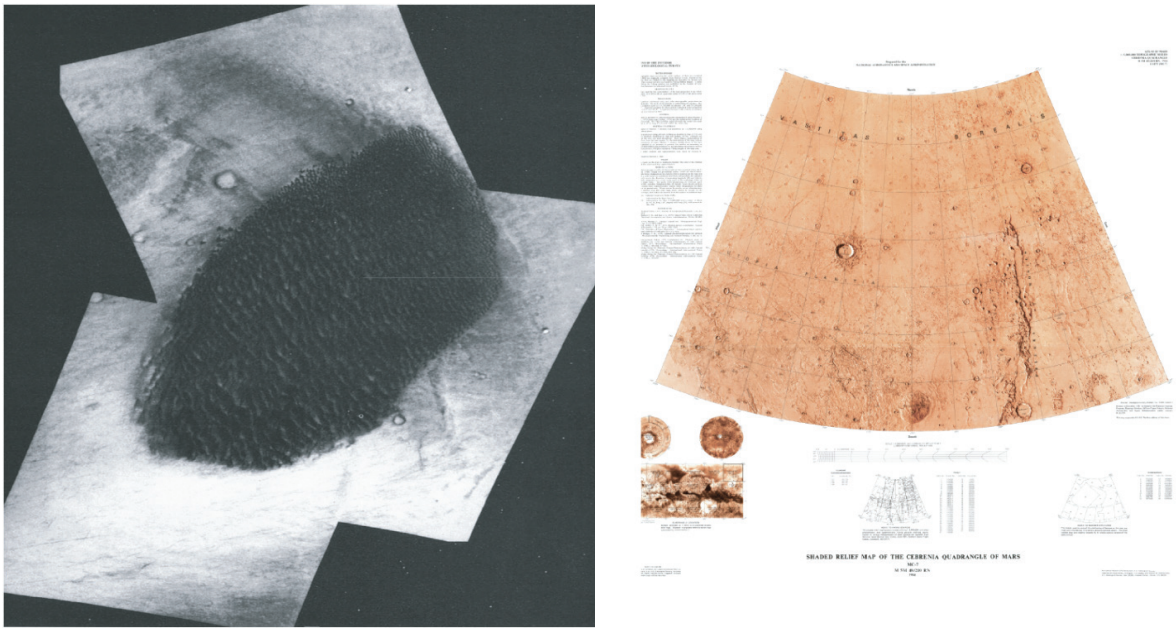


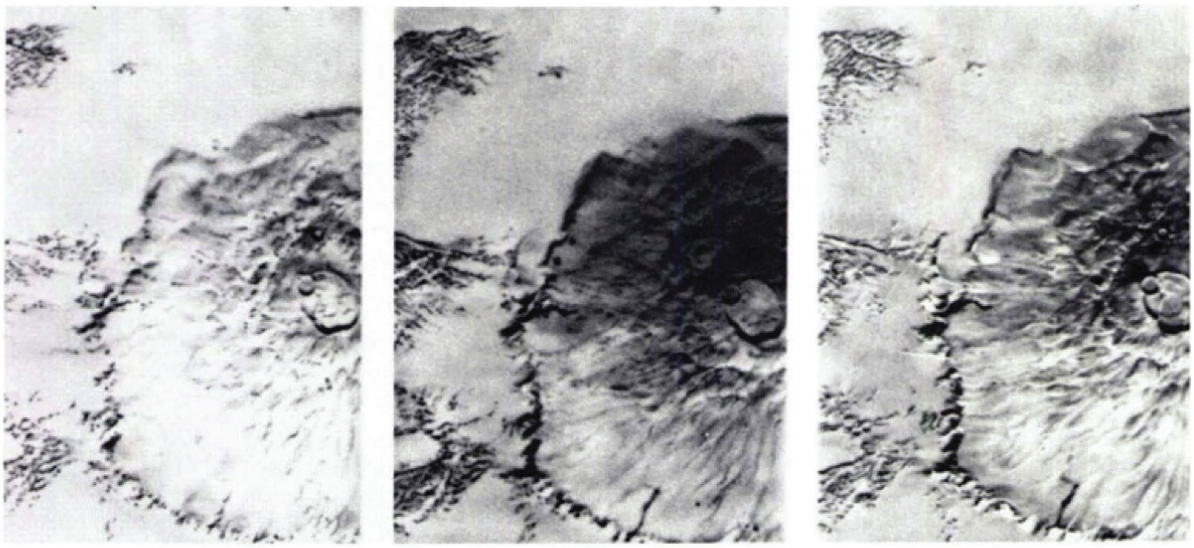
Figure 3.5— Left: Mosaic of Mariner 9 narrow-angle images, in this case Proctor crater. The mosiacs read more like abstract works of art than coherent landscapes. K. E Herenkoff and Ashwin Vasavada,"Dar Material in the Polar Layered Deposits and Dunes on Mars," Journal of Geophysical Research. 104. 16487-16500. 10.1029/1998-JE000589. Right: A map of the Cebrenia Quadranlge produced by Patricia Bridges. Map was made by compiling Mariner 9 images into a mosaic, and then flattening the image into a coherent plane with shading. A guide to the original Mariner 9 pictures is printed in the bottom right-hand corner. A note on the map reads: "No attempt was made on the map to duplicate precisely the color of the Martian surface, although color used may approximate it." By giving the drawing an orange-hue, the map was better able to signal the surface of Mars than the black and white mosaic tiled Mariner 9 images.

II. The Application of Moon Mapping Techniques Beyond the Lunar Surface

Though Patricia Bridges' contributions to astronomical illustration are largely unacknowledged in the historiography of the Space Age, her approach to airbrush art greatly influenced the field of astronomical illustration via her protégé Don Davis. Davis was hired by the U.S. Geological Service's Branch of Astrogeologic Studies in the late 1960s, while he was still a high school student in Menlo Park. Because large-format color printers did not yet exist, the agency hired high school students to hand-color maps with a numerical coding system—much like a large color-by-number picture.[208] Davis' artistic dexterity was quickly noticed, and in 1971 he was sent to Flagstaff to help support the Mars mapping project that was newly underway.

While in Flagstaff, Davis came under the tutelage of Patricia Bridges, who by this time had a decade of experience using airbrushes on astronomical images. The drawing methods the ACIC office deployed for Davis was taught drew heavily from previously established techniques, but the relationship to observation was more heavily mediated

208. Donald Davis, interviewed by author, May 26th, 2020, transcript of phone interview, pg. 1.



(a) (b) (c)

FRONTISPIECE. Progressive stages in the portrayal of relief using airbrush and eraser techniques.

Figure 3.6— an illustration of the shading and relief process Inge and Bridges developed. The image on the far left shows the level of detail added to Mariner's orbiter images. Frontispiece taken from "Applied Photo Interpretation for Airbrush Cartography, published in *Photogrammetric Engineering and Remote Sensing*, Vol. 42, No. 6, June 1976, pp. 749 - 760.

than with the ground-based telescope observation used to produce maps of the Moon.[209] Mariner 9 was the first spacecraft to orbit another planet, and it would successfully return over 7,000 images of Mars over the course of its mission.[210] While the orbiter's Visual Imaging System was able to produce images that could be tiled together into black and white mosaic-like representations, it couldn't produce a smooth bird's eye view.[211] To produce the images, Bridges, Inge, and the ACIC team would lay a piece of acetate over the tiled photographs of Mariner data, and use the tiled image to get a sense of where major topographical features were located. Davis worked with Bridges to shade maps made with composite images into a map that read as one single coherent image.

The time Davis spent with the ACIC office at Lowell Observatory was the closest thing he ever received in formal training in the practice of astronomical illustration; it was a key moment in his artistic credentialing and led to other projects that would bolster his reputation as a scientific illustrator. Even after Davis moved on from Mars mapping and into the production of more heavily imagined landscapes, airbrushes combined with photographic reference material remained a critical component of his

209. Patricia Marie Bridges, interview transcript, pg. 48.

210. "Mariner 9 (Mariner I): About the Mission" JPL Fact Sheet, accessed October 14th, 2020. https://www.jpl.nasa.gov/missions/mariner-9-mariner-i/

211. "Mariner 9 (Mariner I): About the Mission" JPL Fact Sheet.

Figure 3.7— Top: Donald Davis using USGS maps to sketch where crater rims would go on a perspective drawing of a gridded sphere. Bottom: One of the maps Don Davis produced with Donald Wilhelms for the U.S. Geological Survey in 1971. Published in Icarus the same year. Icarus 15, 1971. p 368 - 372. Library of Congress Geography and Map Division Washington, D.C. 20540-4650 USA dcu, Call number: G3196.C2 s5000 .D3

visual practice.[212]

Around the same time Davis relocated to Flagstaff, Donald Wilhelms, one of the USGS's planetary geologists, had an idea for a project that would deploy Davis' talents as a transcriber of visual astronomical information. In a gesture to the types of images produced by Lowell Observatory in the early 1960s, Wilhelms wanted to produce a series of images that illustrated earlier periods of the Moon's history.[213] The resulting paper was published in *Icarus and* titled "Two Former Faces of the Moon." In it, Wilhelms described what the lunar surface looked like at various points in its history and paired his analysis with Davis' detailed airbrush drawings of the Moon.[214] Just as Bridges helped fill the gap cameras couldn't, Davis' used her techniques to make visible a view of the Moon humans could not photograph or view through a telescope.

The paper and its subsequent illustrations—which imagined a Moon of the distant past rather than a contemporary Moon or a Moon of the future—was a pivotal moment for Davis' career. Just after the publication of "Two Former Faces of the Moon," Davis attended a party at a commune owned by Joan Baez. Carl Sagan, also in attendance, was the editor of *Icarus* and remembered the drawings of the Moon Davis produced. Carl was impressed by the series, and the meeting kicked off what would become a long and fruitful set of collaborations. Davis produced several illustrations for Sagan's books over the course of the 1970s—including the cover of *Dragons of Eden*—and joined the *Cosmos* Art Department in 1979 when production for the television series began.

In the 1970s, Davis expanded the training he received in map making at the USGS into fuller depictions of imagined space landscapes. Like Chesley Bonestell's space paintings of the 1950s, these paintings immersed the viewer in new environments as opposed to strictly clarifying topographical information. In 1974, Don Davis spotted a newspaper article titled "Princeton Plan for a New Frontier: A Space Colony by the Eighties" written by Gerard K. O'Neill. [215] The article outlined a plan for developing a space colony as early as 1980s, and for supposedly no more money than the Apollo Program. In Davis's view, O'Neill, a Princeton physicist, had the credentials necessary

212. Don Davis, interview transcript, pg. 16.

213. Ibid., pg. 16.

214. *Icarus* was an Elsevier journal established in 1962 to showcase new work in the emerging science of the solar system. The journal centered the "planet" at the center of its focus, foregoing journal structure oriented around an individual field of study in favor of an interdisciplinary approach. Lisa Messeri (*Placing Outer Space,* Durham: Duke University Press, 2016), pg. 5.

215. Gerard K. O'Neill, "Princeton Plan for a New Frontier: A Space Colony by the Eighties," *San Francisco Examiner,* September 22nd, 1974.

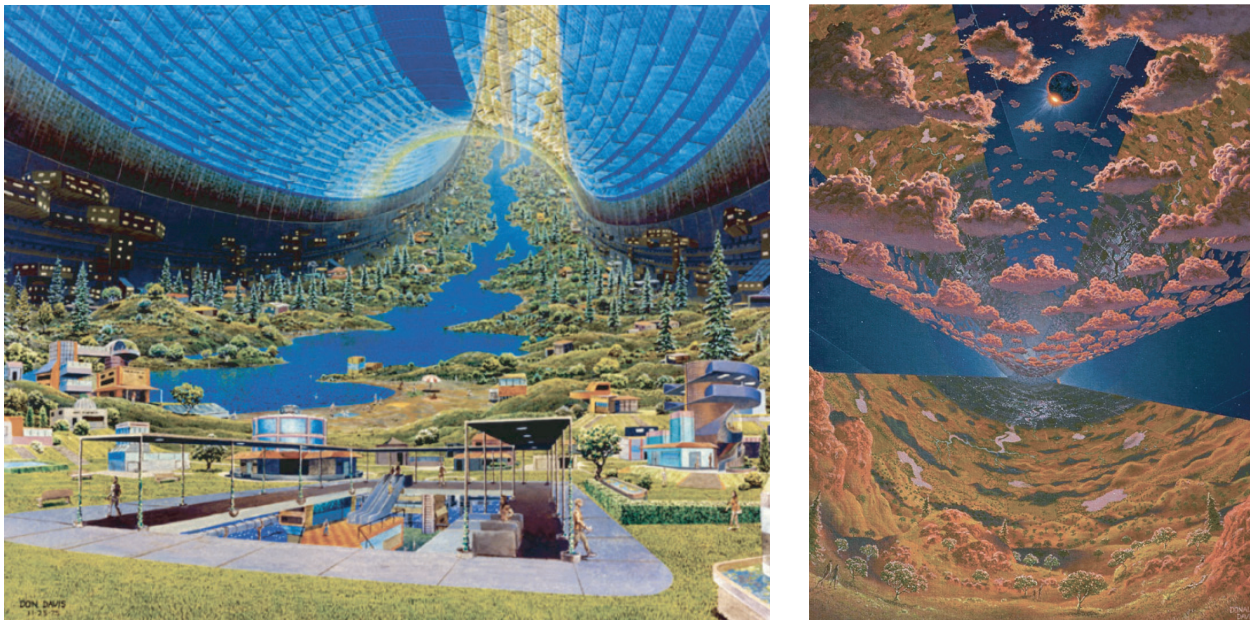


Figure 3.8— Left: Interior view of a Toroidal colony produced by Don Davis for NASA Ames 1975 Space Settlement Design Study. Right: Eclipse of the sun witnessed from on board a cylindrical colony. Produced by Don Davis for 1975 Space Settlement Design Study.

for this to be a reasonable claim.[216] Davis reached out to O'Neill to advertise his services as an astronomical artist, and in response, O'Neill sent Davis a newsletter with drawings and early ideas on the subject.

The resulting collaboration outlined the potential for sustained life in Earth's orbit and took the form of a richly illustrated design study cosponsored by NASA Ames and Stanford University. By the time of his introduction to Davis' work, O'Neill was convinced a habitable space station could build on the momentum generated by the Apollo Moon landings and was actively trying to sell Congress on the viability of a 10,000-person space colony; hiring an artist credentialed in the production of legitimate scientific images was a valuable addition to the project.

The images Davis produced for the design study were rooted in visions of a settled Western landscape; he was living in Atherton when he began collaborating with Gerard O'Neill. Atherton, a wealthy suburb of San Francisco, was spacious and well-manicured, a perfect example of the low-density housing Davis thought represented ideal living conditions. Atherton's surrounding natural landscapes greatly influenced the look of the interiors of the space colonies Davis produced. He deliberately shirked the dense "shopping mall" aesthetic he often saw applied to space colonies, instead couching his architectural structures in Earthly greenery.

According to Douglas De Witt Kilgore, this embrace of the suburban pastoral

216. For more on O'Neill's space settlement designs see: Patrick McCray, *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton, PA: Princeton University Press, 2017); Fred Scharmen, *Space Settlements* (New York, NY: Columbia University, Graduate School of Architecture, 2019); De Witt Douglas Kilgore, *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia, PA: University of Pennsylvania Press, 2003).

in space station design of the 1970s wasn't coincidental. Rather, it mirrored the same impulses that drove white flight out of urban environments in the same period. As with the new suburban neighborhoods sprouting up across the United States, Davis' colonies implied the existence of life on the idyllic periphery of an industrial center. This is especially evident in illustrations of O'Neill's toroidal designs, spinning rings that simulated gravity using centrifugal force. In a visual sense, the colonies are a suburban halo around a city that has ceased to exist. The problems of city life have been literally absented, leaving only a verdant and harmonious mode of existence.[217]

In Davis' view, the beauty of O'Neill's design was the prospect of infinite expansion, which eliminated the need for cramped space stations and the miserly economization of resources in an extreme environment. Davis took this a step further, including detailed depictions of North American wilderness recreated onboard the space station. This was largely an unprecedented style of depiction—Davis cites Roy Scarfo's 1963 painting of a space colony interior as a source of inspiration, but in Scarfo's version colonists are surrounded by cultivated farmland.[218] Though it seems bizarre to think of engineers reconstructing a temperate needleleaf forest to look as though it had sprung naturally from the space station itself, the proximity to natural environments was an important aspect of Davis' version of an ideal future in space.[219] This impulse echoes Frederick Jackson Turner's 1894 Frontier Thesis, which argued that the open spaces of the wilderness fostered an individualism that complemented democracy.[220] Just as the frontier beckoned nineteenth-century Americans westward, Davis' vision of space colony interiors expressed a latent anxiety about the crowding of American cities and the degeneration of society.

Davis's collaborations with O'Neill are a prime example of how the brand of scientific realism cultivated at Lowell Observatory combined with space advocacy efforts to help develop conceptions of outer space in the public imagination. The 1975 Design Study, one of the most iconic collaborations of the post-Apollo period, was contingent on Davis' status as a scientific illustrator capable of producing trustworthy images. It also hinged on the belief that artists could be deployed—in the absence of cameras—to document scientific information. As space advocates imagined what exploration and

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217. Kilgore's reading of O'Neill's attitudes towards suburbs and racial attitudes comes largely from his analysis of the sequel to O'Neil's *The High Frontier, The High Frontier 2081: A Hopeful View of the Human Future. Astrofuturism,* pg. 175 – 177. Kilgore De Witt Douglas, *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia, PA: University of Pennsylvania Press, 2003).

218. Dandridge M. Cole and Roy Scarfo, *Beyond Tomorrow: The Next 50 Years in Space* (Amherst Press: 1965).

219. For the structures necessary to signal human occupation of these sprawling landscapes, Davis sourced reference material from copies of architectural digest in the local library and sketched the ideas they outlined. He also experimented with adding geodesic domes, which were a popular fixture of Bay Area architecture in the early 1970s. Don Davis, interview transcript, pg. 5.

220. This contains an echo of Jeffersonian attitudes towards land, which stipulated that landowner would be free to participate in the democratic process, independently of the landlords common in Old World Europe. Roger G. Kennedy, *Mr. Jefferson's Lost Cause: Land, Farmers, Slavery, and the Louisiana Purchase* (Oxford: Oxford Univ. Press, 2004).

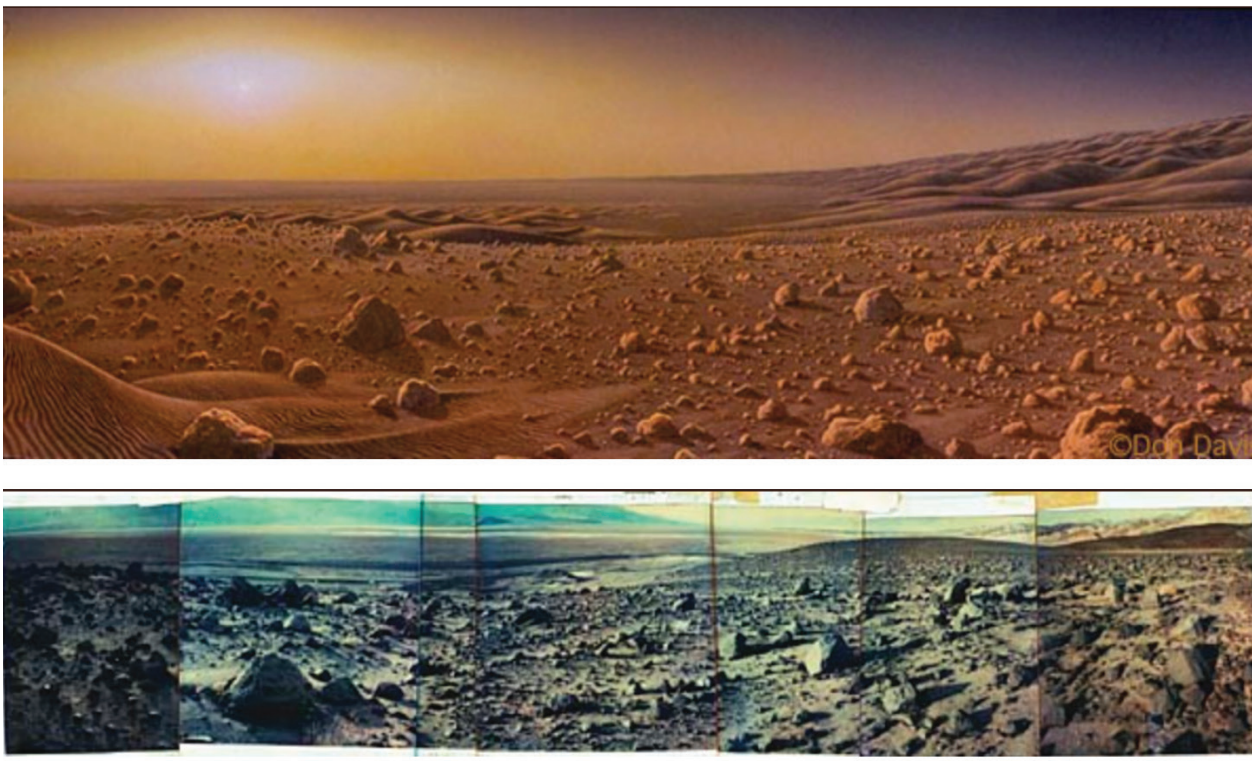

Figure 3.9— Painting of Mars, based on photographs taken in Death Valley. Using a technique similar to the one he learned at the USGS, Davis tiled together photographs in order to produce a Martian panorama. Courtesy of Don Davis.

settlement would look like in the post-Apollo period, this was expanded to include scientific subjects that didn't exist at all.

The space hardware advancements of the 1960s happened so rapidly that newly accessible landscapes weren't always directly visible. Or, if they were visible, there was no way to photograph them. The same technological challenges that led Wally Schirra to suggest arming Gemini astronauts with crayons opened room for trained artists on Earth to work in a supposedly objective capacity. While Don Davis was never formally trained in the practice of astronomical representation—such instruction didn't exist as formal curriculum at any schools Davis was aware of—his time at the USGS served as the equivalent of a credentialing process. This was a function of his proximity to Patricia Bridges and the objective identity she helped craft for lunar illustrators within an astronomical observatory. By comparing Bridges' work with similar styles of drawing cultivated in the fine art world at the same time however, the institutional context that pronounced her work as definitively uncreative can be reframed as socially contingent. Framing Patricia Bridges as a neutral output allowed her maps to circulate as objective representations, but also subsumed her identity as an artist into a larger process. This was the conceptual bedrock on which Don Davis was able to build his career—even imaginative illustrations informed by Davis' lived experience could be framed as neutral representation. This dynamic continued to develop over the course of the 1970s, allowing artists an increasing amount of creative latitude while maintaining a degree of scientific or technical authority.

Chapter 4 — The Market for Space Futurism: Astronomical Art and Advocacy in the Post-Apollo Period

I. Voyage Beyond Apollo: The SS Statendam at Cape Kennedy

On December 4th, 1972, a group of scientists, science fiction writers, and artists boarded a Holland America cruise bound for Cape Kennedy. The *SS Statendam's* primary destination was the December 7th night launch of Apollo 17.[221] Its purpose was to give the space age luminaries onboard the opportunity to watch three American astronauts depart the Earth's surface. Apollo missions 18 through 20 had been cancelled by the Nixon administration in January of 1970, making Apollo 17 the premature conclusion of the space program's efforts to reach the Moon.[222] It was also the only launch to take place after sunset, and functioned for many as a poignant symbol of the twilight of the entire Apollo project. From seven miles out at sea, the *SS Statendam* served as both a viewing platform and a floating meditation on the future of humanity's expansion into outer space. Efforts to reach the Moon had succeeded, but it was unclear what the purpose of a national space program would be in the coming decade.

The group that convened aboard the *SS Statendam* focused explicitly on this question of purpose and was especially concerned with maintaining the momentum generated by NASA in the 1960s. Attendees spent the duration of the cruise brainstorming strategies to make the necessity of continued space exploration evident to both the public and their government representatives. In this way, the cruise's invited guests represented a second cohort of space boosterism reminiscent of the days before NASA's creation. The event's programming was styled like an academic symposium, comparable to the meetings convened by various European and American rocket societies in the mid-twentieth century. These earlier meetings assembled popular science writers and illustrators together alongside technical experts to make publicly accessible arguments for the plausibility of space travel.[223]

The *SS Statendam's* passenger list reflected a similar confluence of people uniquely involved with the negotiation of humanity's future in space. The roster of attendees ranged from science fiction writers—Isaac Asimov, Robert Heinlein, Frederick

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221. The cruise's organizer, Richard Hoagland, dreamed of filming both a documentary and a science fiction film about the cruise. The work of science fiction was intended to visually enact the ideas explored over the course of the floating seminar but never materialized. However, one reel of the two-reel documentary survived and was uploaded to YouTube in 2015. *Voyage Beyond Apollo* (1972), directed by Marie Morgan, https://www.youtube.com/watch?v=JTrzxIh8jX8&feature=youtu.be. Accessed May 6th, 2020.

222. John M. Logsdon, "National Leadership and Presidential Power," in *Spaceflight and the Myth of Presidential Leadership,* eds. Roger Launius and Howard McCurdy (Champaign: University of Illinois Press, 1997), pgs. 210 – 211.

223. The First Annual Symposium on Space Travel, organized by Willy Ley in October of 1951 was modeled after the meetings of European space societies. The meeting, attended by popular print journalists in addition to space advocates, kicked off a series of professional collaborations between scientists, engineers, journalists, and artists. Michael Neufeld, *Von Braun: Dreamer of Space Engineer of War* (New York: Vintage Books, 2007), pg. 254 - 255.

Pohl, and Theodore Sturgeon—to publicly recognized men of science. Marvin Minsky, Carl Sagan, and Frank Drake all delivered presentations, as did Pulitzer Prize-winning journalist Norman Mailer.[224] Two astronomical artists were also invited—Donald Davis and Rick Sternbach—who, appropriately enough, cited Chesley Bonestell as a major inspiration in their work.[225]

Scholarship on the history of the space age has done much to reframe the cosmos as an invented sociotechnical imaginary.[226] The scientific discoveries and engineering breakthroughs that informed this collective picture were necessarily wrapped up in the social and political context that functioned as the operative backdrop. In his 1997 book, *Space and the American Imagination,* Howard McCurdy described the efforts of spaceflight advocates in the 1950s with language reminiscent of nineteenth-century land boosterism.[227] "Space boosters" attracted members of the public to the cause of spaceflight the way land boosters lured new residents to growing western townships. In 2003 Douglas Dewitt Kilgore described the work of the space boosters as a type of fictive literary genre, which he dubbed "astrofuturism." According to Kilgore, first-wave astrofuturism—pioneered by von Braun, Willy Ley, and other space futurists of the 1950s—framed outer space as a topography that could strengthen the development of western political orders and capitalism.[228]

Second-wave astrofuturists, the writers, scientists, and artists pitching space exploits in the post-Apollo moment, needed to contend with a different political reality

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224. Writing in *The Paris Review* in 2012, Rex Weiner recalled sneaking onto the cruise as a stowaway with his friend Thomas King Forcade. According to Weiner, they were on a mission "to rescue Norman Mailer from the clutches of a diabolical cabal of elite space imperialists." Weiner's companion was convinced that the cruise was just a "cover for an elite conclave conspiring to jettison Earth once they'd totally ravaged it and establish an exclusive colony for the rich and powerful in space." His view of the symposiums project was much more sinister: "Everyone else on Earth be left to fight over dwindling resources and perish in the terrestrial ruins." Rex Weiner, "A Stowaway to the Thanatoshpere: My Voyage Beyond Apollo with Norman Mailer," *The Paris Review,* December 31st, 2012.

225. Bonestell's legacy loomed large in the ship's envisioned project. Fred Ordway, the steward of Bonestell's collection, was thanked in the program's section on special assistance. Several of Bonestell's paintings also appeared in the documentary produced about the cruise. *Voyage Beyond Apollo* (1972), directed by Marie Morgan, https://www.youtube.com/watch?v=JTrzxIh8jX8&feature=youtu.be. Accessed May 6th, 2020.

226. As Sheila Jasanoff has pointed out, sociotechnical imaginaries exist collectively but are disproportionately influenced by those with outsized power to realize this vision, like the technical experts or their wealthy patrons. The vision of space articulated here reflected the interests of an almost entirely white male demographic. That the language of "space settlement" was still key to their conceptualization of scientific expansion is very telling. Sheila Jasanoff and Sang-Hyun Kim, *Dreamscapes of Modernity: Sociotechincal Imaginaries and the Fabrication of Power* (Chicago: The University of Chicago Press, 2015), Ch. 1.

227. Howard McCurdy, *Space and the American Imagination* (Baltimore: Johns Hopkins University Press, 1997).

228. De Witt Douglas Kilgore, *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia: University of Pennsylvania Press, 2003).

Figure 4.1— Left: Reproduction of the program for "Voyage Beyond Apollo." Right: Reproduction of the program calendar. Enzmann Archive. http://3.bp.blogspot.com/-tXqOJjGE9pA/USxWUXI3RJI/AAAAAAAACrY/myg1TzqF8YQ/s1600/voyage+symposium.jpg . Courtesy of Enzmann Archive.

than that of the immediate postwar period. The social movements of the long 1960s cast American government as an oppressive entity propped up by a swollen military industrial complex, while anxieties about natural resource depletion undermined the presumed viability of a capitalist future predicated on consumer culture.[229] Space also looked different—the Mariner, Viking, and Voyager projects provided new images of our neighbors in the solar system that didn't conform to the landscape format of imagined in previous decades.

The chapter is broken up into three sections, loosely following the careers of three

229. For more on how the social movements of the 1960s impacted perceptions of the space program, see Neil Maher's *Apollo in the Age of Aquarius* (Boston: Harvard University Press, 2017).

illustrators to explore a different aspect of astronomical art in the 1970s.[230] This is not an exhaustive view of the profession in the post-Apollo period, but one that explores how the practice of astronomical illustration was integrated into the culture of popular science. In each of the following case studies, there was a need for interesting art that could be defended as scientifically accurate.

The first section focuses on planetarium art production as a form of pedagogy, using a planetarium show based off drawings Don Davis produced with Gerard O'Neill and Rick Guidace. Davis' work is an example of how the discipline maintained certain pictorial conventions into the 1970s, and how accuracy was framed in terms of fidelity to scientific reference materials. This methodological continuity contrasted with the decline in support for the midcentury planetarium show, which gradually attenuated in the post-Apollo moment. The planetarium show illustrates the type of decline the space boosters on-board the *Statendam* were afraid of, but also the ways in which a changing political context could alter whether an image functioned as art or scientific illustration.

The second section follows the early career of Rick Sternbach, who broke into the profession by illustrating science fiction periodicals, popular science magazines, and eventually storyboards for the *Star Trek* film franchise. Sternbach's career illustrates how the "look" of scientific neutrality was abstracted and applied to works of science fiction over the course of the 1970s. His work is also useful for tracing the market that emerged for accurate representations of outer space in popular culture.

The third section, which looks at Jon Lomberg and Carl Sagan's working relationship, focuses on how Lomberg's visual style lent itself to Sagan's brand of space science advocacy. Lomberg's approach to astronomical art framed outer space as an extension of the natural world, imbuing his space landscapes with a type of environmentalist messaging distinct to the period. All three stories intersect on the set of *Cosmos,* the educational television program Carl Sagan produced for the Public Broadcasting System, which needed accurate-looking visuals of the space landscapes it described for viewers. The Jet Propulsion Lab is also a frequent backdrop in this story, although it can be thought of in dual capacity as both setting and actor invested in the visibility of its projects.

While scientists and writers actively negotiated a conceptual picture of what the next decades in space might look like, so too did the artists they collaborated with play a part in inventing the future of outer space. If scholars now understand works of astrofuturism from this period as a type of literary movement, then the paintings that

230. The actors in this story were paid *illustrators,* but they evaluated their contributions to astronomical illustration in terms of their *artistic* dexterity. Some of them described the act of scientific visualization as a type of high realism consistent with the history of western art, even though they weren't producing what galleries or museums considered art objects. As noted in the introduction, I use Michele H. Bogart's historical approach to writing about illustration in the twentieth century. In Bogart's view, art and illustration aren't static categories, but historicizeable practices that changed over time. In this explanation, twentieth century technological advancements in print culture and television expanded the terrain of art practice, but this proliferation prompted a narrowing of fine art's ideological borders. While the act of artmaking expanded for commercial reasons, the definition of "fine art" solidified around a specific set of objects. Bogart, *Artists, Advertising, and the Borders of Art* (Chicago: The University of Chicago Press, 1995), pg. 4.

gave material shape to their ideas should be thought of in the same capacity.[231]

The voyage of the *SS Statendam* and its viewing of the Apollo 17 night-launch was a powerful symbol for those in attendance. The cruise is also a useful vehicle for getting to the core of this chapter's most central question—how is an "accurate" representation of something difficult to see determined? Shortly after the cruise concluded, its organizer, Richard Hoagland, was ostracized from the community for championing a conspiracy theory that photographs of the surface of Mars contained visual evidence of ancient alien civilizations. As I'll discuss in the conclusion of this chapter, Hoagland's fixation on reading ambiguous visual material in the "truest" possible way paralleled the goals of the artists in question. Though Hoagland's epistemology was a thoroughly corrupted one, his case will function as a reminder of the link between accuracy, the legibility of images, and the broad social systems that validate knowledge as authoritative.

II. The Planetarium Show

In 1969, Don Davis took a model-building and painting job for "Grand Tour of the Planets," a show produced by the Morrison Planetarium in San Francisco. Davis worked as an artist in various planetariums over the course of the next two decades. His occupation was largely a function of midcentury Cold War efforts to draw America's youth into the sciences; at the onset of the Space Age, planetarium shows gradually added film projectors and other special effects to produce content that was more cinematic than the traditional projection of stars on an interior dome.[232] Artists would hand-paint celestial subjects, and the paintings would be reproduced on film. This peaked in the 1960s with the creation of "Spacearіums," planetariums that fully embraced narrative structure for their shows over simple star projections. By virtue of their establishment as pedagogical spaces, planetariums were expected to produce content rooted in scientific fact. However, since the overt purpose of the space was to interest audiences in the possibility of future scientific achievements, it relied on the deployment of artistic license out of necessity

The arc of twentieth-century planetarium programming illustrates how support for space science education attenuated in the decade post-Apollo. This changing context altered how images were designated as accurate, ultimately blurring lines between plausible scientific futures and speculative fiction. In addition to the Spacearium's particular use of three-dimensional space, it also offered a degree of instructional authority flat film screens didn't necessarily have. Even if audience members didn't recognize the term "spacearium," they'd likely heard of or attended a planetarium show, which was generally associated with some semblance of scientific truth given its

231. De Witt Douglas Kilgore introduced this idea of space age futurism as a type of literary genre, but it's an idea that's gained traction in other studies of the period. Alexander Geppert's work on Astroculture treats science and popular culture as similarly coproductive. For more on Geppert's interpretation see, *Imagining Outer Space: European Astroculture in the Twentieth Century* (London: Palgrave Macmillan, 2018) Pgs, 3 – 28.

232. Marche, Jordan, *Theaters of Space and Time: American Planetaria*, 1930 – 1970 (Camden: Rutgers University Press, 2005).

pedagogical nature.

Though extremely popular in western Europe from the 1920s onward, the United States did not construct its first modern planetarium until 1930. The practicality of the planetarium as a tool for astronomical instruction, however, was quickly realized along with its novelty as popular spectacle.[233] The illusion of depth created by the planetarium dome's shape allowed instructors to demonstrate the positions of stars relative to one another, and easily explain concepts like retrograde motion, or other astronomical phenomena that were typically difficult to visualize. In addition to its scholastic value, the planetarium's format made it an attractive addition to museums and universities; for many living in urban areas, the preindustrial view of the night sky offered by a planetarium's projector was the clearest available. As a result, planetarium construction over the course of the 1930s and 40s gradually increased despite their high costs, ultimately rekindling a public interest in astronomy as a field of study that had waned over the course of the 19th century.[234]

Though the establishment of new planetariums eventually slowed after the outbreak of World War II—partially due to the dominance of German planetarium projector manufacturing— the postwar boom they enjoyed far surpassed construction rates recorded at any other point during the twentieth-century.[235] The high-yield growth of American planetariums after 1945 was partially facilitated by shifting attitudes towards science education underwritten by the United States' new postwar political position. In 1958, almost one year exactly after *Sputnik's* launch, Dwight D. Eisenhower signed both the National Aeronautics and Space Act—establishing NASA—and the National Defense Education Act, which redirected over a billion dollars to science education efforts. The overt goal of the NDEA was to train future defense-oriented personnel. Over the course of World War II, science and engineering experts were concentrated in industry—most often, the defense industry—where they made more money than if they returned to schools to teach.[236] The NDEA lavished resources on high schools and universities to attract both teaching talent and new science and engineering students. Because fields like space science, physics, and astronomy were emphasized as directly relevant to the skill sets the government was attempting to bolster, this

233. Jordan Marche's account of the history of the American planetarium in *Theaters of Space and Time* (2005) is the most complete to date, though other authors have written about the significance of planetariums in visual culture and media studies. Charles R. Acland and Haidee Wasson's *Useful Cinema* (2011) and Allison Griffiths *Shivers Down Your Spine* (2008) both discuss the planetarium show as a cinematic spectacle.

234. Jordan Marche, *Theaters of Space and Time: American Planetaria, 1930 – 1970* (Camden: Rutgers University Press, 2005), pg. 25.

235. Marche, *Theaters of Space and Time*, pg. 95.

236. National Defense Education Act (NDEA), *United States Statutes at Large Vol. 72*, pgs. 1580 -1605, http://wwwedu.oulu.fi/tohtorikoulutus/jarjestettava_opetus/Troehler/NDEA_1958.pdf

influx of resources facilitated a postwar boom in planetarium construction.[237] Because of their history and growing presence as a pedagogical tool, planetariums signaled an instructional authority that film screens—which often displayed fiction—did not necessarily have.

In 1976, a concept script titled "Worlds of Tomorrow" began to circulate through the Albert Einstein Spacearium, the planetarium constructed inside the National Air and Space Museum in Washington D.C.[238] Though Davis didn't work on the script directly, "Worlds of Tomorrow" was based on space settlement designs he created in tandem with Gerard O'Neill and Rick Guidace in the mid-1970's. The show described the future of humans in space and functioned as a simulated tour of the various interplanetary facilities they might one day inhabit.

The productions undertaken at the Albert Einstein Spacearium were all produced in-house. Since staff members couldn't design a spacearium show around planets they couldn't depict, a certain degree of artistic license was usually necessary for the productions to be developed at all. In most cases, Spacearium illustrators were given grainy satellite or telescope images of distant planets and asked to "extrapolate" images with higher resolutions. In some cases, like with all representations of Pluto, Uranus, and Neptune, no real reference material was even available, and artists were given free rein to speculate on how the surfaces might appear to the naked eye.

Ultimately, it didn't matter what the images looked like if they appeared sufficiently photographic and gave the impression that they were based on scientific information. Illustrators were viewed as professionals by other members of the planetarium's staff, partially because none of the images produced for the spacearium looked especially painterly. They were all as close to photographs as possible, obscuring the artist's role in the representation process and contributing to a homogenized "group style" replicable by individual members of a team.[239] This cohort of illustrators moved between planetarium painting, publishing work, science popularization, and television special effects, eventually forming their own professional guild—the International Association of Astronomical Artists—discussed at length in the next chapter.

When the shows themselves were finally completed, the role of the illustrators in actively producing visual material was typically underemphasized; because of the Spacearium's pedagogical nature, the programs were always described as the products

237. As Jordan Marche notes in his book Theaters of Space and Times, there was significant overlap between planetarium operations and government space projects at the onset of the Cold War. Project Moonwatch, an offshoot of the Vanguard program established in 1957, needed astronomers for help tracking the Vanguard satellite. When university-trained astronomers proved hard to come by, project officials turned to planetariums and hired several amateur astronomers for the job.

238. "Worlds of Tomorrow" 1978 Spacearium Script, *Spacearium Papers,* Folder 1, Exhibit Design Department files, National Air and Space Museum Archive, Smithsonian Institution, Washington D.C.

239. Even though many different illustrators sometimes participated in the production of a show's illustrations, other members of the production team noted that the images were typically not stylized. Tom Callen, "Visual List" 1983, Record Unit 0000356, Box 14, Smithsonian Institution Archives, Washington D.C.

of collaborations grounded in scientific information, not artistic interpretation. Spacearium staff member Tom Callen described the work of clarifying Voyager images of Venus as a form of "sharpening." The artist was the solution to low resolution photographs. As with images discussed in the previous chapter, planetarium art needed to replicate photography as closely as possible to look sufficiently scientific. Attempts to recreate photographic quality had a homogenizing effect on the overall aesthetics of planetarium art, at the Albert Einstein Spacearium and elsewhere.

The space settlements O'Neill envisioned were the perfect subject for a show intended to dazzle audiences as much as educate them. These floating techno-utopias were intended to function as permanent civilian residences complete with the luxury creature-comforts of Earth.[240] Unlike the confined spaces of Skylab, or the space station designs that would eventually become the International Space Station, O'Neill described bustling structures intended for long-term occupation. New space settlement communities would be composed of "talented and hard-working people," living on board the settlements either permanently, or for periods of several years.[241]

The concept script for "Worlds of Tomorrow" began circulating to the Albert Einstein Spacearium's staff in late 1976—right around the time O'Neill was trying to push his ideas further into the public eye. O'Neill, who was on the museum's board of advisors, was available to the Spacearium's producers, and it was understood he would be able to lend his guidance once a finalized version of the script was drafted.[242] The concept script, which was shorter than a fully developed script, was intended to give readers a sense of the mood and general content of a proposed show.

Concerns over accurately depicting structures that did not yet exist, foregrounded a more pressing philosophical question; did these space station designs represent a plausible scientific future, or something more fanciful? Initial reactions to the "Worlds of Tomorrow" concept were positive, but some expressed concern over the show's ability to visually represent a concept like the colonization of space in a pedagogical way. Don Hall, then director of the Strasenburgh Planetarium in Rochester New York, lauded the show for its great "affective potential," but urged that the production quality be held to the same standard.[243] Carl Sagan, also expressed enthusiasm over the topic, but emphasized the importance of the program's graphics for imparting appropriate

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240. According to Patrick McCray, O'Neill was untroubled by calling his space settlements "colonies," although he was criticized by Carl Sagan for his word choice. W. Patrick McCray, *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton and Oxford: Princeton University Press, 2012), pg. 52.

241. The most reasonable locations for the colonies were determined to be the Earth-Moon L4 and L5 Lagrange points. Lagrange points are stable points in the Solar System where a spacecraft can maintain its position without expending energy. David Brandt-Erichsen, "Brief History of the L5 Society, *"Ad Astra*, the magazine of the National Space Society, Nov.-Dec. 1994.

242. O'Neill to Von Del Chamberlain, January 31st, 1977, Spacearium Papers, Folder 1, Exhibit Design Department files, Smithsonian's National Air and Space Museum, Washington D.C.

243. Don Hall to Von Del Chamberlain, January 14th, 1977, Spacearium Papers, Folder 1, Exhibit Design Department files, Smithsonian's National Air and Space Museum, Washington D.C.

impressions.[244]

The plausibility of the project was not clear. O'Neill was serious about selling his idea to the U.S. government as a civilian project, and began publishing his designs in publications with broad readerships.[245] He viewed the colonization of space as a "right-now" opportunity, that when contrasted with "the elitism of the Apollo project or of a manned mission to Mars," offered the possibility of "direct personal participation by large numbers of ordinary people."[246] For O'Neill, everyone from "hard-hat construction workers to highly-educated professional people" were candidates for space colonization.[247] While O'Neill's attitudes towards energy and consumption resonated with liberal environmentalist groups—like those associated with Stuart Brand and the *Whole Earth Catalog*— his work also appealed to more conservative proponents embedded in the aerospace industry who believed that if the United States didn't immediately increase efforts to sustain its superiority in space, it would soon be eclipsed by the international community.

Despite the near inconceivability of Island One today, O'Neill's designs weren't considered implausible by his contemporaries. In the wake of the moon landings, many scientists and engineers affiliated with the space program and the aerospace industry were eager to redirect the Apollo project's momentum in a new, equally ambitious direction. O'Neill was a respected scientist with experience designing large expensive projects, and continuously received funding from reputable institutions interested in capitalizing off technical developments advanced during the Space Race.[248]

For some, Gerard O'Neill's space settlement designs were appealing precisely because they were ambitious and implied the continuation of American dominance in space. When O'Neill published his ideas in the October 1976 issue of the American Institute of Aeronautics and Astronautics, the journal's cover-story warned, "The Russians are Coming—and So is Everyone Else."[249] This pre-Apollo rhetoric, espoused by proponents of a robust space program, had served a functional purpose over the course of the 1960s—but by the mid-1970's, it had lost its purchase with government benefactors.

For some of the concept script's reviewers, the challenge with "Worlds of

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244. Carl Sagan to Von Del Chamberlain, January 28th, 1977, Spacearium Papers, Folder 1 Exhibit Design Department files, Smithsonian's National Air and Space Museum, Washington D.C.

245. O'Neill was a frequent contributor to *the American Institute of Aeronautics and Astronautics,* and well as *Physics Today*, but he expanded his publicity efforts after 1976. He published an interview in the *Whole Earth Catalog* about his work in 1977 and published his book *The High Frontier: Human Colonies in Space* later that year.

246. "Future Space Programs 1975," Hearings Before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Fourth Congress, pg. 15.

247. Ibid, pg. 30.

248. McCray, *The Visioneers*, pg. 150 – 151.

249. Gerard K. O'Neill, "Engineering a Space Manufacturing Center," Astronautics & Aeronautics October 1976, Vol. 14, No. 10, pg. 20 – 29.

Tomorrow" extended beyond accurate representations of imaginary space colonies. Mark Chartrand, then-director of the Hayden Planetarium in New York, thought the script would be an exciting improvement from Spacearium's first program, "Cosmic Awakening"—but felt compelled to ask why anyone would want to settle the "Worlds of Tomorrow" in the first place: "Why will people be living in places that are inconvenient, uncomfortable, and dangerous? I think it would be good to bring out the practicality of living in other worlds, as well as the pioneering spirit."[250] Eric Chaisson, a Harvard astrophysicist with ties to the Smithsonian Astrophysical Observatory, couched his approval in similarly prudent language; despite the "very reasonable approach towards first solar-system habitats and space colonies," he found in the concept script, Chaisson urged the Spacearium's producers "to draw a clear distinction between what we currently view as scientific fact, and what is speculative science fiction," especially when dealing with non-scientific people, as they would be in the Spacearium.

After collecting the various reactions to the "Worlds of Tomorrow" concept script, the Spacearium responded to concerns about accuracy by grounding the show's content further into the visual information it was based on—Don Davis and Rick Guidace's settlement designs. By the time the second draft of the script was sent out for review, a large portion describing orbital space colonies had been added, based on the drawings in the initial study. According to the new script, viewers could expect "bulging apartment houses" with permanent residents fed by chemist-farmers "growing pills in test-tubes rather than corn in plowed fields," which may have accounted for the lack of farmland depicted in the illustrations.[251] Shortly after the concept script was circulated, Gerard K. O'Neill himself offered to review the new draft and offer his own edits, thereby lending additional credibility to the show's content.[252]

O'Neill's corrections to certain elements of the show's script reflected many of his own expectations about the feasibility of space colonization. In one passage, he changed "some futurists describe" to "scientists and engineers have designed," and vetoed the image of "chemist-farmers growing pills." He replaced test-tube food production with the familiar agricultural spaces outlined in his settlement descriptions and added lunar and asteroid materials processing as an occupation in addition to the industries the producers had already listed. In his letter to the show's director, O'Neill also cautioned the show's producers about the scale and timeline they were implying. According to his designs, "progress up to the level of a few thousand people in space, under Spartan conditions of small, modular habitats, is possible within the Shuttle era (i.e., within the next 15 years). Progress to large monolithic habitats is likely to occur in the following era, perhaps 15-30 years from now."[253] Nowhere in O'Neill's letter does he suggest that

250. Mark Chartrand to Von Del Chamberlain, January 17th, 1977. Spacearium Papers, Folder 1, Exhibit Design Department files, Smithsonian's National Air and Space Museum, Washington D.C.

251. "Worlds of Tomorrow," Narration Notes, 1978, Spacearium Papers, Folder 1, Exhibit Design Department files, Smithsonian's National Air and Space Museum, Washington D.C.

252. O'Neill to Von Del Chamberlain, 1978, Spacearium Papers, Folder 1, Exhibit Design Department files, Smithsonian's National Air and Space Museum, Washington D.C.

253. Ibid, pg. 1.

space colonization should be couched in hypothetical terms, and because of O'Neill's role as a "scientific authority," his corrections didn't necessarily counter Eric Chaisson's earlier cautions. For Gerard O'Neill and his supporters, large-scale space settlements were squarely within the realm of probability.

By 1977—a short while after the "Worlds of Tomorrow" concept script was initially drafted—public interest in space colonization appeared to have peaked. On October 9th, the CBS program *60 Minutes* ran a segment about space colonies, and later aired mixed responses from the viewers who had seen the program. One response, from Senator William Proxmire, chairman of the Senate Subcommittee responsible for NASA›s budget, called O'Neill's idea the "best argument yet for chopping NASA›s funding to the bone," and stipulated that "not a penny" more should be spent on such a nutty fantasy.[254]

Proxmire's outrage and subsequent public crusade against O'Neill's space settlement proposals echoed a growing cynicism in Congress regarding the value of continued spending on the space program; for proponents of NASA, the government's reluctance to fund projects on the scale they once had was equally disenchanting. The July 1979 issue of *Aeronautics & Astronautics*, which commemorated the 10-year anniversary of the moon landing, openly lamented the sabotage of American expansion into space at the hands of ignorant bureaucrats. The cover of the journal featured a photograph of the Apollo Lunar Excursion Module, sitting inside the National Air and Space Museum—and positioned in front of a large window that looked out towards the Capitol building. The caption, "LEM at the National Air and Space Museum—new exploits to match the Moon landing will depend on votes under the dome in the background" echoed the tone of the journal's various reflections on the ten-year period following Apollo; frustration over lost momentum was compounded by despair over a bleak future.

The letters selected for publication all reflected a preoccupation with government funding for space. One, submitted by Theodore Simpson, and electrical engineer from Virginia, called for an increase in NASA's budget from .5% of the federal budget to 1.5%, as well as the construction of a permanently manned space-station and an expedition to Mars. He wrote, "I believe that these activities are essential if the U.S. is to retain its scientific and technological leadership and its position as a world power. And since the overall Federal budget will reach a trillion dollars per year in the mid-1980s, there is no question that the U.S. could afford to spend an additional $10 billion a year on its civilian space program. The only thing lacking at the present time is the political will to do so."[255]

William Proxmire—who may have agreed with Theodore Simpson's assertion that the political will to support the space program had expired—was ultimately successful in his quest to eliminate spending on space colonization research from NASA's budget. Gerard O'Neill was forced to turn to private investors to fund the continuation of his work, and when "Worlds of Tomorrow" opened in November of 1978, the tone

254. "Letters to L-5: Darth Proxmire," Robert Lovell, *L-5 News,* November 1977, Vol. 2, No. 11, pg. 1.

255. Theodore Simpson, "Push for More Space Funding," *Aeronautics & Astronautics,* July/August 1979, Vol. 17, Nos. 7.8, pg. 6.

Figure 4.2— Rick Sternbach's cover art for the October 1973 edition of *Analogue Magazine*. Sternbach's art illustrated the Enzmann ships in G. Harry Stein's article, "A Program for Starflight.

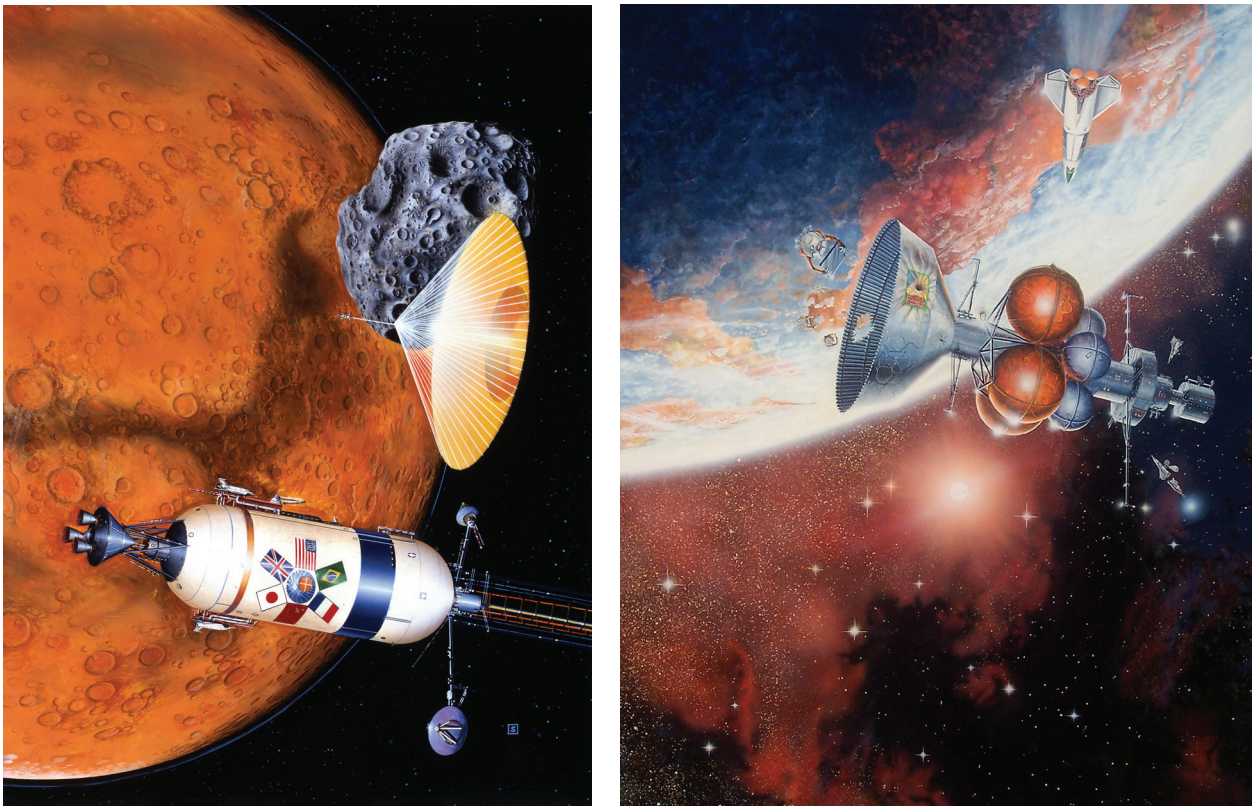

Figure 4.3— Left: "Sailing to Mars," painting done for *Analog Magazin*e, 1975. Illustration produced for a short story written by Richard Hoagland about a large international space organization. The space-built habitat of one ship, at the tail end of its tether, is visible in the foreground, while the entirety of the other solar sail ship is seen passing Phobos. Right: "Tricentennial" for *Analog Magazine*, July 1976. Illustrtion for Joe Haldeman's short story, "The Forever War." In the image a space ship breaks down near the North American nebula in 2076. Courtesy of Rick Sternbach.

of its promotional materials indicated a reassessment of factual authority.[256] While the script still read like a civilian space program fantasy, there was tacit acknowledgment that "some scientists" believed space colonization was possible, and that the show was ultimately a blend of educational material and speculation.[257]

Planetarium art represented an expression of the type of "accurate" astronomical image making described earlier in this dissertation. It was one of the places artists like Don Davis found consistent work. The arc presented by "Worlds of Tomorrow," which described structures that gradually shifted from plausible to fantastic, demonstrates the extent to which accuracy is the product of group consensus. The show also demonstrates the tenuous line between scientific illustration and science fiction art, which will be explored in the next section.

256. O'Neill's space settlement designs weren't funded by private interests for very long. After oil prices dropped in the 1980's following the 1979 crisis, the resource boon O'Neill's concept promised lost its immediate appeal.

257. Nancy Hornick, "Space Show is All-Staff Effort," *Smithsonian Institution Torch,* No. 79-2, February 1979.

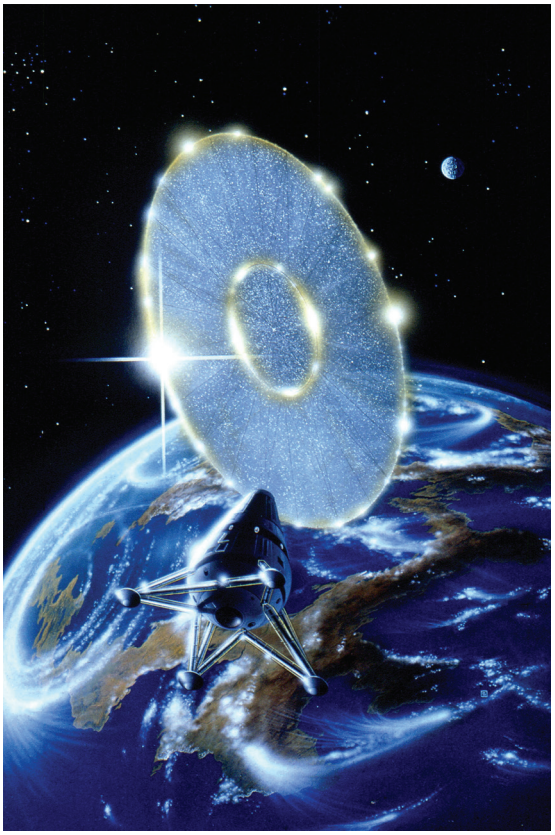

Figure 4.4— "Laser Light Sail" for *Science Digest,* May 1983. Part of an article on starships, depicting a concept by the Dr. Robert Forward. Illustration shows a landing vehicle performing a descent maneuver in a distant solar system, the giant aluminized sail left in the distance. As the sail passes an Earth-like planet in a distant star system, it dispatches a fusion-powered landing craft that will drop exploratory crews on the surface. When the visit is complete, the lander will rejoin the sail, the center portion of which will separate and return to Earth using laser light bounced from the jettisoned ring. Courtesy of Rick Sternbach.

Like Don Davis, Rick Sternbach—the other artist invited on board the *SS Statendam*—had multiple connections to the network convened aboard the "Beyond Apollo" cruise. He was introduced to Richard Hoagland in 1972 by G. Harry Stein, a former White Sands missile engineer who'd turned to writing science fiction. Stein pitched Sternbach to Hoagland as a promising young artist, and Hoagland soon hired him to create a color painting of the *SS Statendam*. It was Hoagland's hope that the painting would help sell the Apollo 17 cruise to Holland America. In exchange for his artistic assistance, Sternbach was invited to attend the cruise free of charge.[258]

Stein and Sternbach had recently collaborated on an article titled "A Program for Starflight," which outlined a plan for transgenerational voyage between distant star systems. Sternbach illustrated the Enzmann starships Stein identified as the most likely transit vehicle, showing them pointed towards distant celestial bodies while framed by the hazy atmosphere of a nearby planet. The ship's design was characterized by a three million-ton ball of frozen deuterium fueling a nuclear rocket engine, combined with modular crew dwellings intended to support hundreds of passengers on an interstellar voyage. The ships were designed by Robert Enzmann, an MIT professor and Raytheon collaborator, who helped organize the *SS Statendam* cruise along with Richard Hoagland.[259] Ben Bova, then editor of *Analogue Magazine,* was also onboard the cruise, and agreed to use Sternbach's painting as the cover for the issue in which Stein's article appeared. Sternbach's illustration of the Enzmann ship served as the cover for the October 1973 issue of *Analogue Magazine* and functioned as a portfolio addition he

258. Rick Sternbach, interviewed by Lois Rosson, May 26th, 2020, transcript, pg. 2.

259. Adam Crowl, K.F. Long, and R.K. Obousy, "The Enzmann Starship: History and Engineering Appraisal," *Journal of the British Interplanetary Society,* Vol. 65(6): Pg. 185

could take to other science fiction publications as evidence of his talents.[260]

Like Don Davis, Sternbach was trained to produce images that were faithful to their astronomical subjects. The early 1970s represented a "Golden Age" of space art in print publication. Work was abundant; after his cover for *Analogue,* he published illustrations in other science fiction publications as well as popular science magazines like *Sky and Telescope* and *Astronomy*. He'd create two or three rough paintings about the size of the magazine itself, shoot several Ektachrome photographs, mail the film into the publisher, and wait for feedback. They'd select a work for publication and give Sternbach two weeks to produce a final draft. Sternbach's working process was like Davis's, even if Sternbach actively produced more "science fiction" art than work for scientific institutions. If Davis's work helps showcase the centrality of reference material to the production of trustworthiness, then Sternbach's help illustrate how it often collapsed distinctions between science and science fiction.

Sternbach's career coincided with a resurgence in popularity of the melodramatic space opera, a subgenre of science fiction that used outer space as the backdrop for action-packed plot lines. The tipping point was George Lucas' 1977 smash hit *Star Wars,* which helped turn Sternbach onto film from the print periodicals he'd spent most of the 70s working on. In 1976, Sternbach attended a science fiction convention in Kansas City, where he encountered Ralph McQuarry's preproduction paintings for *Star Wars*. There was a room full of prints of McQuarry's work all around the walls, along with a set of C3PO, Darth Vader, and Chewbacca costumes. A twenty-four year-old Mark Hamill was also there, "jumping around in a *Star Wars* t-shirt."[261] The franchise was still virtually unknown, but Sternbach was impressed by the materials on display. Ralph McQuarry had spent time at Boeing, and Sternbach respected the attention to plausible engineering that characterized the structures in his paintings.[262]

Prompted by the type of work he'd seen in Kansas City, Sternbach decided to leave the magazine jobs he'd found on the East Coast and try his hand in the film industry. He relocated to Los Angeles in 1977 and started visiting studios like MGM and ILM to drop off slides of sample work. At Paramount, he met with Joe Jennings, a production designer working on *Star Trek: Phase II,* a television show detailing the second five-year mission of the Starship Enterprise. The project was one given to Gene Roddenberry from Paramount after his active lobbying for the revitalization of the *Star Trek* franchise. The show was cancelled after three seasons, prompting Paramount to license the broadcast syndication rights to help mitigate the financial losses of production. Reruns started almost immediately, airing in over 150 domestic and 60 international markets. As a result, *Star Trek* grew more popular over the 1970s than it had been during its

260. Tom Buckley, "Caribbean Cruise Attempts to Seek Meaning of Apollo," *The New York Times,* December 12th, 1972. Pg. 98. Accessed September 3rd, 2020. https://www.nytimes.com/1972/12/12/archives/new-jersey-pages-caribbean-cruise-attempts-to-seek-meaning-of.html

261. Rick Sternbach interview transcript, pg. 3.

262. Ibid, pg. 3.

Figure 4.5— Shot of USS Enterprise monitors, *Star Trek: The Motion Picture*, (1979), 0:48:04.

original run.[263] Though Sternbach wasn't offered a job on *Phase II*, he did leave his portfolio, and was called back a few months later when the studio announced *Star Trek: The Motion Picture*. The release of *Star Wars* prompted executives at Paramount to rethink the viability of a revamped *Star Trek* universe. They upgraded *Phase II* to a film scheduled to hit box offices by Christmas of 1979. *Star Trek: The Motion Picture,* would be Paramount's response to the space opera frenzy of the late 1970s.[264]

Rick Sternbach was especially interested in plausible depictions of space hardware, which made *Star Trek: The Motion Picture* an attractive project. Both Matt Jefferies and Gene Roddenberry had experience working with real aircraft, which Sternbach considered a sort of qualification for representing feasible spacecraft. Jeffries, the designer of the original Starship *Enterprise,* worked inside of several American bomber planes during World War II. Gene Roddenberry, *Star Trek's* creator, studied aeronautical engineering before enlisting as a bomber pilot in 1942 and eventually earned both a Distinguished Flying Cross and an Air Medal from the U.S. Army. He worked as a commercial pilot for Pan American after leaving the military but resigned in 1948 after

263. Schult, Doug. "Cult Fans, Reruns Give Star Trek an out of This World Popularity," Green Sheets, *The Milwaukee Journal*, July 5, 1972, *Los Angeles Times News Service,* Retrieved October 19, 2011.

264. Ed Power, "A Troubled Enterprise: How Star Trek: The Motion Picture Flirted with Disaster Only to Become a Surprise Smash." *The Independent,* December 6th, 2019.

Figure 4.6— View of the V'yger spacecraft, *Star Trek: The Motion Picture*, (1979).

a plane crash in the Syrian Desert killed fourteen passengers.[265] His departure from Pan Am left him free to pursue new interests, including writing for the new medium of television.[266]

For Sternbach, *Star Trek* was a science fiction franchise that combined fanciful plot lines with "smartly extrapolated science."[267] Rather than situating science and science fiction on opposite ends of an epistemological spectrum, fidelity to the rules of the physical world was one of the metrics by which he judged quality science fiction. In his view, the more realistic the depiction, the more entertaining the content.[268] Sternbach identified collaborations between Werner von Braun and Disney in the early 1950's as a sort of model for the work *Star Trek* was doing—in fact, Robert H. Justman, one of *Star Trek's* producers had been at Disney during the company's production of the *Tomorrowland: Man in Space* series.

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265. David Alexander, *Star Trek Creator: The Authorized Biography of Gene Roddenberry,* New York City: Roc Books, 1995.

266. Alexander, pg. 83 – 84.

267. "For me Star Trek was a wonderful combination of science fiction that most audiences would think was way out there. But! For me, it also hinged on a lot of real science. Or smartly extrapolated science." Rick Sternbach interview transcript, pg. 4.

268. When asked about his attitudes towards producing material for science fiction, Sternbach explained: "If I'm putting together a model of a space craft, I'm not just throwing parts together. I'm trying to learn about the bits and pieces that go into an interplanetary spacecraft. I know the hydrogen fuel tank sizes. I know the square footage of the radiators. I understand an okay amount about the thermonuclear rocket motors… Some people think that we don't need artificial gravity, going out to Mars and back, I think it would help. So, as an artist, my head is always thinking about the mechanical and scientific things. And that's followed me all through doing space art, doing science fiction art, doing film and television work." Sternbach interview transcript, pg. 4.

1977 was a tremendously visible year for outer space; *Star Wars* was released in late May, *Star Trek: The Motion Picture* entered production shortly after, and by August engineers at the Jet Propulsion Lab in Pasadena had watched both Voyagers 1 and 2 launch from Cape Canaveral. Science fiction blockbusters of the late 1970s expanded the look of outer space in the popular imagination, but this was done in conjunction with expanding views in the field of planetary science. The Voyager missions had a significant impact on the look of *Star Trek: The Motion Picture;* the geographic proximity of Pasadena to Hollywood made collaboration convenient, but even more generative was JPL's embrace of the visual display of information.

JPL managed the spectacle of the Voyager encounters in a way that reflected the centrality of film and television to American media in the 1970s. Instead of waiting to publish incoming data in journals, the team held press conferences that made discoveries immediately visible to science writers and journalists. Though some were uncomfortable with the departure of "instant science" from the peer review process, the press conference model served the reality of communicating the project's results. Because Voyager data was largely visual, it was popular with science writers and journalists writing for lay audiences. The trajectory of the spacecraft was also typically made known in advance, so members of the media could time their inquiries around planned encounters. The findings were also novel, showcasing never seen images of Jupiter and Saturn.[269]

There was also a shift in JPL's attitude towards publicity that encouraged the showcase of its projects for nontechnical audiences. As Peter Westwick notes, the lab's cultivation of a public image was part of a longer twentieth-century trend of deploying professional public affairs specialists on behalf of science.[270] This was a boon for *Star Trek* and other forms of popular media that were interested in using Voyager's discoveries to make their depictions of space more sophisticated. The visual nature of incoming data also prompted the development of new and better computer animation techniques, undertaken at JPL by Jim Blinn and his team at the Computer Graphics Lab. Though computer graphics was still in its early stages, it looked cutting-edge and *Star Trek* managed to poach some of the vector animations JPL was working on for display onboard the *USS Enterprise's* video monitors.

Rick Sternbach functioned as a liaison between the lab and studio, sourcing reference material that could help make the film appear more technologically sophisticated. In addition to the animations displayed on the *Enterprise's* monitors, Sternbach was also charged with overseeing the look of one the film's major props, the mysterious V'yger. The admiration shared between JPL and the *Star Trek* franchise was mutual; when project managers were weighing new names for MJS77—Mariner Jupiter-Saturn

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269. The Voyagers projects turned Jupiter and Saturn from "blurry smears on astronomer's plates" to material topographies with knowable features. "Voyager rewrote the textbooks—or, perhaps more accurately, drafted them from scratch, since knowledge of some of Jupiter's and Saturn's satellites and features was previously too scant to support detailed description." Peter Westwick, *Into the Black: JPL and the American Space Program, 1976 - 2004* (New Haven: Yale University Press, 2011) Pg. 17.

270. In Westwick's view, this process began with industry, spread to scientific societies, and by the 1970s was a guiding principle for campus research at universities. *Into the Black,* pg. 35.

’77, the mission hardware that would become Voyager— “Planet Trek” and “Trekker” were both considered.[271]

In the film, the Starship *Enterprise* is dispatched to investigate an ethereal and menacing force moving towards Earth. Towards the end of the movie, the being is revealed to be Voyager 6, which was intercepted by sentient machines and developed both a consciousness and yearning to meet its creator. In the film, Voyager 6 is a replica of the Voyager hardware used for missions 1 and 2, which were visible enough in the media that the studio believed audiences would recognize. To physically create V’yger, which was cast in the image of its parent model, Sternbach and several others working on the project went directly to JPL’s Public Affairs Office. After the production team acquired a set of blueprints, Sternbach’s job was to help set designers break the drawings down into manageable parts.[272] V’yger is finally revealed at the very end of the film—its name taken from a corrupted reading of “Voyager”— piloting its own spacecraft towards Earth to meet its creators. Though the film never clarified where on Earth V’ger anticipated encountering its maker, both Pasadena and Hollywood would have been strong contenders.

Star Trek: The Motion Picture was released in December of 1979. The film was rushed to completion to make it into theaters by Christmas and beset by several special effects hang-ups. The writing was especially harried—Ed Power dubbed it “*2001: A Space Odyssey* for slow learners.”[273] Even though it was met by lukewarm reviews, the film was a box office hit, earning much more money than had been spent on production. Just before the film was released, Rick Sternbach pivoted to a new project being undertaken in nearby Hollywood at public television station KCET—*Cosmos: A Personal Voyage*.

In addition to Carl Sagan, who Sternbach met on the *Statendam* cruise back in 1972, Sternbach was well-acquainted with many of the people working on *Cosmos*. Don Davis was working in the Art Department, and Sternbach knew the show’s Art Director, Jon Lomberg, from various run-ins over the course of the 1970s. While the day-to-day working process on the set of *Cosmos* was fairly like the one Sternbach was accustomed to on the set of *Star Trek,* there were differences in how a television show produced for public broadcasting approached special effects. In both cases, images started out as hand-made drawings and paintings. But because *Cosmos* couldn’t outsource as much of its content to external special effects teams, the Art Department had a much more hands-on relationship to specific effects production, miniature design, and animation. On the set of *Star Trek,* illustrators would typically hand off their work to other crafts people or vendors on the studio lot. The *Cosmos* Art Department was more insular, opting for a higher degree of in-house production that helped maintain fidelity to the

271. *Westwick, Into the Black,* pg. 38.

272. Rick Sternbach interview transcript, pg. 4.

273. Ed Power, “A Troubled Enterprise: How Star Trek: The Motion Picture Flirted with Disaster Only to Become a Surprise Smash.” *The Independent,* December 6th, 2019.

Figure 4.7— Left: Cover of *The Cosmic Connection,* designed by Jon Lomberg. Right: Lomberg's *Portrait of the Milky Way*, displayed at the National Air and Space Museum in Washington D.C. Lomberg attempted to paint every star in the galaxy in its correct location. Courtesy of Jon Lomberg.

types of data used as visual reference material.[274]

Cosmos approached the representation of space in a way Sternbach was familiar with, privileging ideas about accuracy and up-to-date reference material in a way that also centered heavily around access to the Jet Propulsion Lab. Carl Sagan, Steven Soter, and Ann Druyan's connections to astronomy and science writing represented a much tighter network of scientific expertise on which to draw. Unlike *Star Trek,* the show's producers billed it as a piece of pedagogical programming intended to instruct audiences about subject matter in the space sciences.[275] This commitment to scientific accuracy presented new challenges, especially considering the amount of Voyager data coming in over the course of 1978. It presented an element of inescapable contemporaneity—the Voyager encounter at Jupiter and Saturn took place while the show was in production. On occasion, visualization the special effects the team was working on were rendered obsolete by imagery being gathered by the spacecraft.

Even though *Star Trek: The Motion Picture* was a work of science fiction and *Cosmos* was a TV series that boasted the sheen of scientific credibility, for Sternbach the projects were functionally the same. The material overlap is also worth noting, as both *Star Trek* and *Cosmos* sourced both images and animations directly from JPL. In both cases, Sternbach's job was to take information about what space or space hardware might look like and produce an image or model that looked as convincing as possible.

Rick Sternbach's career is an example of how astrorealism proliferated in the post-Apollo period. An expansion in technologies that produced new pictures of outer space, coupled with the increasing centrality of film and television to American media

274. Sternbach interview transcript, pg. 6

275. Ibid, pg. 6.

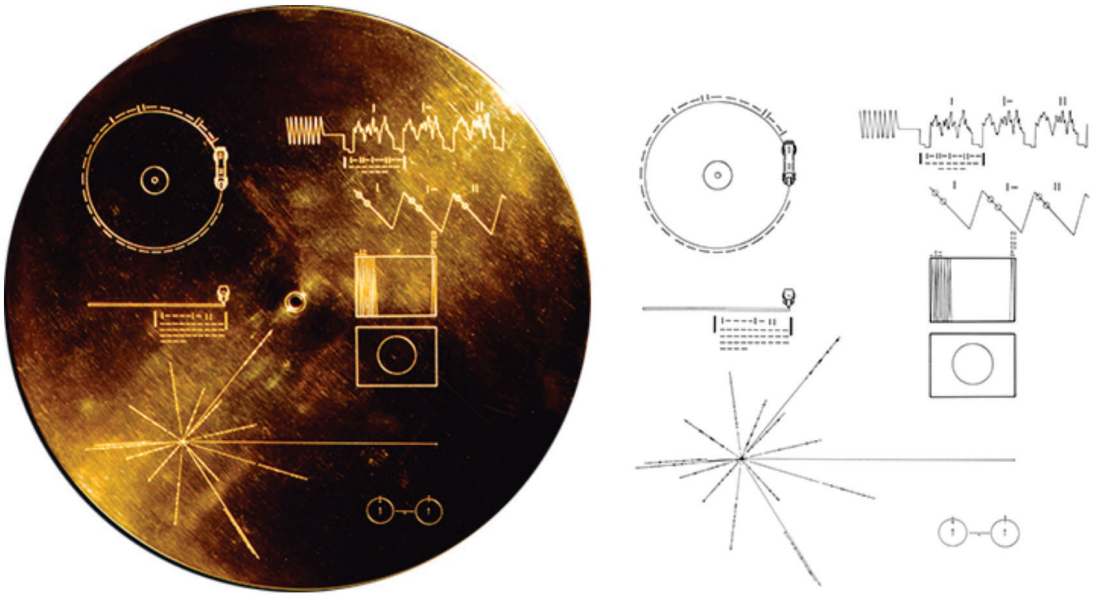


Figure 4.8— Voyager Golden Record and its instructions.

consumption helped spur a market for visual representations of the cosmos. Sternbach's career also helps illustrate the close ties between astronomical illustration and science fiction, and how this relationship grew more entangled over the 1970s. Whereas Don Davis got his start collaborating with scientific institutions that positioned his images closer to empirical illustration, Sternbach deployed many of the same visual techniques in his science fiction art. This was evidenced by the fact that both artists were tapped to work on *Cosmos,* a television program that blended imagined space landscapes with science pedagogy. Though it's easy to view works of science fiction as fundamentally distinct from "real" science, I argue that Sternbach's approach to art making was the same regardless of if the customer was a scientific publication, a popular film franchise, or educational programming.

IV. Space Science on Television

Roughly eleven minutes into the documentary produced on board the *SS Statendam,* Carl Sagan can be seen on deck extolling the value of space exploration in financial terms. "The costs of space exploration are less than those gross expenditures Americans are largely used to. The unmanned probe and satellite projects of the 1970s, that explore every object in the solar system, cost less that the cost overrun of the ICBM program of the fiscal year 1970."[276] Sagan's morally-tinged contrast of scientific exploration against the technological machinery of the military industrial complex was a definitive feature of his brand of space advocacy. This became increasingly visible over the course of the next

276. Carl Sagan in *Voyage Beyond Apollo,* 11:01, YouTube, https://www.youtube.com/watch?v=JTrzxIh-8jX8&feature=youtu.be.

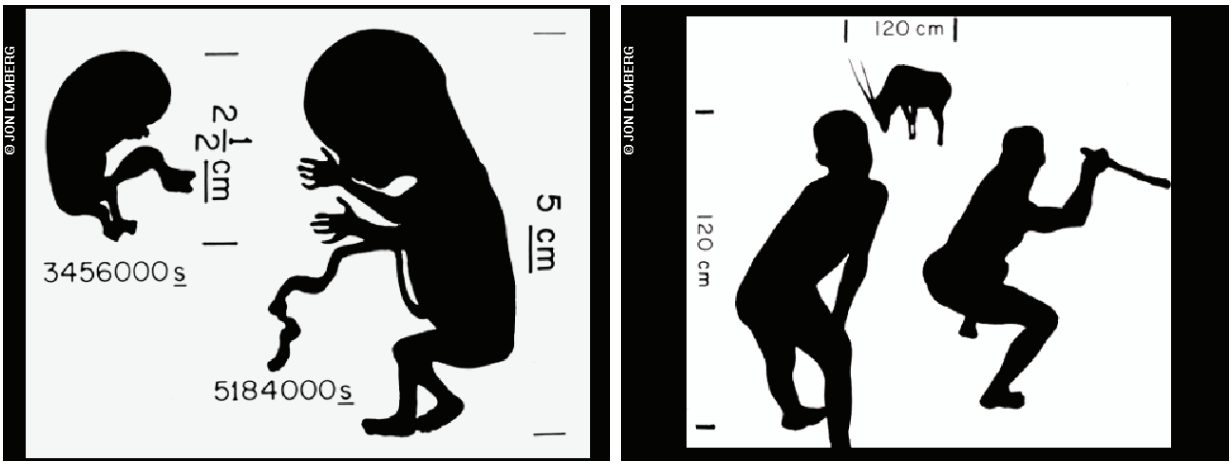


Figure 4.9— Examples of two of Jon Lomberg's "shadow" silhouettes.

decade as Sagan's status as a celebrity science advocate mushroomed in both print and television media.

As with the generation of space boosters that came before him, he also recognized the relationship of public perception to support of government science. This section focuses on Sagan's belief that quality science education would seed a future citizenship more sympathetic to the funding needs of Big Science projects. His approach had a distinctly visual component; Sagan realized that science education needed to compete with a dizzying landscape of high-production value entertainment, and that if the public was expected to pay attention at all, the content needed to be visually striking. In Sagan's view, audiences needed to be shown real science—and know that was what they were getting. Thus, to function as intended, this material would have to clearly demarcate its relationship to scientific accuracy.

This section explores how Sagan's approach towards science education television, in this case *Cosmos: A Personal Voyage,* was made possible by the skill set cultivated by the artists discussed in this chapter. I focus especially on Carl Sagan's collaborations with Jon Lomberg, a Canadian painter whose style represented a departure from the types of astrorealism described in this dissertation. Lomberg's work was as technically precise as that of Rick Sternbach or Don Davis, but he combined views of space with symbolic touches that suggested continuity with terrestrial landscapes. This approach, which framed outer space as continuous with nature instead of as a separate realm, was especially useful for Carl Sagan's brand of space advocacy.[277] Sagan and Lomberg's work on Voyager's Golden Record, and their attitudes towards representing space on *Cosmos,* help demonstrate the extent to which astronomical art responded to political discourse of the 1970s. If Don Davis' work represents the technical continuities of astronomical art with the genre in previous periods, and Sternbach's the way that these images proliferated across new forms of popular media, then Lomberg's art helps demonstrate how the genre responded to shifting ideas about environmentalism and the future. This portion

277. Jon Lomberg, interviewed by the author, May 18th, 2020, transcript, pg. 12.

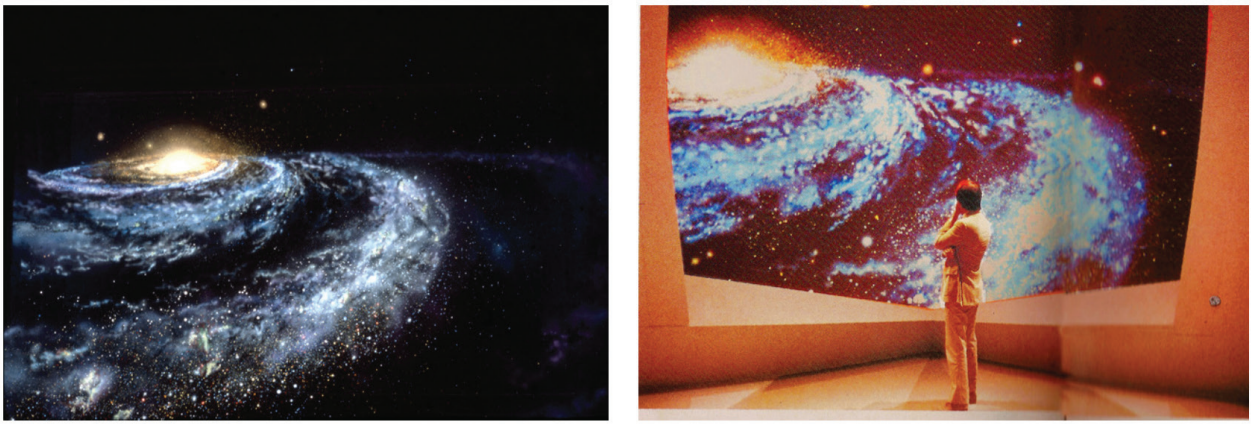


Figure 4.10— Lombergs's painted view of the Andromeda galaxy, and the same view again from the vantage point of the *Cosmos* spaceship. Courtesy of Jon Lomberg.

of the chapter also represents the intersection of their respective stories—Lomberg was tapped as *Cosmos'* Art Director, where Sternbach and Davis both worked as contributing artists.

Sagan's approach to drumming up support for new space ventures was a dramatic departure from the space boosterism of the 1950s. Rather than celebrating space exploration as an activity that would cement American hegemony in space, he framed the cosmos as an intellectual antidote to aggressive political impulses. The hardware that allowed space science to cohere into a bounded discipline in the mid-twentieth century was not a function of the same defense-minded spending habits that gave us nuclear weapons, but rather part of a much older tradition of astronomical observation. He framed space science as part of an ancient practice of human stargazing, rather than a set of technologies similarly borne out of Cold War conflict.[278]. In Sagan's view, which was reiterated in his popular writing and television appearances, the cosmos offered the type of humbling perspective the political squabbles of the 1970s so desperately needed.

Whereas Chesley Bonestell's work was celebrated by his collaborators for its dry accuracy, Sagan embraced Lomberg's art precisely because it combined astronomical art's usual visual tropes with humanistic touches.[279] Lomberg and Sagan's first collaboration was for *The Cosmic Connection: An Extraterrestrial Perspective*, which Sagan published in 1973. The painting Lomberg produced to accompany the book's opening chapter shows a cluster of stars framed by backlit trees and their shadowy silhouettes.

278. This was a common theme reiterated in the first episode of *Cosmos,* "The Shores of the Cosmic Ocean," which narrates the history of astronomy from the ancient Greeks onward as relevant prehistory to the advancements of space science in the mid-twentieth century.

279. Sagan was also a fan of Chesley Bonestell's and purchased several of his paintings over the course of the 1980s. His 1981 book *Visions of the Universe,* written with Isaac Asimov and illustrated by Japanese space artist Kazuaki Iwasaki, was dedicated to Bonestell. He also paid the Bonestell estate for rights to use his work in several popular publications. The Seth MacFarlane collection of the Carl Sagan and Ann Druyan archive, 1860 – 2004, Correspondence: Fred Durant, Box 57, Manuscript Division, Library of Congress, Washington, D.C.

Figure 4.11— Lomberg standing in front of a model of Jupiter, and working on an airbrush painting to be used in the show. Courtesy of Jon Lomberg.

This recasting of space as an extension of the natural environment, as opposed to a dark void between planets, was characteristic of Lomberg's work.

In 1976, Carl Sagan and Frank Drake reprised the gold-anodized aluminum plaques included on the Pioneer spacecraft in 1972, organizing a similar project for Voyager. The Pioneer plaque was designed to communicate a message to an imagined extraterrestrial audience, but because of a compressed timeline, had to be designed, vetted, etched, and mounted in a time frame of approximately three weeks. Since Voyagers 1 and 2 were anticipated to reach even further distances, it was concluded that the spacecraft should also carry a message composed on behalf of Earth's people. By this point, Drake had identified a method for encoding images into the grooves of a record, so it was decided that a golden LP would replace the etched plaque. Lomberg was charged with sourcing photographs to accompany the various sonic components of the record's messaging, as well as offering feedback on the music and sound recordings contained on the record.[280]

At its conceptual core, the project's goal was to produce an object that represented the non-technical dimensions of Earth, and to communicate them to an imagined alien species. Lomberg's task was to collect a range of images that described human life in a coherent way. Of course, no totalizing narrative of Earth could be communicated in 116 images; the selection included says much more about the compilers of the record's contents than anything essential about life on Earth in 1976. There were diagrammatic images meant to describe concepts believed to be universal: lists of mathematical equations, a diagram of a DNA helix, as well as a chart describing the distances between all the planets in our solar system. There were also photographs of various human activities: one image showed three people eating and drinking, while another showed a baby breastfeeding. Olympic athletes, a teacher, and a woman at the grocery store were shown, as well as several cityscapes, cars, and Titan Centaur rocket.[281]

280. Lomberg, interview transcript, pg. 12.

281. "Images on the Golden Record," Voyager Image Gallery, Jet Propulsion Laboratory, accessed October 14th, 2020, https://voyager.jpl.nasa.gov/galleries/images-on-the-golden-record/

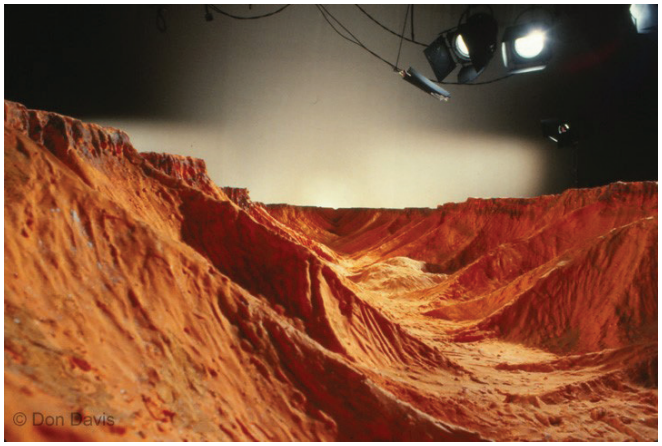
Figure 4.12— Don Davis working on a model of Venus, to be used in a shot of the Soviet Venera 9 lander. The models were built out of plaster shaped on carved foam. The rocks were formed out of pieces of the broken plaster. Courtesy of Don Davis.

Lomberg was concerned that even if an alien civilization intercepted the record and was able to decode the disc, they might not be able to read photographs as containing any intelligible information. In his view, "not even all people can necessarily read photographs" unambiguously, and that most people take for granted the extent to which the ability to decipher visual information is a learned skill. In 1976, his solution was to include eleven drawings on the record that broke down visual information into black and white shapes. He concluded that if an alien organism were ever to encounter the record, its physical ability to decipher visual information encoded by humans would warrant proximity to some sort of star system. In other words, if an alien being were to "see" visual information the way humans do, it would likely be the result of evolutionary sensitivity to a centralized light source. Thus, Lomberg's solution was to depict certain forms as shadows. If the hypothetical alien observer had any familiarity with light emanating from a single source, then it was likely familiar with the concept of a shadow. If it was familiar with shadows, it might also understand that they represent complex physical objects in two-dimensions. If it got that far, it might also realize that the rest of the images on the record were two-dimensional representations of three-dimensional beings and structures.[282]

The record itself reflected the anxieties about nuclear annihilation that characterized postwar Big Science and can be viewed either as an effort to reach an alien civilization or to preserve aspects of human culture in the event of Earth's destruction. Notably absent from the record were any images that spoke to the nuclear arms race Sagan spoke out so vehemently against. Sagan later wrote in *Murmurs of Earth* that "it was an issue we debated long and hard during our deliberations on repertoire. . . There is no question that destruction is a characteristic aspect of what we are pleased to call human civilization."[283] He explained that this was done to prevent the message from

282. Lomberg, interview transcript, pg. 13

283. Carl Sagan et al., Murmurs of Earth, pg. 40, as cited in "Archiving "The Best of Ourselves" On the Voyager Golden Record: Rhetorics of the Frontier, Memory, and Technology," by Rachel M. Schmitt (Master's Thesis, University of Colorado, 2017), Pg. 50.



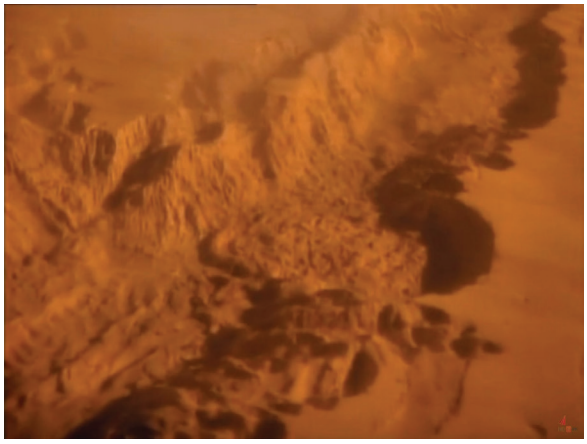


Figure 4.13— Left: tabletop model of the Vallis Marineris. Bottom: view of the Vallis Marineris as it appeared in the show. Dry ice vapors were used to suggest a dust storm. Courtesy of Don Davis.

Figure 4.14— Left: Don Davis, John Allison, and Adolf Schaller working on a globe of planet Earth at the KCET "Artist's Apartment." The globe was coated in many layers of sanded gesso, and the coastlines were drawn using Sagan's personal copy of the Oxford World Atlas. Right: photograph of camera panning over the Vallis Marineris model and dry ice vapors. Courtesy of Don Davis.

potentially being interpreted as aggressive, rather than to scrub violence from the team's portrait of life on Earth.

Two copies of the record were mounted on each of the Voyager spacecraft before launch in 1977. According to Lomberg, no one who worked on the Voyager record was certain that either spacecraft would make it off the launchpad, let alone to their anticipated destinations. Though the records achieved modest popularity after the spacecraft's launch, Lomberg was still humbled by the record's celestial reach, and the nature of his contribution.

In a New York Times interview published in 1977, a reporter asked Carl Sagan how he would spend the government's very last billion dollars, if Congress had passed a law that prohibiting any further spending on science. Sagan responded with "I'd put it all into science education and hope to undo the legislation."[284] While it's easy to read this as an altruistic interest in the betterment of society, Sagan himself attributed a desire for increased science education to naked self-interest. In his view, not only had government had done a poor job of maintaining its mid-century science initiatives but had also failed to educate its citizenry in a way that might help those projects maintain momentum. The space program was a prime example—in the years after Apollo Moon landings, NASA's purpose became less clear. Over the course of the 1960s, the agency was oriented almost exclusively around the Moon shot. What was the point now? Indefinite exploration?

284. Boyce Rensberger, "Carl Sagan: Obliged to Explain" *The New York Times,* May 29th, 1977, accessed October 1st, 2020. https://nyti.ms/1QJjLo9

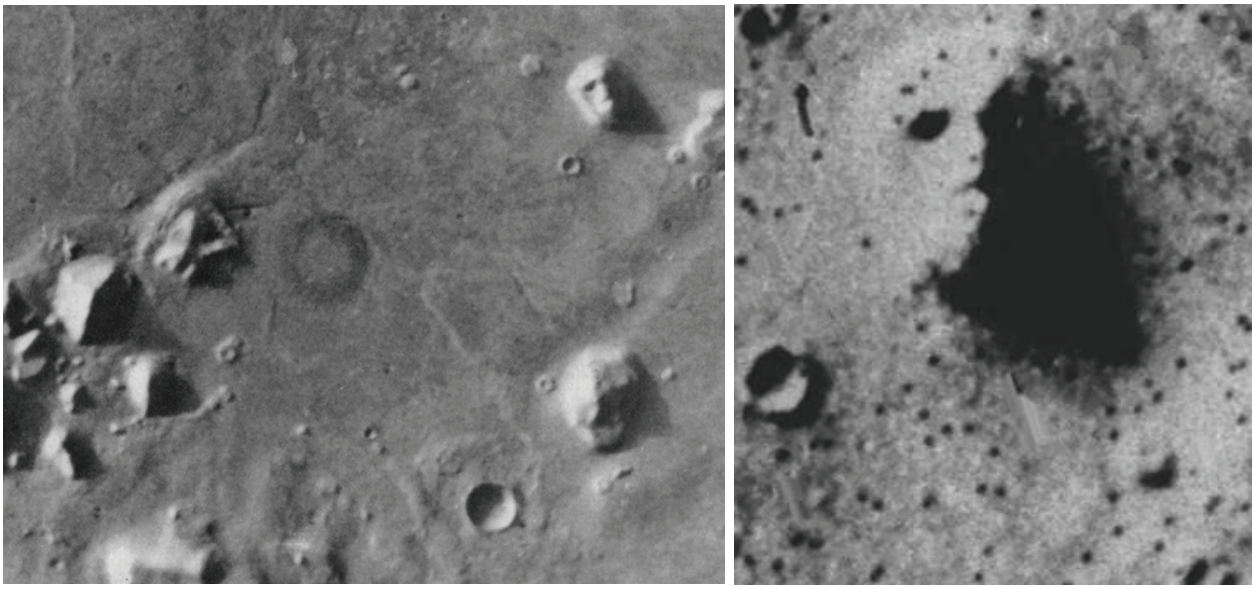


Figure 4.15— Left: NASA Frame 35A72, Viking 1, 1976. Right: Close-up of supposed face shape. Richard Hoagland claimed the frame showed a the "face" (upper right) and the "city," made up of pyramidal shapes to the left of the center that Hoagland claimed as evidence of alien life.

Settlement? These questions needed to be answered, but enthusiasm waned almost as quickly as congressional interest.

Cosmos: A Personal Voyage, entered production in 1979 and pitched outer space as a realm worthy of investigation for investigation's sake. It situated humanity and Earth and continuous with the rest of the solar system, often suggesting that answers to questions about life on Earth might be found in outer space. The opening sequence of the first episode of *Cosmos,* "The Shores of the Cosmic Ocean," showed a painted ocean of stars fading into camera footage of a terrestrial ocean. The second episode, which explained human evolution and suggested that the answer to the question of life on Earth could be found in space, showed images of human DNA overlaid on top of galaxies. If Bonestell's work represented space as a type of arid frontier waiting to be settled by scientist-explorers, then Lomberg's art suggested that man was already a part of this landscape. Lomberg's approach to astronomical art was visually congruous with Sagan's often-quoted line, "we are made of star stuff."

While the metaphorical style of visual representation embraced by both Sagan and Lomberg was more capacious than traditional astronomical illustration, it still maintained a beholden relationship to ideas about accuracy. Just because *Cosmos* over-laid interpretive symbols of Earthly biology on top of images of space didn't mean astronomical representation was taken any less seriously. The show leaned heavily on the idea that it was giving viewers real science, and thus the accuracy of the images composed in production was judged to be a critical component. Reference material that wasn't sourced directly from JPL was culled from images in scientific papers, while representations of celestial subjects without usable reference material were presented to experts for input. In a move that signaled wholesale trust in an artist's ability to draw "objectively," the production team cross-checked the Mars models produced for the

series with Jay Inge's airbrush maps.[285]

The 1970s represented a shift in attitudes about the purpose of space exploration as well as a deluge of new information about its composition. Carl Sagan had access to Jet Propulsion Laboratory's library of materials, which meant the *Cosmos* Art Department had a wide variety of cutting-edge visual references at its disposal. There was also a lot of important chronological overlap; at the time that production on the show began, Voyager 1 passed Jupiter on its way to Saturn. Plus, the geographic proximity of JPL's resources to KCET's production studio made it a natural resource. Jon Lomberg recalled moments in the production schedule when he'd be sitting at JPL, and new pictures from the Voyager spacecraft would reach the lab. "We'd get the picture and I'd hop in the car and drive at high speed from Pasadena back to Hollywood, and literally would revise the paintings—the models—as new data was coming in."[286] According to Lomberg, attempting to visualize the solar system at this point in time felt experimental in its own right. There was a tacit understanding amongst the staff that whatever work was done to visually represent the solar system might soon be rendered obsolete. There were upsides, however: Don Davis recalled with satisfaction being able to use fresh Voyager 1 images to inform the color of the globes he constructed for the show.[287]

Not only did JPL handle all the incoming information transmitted by Voyagers 1 and 2, but it was also pioneering new developments in computer graphics. The *Cosmos* production team contracted with JPL to help produce some animation sequences for the television series, which was beneficial for both since it gave the Computer Graphics Lab at JPL a little more money to work with. These collaborations resulted in several usable sequences for both entities; imagery of the Voyager spacecraft flying past Jupiter shown in *Cosmos* was also used in JPL press releases. Jon Lomberg saw this relationship as one of kindred spirits. When interviewed about the extra resources *Cosmos* was able to provide Jim Blinn and his team, he described Blinn as an "astronomical artist himself." Lomberg explained that "When Jim Blinn couldn't get the money from JPL to do his Voyager fly-by, he got the money from *Cosmos*. And one of the things he found, because Jim was an astronomical artist in a sense, was that if there was a starfield he wanted it to be an accurate starfield."[288]

Lomberg's likening of Blinn to an astronomical artist precisely because of his respect for visual accuracy is very telling of his own attitudes towards what made good space art. Lomberg described the artistic impulse spurred by collaborations with *Cosmos* as one that prompted novel insights that might otherwise remain invisible to teams of engineers: "When [the CGL team] did the animations, like when they did the Saturn animations, they noticed that there was a bright star that was going to pass right behind the rings. And it gave them the idea: 'well if we look at that star as it passes behind the rings and measure how the light varies, that gives us a profile of the thickness of the

285. Lomberg interview transcript, pg. 3.

286. Ibid., pg. 5.

287. Don Davis interview transcript, pg. 6.

288. Lomberg interview transcript, pg. 10.

rings.' And they'd never have seen that if it'd never been done as computer art."[289] The result of these collaborations was a shared body of animated visual representations that were functionally accurate as well visually compelling.

The technological innovations of the 1970s changed what kinds of reference material astronomical artists were able to use, but also how they were able to represent them. Despite the early stages of computer animation, Davis, Sternbach, and Lomberg had early access to these technologies via their connections to JPL. Jim Blinn, the computer graphics pioneer that headed the CGL, hired Davis and Sternbach to produce some of the first planetary texture maps ever created. Davis worked on 3D maps of Saturn and its various satellites, as well as Uranus and Neptune. In his view, these tools were perfectly continuous with the tools of astronomical illustrators in previous periods. The maps he produced at JPL were portrayals of what a planet should look like, but in a way that bridged 2D and 3D representation.

Davis compared these texture maps to the Mercator projections of the sixteenth-century. Mercator projections were cylindrical maps that presented north and south as up and down but in a way that preserved local directions and shapes. The idea for the texture maps was relatively similar—rectangular planetary texture maps were wrapped digitally around a virtual globe, so they could be examined from any angle.[290] Accounting for distortion while using this method was tricky, because the closer you got to the planet's pole the more distorted the representation became. Producing the projection maps was like drawing an anamorphic picture, an image that will only reveal itself to the viewer when seen through a mirrored cylinder. Round craters on the surface of a planet would look round only if painted near the equator. If they were shown anywhere near the top or bottom of the planet they stretched into a long ellipse. After hand-painting the textures themselves, Davis and Sternbach solved this distortion problem by using the stamp tool Blinn and his team created as a visual guide. The collaboration was a fruitful one for both teams—the artists proved invaluable for tasks that required the plotting of information according to visual perspective. [291]

Despite the perks of its connections to JPL, Cosmos entered production prior to any sort of commercial proliferation of CGI technology. This meant most of the special effects needed to be engineered by hand in a highly labor-intensive process. If producers wanted to show the surface of a planet, the Art Department needed to a sculpt detailed tabletop model to function as a visual stand-in.[292] After the model was created, the production crew passed a camera over the landscape. The camera had a lens with a small mirror attached to the bottom, operated by a bigrig set up piloted by someone "driving" with both hands. On screen, this simulated a fly-over of the planet in question, but occasionally the mirror would scrape the surface of the model and the sculptor would need to quickly repair the model to continue the shoot. Large globes that allowed the

289. Jon Lomberg interview transcript, pgs. 2 - 9.

290. Don Davis interview transcript, pg. 8.

291. Don Davis, interviewed by author, transcript, pg. 18.

292. Ibid., pg. 18.

planets to be viewed from distant vantage points in outer space were also commissioned. According to Don Davis, a globe of the Earth that was three feet in diameter took about a "man-year's" worth of work. "Speaking generally: you know like, man hours." [293]

Cosmos aired in 1980 and remained the most watched television show produced for American public broadcasting until the start of the next decade. Carl Sagan's desire to educate audiences about "real science" in a visually striking way was directly served by the Astrorealist impulse the artists in this chapter cultivated over the course of the 1970s. The visuals for which the show was celebrated appeared on screen as a simple 1:1 capture of outer space. For this effect to work as intended, the role of the artist's interpretive judgement needed to be subsumed into the clarity of the image; what viewers were seeing was visual information about the cosmos, mediated through a trained artist, who functioned only as a temporary vessel. The appearance of scientific neutrality was quite literally constructed by a group of people with a distinct form of professional expertise.

The *SS Statendam* "Voyage Beyond Apollo" represented a physical confluence of second wave astrofuturism. The discussion onboard mirrored the space boosterism of the 1950s, but in a new political, economic, and technological context. All was framed, quite literally, by the twilight of the Apollo program. At the time that he organized the *Statendam's* voyage, Richard Hoagland was still a respected member of circles advocating for expanded public interest in space activities. A popular lecturer at the Springfield Planetarium throughout the 1970s, he'd made a name for himself as a science writer and frequently intersected with many of the people discussed in this chapter. The conspiracy theories that would ostracize him were still roughly a decade away; in 1976 he successfully undertook a campaign to rename one of the U.S. Space Shuttles after the Star Trek *Enterprise*. He was listed in the report as a "science advisor at CBS News and devoted Star Trek fan."[294]

Hoagland was very much a part of the professional network the emerged around space advocacy in the 1970s. His relevance to this chapter though, has much more to do with the claims that eventually saw him excommunicated. The beliefs that would estrange Hoagland from the group he convened in 1972 were contingent on the same influx of images of space that the artists in this story were also contending with. In 1987, Hoagland published *The Monuments of Mars: A City on the Edge of Forever*, which claimed that the four Viking spacecraft NASA sent to Mars in 1976 sent back photographic evidence of ancient alien civilizations.[295] The lynchpin of Hoagland's argument was a Viking 1 image that he interpreted as showing a human-like face. He claimed this was evidence not only of the existence of intelligent alien life, but of a widespread

293. Ibid.

294. Hoagland was also responsible for initiating the campaign to name the first U.S. Space Shuttle after the Star Trek *Enterprise*. "NASA-wide Survey and Evaluation of Historic Facilities in the Context of the U.S. Space Shuttle Program: Roll-Up Report" prepared by Archaeological Consultants, Inc. Pg. 36 https://www.hq.nasa.gov/oia/nasaonly/itransition/Shuttle_Historic_Facilities_Roll-up_Report.pdf

295. Richard Hoagland, *The Monuments of Mars: A City on the Edge of Forever,* 5th Edition (Berkeley: North Atlantic Books, 2001).

cover-up by both NASA and the U.S. government.[296]

Hoagland's conspiracy theory is an epistemological inversion of the work done by Don Davis, Rich Sternbach, and Jon Lomberg over the course of the 1970s. The Astrorealists discussed in this chapter used machine-mediated images as reference material to cross-check the accuracy of their depictions of other planets. Hoagland took many of the same NASA images and seized precisely on the pictorial ambiguity these artists sought to clarify. He used similar looking images, produced by the same agency, to draw wildly different conclusions about the meaning of their content. There was also a similar appeal to scientific expertise; Hoagland used his interpersonal connections to space advocacy as a sort of credential for his readers, cultivating a fictional image of a planetary scientist exiled from his community for speaking "the truth."

Hoagland's case is a reminder of the interpretive cognitive work necessary to produce an image, but also to read it as something other than muddled visual gibberish. For Hoagland, a random pattern of shadows cast by rocks on the surface of Mars could be read as a human face—all someone needed to be able to see it was the gestalt-shift trigger of appropriate framing. For Hoagland and for the working Astrorealist, clarity was something that often needed to be coaxed out of an image of outer space. This was precisely the conceptual problem Jon Lomberg had in mind when he included black and white diagrams on the Golden Record; he was concerned that the alien species that intercepted the record would lack the pictorial literacy necessary to read photographs at all.

The Golden Record's shadow images are a useful prompt for thinking about how the legibility of an image is constructed according to certain conventions. This chapter argues that the visual signals that make an image read as "scientific" can be abstracted from the image itself and understood as a set of aesthetic tropes. For Rick Sternbach, the aesthetic of scientific neutrality was a tangible one that could be easily applied to works of science fiction. When he sourced animation sequences for display onboard the *USS Enterprise,* he wasn't interested in the content of these sequences, but rather the look of technological sophistication they lent to the ship's console.

It's important to note that this was not always a conscious process. For Don Davis, rooting his space station drawings in a study of Atherton's various architectural styles was a way to sharpen the clarity of his depictions and signal the importance of environmental engineering. While this was an attempt to inform the technical refinement of the drawings, it inadvertently recycled racialized ideas about urban environments and the superiority of suburban living. By excavating the material references used in the production of outer space, we can start to appreciate the true work of the astronomical realist: creating a believable image of outer space that obscured their own hand in the process. This group of people is a useful case study for historicizing accuracy as a category that was periodically renegotiated. The pictorial record of what outer space looked like was rapidly transforming, revealing the ways in which previous interpretations were misguided. Over the course of the 1980s, astronomical illustration cohered into a bounded profession that addressed these questions collectively.

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296. Richard Grossinger, "The Face on Mars: An Interview with Richard Hoagland," *The Sun,* July 1986. Accessed September 4th, 2020. https://www.thesunmagazine.org/issues/128/the-face-on-mars

Chapter 5 — The Rock and Ball School: Codifying the American Space Landscape, 1981 – 1987

I. The Politics of Space Art Patronage

In 1984, Ron Miller explained to his fellow astronomical artists that while photographs from NASA probes such as Voyager, the Lunar Orbiters, and Viking "have been true goldmines for the astronomical artist," they should not be deceived by "the *apparent* reality of NASA photos." "Yes," he continued, "they are photos taken with real cameras of real places, but they do not necessarily represent what you would see if you were to go to these places yourself—no more so than your own insides look like an X-ray." Miller's audience was the International Association of Astronomical Artists, his platform an article published for their spring 1984 edition of *Parallax,* the guild's in-house journal. Miller's article cautioned fellow artists against taking scientific images at face-value, but his concern wasn't that NASA was deliberately misleading. Rather, he believed that truthful representations of the surfaces of alien worlds were nearly impossible to capture with the hardware available. This was a problem the IAAA frequently returned to because it was one that reinforced their professional intervention. If what you wanted was an image that approximated what a naked eye view of outer space might look like, then you needed an astronomical illustrator to help interpret the data you were getting from machines.[297]

The International Association of Astronomical Artists formed in 1981 and formally codified the Astrorealist style into a set of standards and practices for producing sufficiently accurate illustrations. The head of the NASA Art Program dubbed their style "the rock and ball" in an explanation of why he didn't seek out their work for the agency's collection. Their illustrations frequently depicted a "ball," typically a star or moon, floating above a hard rocky hocky horizon. The format was lambasted as derivative of the one Chesley Bonestell popularized in the 1950s. For IAAA members, this was precisely the point—Bonestell painted space landscapes "accurately," and thus working in his style was another way to signal that an illustration wasn't simply a work of artistic fancy.

Scholars that have written on the topic of astronomical art in the twentieth century typically turn to the sublime views of the Rocky Mountain School that visualized the American west at the end of the nineteenth century.[298] This explanation leans on the widespread legibility of frontier tropes as places that invite colonial expansion, positing that space landscapes adopted the same visual format. The problem with this argument is that it doesn't explain the persistency of these tropes over the course of the twentieth century. I argue that the thread that connects astronomical art to the history of the American west lies in the necessity of reference material to create sufficiently believable

297. Ron Miller, "Using NASA Photos as Reference," *PARALLAX: Journal of the IAAA,* 1984:2, pg. 6 - 7.

298. Daniel Sage, *How Outer Space Made America: Geography, Organization and the Cosmic Sublime* (London: Ashgate, 2014). Catherine Newell, *Destined for the Stars: Faith, the Future, and America's Final Frontier* (Pittsburg: The University of Pittsburgh Press, 2019). Elizabeth Kessler, *Picturing the Cosmos* (Minneapolis: University of Minnesota Press, 2012).

images. Images of the West were readily accessible to artists who needed to create a sufficient level of detail in their work to produce something "realistic" looking. If we turn to space art produced in the Soviet context during the same period, we find a radically different approach to representing the cosmos in an "accurate" way.

"The Rock and Ball School" can be understood as a set of codified practices and artistic philosophies embodied by the International Association of Astronomical Artists. Like the Rocky Mountain School of the nineteenth century, the IAAA was concerned with producing images that captured the truth of observed landscapes. While the Rocky Mountain School was guided by the Christian meaning of western landscapes, the IAAA produced truth via scientific accuracy. Both dealt with Western landscapes and illustrated the deeply cultural process by which remote landscapes are made legible as knowable places.

The IAAA rallied around a philosophy that privileged scientific information as the most important form of artistic reference material. This was not straightforward work, and the group was constantly plagued by the question of whether the illustrations they produced were 1:1 visualizations of scientific data or a form of art-making more in line with the history of American landscape painting. If a painting displayed scientific subject matter in an attractive way, did this compromise the image's validity? Or could beauty and accuracy exist simultaneously? This tension persisted over the course of the 1980s and led to the undermining of astronomical illustrations status as a scientific image much more than the proliferation of computer graphics.

This case study helps explain why visual tropes that cast outer space as a type of western landscape continued to influence contemporary space science in the late twentieth century. I explain the paradox of a single image simultaneously referencing a specific artistic movement, while circulating as a scientifically neutral representation. The IAAA recycled views of the American West into illustrations of other planets, but they also used principles borrowed from planetary geology to justify this methodology as an accurate one. Their primary patron, a space advocacy group called the Planetary Society, circulated their images alongside NASA photographs as accurate representations of distant space landscapes.

Despite their attempts to produce neutral visualizations of science, the IAAA produced a pictorial record encoded with cultural artefacts. Why did their images replicate the visual tropes associated with the American West? How was this reconciled with their preoccupation with scientific accuracy? How was this reconciled with the belief that their work inherited the legacy of high Western art? How can an image be a neutral representation of a scientific subject and still plugged into an older aesthetic genealogy? On its surface, the IAAA was where commercial illustrators employed in planetariums, science television, and the publishing industry negotiated standards of accuracy for manufacturing "naked eye" views of the cosmos. But it also functioned as the institutional vector for making sense of the genre's history; the IAAA's brand of astronomical art traced its aesthetic genealogy through much older forms of scientific illustration, but also looked to classically representational art as a stylistic progenitor. This is a story about how a group of artists used different tools and technologies to produce "accurate" views of space, but also how they organized into a professional body that operated on the peripheries of both the contemporary art world and planetary science.

The IAAA is a case study that illustrates how the "aesthetics of neutrality" described in the last chapter were integrated into a professional identity. Accuracy was constructed via group consensus, and though the images the IAAA produced looked neutral to their membership, a comparative look at their views of the cosmos reveals the extent to which The Rock and Ball school was a distinctly American phenomenon. Art produced in the Soviet context during the same period operated with an entirely different set of assumptions, relying on abstract representation of scientific ideas. Members of the Soviet United Artists Guild found the work of their American counterparts overly "materialist" in its fixation on representations of reality.

While the IAAA is a relatively obscure professional organization in the history of spaceflight, its individual members enjoyed a tremendous amount of visibility and played an integral role in shaping the look of outer space in both the popular and scientific imaginary. As with the modes of collaborative "seeing" established in Janet Vertesi's *Seeing Like a Rover,* members of the IAAA implemented several strategies for standardizing the way the group approached their interpretations of outer space. Their approach to the space landscape as a sort of perceptual problem in representation can also be placed in direct conversation with Lisa Messeri's work on picturing exoplanets, *Placing Outer Space*. The IAAA used contemporary space science to simulate the first-hand experience of remote landscapes, a critical exercise in what Messeri termed "place-making." For example, an illustration of the surface of Titan required a basic working knowledge of issues like light amplitude and atmospheric composition, in addition to basic topography. Synthesizing these into a coherent picture imagined from a first-hand perspective helps make an otherwise unfathomably complex body much more legible to the human eye.

As with all the other case studies in this dissertation, this is a story animated by patronage. Three years prior to Ron Miller's cautionary note about the deployment of NASA imagery, Voyager 2 breached Saturn's region of magnetic influence, marking the completion of the mission's inspection of planets visible to the naked eye.[299] This was the closest encounter with the planet humankind had ever engineered. The spacecraft was slated to transmit live images back to Earth during its journey. To publicize the rendezvous, the Planetary Society organized Planetfest '81, a three-day convocation of panels, tours, and watch parties, intended to bolster excitement around the Voyager encounter.[300] The event, a combination of images of outer planets as well as information about them, brought together space advocates and artists interested in presenting space exploration as a worthy cause for public interest and investment. In the January issue of The Planetary Report, Carl Sagan lamented that "the pace of planetary exploration has slackened ominously. After the *Voyager* encounters with the Saturn system in November 1980 and August 1981, there will be a period of more than four years in which no

299. Carl Sagan and Bruce Murray, "Welcome," Planetfest '81: The Pasadena Planetary Festival, Program of Events, August 23rd – 25th, 1981. Archive of Visual Arts MS 001, Box 12 Folder 109, Robert McCall Collection (1937 – 2010), University of Arizona Museum of Art, Tucson, Arizona.

300. William Hartmann, Andrei Sokolov, Ron Miller, and Vitaly Myagkov, *In the Stream of Stars: The Soviet/American Space Art Book* (New York: Workman Publishing, 1990), pg. 12.

Figure 5.1— Louis Friedman, Bruce Murray, and Carl Sagan presenting at Planetfest '81. Accessed via Twitter: https://twitter.com/exploreplanets/status/629346736037855232/photo/3

new images are returned from the planets by any United States space craft."[301] Over the course of the next decade, the relationship of art to space advocacy evolved into a more formal union. Planetfest was composed of a series of exhibitions themed after planets in the solar system, designed to engage young attendees and members of the public.

Formed in 1979 by Carl Sagan, Bruce Murray, and Louis Freedman, The Planetary Society mirrored advocacy organizations like the Sierra Club or Greenpeace.[302] Its goal was to promote space exploration at a time when political support for the endeavor was dwindling.[303] The point of the Planetary Society was to document public support for space exploration in a way that was legible to Congress in the form of an advocacy group. In July of 1980, Sagan lamented that he could remember a Congressman telling him that the only letters he had received in support of the Galileo exploration of Jupiter

301. Sagan went on to explain that "the Soviet Union also shows signs of slowing its once vigorous program of space vehicle exploration of the Moon, Venus, and Mars – although it is still spending probably two or three times more per year on such enterprises as the United States. If we back off from the enterprise of the planets, we will be losing on many different levels simultaneously… it uses aerospace technology in an enterprise which harms no one, which is a credit to our nation, our species, our epoch." Carl Sagan, "The Adventure of the Planets," *The Planetary Report,* December 1980, January 1981. Vol. 1. Pg. 3.

302. "Our membership, now over 20,000 is growing at a remarkable pace… We meet and share information with the National Space Institute, the L-5 Society, the Aerospace Industries Association, the American Astronautical Society, and the Space Studies Institute. We are also keeping a liaison with the Viking Fund, the World Space Foundation, and the Space Foundation. Duplication of effort is not a problem and the Planetary Society's attempt to organize the great public interest in deep-space exploration is supported and welcomed by all." Louis Friedman, "Society Notes." *The Planetary Report,* February - March 1981, vol. 1, No. 2.

303. Westwick, *Into the Black,* pg. 53 - 57.

The Next Giant Leap: SPACE EXPLORATION AS FOREIGN POLICY

by Ann Florini

Those interested in the peaceful uses of space have long understood that exploring the cosmos must be the work of many nations. The search for knowledge and for ways to make life better on Earth is not a uniquely American quest. The Soviet Union, Japan, the nations of Western Europe, China and India have all forged ahead with extensive space programs of their own.

This makes space exploration a foreign policy issue as well as a national endeavor. But the United States has yet to develop a coherent space policy that both fully exploits the great potential of space as an instrument of foreign policy and recognizes the importance of international collaboration to the successful exploration of space.

Over the past year, many Planetary Society members have participated in the first nationwide study of the prospects for international cooperation in space. In early 1986, shortly before the *Challenger* tragedy, the United Nations Association of the United States of America (UNA-USA, chaired by Elliot Richardson) launched the study, the third in an annual series of studies of global issues. Some 90 communities around the country set up study panels, which spent several months examining the issues and devising recommendations for US policy. Their conclusions were released on October 24, 1986 in a consensus report entitled *The Next Giant Leap in Space: An Agenda for International Cooperation.*

As the report emphasizes, cooperation is not an end in itself. To carry out effective space programs, countries must have well-defined goals and must be willing to commit the resources needed to reach those goals. To collaborate in space, countries must perceive that they can best achieve those ends by working together. The scores of community panels participating in the UNA study concluded that there are two goals that can best draw nations together in a mutually advantageous space venture: the exploration of Mars and the study of Earth.

The Mars goal, particularly the prospect of a human mission, has been much discussed as a way of bringing together the United States and the Soviet Union in a joint program that could teach the two countries to work together and usher in a new era of harmonious superpower relations on Earth. Unfortunately, it is far more likely that the distinctly unharmonious superpower relations that currently prevail would make it impossible for the two countries to see the mission through together. The political differences between the superpowers reflect fundamental differences in basic values, not just misperceptions based on lack of contact. A strictly US-Soviet joint program would suffer from all the slings and arrows inherent in bilateral programs between the two. As the past two Olympics held in Moscow and Los Angeles made clear, at times of tension, any bilateral program can fall victim.

But as the Halley's Comet and Cospas/Sarsat (a cooperative US, Soviet, Canadian and French search and rescue satellite system) programs demonstrate, cooperative programs may stand a better chance. If the other spacefaring nations play major roles in the Mars missions, up to and including a human expedition, and if the program is perceived as a multilateral rather than a bilateral goal, the United States and the Soviet Union would be far less likely to try to use a cutoff of cooperation to send political signals to each other.

The other proposed focus for international cooperation in space, the study of Earth, will draw virtually all nations into a crucial program of research on the fate of our planet. Earth is a constantly changing world, enduring ice ages, earthquakes, volcanic eruptions and continual evolution — and extinction — of life in many forms. Only recently, though, have scientists realized that humanity itself is changing the global environment, in largely unknown ways with unforeseen consequences.

A massive, coordinated, international research program of space-based and ground-based measurements is desperately needed to determine what we are doing to our planet and how potentially catastrophic changes can be averted. Such a program will require the cooperation of all nations, both for the initial research and to take whatever steps are then called for to safeguard Earth.

The UNA report goes into considerable detail about why the exploration of Mars and the study of global change on Earth are needed and how they should be carried out. But these are only two of the many activities that can and should be undertaken in space. In the coming decades, international institutions will play an ever-more-important role in facilitating the peaceful uses of space, both cooperative and competitive, as more and more countries become involved. The United States must develop new skills in dealing with international institutions. It can provide the leadership that will enable these bodies to live up to their potential as useful instruments for reaching global consensus on humanity's future in space.

As this brief sketch makes clear, the report stresses that the United States' foreign policy interests and the long-term interests of its space program coincide. In this area, the public is far ahead of the politicians, who continue to subject space exploration to the usual short-term vagaries of national politics and who have failed to provide the necessary vision.

UNA will take the report to Congress, the Executive Branch, the United Nations and policymakers overseas to bring about the implementation of the report's recommendations. Planetary Society members who participated in study groups around the country can be sure that policymakers will now hear their views.

Ann Florini is the Project Director for the UNA study. The Next Giant Leap in Space: An Agenda for International Cooperation *is available for $5.00 from USA-UNA, 300 East 42nd Street, New York, NY 10017.*

MARS ARTWORK FOR SALE: To help achieve the goal of sending an international team of explorers to Mars, The Planetary Society commissioned a series of paintings depicting a possible mission. We have been using these paintings in lectures and publications promoting international cooperation in the exploration of Mars. Since Mars has proven such a popular topic with our members, we are now offering these paintings for sale. If you are interested in any of these paintings, contact Donna Stevens at The Planetary Society, 65 N. Catalina Ave., Pasadena, CA 91106.

1 ***Polar Outpost Pioneers*** — Finding useable water will be a primary concern for the first martian explorers. Since water condenses out of the thin martian atmosphere and freezes into layered sheets at the North Pole, this could be among the first areas investigated. Painting by M. E. Vicary, 30" X 40", price $1,500.

2 ***The First Great Steps*** — An American and a Soviet astronaut share the honor of being the first humans to walk on Mars. Their landing craft has set down in Valles Marineris, a gigantic canyon stretching one-fifth of the way around the planet. Painting by Michael Carroll, 24" X 40", price $800.

3 ***Exploring the Northern Polar Regions*** — Many ingenious and new technologies will be needed to explore Mars. One possibility could be a dirigible, which could transport people and machines around the planet. Painting by Don Davis, 25" X 48¼", price $3,000.

4 ***Descent to Valles Kasei*** — The technique of aerocapture will be used to slow down the descent craft when it reaches Mars. The craft will use the friction of the upper atmosphere as a braking device — a dangerous but highly efficient operation. Painting by Don Dixon and Rick Sternbach, 19" X 24", price $1,500.

5 ***Sunrise at Noctis Labyrinthus*** — Clouds do form in Mars' thin, mainly carbon dioxide atmosphere, seen here over Noctis Labyrinthus. The maze-like canyons of this region lie near the source of Valles Marineris, and so may be a target for exploration. Painting by Don Davis, 27½" X 36", price $3,000.

6 ***Return to Earth Port*** — After the dusty reds of Mars, the cool blues of home will be magnificent sight to the explorers returning to Earth. They will dock with a station in Earth orbit for quarantine and debriefing before their triumphant welcome home. Painting by Don Dixon, 19" X 24", price $1,500.

Not pictured: ***Mars Outpost*** — Violent dust storms often blow up suddenly on Mars, providing a hazard to unwary visitors. In this painting, space-suited explorers run for cover as a storm approaches. Painting by M.E. Vicary, 20" X 30", price $700.

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Figure 5.2— *The Planetary Report,* Vol VII Number 1, January/February 1987, pgs. 12 - 13. "Mars Artwork for Sale: To help achieve the goal of sending an international team of explorers to Mars, The Planetary Society commissioned a series of paintings depicting a possible mission. We have been using these paintings in lectures and publications promoting international cooperation in the exploration of Mars. Since Mars has proven such a popular topic with our members, we are now offering these paintings for sale. Painting 1 is by Marilynn Vicary-Flynn, and depicts pioneers at a polar outpost. Caption emphasizes the action depicted, not the fact that the image is a painting. " Finding usable water will be a primary concern for the first martian explorers. Since water condenses out of the thin Martian atmosphere and freezes into layered sheets at the North Pole, his could be among the first areas investigated. " All of the paintings depicted were produced by members of the IAAA.

[set to launch in 1989] were sent by people too young to vote." [304] The popularization of space was key to the organization's political goals; Johnny Carson and actor Paul Newman were both on the Planetary Society's initial advisory board, as were Ray Bradbury

304. *The Planetary Report* functioned as a mouthpiece for Sagan and Murray's explanations of misplaced federal financial priorities. Though it's unclear where Sagan sourced many of the financials he cites, he wrote to its readership n 1980: "We are told that is expensive – although a program of unmanned planetary exploration would cost about a tenth of the federal budget; the voyager spacecraft, when they are finished with their explorations, will have cost about a penny a world for every inhabitant of the Planet Earth… But mainly we are told that, although arguments for planetary exploration are widely understood in government, they are not supported by the people. We are told that spending money on planetary exploration – on the discovery of who we are, what our history and fate may be – is unpopular, that it is a political liability to support such ventures. I can remember a congressman telling me that the only letters he had received in support of the Galileo exploration of Jupiter were sent by people too young to vote." Carl Sagan, "The Adventure of the Planets," *The Planetary Report,* December 1980 - January 1981, vol. 1, pg. 3

and Isaac Asimov.

By the 1980s, NASA was involved in comparatively fewer interplanetary expeditions than its Soviet counterpart, a fact which deeply frustrated members of the Planetary Society. Bruce Murray, Director of the Jet Propulsion Laboratory at Caltech spelled out explicitly that frugality with respect to planetary exploration would only hobble the United States: "What we do in space is a reflection of how our society chooses to invest its resources; creative space explorations projects a positive commentary on our self-image."[305] The Planetary Society's formation complicates simple narratives that space art was a way for the U.S. government to sell the public on space exploration. Planetary science was a comparatively small part of NASA's budget in the 1980s, one that found itself competing with other NASA objectives—namely the continuation of human spaceflight onboard the Space Shuttle.[306] In fact, in the Planetary Society's view, the space shuttle represented a misguided placement of the bulk of the agency's resources. In an op-ed, space scientist James D. Burke wrote that the space shuttle's launch capacities were inferior to those of the Apollo era vehicles, and that the shuttle's modest successes were coming at the expense of other programs.[307] *The Planetary Report* typically contained a news report at the end called "Washington Watch," in which Louis Friedman reported on Congress' treatment of NASA's budget and monitored public opinion on space exploration.

By 1981, the Planetary Society reported 40,000 members.[308] Planetfest '81 was an attempt to both drum up support for the type of exploration being done by the Voyager missions, as well as to demonstrate their popularity with the public. Carl Sagan called the government's perception of the public's lack of interest in space a paradox that overlooked the popularity of space exploration in both print and television. Of the dissonance he wrote, "it became apparent to me and a number of my colleagues

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305. Echoing debates hashed out since the onset of Project Apollo, the question of what constituted a valid expenditure continued to guide space policy. Part of the work of the Planetary Society was to convince its readership of the space program's worth. "By one obvious measurement the price is high – between $200 million and $1,000 million dollars per mission. Spread over time the total space science budget in NASA – covering astronomy and as well as planetary science- runs about $550 million per year, about ten percent of the total NASA budget, or about one-tenth of one percent of the total Federal budget." Bruce Murray, "Space Exploration, Is It Worth the Cost?" *The Planetary Report,* December 1980 - January 1981, vol. 1, pg. 3.

306. Valerie Neal, *Spaceflight in the Shuttle Era and Beyond: Redefining Humanity's Purpose in Space* (New Haven: Yale University Press, 2017). John Logsdon, *Ronald Reagan and the Space Frontier* (New York and London: Springer, 2018).

307. "NASA's people settled for what they could get from a reluctant government—not the space station of their desires, but a vehicle that can go to and from the space where they believed the station would someday be. In its development the shuttle has gobbled up NASA's resources, causing the demise of the reliable *Titan-Centaur* that launched the *Vikings* and the *Voyagers,* and delaying and dislocating numerous other programs. The shuttle cannot support human life for more than a few weeks in orbit. In comparison, the American *Skylab* and the Soviet *Salyut* craft could do so indefinitely. James D. Burke, "Deep Space Exploration and the Space Shuttle," *The Planetary Report,* June - July 1982, vol., no., 4, pg. 3.

308. "Letter from the Editor," *The Planetary Report,* April - May 1981, vol. 1, no. 3.

Figure 5.3— Left: Marilynn Vicary-Flynn painting on the 1982 Hawaii trip. Right: Vicary-Flynn's painting of a fire pit on Io, reprinted on the back page of the *The Planetary Report*. The periodical reserved the back page of the magazine specifically for works of space art, since they would appear directly above the name and address of the recipient. The painting of Io depicts "a black lake of molten sulfur" cooling slowly on the moon's surface, "while gases vent from cracks in the ruddy crust…" The painting's caption maintained a pedagogical tone, explaining that Io "is the most volcanically active body known in our solar system."

that the solution would be a non-profit, tax-exempt, public membership organization devoted to the exploration of the planets and other themes… If such an organization had such a membership, its mere existence would counter the argument that planetary exploration is unpopular."[309] The endeavor was widely supported by players in the space field, as well as local political figures. Astronaut Rusty Schwikert, *Star Trek* star Nichelle Nichols, and Tom Bradley, the mayor of Los Angeles were all members of the event's advisory board.

The Planetary Society engaged space art directly.[310] Planetfest '81 is a robust example of the role art played in the marketing of space. The first in a long series of public-facing the society would eventually hold, Planetfest '81 event was a markedly visual experience. The "Mars" room, for instance, featured paintings and set pieces created recycled by the *Cosmos* art department. The exhibition hall also featured a display of further views of the solar system, produced by artists who encountered the Planetary Society after its founding. Jon Lomberg, Rick Sternbach, and Don Davis all showed work, largely as a function of their connection to the *Cosmos* Art Department; but the show also attracted a new roster of artists that identified as astronomical illustrators.

The Planetary Society's artist-collaborators were critical to the success of their

309. Carl Sagan, "The Adventure of the Planets," *The Planetary Report,* December 1980 - January 1981, vol. 1, pg. 3.

310. In 1985, the society named asteroid (3129) 1979MK2, discovered and "donated" by Eleanor Helin of the Jet Propulsion Lab, "Bonestell." Ronald Paludin, "Letters to the Editor," *The Planetary Report,* November - December 1986, vol. 6, no. 6.

Figure 5.4— Top: Mikey Carroll painting in Hawaii. Bottom: Bill Hartmann's December 1982 painting of Martian lava, based on the formations observed in Hawaii.

public campaign, providing the organization with compelling color images that helped it position itself as a means by which new space futures could be achieved. Like other advocacy groups in the early 1980s, The Planetary Society interfaced with its members primarily via material mailed directly to their homes. In Sagan's explanation, this was an attempt to put planetary scientists directly in touch with members of the voting public.[311] Direct mail was a largely visual format that took the form of newsletters and magazines, and needed to compete with other mail items for a recipient's attention.[312] At the start of the direct mail campaign, Bruce Murray enlisted the help of John Gardner, who had served as Secretary of Health, Education, and Welfare under President Lyndon Johnson. Gardner, a Presidential Medal of Freedom recipient, founded Common Cause and was considered an expert at building public constituencies. Gardner suggested placing color illustrations on the back page of the publication, near where the recipient's name and address were listed. This positioning ensured the first thing its readership saw was a compelling vision of the cosmos, always printed in color. By the 1980s, the space program's main product was images, and the Planetary Society leaned heavily on visual content to amplify their messaging.

In turn, the Planetary Society's patronage helped galvanize the IAAA into a fully-fledged organization with a clear professional purpose. *The Planetary Report* helped

311. "We hope to be able to put planetary scientists in touch with their local supporters. With the encouragement we have received we have been able to mount a very encouraging sample direct mailing to test the interest of the American public." "The Adventure of the Planets," *The Planetary Report,* December 1980 - January 1981, vol. 1, pg. 3.

312. Murray enlisted the aid of John Gardner, who had served as Secretary of Health, Education, and Welfare under President Lyndon Johnson. Gardner, a Presidential Medal of Freedom recipient, founded Common Cause and was considered an expert at building public constituencies. Murray learned how to build an organization like The Planetary Society directly from Gardner. Louis Friedman, "Bruce Murray (1931 – 2013)" *The Planetary Society*, August 29th, 2013, https://www.planetary.org/articles/0829_bruce-murray-1931-2013

Figure 5.5— The group staged a mock Soviet Venera lander on the volcanic surface of Hawaii, in order to simulate the probe's appearance on the Venusian surface. Sunglasses with a yellow tinge were also placed over the camera lenses, to give the photographs an atmospheric quality closer to that of the Venusian surface.

legitimize the IAAA as scientific by association and encouraged the group's pursuit of pictorial accuracy. This relationship was mutually beneficial. The IAAA's approach to sourcing reference material allowed them to depict the surfaces of other planets in a way they defended as scientifically valid. This was tremendously useful for space advocacy efforts that framed space as a tangible future that could be reached with enough constituent support.

Illustrations weren't just confined to *The Planetary Report's* back cover. Occasionally, illustrations commissioned by the Planetary Society were advertised for sale to fund various society efforts. A 1987 article used IAAA paintings to raise money for possible expeditions of "international explorers to Mars."[313] The article, penned by a United Nations Association member, focused on the peaceful settlement of space as a pressing foreign policy issue.

The accompanying paintings depicted the presumed goings-on of the mission, and the article emphasized their status as valid depictions of scientific expedition. A caption explained to readers that The Planetary Society was "using these paintings in

313. Ann Florini, "The Next Giant Leap: Space Exploration as Foreign Policy" *The Planetary Report,* January - February 1987, pgs. 12 -13.

lectures and publications promoting international cooperation in the exploration of Mars." Though the images were being sold as art objects to raise money for the project discussed in the article, they were still described as functional illustrations. Captions for the paintings emphasized the subject matter they depicted, not the interpretive judgments of the artist. The caption for "Sunrise at Noctis Labyrinthus" explained that, as in the painting, "clouds do form in Mars' thin, mainly carbon dioxide atmosphere." The maze-like canyons also depicted the source of Valle Marineras, another target for exploration. "Sunrise at Noctis Labyrinthus," painted by Don Davis, was offered for $3,000. By this point by this point Davis was an established astronomical illustrator, known for his painstaking level of attention to scientific detail. Paintings by other IAAA members were offered for slightly more modest sums but represented a variety of subject matter The Planetary Society was willing to explain as plausible. "The First Great Steps," painted by Michael Carroll, was decidedly more imaginative than Davis' but complemented the message of the article it was meant to illustrate. The painting depicted a landing craft in in Valles Marineras and showed an American and a Soviet Astronaut sharing the honor of being the first humans to walk on Mars.[314]

The IAAA's methodological approaches help explain how this rhetorical framing was coproduced, instead of unilaterally applied by advocates at The Planetary Society. *The Planetary Report's* application of the language of "scientific accuracy" was largely a response to the tools the IAAA developed to defend their work as a form of scientifically informed representation. These strategies built on decades of visualization techniques established within the practice of astronomical illustration, combining them with new forms of observation over the course of the 1980s. Most importantly, the IAAA developed a strategy that incorporated direct observation of the space landscape by way of terrestrial proxy. By traveling to different locations in the American Southwest, the IAAA helped scientifically codify visions of western frontiers as legitimate stand-ins for the landscapes of outer space.

II. The Frontier Proxy

William K. Hartmann attended Planetfest '81 as an artist, though he could just have easily attended in a professional capacity as a planetary scientist. A graduate student of Gerard Kuiper at the University of Arizona, Hartmann was a painter who had recently spent six weeks in a stone cabin near Mauna Kea Observatory conducting research. Hartmann, a native of Pennsylvania, considered exposure to Hawaii's unfamiliar landscapes to be a pivotal experience. Having never visited a volcanic island before, the topographies looked nothing like anything visible on the North American continent.[315] Hartmann figured that many of the artists in attendance at Planetfest—held in Pasadena, near the Jet Propulsion Laboratory—had never seen real craters or lava formations.

Hartmann was friends with Bruce Murray, then-director of the Jet Propulsion

314. Michael Carroll's painting was offered for $900. Ann Florini, "The Next Giant Leap: Space Exploration as Foreign Policy" *The Planetary Report,* January - February 1987, pgs. 12 -13.

315. William K. Hartmann, interview with Lois Rosson, May 19th, 2020, transcript, pg. 3.

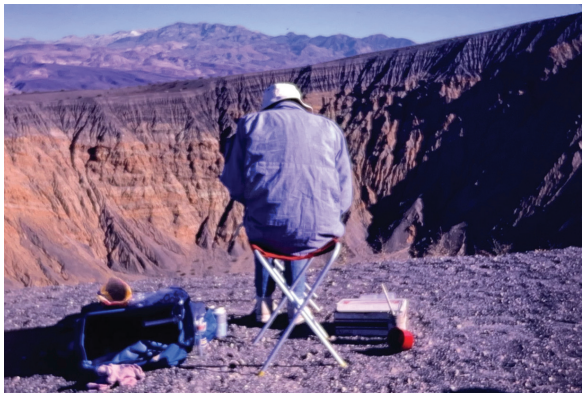

Figure 5.6— Top: Andrew Chaikin stands on Mars Hill in Death Valley. Bottom left: Bill Hartmann works on a drawing of Ubehebe Crater. Right: Rick Sternbach stands in a mock spacesuit in front of the crater in order to distinguish it as a space scene.

Figure 5.7— Left: David Hardy's drawing of Meteor Crater in Arizona. Right: Members of the IAAA standing on Meteor Crater's ridge.

Lab and cofounder of The Planetary Society.[316] In Hartmann's view, the type of art circulating in *The Planetary Report* and in other popular science periodicals, like *Sky and Telescope* and *Astronomy Magazine,* represented a viable and emergent genre of art enmeshed with the practice of planetary science. Hartmann recognized many of the other Planetfest '81 artists from the circulation of their work in print, or, as in the case of Jon Lomberg, Don Davis, and Rick Sternbach, on film and television.

Encouraged by the critical artistic mass reached at Planetfest, as well as the institutional support represented by The Planetary Society, Hartmann reached out to connections on the Big Island of Hawaii made during his time as a graduate student and started making plans for a space art related workshop. The next year, Hartmann inaugurated what he called the first "international space art workshop," using Hawaii's barren volcanic landscapes as a terrestrial analog for the surfaces of distant planets. Several artists attended the Hawaii workshop, spending a week hiking, sketching, photographing, and studying the geology of an otherworldly environment. Ron Miller, Don Davis, Rick Sternbach, and Jon Lomberg all attended, but the roster of participants also represented an expanding interest in space art as a form of professional practice. Bill Hartmann attended, as did Pamela Lee, Michael Carroll, Jim Hervat, Laurie Ortiz, Joel Hagan, Don Dixon, Andrew Chaikin, Robert Kline, Mary Zisk, Maralyn Vicary, Larry Ortiz, and Kim Poor.

The workshop was meant to provide participating illustrators with new forms of dramatic and informative reference material. In Hartmann's rationale, the study of topographical formations on Earth would prepare the working artist to simulate the landscapes of other planets. The workshop that resulted was a two-week long excursion through various volcanic topographies, prioritizing landscapes with easily observable geologic formations. Participating artists had the chance to visit a range of different geologic phenomena, including "spectacular volcanic terrain, lava flows, rift cracks, craters, lava tubes, ash fields, steaming vents, Devonian fern jungles, windswept deserts, and your general lunar, Martian, Ganymedean, and prehistoric scenery."[317] In Hartmann's descriptions of the Big Island, the landscapes of Hawaii were interchangeable with celestial subjects.

The workshop combined *plein-air* painting with principles of scientific observation to create a method for informing the accuracy of the group's illustrations. The workshops also accelerated a budding professional identity. Hartmann occasionally reminded attendees that they had a mutual obligation to encourage each other to "paint it right," and emphasized a more general responsibility to make images as faithful as possible. The accuracy of the images they produced was supposed to be bolstered by direct observation of parallel geological phenomena, but also by the group critiques

316. This was also the same time that many of these artists were publishing work in *Astronomy Magazine* as well as *Sky and Telescope*. William K. Hartmann, interview transcript, pg. 4.

317. William Hartmann, "Bulletin 1: 3rd Space Art Workshop," Announcement for First Interplanetary Space Art Workshop, The *Parallax* and Other Newsletters, 1982-1, Pulsar Newsletters, https://iaaa.org/pulsar/

scheduled on the trip. The "correct" ways to paint were judged via group consensus.[318]

The landscapes of Hawaii represented a visible geologic topography, and the concept of a plein-air workshop was hugely popular since most workshop attendees lived in areas blanketed by grass, trees, or urban infrastructure. The group nature of the excursion helped accelerate the formation of an organizational identity, and over the course of the 1980s, the IAAA arranged several more trips intended to help its membership paint more accurately. The roster of visible of landscapes expanded to include landscapes of the American West, which was equally as "uncovered" as Hawaii's volcanic regions, as well as more accessible to members living in North America. Death Valley was a popular location, and especially convenient for the group's southern California contingent, as was the Moab Desert in Utah, and Arizona's Meteor Crater. After a second Hawaii workshop, the vast majority of the IAAA's outings took place in the American Southwest, deploying the same principles hashed out by Bill Hartmann on the Big Island. Though the IAAA was interested in exploring international landscapes, the accessibility of places like California, Utah, and Arizona meant that their place in the American space imaginary was disproportionally represented.

The illustrators Bill Hartmann convened in Hawaii formally created the International Association of Astronomical Artists in 1984, during a workshop in Death Valley. In addition to formalizing a collective identity, workshop participants expanded on their methodology by finding individual features of the landscape to function as specific proxies. In Death Valley, one of the geologic centerpieces was Ubehebe Crater, a nearly 600-foot basin created by a violent gas and steam explosion.[319] The crater was formed when hot magma reached the ground water collected above it, and revealed a dazzling eastern wall characterized by thick bands of orange and pink sandstone. Its color and volcanic origins made it a suitable stand-in for craters on the surfaces of geologically volatile planets, especially Jupiter.

These topographical features functioned as usable proxies for the space environment, prompting much reflecting by the IAAA's membership on the nature of human vision and objectivity. Noting the deep red colors of the mountains in Death Valley and the contrast of the neighboring salt flats at different times of day, IAAA member Michael Carroll marveled at the mercurial qualities of the landscape. Which time of day offered the clearest vision of the region's true state? The appearance of the landscape's many colors changed almost hourly, and Carroll was awed by their ephemeral nature. Writing of the trip later, Carroll noted that "the many colors of these mountains cannot be put into words. It is strange how a limited pallet of Earth tones can be so varied! No artist could capture the subtle color changes. We were here to try."[320] In Carroll's view, the capabilities of human vision were insufficient not because they were too subjective, but because the landscape itself didn't appear to take on a singular form.

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318. Hartmann, *In the Stream of Stars*, pg. 12.

319. "Ubehebe Crater, Death Valley National Park," National Park Service, https://www.nps.gov/deva/planyourvisit/ubehebe-crater.htm

320. "Impressions of Death Valley," Michael Carroll, *PARALLAX: Journal of the IAAA,* 1984:1, pg.5.

In this evaluation, humans couldn't necessarily capture the landscape's "true" appearance, but perhaps it could capture more than what a camera was capable of replicating. At this point in the 1980s, cameras and photography still reigned supreme as the most trustworthy form of image reproduction, but the "objective representation" of a landscape's kaleidoscopic colors posed a problem. The complexity of a landscape represented a situation where the photograph failed to capture the nuances of what was observed by the eye. This frustration, one addressed directly by Ansel Adams in the 1930s, was precisely what the IAAA sought to mitigate.[321] Why couldn't painters offer an interpretation that was truer to the experience of a place than a photograph? If it was difficult to capture the play of light on the vast landscapes of Earth, how was the human species ever expected to truly know what the surfaces of other planets were like? For the IAAA, the human experience of distant space landscapes came through even more heavily mediated channels. The question of whether unmanned hardware could capture alien environments any more so than a Polaroid of a crater in Death Valley remained a driving question for the IAAA's membership. Despite the challenges inherent to capturing the true appearance of a given landscape, the topographies of the American West were as close as the IAAA could come to an alien planet.

Much of the IAAA's focus on landscapes of the American west was a function of practical accessibility. After the Death Valley workshop, the question of which landscape the group should visit next soon emerged. While the group weighed the possibility of traveling to more distant lands for its future conferences, it also noted the logistical challenges of orchestrating international travel along with increased travel costs. Several international landscapes were identified as especially desirable. Iceland, because of its similarities to Mars was suggested as a possible site for the 1985 summer workshop, as were viewing points for Halley's comet in Australia.[322] Icelandic volcanoes were especially attractive and deemed an "unparalleled" stand-in for analog for the large shield volca-

321. The inherently subjective nature of photographic representation was a view shared by renowned American landscape photographer Ansel Adams. Ansel's 1927 photograph "Monolith—The Face of Half-Dome," was made by manipulating a red filter in the dark room process to achieve a clearer representation of what Half Dome *felt* like. Because of photography's epistemological status as a form of documentation, its role as a tool for art making was largely dismissed by critics. For Adams, emphasizing the construction of a photographic image from composition to dark room development allowed him to reinsert artistic agency into the practice. Robert Turnage, "Ansel Adams: The Role of the Artist in the Environment," *The Living Wilderness,* March 1980, reprinted by the Ansel Adams Gallery courtesy of the Wilderness Society, https://www.anseladams.com/ansel-adams-the-role-of-the-artist-in-the-environmental-movement/

322. The dry icy valleys of Antarctica were also a popular choice, as members were especially interested in visiting Antarctica over the austral summer of 1987-88. In theory, this would offer members the opportunity to develop low-temperature painting techniques in addition to observing Martian analogues. "As you probably know, the dry valleys of Antarctica are some of the driest places on Earth and resemble the Martian physiographic profile more than any other area on Earth." Dennis Davidson, "Air to Ground Chatter," *PARALLAX: Journal of the IAAA*, 1984:2, pg. 9.

Figure 5.8— Film crew setting up in the part of Death Valley dubbed "Mars Hill" by the IAAA because of resemblance of the surface textures to those seen by the Viking 2 lander.

noes on Mars.[323] Despite the attractiveness of international topographies however, they were much less accessible than regions located within the United States. As a result, the IAAA searched for cold climates analogs within U.S. borders.[324] It was noted that while, in Iceland, one could find "hauntingly" similar landscapes to those found at the Martian poles, the theory that Martian geology was shaped by debris carried by thick sheets of ice made it remarkably like the cold-climate features in the Malaspina Piedmont Glacier

323. In 1985, IAAA member Marilynn Vicary-Flynn received a response to a question about places of geologic interest in Iceland from Elliot Morris of the USGS. "The volcano Skjalbreidur would be a good, particularly since it is the classical type of area for shield volcanoes." There were other features that made Iceland's geography comparable to that of the Martian landscape: "Lava flows are ubiquitous in Iceland of all ages. Any good fresh lava flow could be a good analog for a Martian lava flows. Fields of pseudocraters (cindercone-like features) near Kirkjubaejarkloustatur and along the south shore of Mars in northern Iceland are analogues to similar features on the northern plains of Mars." At the end of his letter, he encouraged Vicary to reach out to his colleague Dr. Richard S. Williams, with whom he would go on to publish *Illustrated Geomorphic Classification of Icelandic and Martian Volcanoes*. The appeal to geologic experts like Morris and Williams ensured the scientific validity of travelling to these places to generate usable reference material for the surface of Mars. Marilyn Vicary, "Air to Ground Chatter," *PARALLAX: Journal of the IAAA,* 1985:1, pg.6.

324. Carroll, "MARS," pg. 16.

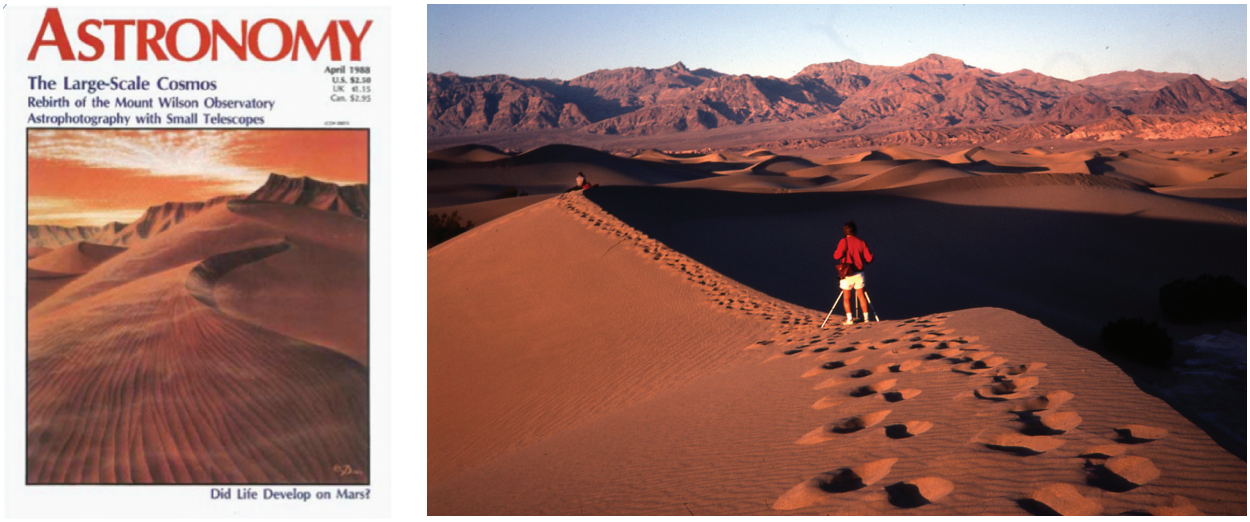

Figure 5.9— Left: cover of *Astronomy Magazine* illustrated by IAAA member Kim Poor. Right: Rick Sternbach photographed along the sand dunes of Death Valley, which informed many of the organization's depictions of the Martian surface.

Formations of Alaska.[325]

Painting in challenging conditions was considered a valuable learning opportunity as well as exposure to distant landscapes. One member even made a case for a workshop aboard the International Space Station. "I do not think it's unreasonable for the IAAA to start pushing for a workshop aboard the Space Station in 1996, four years after it is scheduled to come online... If we start pushing for a Space Station Workshop now, we may be able to get at least a Space Shuttle workshop by 1996." The proposal was followed by a note by suggesting that in twenty years maybe it would be possible to hold the ultimate space art workshop on the surface of Mars itself.[326]

While international travel proved too difficult for much of the IAAA's existence, the cultivation of images in tandem with scientific expertise continued throughout the decade. In addition to continued workshops in Hawaii and Death Valley, in 1987 the IAAA convened in Clearlake Texas for a workshop at Johnson Space Center.[327] This workshop emphasized the input of astronauts with first-hand experience of spaceflight over naked eye observations of landscapes but was still designed to further the IAAA's understanding of the experience of space. Most notably, the workshop was organized in tandem with Alan Bean, who was both a member of the IAAA as well as an Apollo astronaut. Bean was celebrated by the group because he had travelled to the lunar surface

325. "Looking at orbital photos of craters with great canyons curving around them, or apparent flood plains with sand bars and islands, one might envision a wall of water racing across a golden cratered plain. But the features carved across the face of the red planet can also be explained by the more gradual erosion of glaciers." Michael Carroll, "MARS: Where Did All the Water Go?" *PARALLAX: Journal of the IAAA,* 1984: 3, pg. 15.

326. Davidson, "Air to Ground Chatter," pg. 9.

327. "JSC Workshop," *Pulsar: IAAA Newsletter*, May 1987, pg. 1. https://drive.google.com/drive/u/0/folders/14A5XvO7HtTdU7BwP8JxV-uMlU7adKm3w

and seen it himself. Though his paintings maintained a comparatively impressionistic approach, his status as a direct witness made him a cherished member of the organization.[328]

The invocation of scientific authority was also encouraged internally. This strategy also included the invocation of expertise in the sciences. While the IAAA saw itself as the best suited to the pictorial representation of physical landscapes, geologists still represented a necessary from of expertise. In a follow-up article on the table mountains of Iceland, Michael Carroll reminded group members that, according to geologist Elliot Morris, "Iceland and the Arctic Circle provide the most Mars-like terrain on Earth." He also included Dr. Baerbarel Lucchitta's paper "Mars and Earth: Comparisons of Cold Climate Features" in a packet for them to review during the 1985 Hawaii workshop.[329] Carroll reminded his readers that, if one was trying to produce an accurate representation of space, it was helpful to know why certain topographical subjects looked the way they did, and this was information that could be found in the sciences. [330] This prompted a culture of research internal to the group. Excerpts from scientific papers and input from geologists frequently included in the IAAA's publications. The IAAA's invocation of geologic expertise reveals that "seeing" alien topographies was only part of the challenge. The astronomical artist also needed to understand them if they were to make proper sense of the landscape. "For astronomical artists attempting to create accurate renditions of other worlds it is often helpful to know *why* things look as they do and *how* they got that way. Studies done by scientists … underscore the value of examining areas of Earth which are analogous to areas on other planets."[331]

The IAAA's deployment of the American West reflected logistical constraints, and not the belief that the landscapes of the United States were more like alien planets than landscapes found internationally. This mundane circumstance however, meant that western topographies, already associated with the ideologies of frontier settlement, were disproportionally integrated into the IAAA's representations of space. As a result, illustrations of space landscapes circulated in places like *The Planetary Report* and *Astronomy Magazine* were directly rooted in recycled observations of western landscapes. For members of the IAAA, replicating the geology of the American West wasn't a direct regurgitation of visual tropes related to Manifest Destiny, but rather a valid

328. Bean's work would later be revisited by Richard Hoagland, who claimed that Bean's paintings contained evidence of ancient alien civilizations erected on the Moon. In Hoagland's view, Bean's paintings were a bald uncovering of NASA's secret investigations of alien life. Bean was invited by Robert McCall to hide his signature in the painting he installed at the National Air and Space Museum in Washington D.C.

329. Carroll, "Iceland Site Bid Urged," pg. 6.

330. "Studies done by scientists such as Drs. Lucchitta and Squyers underscore the value of examining areas of Earth which are analogous to areas on other planets." Michael Carroll, "Iceland Site Bid Urged" *Parallax: Journal of the IAAA*, 1985:4, pg. 6.

331. Ibid., 17.

way of studying the most likely topography of places like the Martian surface.[332] Earth's geographic structures could stand in as valid substitutes for the landscapes of other planets, since the physics of geologic formation were presumably the same throughout the universe. With this reasoning, places like Hawaii and Death Valley were judged to be suitable analogues for geological phenomenon like volcanism on Mars or early lava flows on the Moon.[333]

By the time the Death Valley workshop concluded, participating artists has fully embraced the geologic metaphor of parallel observation. A set of fifty 35mm slides of artwork produced during the workshop was made available for the group's collective reference, including scenes of "Mars, Venus, the Jovian system, and other locations both in the solar system and beyond."[334] By extension of the IAAA's purchase over popular astronomical art, several of the *plein air* paintings produced at the Death Valley Workshop eventually came in to stand in for alien surfaces in print. One of Kim Poor's paintings of the Death Valley sand dunes eventually appeared on the cover of *Astronomy Magazine* as the surface of Mars. Over the course of the 1980s, the IAAA contributed to tropes that made sense of outer space as a type of western frontier, ripe for expansion and settlement.

This moment in the history of astronomical illustration offers a rich entry point into the way cultural products can be recast as neutral representation. The pursuit of reference material that could bolster the clarity of an illustration inadvertently tapped into much broader conceptions of the barren and unsettled landscapes. At the same time the IAAA emphasized the astronomical illustrator's responsibility to accuracy, the group also openly embraced the sublime visual language of nineteenth-century American landscape painting as a philosophical influence—further deepening the group's invocation of frontier tropes.

As with painters of the Rocky Mountain School, who emphasized natural structures on such a large scale that human observers were either dwarfed or unseeable, the IAAA used the absence of human inhabitants to emphasize the grandeur of the space landscape. Much recent scholarship on environmental thought in the nineteenth century has noted the political charge encoded into depictions of wilderness as "empty," which the *plein air* paintings of the IAAA perpetuated.[335] John Muir, for instance, famously

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332. In an article about water sources on Mars, Michael Carroll pointed out how several cold-climate features on Earth were valid comparisons. "In Iceland, features known as table mountains occur where volcanoes have erupted under ice flows. Circular mesas with central pits which resemble table exist in Utopia Plantitia. Perhaps the most direct analogues of terrestrial ice formations can be seen at Mars' poles, where ice still exists in relative abundance… Similar terrain is found Iceland at the edges of the Sidujokull Glacier, where layers of ice are sandwiched within layers tephra (volcanic ash). "Mars: Where Did All the Water Go?" Michael Carroll, *PARALLAX: Journal of the IAAA, 1*984:3, pg. 14 – 17.

333. Hartmann Transcript, pg. 3

334. The slide sets were eventually cancelled after copyright issues weren't resolved. "Death Valley Slides," *PARALLAX: Journal of the IAAA*, 1984:2, pg.3.

335. Eric Michael Johnson, "How John Muir's Brand of Conservation Led to the Decline of Yosemite," *Scientific American,* August 13th, 2014, https://blogs.scientificamerican.com/primate-diaries/how-john-muir-s-brand-of-conservation-led-to-the-decline-of-yosemite/.

Techniques in Astronomical Art

Bill Hartmann's Fab Formulae

by Maralyn Vicary

Have you heard of Bill Hartmann's terrific formulas for calculating the height of a planet in the sky of a given moon, and the degrees of 'tilt' for equator or ring plane? I goaded him into developing these formulas for me a few years ago.

I like to pick precise locations on moons or planets, especially when I have a map to work with. I either start with an Earth scene, and look for an analog on the planet or moon, or I find an interesting-looking area [on the map] and go from there. Sometimes just a name will catch my eye. Anyway, since there are maps available for most places, with coordinates, I started wishing for a precise way to find exactly how the planet would appear in the sky from my subject's location. So I wrote to Bill, and after being inundated with letters from me he gave in and developed these great equations. The only drawback to them is if my calculator breaks down, I could never do them in my head. I drafted charts depicting all the basic angles and elevations, so now I have a quick reference guide.

These equations are valid for:

Moons in Equatorial Plane of Planet
Prograde Orbits
Tidally Locked

Only surface locations from 0°-90° longitude or 270°-360° longitude will show the planet in the sky (Fig. 1).

On the moon involved:

90°	Leading Side
180°	Opposite Planet Point
270°	Trailing Side
360°,0°	Sub Planet Point

For an observer standing at the sub planet point, the planet will appear on the zenith.

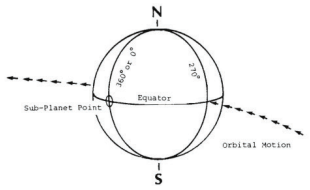

Fig.1

The Equations:

△ = the difference in longitude in degrees from the 0°,0° point on the moon of your choice.

ELEVATION:

This is the number of degrees from your painted horizon to the planet's **center** (Fig. 2).

Elevation°=SIN^{-1}(COS(Latitude)*COS(△Longitude))

I enter it this way on my calculator:
Latitude, COS, *, △Longitude, COS, =, INV, SIN

[Editors note: the keystrokes on an RPN calculator would be:
Latitude, COS, △Longitude, COS, *, SIN^{-1}]

RING OR EQUATORIAL TILT FROM VERTICAL:

Tilt°=SIN^{-1}(SIN(Latitude)/COS(Elevation))

My calculator version:
Latitude, SIN, /, Elevation, COS, =, INV, SIN

[Ed. note: RPN keystrokes:
Latitude, SIN, Elevation, COS, /, SIN^{-1}]

(continued)

20° Equatorial tilt from vertical

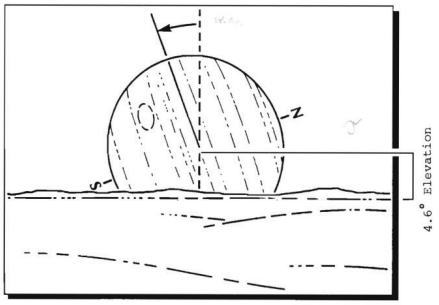

Fig.2

Here is a **sample problem**:

Suppose I looked at a map of Io and decided to do a painting showing how Jupiter would look in the sky as seen from **Daedalus Patera.**

Daedalus Patera location: 20° N. Latitude, 275° Longitude
COS(20°) * COS(85°) = .0818
Latitude Longitude SIN of Elevation

The **elevation** is then 4.6°.

SIN(20°) / COS(4.6°) = .343
Latitude Elevation SIN of Tilt

The **tilt** is then 20°.

Now you get to figure out which way the rings or equatorial plane are tilted! Whether the west or east edge of the ring plane is "up" depends on which side of the 0°,0° spot you're on, or as

Planet as seen from:

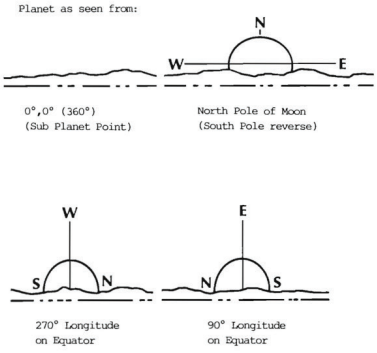

Fig.3

Bill calls it, the subplanet point (that point under which the planet would appear at your zenith).

Techniques II **A Simple Airbrush Compass**

by Rick Sternbach

Have you ever needed to airbrush a smooth airglow or thin cloud layers around a planet, only to find your wrist and arm aching from trying to match the curve pass after pass?

Ever had to paint a glowing stellar atmosphere and watch as the spray describes an annoyingly lumpy circle?

You probably need a tool to help guide your airbrush through clean arcs of various sizes, and here we offer a few basic

Figure 5.10— "Techniques in Astronomical Art," printed in *PARALLAX*. Correct visual representations of planets were grounded in an understanding of geometry. Part of the IAAA's goal was to distribute knowledge and techniques that could bolster accurate depiction.

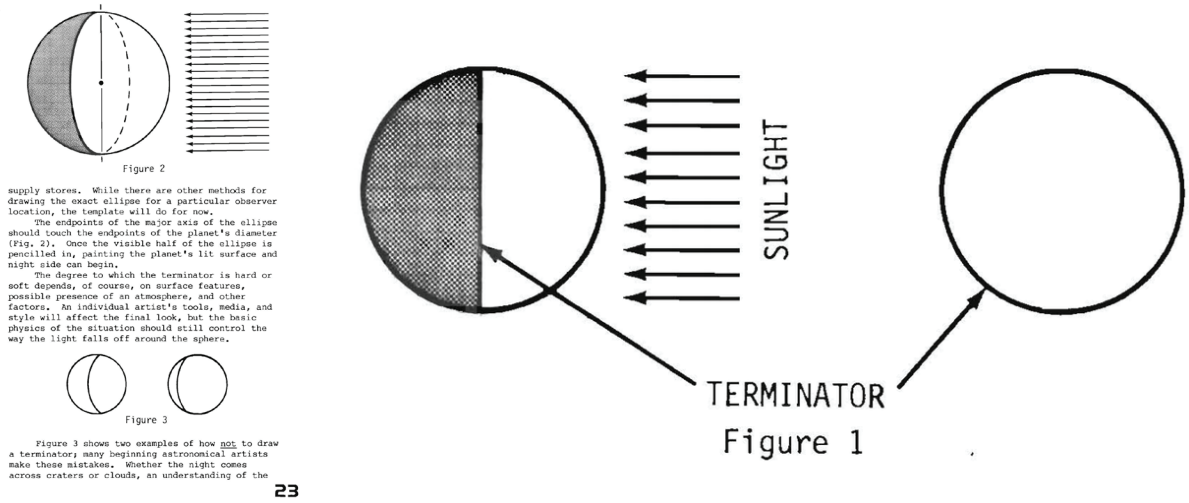

Figure 5.11— Description of how to correctly depict a terminator line. The illustration in the bottom left-hand corner demonstrates an incorrect depiction often observed in amateur artworks.

maintained that landscapes like Yosemite should be kept free of human residents—especially the "strangely dirty" indigenous peoples that populated the "clean wilderness" of the Sierras—and preserved as pristine and empty environments.[336] While the IAAA may not have intentionally reified pictorial conventions that served racial hierarchies, the circulation of astronomical illustrations that recalled western frontiers helped colonialist tropes circulate as neutral in American media. In this view, which has persisted into the twenty-first century, metaphors describing the colonialist settlement of places like Mars are harmless because Mars obviously contains no human populations to exploit or oppress. This process has helped naturalize the application of colonialist language to natural resource extraction on the surface of other planets.

The IAAA developed an entire methodology for codifying the western landscapes they visited as legitimate proxies for alien landscapes. Like the astronomical artists that came before them, they cultivated an artistic style that read as scientifically neutral. The production of this pictorial neutrality however, helped to reify the space landscape as a type of frontier well into the late twentieth century and at roughly the same moment as academic discourse on decolonial thinking. As Dylan Mulvin has noted in his work on the construction of proxy battlefronts to train American soldiers, proxies can only serve their function via the suspension of disbelief.[337] In the case of the IAAA, the group's clientele did not treat their images like photographs of alien surfaces, but the art was believable enough to function as an instructional stand-in. The space between a designated proxy and the real thing, however, always contains cultural baggage. Though landscapes like Iceland and the Arctic were viewed as more instructive from a geologic perspective, the IAAA had the easiest access to Hawaii and the American Southwest.

336. Rebecca Solnit, "John Muir in Native America" *Sierra: The Magazine of the Sierra Club,* March 2nd, 2021, https://www.sierraclub.org/sierra/2021-2-march-april/feature/john-muir-native-america.

337. Dylan Mulvin, *Proxies: The Cultural Work of Standing In* (Boston: The MIT Press, 2021).

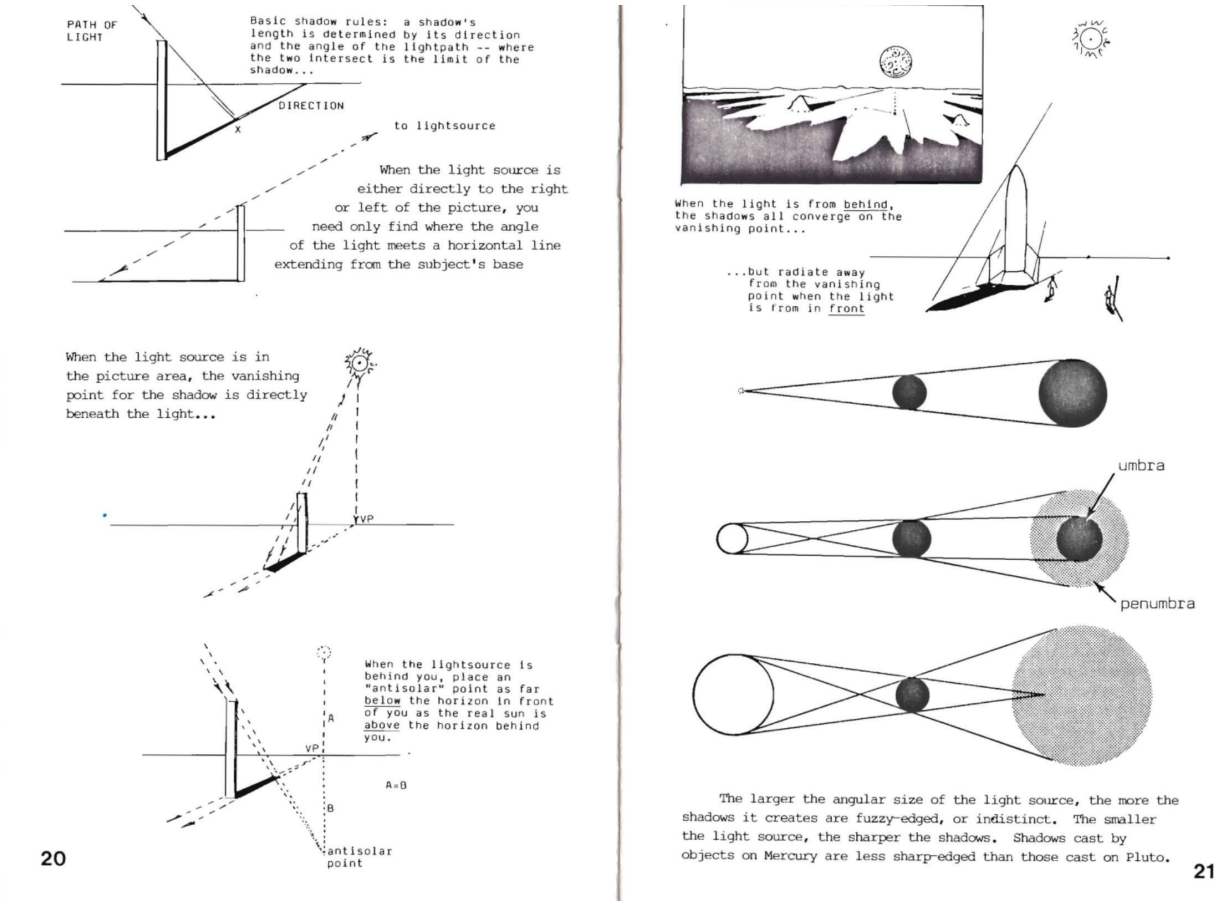

Figure 5.12— Diagrams depicting how to use the sun as a light source illuminating specific locations on a planet, versus entire planets themselves.

III. Circulating a Professional Journal

The IAAA's in-house journal, *PARALLAX*, was a major tool in codifying the organization's professional identity. The journal was relatively modest, typically clocking in under twenty pages and released four times a year. It circulated news and information to dues-paying members, making the organization's trajectory legible to its constituency. The journal's content hinged around the question of pictorial fidelity. How could the working astronomical artist use contemporary space science to produce the most possibly accurate illustration of a celestial subject? And, more importantly, how could artists monetize this skillset into a sustainable professional practice? These questions often overlapped, particularly during discussions aimed at defining the true value of the astronomical illustrator. In this view, the most aspirational forms of space art combined both research and artistic sensibility to make visible an otherwise unseeable subject. The journal circulated everything from calls for exhibitions to philosophical musings on the nature of human perception, helping to standardize the tool-kit members used to produce "accurate" representations of outer-space.

While the IAAA maintained throughout its history that the plurality of different

styles deployed by its members meant that it didn't prescribe a particular type of astronomical art, columns published in *PARALLAX* often implied a "correct" way to represent certain subjects. In an article published for the section "Techniques in Astronomical Art," Rick Sternbach instructed readers on the accurate representation of a terminator line, the line dividing the illuminated and dark parts of the moon or a planet. "Unless you always paint planets in a full or a new phase, you will have to deal with the terminator." He went on to explain that "parallel light rays will illuminate one half of the sphere and the division between light and dark," and that the "division of light and dark" would itself form a circle banded around the surface of the three-dimensional sphere. Along with his explanation, Sternbach also included examples of incorrectly represented terminator lines, demonstrating common mistake seen in works of astronomical art produced by the uninitiated.[338]

Similarly, an article on techniques for light, shadow and perspective written by Ron Miller clarified that "There are a number of ways in which artists can construct perspective views of objects and determine correct light and shadow, with varying degrees of accuracy." The techniques listed in the subsequent article adhered to the "basic rules of perspective, light, and shadow." These were rules expressed visually, but that functioned as rules nonetheless, and were treated as a sort of mathematical principle. They were usually framed in terms of a correct application.[339]

The question of correct or incorrect painting intersected with another question of great interest to the IAAA. If the quality of a painting was to be judged in terms of its accuracy, what was the role of artistic sensibility. The balance between accuracy and aesthetic appearance was difficult to formally define.

Responding to Ron Miller's article on the problems with trusting NASA images as a visual source equivalent to a naked eye view, member Bob Eggleton about the efficacy of prioritizing accuracy over attractiveness if the client ultimately wouldn't notice. "Miller's article on the misleading colors of NASA pictures is something I've stumbled onto myself. Jupiter just isn't that orange-red all of the Voyager pix [sic] show. It looks unnatural. I tend to paint it (now) as a beige/raw sienna with the darkest area being the "red spot," which is actually brownish. I can tell you, it looks a lot better." He continued by explaining why, in the balance between "pretty" and "accurate," he generally preferred attractive images. "My planet sides are determined by a very basic formula, (diameter)/(distance x 57.3), since I don't have a home computer nor am I about to wear my pencils and nerves to nubs determining something nine tenths of my buyers don't really worry about."[340] Don Dixon and Rick Sternbach replied to Eggleton's letter jointly, as *PARALLAX's* editors: "While one does not have to calculate sizes of positions of celestial objects accurately to ten decimal places, most of us would agree that it helps

338. "Techniques in Astronomical Art: The Terminator," *PARALLAX: Journal of the IAAA,* 1984: 3, pgs. 22 -23.

339. Ron Miller, "Techniques III: Light, Shadow, and Perspective," *PARALLAX: Journal of the IAAA,* 1985:1, pgs. 19 – 21.

340. "Excerpt from Bob Eggleton" *PARALLAX: Journal of the IAAA,* 1984:3. Pg. 4.

to get things looking right. This is especially true if your client is a principal investigator on an important space project, a planetarium, or a textbook publisher." They noted in their response that *PARALLAX* was implementing a new column, called "Tool Kit," to help astronomical artists prepare accurate looking astronomical scenes. This exchange revealed the variety of clients members of the IAAA were working with, as well the groups attitudes towards accuracy in astronomical painting. While Miller pointed out that NASA images used enhanced color and astronomical artist should be wary of trusting them at face value, the editorial team reminded its readership that, while it might be tempting to focus on aesthetic cohesion, there was a professional responsibility to produce images that "looked right."[341]

In 1985, *PARALLAX* published the results of a questionnaire sent out to the group's membership in an earlier issue.[342] They received twenty replies, offering a succinct analysis of the organizations demography and level of education. While the number of questionnaires sent out was not listed, the survey's compiler considered the responses to be a representative sample. The first conclusion was that the IAAA's membership was growing as of 1985, the second was that the group's median age was 33.2 years old. The youngest member was twenty-seven, and the oldest was 97. The 97-year-old member was likely Chesley Bonestell, who turned 97 the year the survey was issued, and was given an honorary membership to the organization.[343]

The questionnaire results offered valuable insight into the IAAA's membership, especially their access to education. 75% of respondents felt that self-teaching was their primary training as an astronomical artist, followed by books, school, and other artists. Despite this fact, 100percent of members had graduated from high school, 90% had attended some college, 55% had graduated from college, and 15% had received advanced degrees. Of those who went to college, 40% were art majors, but physics, teaching, biology, architecture, anthropology, and geology were also listed. The average age at which respondents first got interested in space was ten, though a small percentage listed the onset of their interest at around thirty. As to what triggered their interest in space or art, books and illustrations were listed most often. The next most popular response was "viewing the night sky with and without a telescope," followed by "reading science fiction," and "watching Disney films and other space programs" Witnessing Sputnik and other space missions was also mentioned. The most demographically revealing answer listed, "having a father who was an engineer," and being "exposed to science in general," which signaled socioeconomic adjacency to higher education, even if they themselves had not attended. The comments also revealed participation in the popular culture of space science Carl Sagan and Bruce Murray attempted to accelerate in the late 1970s—"don't laugh," one responder wrote, "*Cosmos* did it. I suddenly discovered that I could do something with [an interest in space]."

The survey also reflected engagement with the fine art world, but a clear prefer-

341. "Editors reply to Bob Eggleton," *PARALLAX: Journal of the IAAA,* 1984:3. Pg. 4 – 5.

342. "Sharing the Wonder Part II: The Questionnaire Results," *PARALLAX: Journal of the IAAA,* 1985:3, pgs. 4 – 12.

343. "Sharing the Wonder Part II," *PARALLAX*, pg. 5.

ence for representational art and popular illustration. To a question asking participants to list their favorite artists, Chesley Bonestell was listed 13 times. Robert McCall and Maxfield Parrish tied for second, each receiving five votes. Salvador Dali, IAAA member Ron Miller, and Leonardo da Vinci were also mentioned. 100% of respondents indicated that they thought "space art has a legitimate place in the world of fine art." Comments reflected a frustration with space art's marginal status "Of course space art is a fine art" to "but try to get a space painting in the Louvre." One respondent said that they felt the issue, ultimately, was that space art was perceived more frequently "as belonging to landscape art, or even abstract art in some cases." This was an unsatisfying assessment for many members, who saw their approach to observation and realism as continuous with the history of representational western art. The inclusion of scientifically informed practices was just another development in the progression of artistic methods, rather than a derivative approach that simply copied sources of reference material.

The group's general preference for accurate-looking, representational art, was reflected in a question about the types of reference material most often deployed in the illustration process. The pictorial sources mentioned most often were NASA photographs, astronomical photographs more generally, USGS maps, specialty magazines, landscape photos, models, other astronomical art, and finally, direct observation. Input from professional scientists and engineers also functioned as a type of source material, and 75% of respondents said they consulted "another professional" during phases of the artwork preparation process. Astronomers, planetary scientists, aerospace engineers, and NASA officials were listed as the most common sources.

Technique and materials were important to the representation process. More than half of respondents owned telescopes, ranging from 2.4" to 13" in diameter. 50% of those polled used a computer in their work, while 10% made use of a graphing calculator. 15% of artists said they also worked in 3D. 80% said their primary material was acrylic, 15% said oils, and 5% said pen and ink. 55% used illustration board, while 25% used canvas, and 20% used Masonite. 80% of artists worked with an airbrush. In a nod to the influence of Patricia Bridges and Don Davis, the most mentioned model was the Paasche AB.

Computers weren't viewed as tools for the displacement of artists, but rather as a useful instrument for bolstering the accuracy of one's images just like the other more traditional mediums. "The Keyboard Artist," a recurring column in the journal focused on using computers as aids in the drafting process. "The Keyboard Artist" offered codes and formulas in the programming language simple BASIC to help artists calculate things like the visual size of a spherical object in degrees if viewed from a particular distance.[344] How big would Io be if you viewed it from the surface of Jupiter? Entries like these gave artists a reliable tool kit from which to draw that had been vetted by the IAAA.

Technical strategies for envisioning what the sky would look like from different vantage points in the universe was a frequent subject of interest. In a 1985 issue, Marilyn Vicary published several formulas developed by Bill Hartmann to calculate the height of a planet in the sky of a given moon, as well as the degrees of "tilt" for equators or rings around planets. Vicary explained that she often encountered maps of planets

344. "The Keyboard Artist" *PARALLAX: Journal of the IAAA,* 1984: 3, pg. 18 – 19.

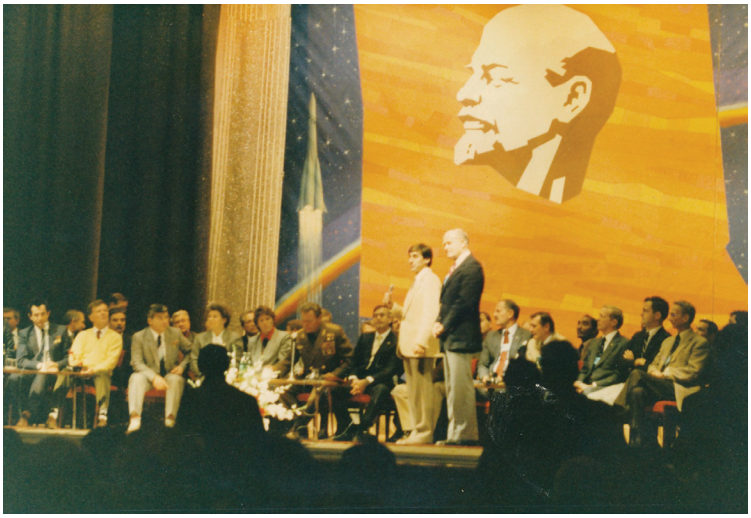

Figure 5.13— Robert McCall and Jon Lomberg onstage at the Soviet Space Future Forum.

and moons that contained precise coordinates, and that she used Hartmann's formulas to figure out how celestial objects would appear in the sky of her subject's locations.[345] Hartmann's calculations, which could be done with a graphing calculator or by hand, offered an alternative method for mapping distances between planets that didn't require simple BASIC.

Another question of interest was that of color, and the appearance of space to the naked eye. In a 1984 article titled, "All the Colors of Darkness," group members weighed the different ways to produce a deeper black for outer space. Carl Chaplin suggested painting on black velvet; Kim Poor recommended a particular brand of black gesso for treating canvas; Bob Eggleton swore by a layer of blue (he recommended phthalocyanine) over a raw black like Mars or Ivory.[346] The final question on the 1985 survey asked whether a ride on the shuttle or time spent on the space station would alter their artistic style. 40% believed it would, and one respondent explained that "It is the artist's ability to creatively acknowledge the objective reality while expressing the subjunctive emotions of the experience in unique and unexpected ways…" Another wrote that it would probably enhance their seeing of real phenomena, "airglow, cloud and mountain shadows, aurorae, lightning, and so on. I suspect my color palette will be significantly altered." Despite all the technical tools developed to bolster the accuracy of an image in terms of a naked-eye view, it was still understood that there was no substitute for first-hand observation.

Just as important as the production and maintenance of accuracy was identifying the market for space art and illustration. The initial reasons for forming the IAAA centered around practical questions—the pooling of information around jobs, calls for artwork, and noting which publishers were difficult to work with. Rather than working individually as a freelance illustrator, IAAA membership offered the benefits of belonging to an organized profession. In 1984, the IAAA began looking into group medical insurance, while a 1985 Treasurer's Report noted spending on group business cards and framing costs.[347] Members were concerned about making money as a working astronom-

345. "Techniques in Astronomical Art: Bill Hartmann's Fab Formulae" Maralyn Vicary, *PARALLAX: Journal of the IAAA,* 1985:1, pgs 12 – 15.

346. "All the Colors of Darkness," *PARALLAX: Journal of the IAAA,* 1984: 3, pg. 26.

347. The group started investigating group medical insurance. Cost break offered by a group plan. *PARALLAX: Journal of the IAAA*, 1984:2, pg. 3.

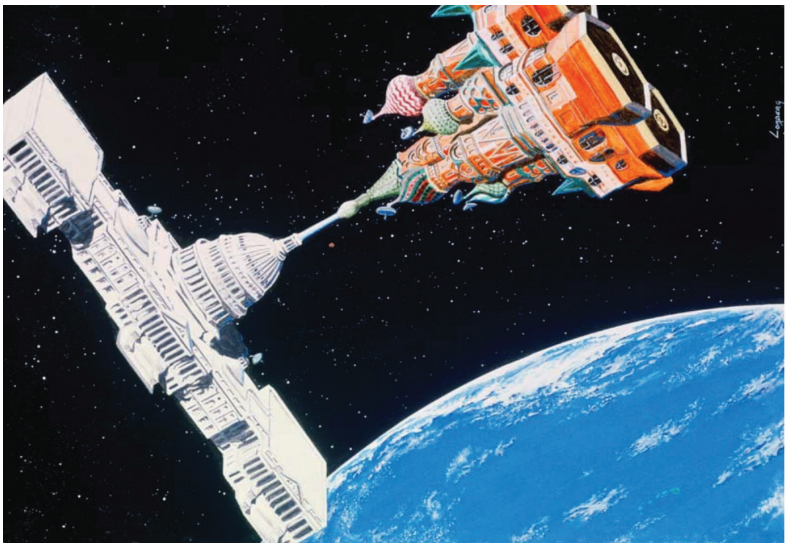

Figure 5.14— Painting by Jon Lomberg commemorating the meeting between the United States and the Soviet Union.

ical artist, and this was a concern that was frequently addressed in the journal's pages. "Market Reports" were occasionally published, listing contact information for periodicals looking for illustrations.[348] Upcoming conferences in planetary science and computer graphics were also noted.[349]

In an article titled, "Where is the Market for Space Art," IAAA member Kim Poor outlined the many ways that members earned steady incomes in the past. This included science fiction conventions, commissions from science professionals, and what Poor called "The General Informed Public." He also gestured to the ways the IAAA could improve its strategies, and pointed to a sister guild also operating on the fringes of the art world—the Cowboy Artists of America.[350] The Cowboy Artists of America were frequently upheld as an organizational model to emulate. Curators and galleries in the American Southwest launched aggressive publicity programs that resulted in high visibility shows that were ultimately very lucrative.

In 1987, an IAAA newsletter reprinted an article from the *Arizona Daily Star,* detailing the opening of a Cowboy Artist's show held at the Phoenix Art Museum.[351] The show raked in $1,156,405.00 in its opening hour, with 800 people paying $100 purely for access to bidding. In reprinting the article, the IAAA noted that "the [Cowboy Artists]

348. In 1984, a call was put out soliciting art for The Planetary Society, as well as the L-5 Newsletter. There were often network crossovers between members of the IAAA and the publishing opportunities made available to them. For instance, Kim Poor, one of the organization's founding members, who also served as an Art Director for the L-5 News. An artist that submitted work would receive forty dollars for a color cover, made up for with "fringe benefits of a year's free subscription." "Market Reports I & II," *PARALLAX: Journal of the IAAA,* 1984: 3, pg. 9.

349. "SpaceSIG on CompuServe" Forum for space-related topics, including NASA Programs, space technology, space politics, and science fiction. Advertising online conference, which the editors planned on participating in, *PARALLAX: Journal of the IAAA,* 1984:3, pg. 10

350. "Where is the Market for Space Art?" Kim Poor, *Pulsar: Newsletter of the IAAA*, July – August 1987, pg. 6.

351. "Cowboy Artists Update," *Pulsar: Newsletter of the IAAA*, September – October 1987, pg. 5.

took another licking from the critics… but laughed all the way to the bank."[352] Kim Poor used the Cowboy Artists as an example of successful market identification. Poor claimed space professionals, though making up the bulk of the IAAA's source base and clientele, was a flimsy customer base. "Western art doesn't sell to cowboys and windmill art doesn't sell to farmers. Western art sells to people who WISH they were cowboys. Windmills sell to folks who perhaps grew up on a farm… people buy art to fulfill sentimental, nostalgic, or fantasy longings." That made "the General Informed Public" the best possible market. That the Cowboy Artists were snubbed by the art elite did not bother Poor, who went on to found Novaspace Art in 1989 as a mail order source for Poor's prints and those of other IAAA members. Novaspace represented Poor's efforts to reach lay audiences, and it moved online in 1994 selling both art and astronaut-autographed memorabilia.[353]

PARALLAX functioned as the primary medium by which the IAAA constructed its identity, in between its yearly workshops. The journal reified commitments to scientific accuracy, offered a space for discussion of tools and techniques, presented a forum for discussion of financial matters and art markets. The group also made sense of its history, articulating the ways in which the techniques they championed were conceptually consistent with visual representation in the history of western art.

IV: The Soviet Space Future Forum

Over the course of the 1980s, an expansion in the amount of people who identified as astronomical artists coincided with an expanding art market that targeted buyers beyond the space sciences. This process took on an international dimension catalyzed by Frederick Clark Durant III, a retired curator at the National Air and Space Museum and the private art dealer responsible for managing Chesley Bonestell's body of work. Durant, the head of Space Art International, represented Chesley Bonestell, Czech astronomical artist Ludek Pesek, and later Russian artist Andrei Sokolov. Durant came to space art by way of aeronautics, working as a rocket engineer for much of the 1950s. He was well-connected to the aerospace industry both at home and abroad, serving as both the President of the American Rocket Society as well as President of the International Astronautical Federation (IAF) from 1953 to 1956.[354] During this time, he became a respected civilian advisor on aerospace technology for the U.S. government, serving on

352. "Cowboy Artists Update," *Pulsar,* pg. 4.

353. Astronaut-signed artefacts quickly outpaced art sales, and n 2007, Novaspace organized SPACEFEST to showcase its various artefacts. Twenty NASA astronauts attended, and the festival quickly became an established hub in the space memorability trade. As of 2022, the IAAA still exhibits work at SPACEFEST. "Our Story" Novaspace.com, https://novaspace.com/about-us/

354. Randy Liebermann, "Frederick C. Durant (1916 – 2015)," *The Space Review: Essays and Commentary about the Final Frontier,* November 2nd, 2015, https://www.thespacereview.com/article/2856/1

a Central Intelligence Agency panel in 1953.[355]

Durant's participation in the aerospace industry, the International Geophysical Year, and his service as rocketry advisor to the CIA made him privy to advancements in Soviet art as well as rocket technology. In a 1973 letter to a NASA Public Affairs specialist, Durant noted that "Soviet Cosmonaut Leonov and Andrei Sokolov are well known for their space painting." Durant explained that Michael Collins, then-director of the nascent National Air and Space Museum, had approved a proposal to bring several works of Soviet Space Art to the United States for display.[356] Durant continued to engage Soviet Space Art over the course of the decade, and 1984, arranged a meeting between Robert McCall and Andrei Sokolov in Moscow. [357]

Because of his role as a Space Art dealer an account of Durant's trip to the USSR was published in *Parallax* in 1984. "Fred Durant reports that he, his wife Pip, and Bob McCall journeyed to Moscow and Leningrad in June as Guests of the USSR Union of Artists. He feels that he succeeded in making the point that Space Art is becoming a distinct genre, with many facets. He did mention the IAAA and left the *Sky and Telescope* article with them. He hopes that an international travelling exhibition might be feasible in 1986-87."[358] While Robert McCall was frequently listed as an honorary member of the IAAA, he resisted any official affiliation with the group, lest he be confused for a scientific illustrator rather than fine artist. Fred Durant's visit with Robert McCall piqued the interest of the Soviet Union of Artists, who maintained a slightly higher profile due to cosmonaut Alexei Leonov's membership.[359]

The Soviet-American connections Durant fostered resulted in a joint meeting by the end of the 1980s. In 1987, The Planetary Society joined Soviet space scientist Roald Sagdaev[360] in organizing a conference to celebrate U.S. and Soviet collaborations in a newly relaxed political context. The policy changes associated with Mikhail Gorbachev's

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355. Over the course of the 1950s he worked for several different aerospace organizations, including: Bell Aircraft Corp., Everett Research Lab, the Naval Air Rocket Test Station, and the Maynard Ordnance Test Station. In 1954 he was recruited to participate in the first civilian-oriented effort to put a satellite into orbit led by Wernher von Braun. The team developed a concept called Project Orbiter, which later served as the foundation of the successful Explorer I mission launched on 31 January 1958. "Remembering Sputnik: Frederick C. Durant III" *IEEE Spectrum*. Interview of Fred Durant by Kieron Murphy, October 1st, 2007. Accessed January 28th, 2021.
https://spectrum.ieee.org/aerospace/space-flight/remembering-sputnik-frederick-c-durant-iii

356. Frederick Durant to John P. Donnelly, December 5th, 1973, Folder 5310, NASA Art Program 1962 – 1979, NASA History Office Archive, Washington D.C.

357. For more on McCall's relationship to Space Art as a genre, see Chapter Two.

358. "USSR Trip," *PARALLAX: Journal of the IAAA,* 1984:2, pg 8.

359. Jon Lomberg interview, May 18th, 2020, pg. 11

360. Roald Sagdaev was the motivating force on the Russian side. Eventually joined the University of Maryland. One of the youngest scientists ever elected a full academician of the USSR Academy of Sciences. US-Soviet Apollo Soyuz mission, the Venera series, and missions to Haley's comet were all overseen by Sagdaev.

Figure 5.15— Left: Vladimir Dzhanibekov, "Portrait of Yuri Gagarin." Right: Vitaly Myagkov, "Launch" depicting the launch of the space shuttle Buran. Buran is depicted as being welcomed into the heavens by angelic trumpeters. *In the Stream of Stars,* pg. 55.

tenure in the Soviet Union relaxed travel restrictions between the Soviet Union and the United States. During the "Era of Glasnost," the number of foreign tourists to the country skyrocketed—500,000 visitors were allowed to visit in 1956, compared to six million by 1988. Though most visitors traveled from elsewhere in the Soviet Bloc, "adventure tourism" and "science tourism" were seen as the most likely to grow immediately. The Soviet Space Future Forum was held in 1987 to coincide with the 30th anniversary of Sputnik.[361]

Soviet leaders were eager to celebrate the accomplishments of the Sputnik program, and to do so in a way that mirrored the international prestige of the first launch. In October of 1987, the Soviet Union organized a three-day symposium focused on the future of space programs. Scientists from around the world traveled to the symposium,

361. Arefyev, V., and Z. Mieczkowski, "International Tourism in The Soviet Union in The Era of Glasnost and Perestroyka." *Journal of Travel Research* 29, no. 4, April 1991, 2–6. https://doi.org/10.1177/004728759102900401.

Figure 5.16— Left: Josef Minsky, *Oh, God, How Tired I Am.* Minsky's painting is a form of astronaut portraiture, but the identity of the astronaut is not specified. Rather, the subject of the painting is space exploration as a form of labor performed by individual human actors. Right: Andrei Surovtsev, *Memory*.

including more than one hundred from the United States. Despite the turnout from other areas of U.S. science, the symposium received an indignant response from NASA officials, who reported that the Soviets were "just showing off." Though the Soviets offered to cover expenses for NASA scientists invited to attend, NASA required that any employees use vacation time and forego the offer of Soviet compensation. This whittled the NASA delegation down to six, including Louis Friedman of the Planetary Society.[362]

Louis Friedman helped organize Planetfest '81 and was well acquainted with the work of the IAAA. The Soviet Union of Artists had a branch devoted explicitly to the production of art related to the cosmos, and so it made sense to include an art exhibition of such cultural materials alongside a symposium celebrating the moment that many believed to have inaugurated the space age. Louis Friedman's involvement, and the Soviet Union of Artists' familiarity with Robert McCall's American approach to space art resulted in an all-expense paid trip to the USSR for the IAAA. Louis Freedman reached out to Jon Lomberg to put together a delegation of artists to exhibit work alongside the Soviet space artists invited to participate in the Forum.

This was perceived as a boon to the organization. A report of the trip circulated in *Pulsar* reported that "the IAAA has taken a giant leap in prestige. Seven of us were invited to attend the Forum during the first week of October. Dr. Roald Sagdeev personally telexed each of the participants, and we were to bring as many artworks as we could carry."[363]

The trip to the Soviet Union represented an unusual departure from the IAAA's usual status as an arts organization on the periphery of the fine art world and its affiliated institutions. According to Bill Hartmann, members "were whisked through customs

362. Lee Dye, "30 Years Later: Sputnik: Soviet Feat Brought Global Change," *The Los Angeles Times,* October 3rd, 1987, pg. 4.

363. Kim Poor, "Space Artists to Save the World," *Pulsar: IAAA Newsletter,* September – October 1987, pg. 1.

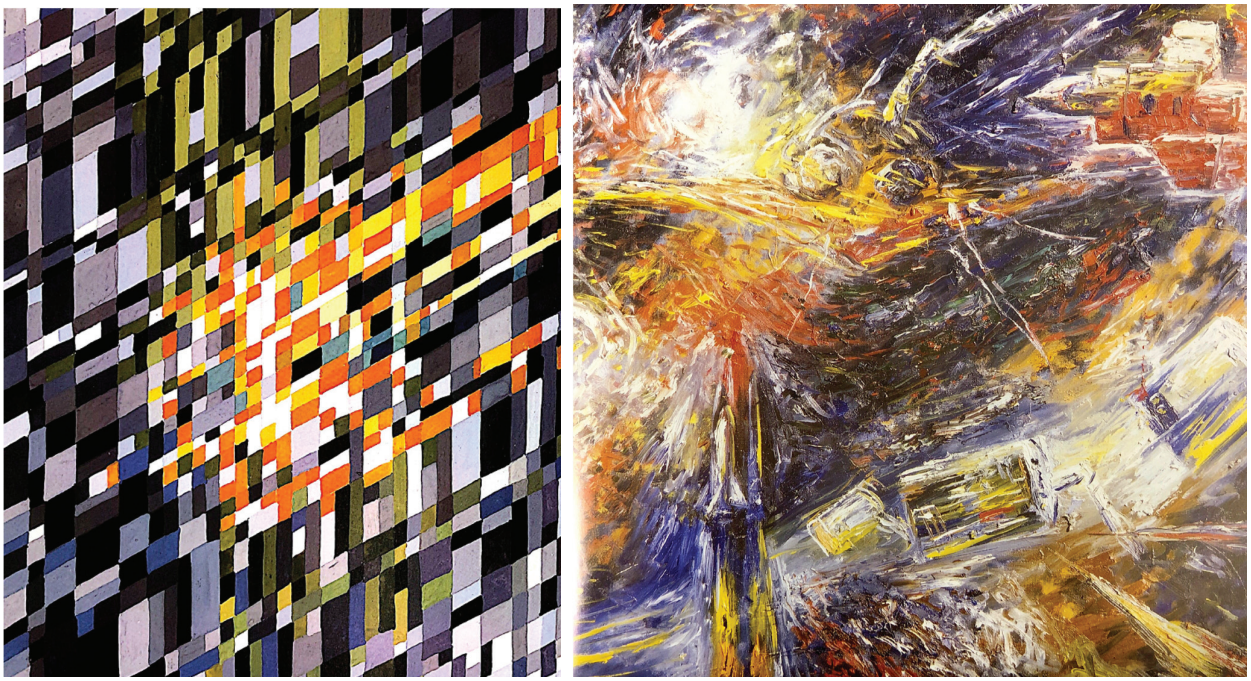

Figure 5.17— Left: Anatoly Paseka, *Sunlight*. Right: Rafik Karaev, *Progress*.

and taken by limousine to gala events with cosmonauts, government officials, and leading Soviet painters."[364] The first meeting was a function of the "glasnost" policies of Mikhail Gorbachev's government; members of the IAAA likened travelling to Russia and interacting with their Union of Artists to first contact. The Soviet artists the IAAA encountered functioned as useful parallel also in their organization. Membership to the IAAA was largely contingent on dues, but beyond a regular financial contribution there weren't any limitations on the type of art that members could produce. Soviet space art, however, was regulated by the USSR's Union of Artists, or Soiuz Khudozhnikov SSSR, founded in 1932.[365]

In contrast to the members of the IAAA, the artists that composed the Union of Artists were well known in fine art circles in the Soviet Union.[366] The Soviet Union of Artists was composed of voluntary members who identified as professional artists and was technically distinct from the government in its operation. The Union was governed by an elected administrative board which oversaw several different committees, including the Committee on Science and the Cosmos. This arm of the Union of Artists was

364. Hartmann, *In the Stream of Stars,* pg. 15.

365. Kornelia Boczkowska, "Space Exploration in 20th Century American and Soviet Literature and Art" (Doctoral Dissertation, University of Adam Mickiewicz in Poznań, Poland 2015), pg 243.

366. There was a Soviet exhibition of art at the Montreal world's fair in 1967. A review in a Soviet art magazine that noted how the last portion of the exhibition was explicitly about space art. "The last section drew the audience's attention with its exposition of a group of satellites, special screening, in which the journey to the moon was simulated, as well as the panoramas of the lunar and Venus's surface, painted by the artist E. Deshalyt. Boczkowska, 245.

responsible for organizing activities intended to bolster interest in space exploration.

The trip to the Soviet Union helped to further codify the IAAA's identity by giving them a foil against which to compare themselves. There had been virtually no contact prior to this meeting, and suddenly artists who identified with two nations represented by major competing space programs were able to physically come together. According to William Hartmann, it was as though two streams of space art forked off from one another at the start of the Cold War. "It was fascinating to see the diverse styles that had evolved in our isolated artistic 'environmental niches.'" The differences were clearly apparent; the Soviet artists found the fixation on accuracy of their American counterparts to be overly materialistic. In Hartmann's words, these were images based on "scientific data."

The Soviets, in his vision, were more interested in showing the "spiritual" side of space exploration, explained as the response of the "soul" to cosmic information rather than the information itself. Other members of the IAAA felt that the comparative opacity of the Soviet space program meant that its painters had not yet absorbed enough scientific and technological information "to render planets and spacecraft with high realism." The high degree of symbolism used in Soviet space art was explained as a function of the CCCP's comparative opacity.

Despite the Union of Artist's restricted access to Soviet space hardware, Hartmann's assessment of their work as a less informed version of the IAAA's output may be more complicated. As Asif Siddiqui points out, Soviet artists may have deliberately self-censored representations that described Soviet space hardware in too much detail. Aleksei Leonov, the cosmonaut turned painter, was well-acquainted with the secret technologies that composed the Russian space program and—according to fellow space artist Andrei Sokolov—deliberately distorted material reality in his work. Sokolov himself had a painting of an imagined rocket censored because he accidentally approximated the form of a real piece of Soviet space hardware.[367]

According to Vitaly Myagkov, this was partially because figurative Soviet space art was heavily subsidized by the Union of Artists. Painters had more access to space hardware by the onset of Khrushchev's Glasnost, but still worked in a largely symbolic capacity.[368] Myagkov noted that artists participating in an exhibition commemorating the 25th anniversary of Yuri Gagarin's orbital flight were allowed to stay at the Cosmodrome's technical sites. The artists also held regular consultations with the U.S.S.R. Federation of Space Exploration, and individual cosmonauts often provided the artists with personal impressions of spaceflight missions. For Myagkov, this allowed artists to "make the contents of their works more interesting and realistic," but this was fodder for the stimulation of creative fantasy as opposed to detailed replication.[369]

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367. According to Siddiqui, Soviet artists and model builders were "notorious for producing versions of Soviet spacecraft that often had little or no connection with reality." This practice was common in the early 1960s and resulted in several outlandish depictions of space hardware. James T. Andrews and Asif A. Siddiqi, *Into the Cosmos: Space Exploration and Soviet Culture* (Pittsburgh, PA: University of Pittsburgh Press, 2011), pg. 72-73.

368. Boczkowska, 243.

369. Boczkowska, 244.

The IAAA's excursions in the Soviet Union didn't lead members to reframe their work as "fine art," but it did unveil the extent to which their supposedly neutral style of representation was shaped by cultural context. In this estimation, the chosen subject matter of the Soviet Union's most well-known space artists reflected a different set of cultural priorities than those of the IAAA. The IAAA decentered humans altogether—except for Pamela Smith, who painted women and children in space—in favor of space landscapes. Their approach to "clean, empty" landscapes reflected a trend in nineteenth-century environmentalism that imagined pristine western environments unsoiled by human visitors, indigenous or otherwise.

Whereas members of the IAAA viewed themselves as inheritors of the western landscape paintings, their Russian counterparts has a different set of conceptual predecessors. The Soviet Union of Artists was founded in 1960, and adherence to socialist realism was enforced in varying degrees. State sponsored works of Socialist realism characterized most state sponsored art throughout the mid twentieth century. Socialist realism was conducted much more closely in the tradition of French Realism, which rejected the neoclassical representation of the aristocracy. This was conceptually different from the mimetic pictorial realism deployed by the IAAA and produced a different aesthetic. Since the truthfulness in representation laid more with the artwork's subject matter over technical execution, the presence of interpretive brushstrokes further imbued the image with subjective meaning.

While works of Socialist Realism frequently depicted idealized Soviet citizens engaged in forms of labor in service of the socialist state, Soviet space art focused on the everyman cosmonaut, a symbol of humanity's triumph over nature via technological means.[370] As with idealized Soviet citizens, the cosmonauts are typically well-fed and fit, which may explain the focus of the Soviet artists on cosmonaut Yuri Gagarin. Comparatively, American space art's fixation on objective technical representation was a radically different interpretation of realism, one which the Soviet space artists read as continuous with American materialism.

In terms of artistic approach and relationship to the state, the Soviet Union of Artists was much closer to the NASA Artist's Cooperation Program of the 1960s. In both instances artistic efforts supported by the government were encouraged to interpret the cultural significance of space activities. That by 1987 the Soviet space artists were interfacing with the IAAA and not a federally sponsored cohort of artists is itself an illustration of how visual culture was approached in each context. Thirty years after the launch of Sputnik, American space art was best represented by self-organized commercial illustrators rather than state sponsored fine art. The art of the NASA Artist's Cooperation program had by this point been long cast as a frivolous expenditure. The strongest expression of visual culture endemic to the U.S. space program was art that

370. Konohen, as cited in Boczkowska. "In her study of photographs published in the 1961 issues of *Ogonek* [Little Flame], the scholar concludes that the portrayal of interplanetary travels were intended to express social utopianism and that the future in space was presented as ordinary as well as employed the style of Socialist Realism, evident, for instance, in the image of a cosmonaut… Space was an influential emblem of modernization, the Promethean victory of Man over nature, freedom from gravity and from past horrors, and the promise of a bright, shimmering future." Boczkowska, "Space Exploration in 20th Century American and Soviet Literature and Art," pg. 246

claimed to function in a purely utilitarian capacity. When couched in this context, the Soviet accusation of American space art as intellectually continuous with capitalist materialism takes on new heft.

The contrast of American space art with its Soviet counterpart reveals the extent to which purportedly neutral representations were culturally stylized. As a function of the IAAA traverses in the Soviet Union, the variety of astronomical illustration developed in the United States over the course of the Cold War suddenly looked like an equally stylized artistic intervention. The language of scientific accuracy that built up around astronomical illustration in the United States was largely due to institutional need that shirked art that wasn't explicitly representational—and the proximity of resource material to trustworthy scientific institutions. The Soviet artists functioned as useful conceptual foil to the IAAA because they worked in the context of a nation equally preoccupied with the propagandization of space, but their approach was markedly different. Comparatively, the IAAA's "Rock and Ball" approach to pictorial neutrality could be characterized as a distinctly American phenomena.

The Soviet Space Future Forum was the beginning of several fruitful collaborations that helped the IAAA develop into an international organization both in name and in practice. In 1988, members of the Soviet Union of Artists and the IAAA met in Iceland to continue exploring the intersections of their interests. With the support of the Planetary Society, the group toured lava plains, glaciers, hot springs, and geysers, in an experience meant to simulate excursions through an alien landscape. In April of 1989 they met again in Moscow and mounted a space art exhibition there planned to coincide with the arrival of the Soviet Phobos 2 spacecraft in orbit around Mars. In August of the same year, the Soviet group travelled to Pasadena, California, home of the Jet Propulsion Lab, where they mounted the same exhibition again, this time in conjunction with the flight of Voyager 2 past Neptune and its moons. The following week, the IAAA invited the Soviet artists to a guest ranch in Moab, Utah, where they painted in Arches and Canyonlands National Parks.[371]

Members of the IAAA continued to produce work in the wake of these trips, as well as hash out the categorical differences between space art (interpretive art about space), astronomical art (representational art about space), and astronomical illustration (the visualization of space landscapes as mediated via science and technology).[372] According to some in the organization, the IAAA lost its professional coherence in the 1990s because of pressure to accommodate too many artistic styles. In line with Louis K. Meisel's attitude towards the multicultural degeneration of fine art museums discussed in Chapter Two, some members believed the organization admitted too many new members who couldn't actually paint.[373]

Though many assume the IAAA was entirely displaced by the rise of computer

371. Hartmann, *In the Stream of Stars,* pg. 15.

372. In 1991, the group circulated a white paper in which members explained their positions on these hotly contested categories. The IAAA "Green Paper" circulated in 1991. Courtesy of Michael Carroll.

373. Jon Lomberg, interviewed by the author.

rendering software, the reality was that most members simply viewed computers as a new tool much in the same way they viewed the development of the airbrush. Several of the IAAA's founding members still publish computer rendered illustrations in mainstream periodicals.[374] While members of the IAAA continue to produce digital works, its more accurate to say that computer software displaced the handmade illustration as a trustworthy medium. In March of 2021, Bill Hartmann published an exception to this rule, circulating a hand-painted illustration of the Oumuamua comet in the *New York Times*. The caption read, "A recently released artist's concept of Oumuamua. An early rendition imagined the object as a cigar-shaped rock and gained widespread circulation, but some astronomers have suggested that it could be shaped like a pancake."[375] Hartmann's illustration at first appears anachronistic, but considering the visual ambiguity of Oumuamua's shape, hiring a trained planetary geologist to draw their professional interpretation signals the challenge of picturing distant enigmatic forms. Oumuamua was especially controversial, because in 2018, Harvard astronomer Avi Loeb published a paper suggesting the comet actually a form of spacecraft sent to Earth deliberately by an alien civilization.[376] Hartmann's illustration deliberately shows Oumuamua as a rock with a red tinge, weighing in on the debate by portraying the comet as one with a decidedly geologic origin.

While computing capabilities have mostly filled in for illustrations made by hand, outer space is still extremely hard to make visible. Dana Berry, a member of the IAAA who worked on Hubble imaging at the Space Telescope Science Institute at Johns Hopkins, contends that the question of representing space subjects in an intelligible way is still a pressing one—even with the use of digital image processing tools and the help of a space telescope. In Berry's view, science visualization is a competition between three elements: believability, pedagogy, and accuracy. In a 2019 interview about his experiences using computational tools in astronomical rendering, he explained that if an astronomer was trying to show the solar system on a computer screen, they'd have to be able to show the planets. In reality, the planets of the solar system would be so small they'd fall between pixels. To scale the planets up in a way that viewers can recognize, accuracy must be secondary to legibility. This is an example of how pedagogy and believability can inform the look of an otherwise "truthful" image.

These competing dynamics are especially true with representations of the Big Bang. In keeping with the computer screen analogy, Barry noted that the Big Bang is usually shown as an empty screen. Then a pixel emerges and blows up to include the entirety of the frame. But the problem with this visualization is that the Big Bang created space as well as time, so the computer screen technically didn't exist yet. Viewers are trained to think of the universe as emerging from a single dot suspended in space—how

374. Ron Miller created an illustration of the galaxy for the July 2015 issue of Scientific American., Vol. 313. Issue 1. https://www.scientificamerican.com/magazine/sa/2015/07-01/

375. Dennis Overbye, "Why Oumuamua, the Interstellar Visitor, Looks Familiar." *The New York Times,* Section D, pg. 3. https://www.nytimes.com/2021/03/23/science/astronomy-oumuamua-comet.html

376. Isaac Chotiner, "Have Aliens Found Us? A Harvard Astronomer on the Mysterious Interstellar Object 'Oumuamua," *The New Yorker,* January 16th, 2019.

Figure 5.18— Proposed Blue Origin space settlement interior.

does one show something expanding into a realm that doesn't exist yet? In these views, accuracy takes a backseat to believability.

While handmade illustrations of the cosmos are comparatively rare today, the sciences are still contending with many of the same questions of legibility. As was true in 1944, space is hard to conceptualize, which makes it hard to see. Our attempts to picture it will always inevitably function in some degree as a cultural product. By the 1980s, plein-air observation of suitable Western proxies was deemed an appropriate way to simulate naked-eye observation. In the 1990s, computer renderings largely displaced the handmade illustrations of space, despite offering a lower degree of pictorial resolution. In each of these instances, artists deployed a range of tools and methodologies to eradicate their presence from the image as best as possible.

As planetary science continues to return images of the solar system, one might ask whether contemporary images of planets like Mars validate comparisons to Western landscapes like the Grand Canyon. The answer, in the absence of direct observation, may be difficult to tell. As with the illustrations central to this project, images of the Martian landscape are heavily mediated and seen with teams of people working in conjunction with complex technological networks. Though an image of the Martian surface may recall a photograph of a landscape snapped with a camera, the reality is often more complicated.

Understanding how the American West was codified as a scientifically legitimate stand-in for outer space is critical to understanding the space imaginary currently being developed by the architects of commercial aerospace. The rhetorical framing of space ventures in the twenty-first century still largely relies on the colonialist vocabulary of settlement and expansion. In his own words, Elon Musk's goal is to make humanity

multiplanetary, describing the journey to Mars in language couched in the metaphor of precolonial conquest—quite literally, old world meets new world.

By the same token, Jeff Bezos's has described future space colonies as the solutions to global climate change. In this view, capitalist expansion can continue unmitigated into the solar system, while life on Earth remains largely "residential." Speaking to the Ignatius Forum at the National Cathedral in 2021, Bezos described his vision of man's future in space as one largely inspired by Gerard O'Neill's 1975 Space Settlement Design Study. In a nod to Don Davis's vision of an American wilderness transposed in space, Bezos emphasized that his future colonies would have rivers and wildlife, replicating the experience of "Earth,"—but here coded as North America—for settlers born in space.[377] In presentations describing the future of Blue Origins proposed space settlements, Bezos uses computer generated images of toroidal interiors that mirror those produced by Don Davis in the mid 1970s. In one, an elk gazes over a landscape reminiscent of the Yosemite Valley while Planet Earth—by this point itself also imagined as a residential pastoral—floats above. Bezos' space utopia, also one of limitless expansion, positions space as the answer to sustainable stewardship of Earth. In this vision, industrial capitalism can march on without concern for the exhaustion of natural resources.

Over the course of the twentieth century, realistic depictions of outer space were necessarily constructed. To produce convincing images, human observers filled in pictorial gaps, a process susceptible to culturally conditioned thinking. The perception of space as a type of frontier has persisted throughout the twenty-first century, influencing even as objective a medium as modern astronomical photography. As Elizabeth Kessler has shown, Hubble Space Telescope photography demonstrates the extent to which astronomers draw on this pictorial framework to make their images both legible and attractive to lay audiences. The celestial subjects of the Hubble Space Telescope's lens, which are first translated into data and then later reconstituted into coherent images, are consciously given landscape orientations, and colored using earth-tones that register as a physical horizon.[378]

Though the differences between the IAAA and the Soviet Union of Artists are easy to characterize along the same nationalistic lines that produced two competing space superpowers, readers should be careful characterizing a distinctly "American" style of astronomical illustration. It's important to note that other visions of outer space located in the contiguous United States didn't deploy the same preoccupation with traditional Western topographies. By acknowledging the contingencies inherent to the institutionally stabilized version of space that dominated the Space Age, we can unpack its status as a cultural artefact.

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377. David Ignatius interview with Jeff Bezos, "Our Future in Space: Ignatius Forum," YouTube Video, Streamed live November 10th, 2021, 57:20, https://www.youtube.com/watch?v=UWyPk_f8aAA

378. Kessler, *Picturing the Cosmos*, 61-63.

Conclusion: The Particular Realism of American Astronomical Illustration

In 1992, in place of an issue of *PARALLAX,* the IAAA circulated a draft of a proposed manifesto, compiled from meditations sent in from various members. The manifesto was a response to a proposed name change from the "International Association of Astronomical *Artists,"* to the "International Association of Astronomical *Arts."* The change was made to claim tax exempt status and receive public funding for continued collaborations with the Soviet Artist's Union, which needed a robust travel budget. Despite the subtlety of the name change, it prompted a fractious debate over the inclusion of non-representational art in official IAAA shows, and the meaning of astronomical illustration more generally.

After collaborations with the Soviet Union of Artists, several members of the IAAA were encouraged to experiment with expressionistic modes of painting. The group split into roughly two camps, one that upheld a "Bonestellian, science-based, representationalism,"—known as the "Rock n' Ballers" after the Rock and Ball style—and another that advocated for "swirlier" works of art unburdened by the constraints of scientific accuracy.[379] . The Soviet art was destabilizing not because it offered an alternative to space landscapes, but because it introduced an approach that made visible a different type of unseeable realm—an artist's individual perception. This was the same approach to documentation that permeated the NASA Artist's Cooperation Program. The expertise of the trained artist lay in their ability to make their experience of a given subject visible to other people. This was a popular turn because it also situated the IAAA much conceptually closer to fine art at a time when the market for accurate hand drawn illustrations waned.

The debate over impressionistic artwork represented a breakdown of the conventions negotiated at the beginning of the Space Age. Don Davis, frustrated by the lack of juried admissions to shows, defended the group's traditional style. "A genre of art which seeks to acquaint its viewers with different *realities* is of necessity a *realistic* one. The behavior of light, perspective, etc. is for all practical purposes the same throughout the known universe, and those who wish to portray the wonders of the known universe must have a working knowledge of astronomy as well as realistic portrayal from nature."[380]

Jon Lomberg took a similar tack but resented the implications that astronomical art was nothing more than a specialized branch of technical illustration. "At this extreme… the artist is the servant of the astronomer or hardware designer, and little attempt is made to inject individual personality into the piece." Lomberg also noted that part of the problem was that the genre itself had grown to include many more artists. When he was looking for astronomical illustrators to work on *Cosmos* in the late 1970s, the roster of available artists was a short one. This was simply the product of historical contingency, and not some grand design to keep the constraints of astronomical illus-

379. William Hartmann thought the split was overstated, noting much "comradely compatibility between the so-called Swirleys and the Rock n' Ballers. Hartmann himself admitted to incorporating less representational elements into his work after seeing the output of the Soviet Union of Artists.

380. Don Davis "An Open Letter to the IAAA," April 23rd, 1991, reprinted in the IAAA Green Paper, pg. 6. Courtesy of Michael Carroll.

tration narrow. Lomberg recalled that at one production meeting with Rick Sternbach, Don Davis, and Adolf Schaller, Carl Sagan quipped "if someone threw a hand-grenade right now, most of Space Art would be annihilated."[381] While Lomberg did feel the early philosophies of the IAAA were being diluted by non-representational art, he noted that it was much easier to maintain conceptual consensus with a small group of artists and that the "Rock and Ball" format was tired and overused anyway.

Marilynn Vicary-Flynn was more explicit, claiming that "trying to please all and offend none is the sort of thing that has ruined the IAAA." She continued, writing that it was fine to allow non-representation artists to make art *about* space, but that "by the original definition of Space Art, the style MUST BE REALISTIC. Yes, that is certainly a restriction on style and technique!"[382] Ron Miller was in accordance, explaining that "the IAAA simply cannot be all inclusive, nor should it even try to be. It was founded by astronomical artists to serve the needs of Astronomical Art. If this is limiting, so be it."

The problem, however, wasn't that the IAAA's methodology was being watered down, but that the cultural context that framed astronomical illustration as something more accurate and utilitarian than fine art was shifting. The IAAA's turn to fine art was exacerbated by the proliferation of computational modeling tools, which meant teams of scientists outsourced visualizations to professional less frequently. By the 1990s, computer-rendered images supplanted the plainly photographic as the most objective-looking. Advancements in commercial CAD software incorporated 2D drafting and 3D modeling into project workflows, allowing users to visualize data in new ways. By May of 1990, Microsoft shipped Windows 3.0, which followed a Graphic User Interface like that of the Apple Macintosh, establishing a solid platform for growth in the field of computer animation and rendering.[383] Computer software offered the interpretive latitude lacked by film, while maintaining a machine-made appearance deemed more trustworthy than hand-made illustration. Computer made images were still identifiably machine made, but this was preferrable to something drawn or painted by an individual. Even if a model generated on a computer required nearly as much human input, the final rendering contained no evidence of the human hand.

Chesley Bonestell's illustrations circulated as authoritative because he figured out how to paint landscapes with a level of detail that recalled photography, at a time when space advocates benefitted from having interesting, realistic-looking images of space. This set of conditions allowed for astronomical illustration to take on a new twentieth-century form outside of the astronomical observatory and inhabit a category that was either art or science depending on context.

The mercurial nature of designating images as either fine art or technical illustration is best evidenced by Patricia Bridges career at the USGS Branch of Astrogeology,

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381. Jon Lomberg, letter to the IAAA, December, 1990, Honaunau, Hawaii, reprinted in the IAAA Green Paper, pg. 6. Courtesy of Michael Carroll.

382. Marilynn Flynn, letter to the IAAA, April 24th, 1991, Mesa, Arizona, reprinted in the IAAA Green Paper, pg. 11. Courtesy of Michael Carroll.

383. Michael Morrison, "Advancements of the 1990s," *Becoming a Computer Animator,* (Sams Publishing, 1994), https://www.cs.cmu.edu/~ph/nyit/morrison/index.html, accessed May 3rd, 2022.

discussed in Chapter Two. While NASA implemented a fine arts program in the early 1960s, Bridges was hired to illustrate the lunar surface in a capacity that framed her as pseudo-mechanical representation device. The NASA Artist's Cooperation Program participants were hired to lend their interpretive lens to the buildup of Project Apollo, while Bridges became a part of an internal visualization process designed to see the lunar surface more clearly. These two activities represented opposite ends of a spectrum delineated within the same institution. On the one end was fine art, included for its interpretive value, and on the other was the visual transmutation of information—a technical process judged by the artist's ability to obscure their presence in the image entirely. The IAAA considered itself to be much closer to Patricia Bridges on this spectrum, but the wholesale absenting of artistic interpretation from an illustration was only possible through the suspension of disbelief. When Bridges work is compared to that of Vija Celmins, a fine artist with a remarkably similar drafting style, recentering her identity in the artistic process becomes easier to imagine. If Celmins was radical for her collaborations with photography and subsequently feminist "cyborg vision," then the same framework can be applied to Bridges, who developed the rendering techniques that defined the USGS's Moon mapping efforts.

Rethinking Bridges' contributions to the Space Age in terms of artistic output disturbs the seemingly static technical end of the art-or-visualization spectrum. By the 1970s however, commercial astronomical illustration was understood as categorically different from fine art, even when the subjects themselves were explicitly fanciful. Astronomical illustrators like Rick Sternbach and Ron Miller were often solicited for work in the realm of science fiction, precisely because they could paint space subjects realistically. This was hugely valuable because consumers of science fiction often judged the quality of a work based on its fidelity to scientific concepts, a preference borrowed from proponents of "hard" science fiction.

The rise in popularity of astronomical illustration in the 1970s was also a function of historical context. The unmanned interplanetary satellite missions of post-Apollo period prompted excitement over the look of space, at the same time that waning government support reinvigorated the political goals of space science boosters. As with Bonestell's collaborations with Willy Ley and von Braun in the 1950s, scientific experts benefitted from color illustrations that made the landscapes of space seem more tangible.

By the 1980s, the market for astronomical illustration expended enough to warrant the professionalization of working artists into a formal guild. The IAAA codified a shared vocabulary for describing the value of their interventions. The astronomical illustrator combined knowledge of light and physics with artistic dexterity to make visible unseeable space landscapes. By using the tools established by the IAAA and subjecting images to group critique, accurate views were produced via group consensus.

The visit with the Soviet Union of Artist exposed members to a guild that more clearly inhabited the fine art world, and that was unbound by the constraints of accurate painting. This visit coincided with a shrinking astronomical art market prompted by the commercial proliferation of computational tools, which forced the IAAA to acknowledge that scientific information could be thought of as just another tool in the art making process. By the 1990s, the social apparatus that legitimated the astronomical illustration

as a form of utilitarian image making shifted course, and the practice was revealed to be just another form of artistic realism. Like the French Realists, the Social Realists, and the Photorealists, the astronomical realists of the twentieth century developed a new toolkit for describing and stabilizing their vision of truth.

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