The Art of Science: The Importance of Art to the World of Science

from the perspective of Motion Media

A Thesis Submitted to the Faculty of the Motion Media Design Department in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Motion Media Design at Savannah College of Art and Design

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The modern way of understanding the scientific world is defined often by the art used to represent the science. How this art is used to represent the science dictates how we perceive it. Therefore, it is important how the art is conceived, designed and created. Motion design is often used in the creation of scientific models, conceptual representations of systems, events or processes. This thesis will utilize the practices of motion design to create a scientific representation of Mars. This project will be defined by its design and aesthetic values.

Keywords: Humanity, Culture, History, Poetic Partnership, Motion Design, Symphonic

1. Introduction

Where would the world be if not for the power of art? For if it was not for art, the world would be left to its imagination, hashing out the complexities of the universe. How would we envision the gaseous planet of Jupiter? Would we know about the whirling gaseous storms that fill the atmosphere and the giant red spot that stares out as a warning to passing space travelers to stay away? In the art of Motion Media, artists frequently are asked to recreate assets that simulate elements in the real world. Motion Media is challenging and explorative in its creative process. The process of creating art that illustrates the exploration of science is one that raises many questions. But none are as important as the significance that art has played for the exploration of science.

Science can be defined as a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. The early roots of art have been traced back to between 3500 to 3000 BCE but that is only due to the cave art that was found. This led historians to believe that the oral traditions of applied science go back even further, therefore, it would be easy to say that the study of applied science goes back almost to the dawning of mankind. For humanity science has played a major role in history. But reading about the earliest days of science, evidence has been found that early cultures were sharing it with others. Early humans communicated through the use of cave art or hieroglyphics, passing down information to visitors of the cave, much in the same way as art is used today to teach about our world. In a way, science and art have shared the same cultural space for a very long time. Therefore, it is important to study art just as much as science. By focusing on art, we can gain a much clearer picture of the overall science at hand.

Throughout history, art and science have frequently been intertwined. One simply has to look to the lives of such artists as Leonardo da Vinci and Albrecht Dürer to see artists that studied nature and developed science as a way to enrich the art they created.

When considering the life and art of Leonardo da Vinci (1453-1519 one can see how the study of science enriched da Vinci's work. Over the course of his life da Vinci filled more than seven thousand notebook pages with sketches and writings. (Amsen 2019) One of the topics of the notebooks dealt with the study of anatomy. Where an artist today can pull any anatomy image from the Internet as a reference, Da Vinci studied anatomy first-hand: by dissecting corpses. He got access to these bodies through hospitals, where staff were keen to support his artistic research. (Amsen 2019) Without this extra attention to the ligaments and muscle structures of people, da Vinci would not have been able to produce such great works.

The northern Renaissance artist Albrecht Dürer (1471-1528, also made strides in the study of science as a means to enhance his art. He produced countless paintings and watercolors of animals and natural phenomenon by using nature itself as a model.

Figure 1.1.1 *Field Hare* by artist Albrecht Dürer, watercolor on paper.

In one particular work, *Field Hare* (1502) one can see the level of detail also known as Dürer's "absolute faithfulness to nature." He would create his art in three stages, first he would draw the animal's outlines, then he colored the body, and finally he would paint every single hair onto the color wash to represent the animal's full coat of fur. (Warneck 2016) This devotion to science paid off in a result that is studied by countless art students in modern day.

Considering the fact that great artists of the Renaissance used science to improve their art, it is also interesting to consider Nikolaus Copernicus and Louis Pasteur who were also talented artists. Perhaps it is due to the fact that both science and art use creativity to shape the results of their endeavors, but why is it that the topic of art and science seems so foreign in the modern world?

Science is essential to our understanding of the world around us. The act of seeking understanding of something is a core fundamental pillar to what makes human beings so unique. But it is hard to find a single principle of science that does not benefit from the existence of art to help illustrate the complex ideas that science tries to explain. Therefore, it is important to study both fields in relationship with one another, in order to gain a better understanding of the world and how it affects our lives.

In order to bring attention to the importance of art to the scientific world, I will be dividing this thesis into five related sections. The first, focuses on the relationship between art and science, then in section two I will discuss scientific illustration and where it can be found throughout the world. Thirdly, I will talk about the science of science fiction, where I will discuss the ways in which science has been portrayed in the entertainment realm. Focusing on entertainment also necessitates talking about education and how science education has shaped the world. The final section of this thesis will focus on Information Technology and the potential future of art in science, and how scientific art could be used in the future. The goal of this thesis is to bring to light a corner of the art world and bring importance to an area that is often overlooked.

2. Scientific Illustration

To tell the story of how scientific art was developed and created, the first area of focus is to look at the relationship between art and space exploration. Art is a major component of the space program and before any of the space missions were attempted, artists were considered and used to determine what a successful mission would be.

Science can often be confusing to visualize. Therefore, it is important that artists can interpret the data and render the art, so that one can easily see what the science is trying to

explain. So, in some ways the art of science is sometimes more important than the science it is trying to explain, because the general public need art to help bring understanding to what the science is saying. In this paper, I will describe in detail the various types of art that are used by science and how that art contributes to the greater understanding of the science. Sometimes the art simply serves as inspiration for scientists and at other times the art is used in models to help explain the science. In both cases, art serves an important role in the field of science.

2.1 Types of Scientific Art

The first place to start talking about art and space exploration is with the NASA Art Program, which was founded in 1962 when the NASA Administrator James Webb, sought to use art as a way to emotionally capture NASA's past and future events. (Alaina 2019) After Alan Shepard orbited the earth for the first time, public interest was captured by the space program, so there was great interest in capturing art inspired by the space program. In 1963, the first group of NASA artists was sent to Kennedy Space Center, in Florida, to watch the final launch of the Mercury Program. Then the second art exhibition took place during the Apollo 11 Moon landing (1969), and the third at the dawn of the Space Shuttle Program (1972). Famed American artists including Norman Rockwell, Robert Rauschenberg, Andy Warhol and Annie Leibowitz have all been part of the NASA Art Program. (Alaina 2019)

> *An artistic record of this nation's program of space exploration will have great value for future generations and may make a significant contribution to the history of American art.*– James Webb, NASA Administrator, 1961 – 1968. (Alaina 2019)

Wanting to help immortalize the emotions and excitement of this new era, Webb recognized the importance and power of artistic expression. For the first time artists were invited into the modern space program. (Alaina 2019) But while art was being created or inspiring the

space program, there weren't real uses for art until the modern era and the art of scientific diagrams. These serve the purpose of demonstrating the science that they are representing.

Figure 2.1.1 *The Solar System* from Earth & Space Science Diagrams on Study.com. (Alcocer 2017)

Like the simple solar system diagram seen above, science diagrams can feature a variety of sciences and concepts to help convey information to the viewer. Science diagrams such as these helps students to understand the Earth and space better. Not only do these diagrams show pictures, but they can also show data related to what the diagram is depicting. (Alcocer 2017)

Another example of a science diagram is of the water cycle on Earth.

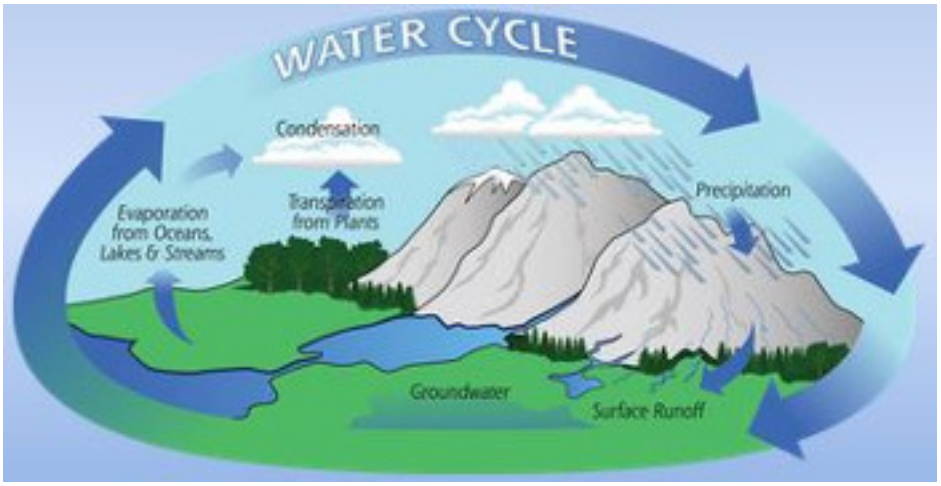

Figure 2.1.2 *The Water Cycle* from Earth & Space Science Diagrams on Study.com (Alcocer 2017)

From the mountains to streams and to lakes, the path the water takes to reach the sky and become rain again can be seen. This diagram puts everything together, so it is easy to see the path the water takes. It is useful for the information to be contained in a simple graphic rather than a complex alternative. The graphic was more than likely created by an artist and not the scientist delivering the information. In a way, this would be seen as typical art in the field related to science, and because of this, it is probably the most popular form of science art that will be considered.

Another type of art that is often associated with science is that of concept art. Often used for movies, concept art is created when a pre-production team are trying to see what the concept will look like before they commit to aesthetic decisions. One example of this is for NASA's mission to Mars, a project large enough and set in the future that having a team of artists come in to create concept art was necessary and beneficial.

In July of 2016, a group of four scientists from NASA, including an astronaut, a robotics expert, and the agency's deputy administrator conferred with some 30 painters, sculptors and poets in order to engage an "artistic response" to NASA's journey to Mars, the space agency's ambitious goal of putting people on Mars sometime in the 2030s. (Pendle 2016) The scientists intended to build interest in the space program and use such artwork to conceptualize the missions.

The most successful example of concept art changing space exploration history took place in *Life* magazine in 1944, when Chesley Bonestell, an American pioneer of space art, created a series of paintings.

> *These paintings showed Saturn from the perspective of its moons, an impossible view but painted in a realistic and plausible manner. His depictions of space travel were so vivid that he almost single handedly rid it of its Buck Rogers connotations, stirring up a torrent of public and government interest and support.* (Pendle 2016)

Bonestell's concept art could even go as far as to endorse future space missions as well as inspiring the space program as a whole.

Figure 2.1.3 Chesley Bonestell's *Saturn as Seen From Mimas, 1944*. (Pendle 2016)

According to Ron Miller, one of the more prolific space-art artists working today, "Most scientists simply don't think visually." (Pendle 2016) So there is a strong need for artists to come in and interpret the data. Also, according to Miller, art and space had a precursor in the art of the

Hudson River School, “Back in the late 19th century when Yosemite and Yellowstone were being discovered, artists like Thomas Moran and Alfred Bierstadt painted gigantic paintings, 10 feet to 20 feet wide, that actually toured the country.” (Pendle 2016) The purpose of this was to show the people that such places did exist and that it was important to support such explorations. (Pendle 2016)

Jon Ramer, President of the International Association of Astronomical Artists is in agreement saying, “We seek to inspire people to want to go and see what is `out there’ in our universe.” (Pendle 2016) For, while we think of space exploration as this modern era, many space artists harken back to the landscape painting of the pre-modern age in order to depict it. This is mainly due to space art still following the dictum of communicating information clearly. Pendle argues that, “…Perhaps this is also a nostalgic wish to return to a time when scientists and artists took each other’s work seriously.” (Pendle 2016)

When Chesley Bonestell was painting his planet-scapes, Wernher von Braun, America’s leading rocket scientist was saying they were, “the most accurate portrayal of those faraway heavenly bodies that modern science can offer.”(Pendle 2016) Such a pronouncement was shocking at the time, but it depicted a type of mutual appreciation that you don’t see in the modern era.

In the modern era, the interactions between artists and scientist are minimal at best. But this is not to say that such interactions don’t occur. In 1995, there was a star known as 51 Pegasi that was being made to wobble. (Pendle 2016) It wasn’t wobbling too much, but only enough to cause small changes in light to fluctuate and be picked up by an earthbound spectrometer, a machine that analyzes the shifting spectrum of starlight. Scientists at the Geneva Observatory concluded that the only thing that could cause a star to wobble in such a manner was a planet.

(Pendle 2016) At the time of this discovery, Lynette Cook was a freelance scientific illustrator living in San Francisco. She was working part-time as an artist and photographer at the Morrison Planetarium at the California Academy of Sciences, providing visuals of the cosmos to the delight of children and adults. A scientist friend suggested she try her hand at depicting this new discovery and she accepted the offer. (Pendle 2016) The result was the first ever picture of a confirmed exoplanet, or a planet that orbits a star outside our solar system. Without the art of Lynette Cook the depiction and clearer idea of what such an occurrence looked like would not have existed.

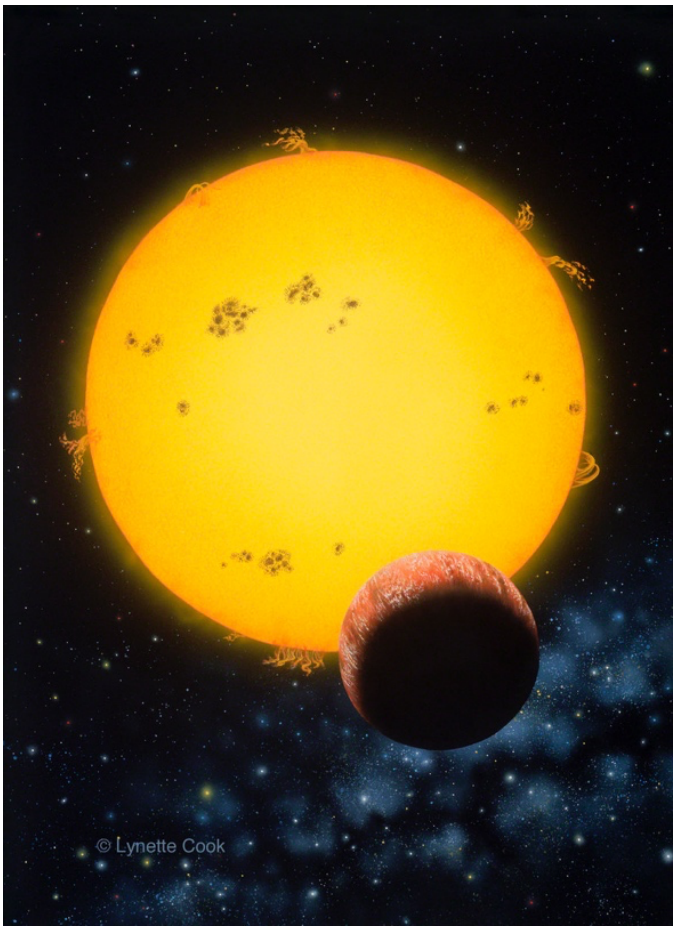

Figure 2.1.4 Lynette Cook's artwork of 51 Pegasi b. (Pendle 2016)

Without the work of artists such as Lynette Cook, a lot of ideas regarding space would be lost without any tangible illustration of what the data suggests. Therefore, it is easy to see the importance of such art in the scientific world.

Another area of the art and science overlap that has occurred today, is the art of logo design. As new ventures are pursued, each new endeavor often comes with patches or logo designs that will represent the program to the public. The logo to be focused on in this paper is the design of the NASA logo, which is also known as the `meatball' because of its similar shape to the food.

NASA's original logo dates back to 1959, when the National Advisory Committee on Aeronautics (NACA) changed into an agency that would advance both space and aeronautics, the National Aeronautics and Space Administration (NASA). (Airey 2011) Created by James Modarelli, the logo was designed so it could be used for less formal purposes.

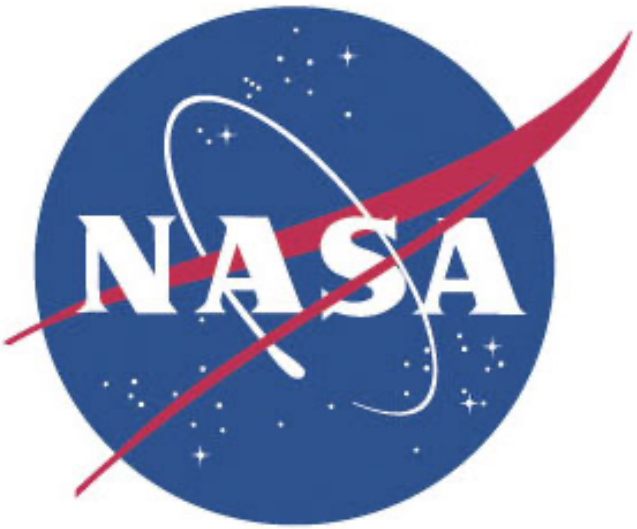

Figure 2.1.5 The "MB" NASA Logo designed by James Modarelli. (Airey 2011)

> *In the 'meatball' design, the sphere represents a planet, the stars represent space, the red chevron is a wing representing aeronautics (the latest design in hypersonic wings at the time the logo was developed), and then there is an orbiting spacecraft going around the wing.* (Airey 2011)

Though popular in design it wasn't called the `meatball' until 1975, when a new logo was being discussed.

At that time Richard Danne and Bruce Blackburn were brought in to replace the complex meatball design with something that would be more streamlined in design. Though the new design was met with pushback, it was eventually approved, giving birth to what would later be referred to as "the worm."

Figure 2.1.6 *The Worm* designed by Richard Danne and Bruce Blackburn. (Airey 2011)

Although the new design received much praise and awards, winning the "Award of Design Excellence" by The Presidential Design Awards in 1985, it would later be thrown out for

political reasons, returning to the “meatball” design some 17 years later. Which proves that designing logos is challenging work.

While the design process may be controversial, and there are those who like some designs more than others, it’s still an important art form with regards to the space program. Without logo design, the agency would lack professionalism and organization required to undergo such groundbreaking work; therefore, I would argue that the logo design was just as important as the other space related art forms.

From concept art to logo design, scientific diagrams to fine art, the art of the space program continues to increasingly challenge the public to believe in the space missions. It is my view that the success of space exploration is due to the hard work of artists and designers doing their part to support the exploration of the unknown. Therefore, it is possible to conclude that the design of art in space exploration is an important part of the endeavor.

2.1.2 SpaceX

In terms of the way art and science interact in the modern, it is important to consider the story of the ambitious space exploration company, SpaceX and their lead designer Tom Mueller. In late 2001, Tom Mueller spent his nights and weekends building a liquid-fuel rocket engine in his garage. It was his hobby to build his own engines, attach them to airframes and launch them in the Mojave Desert with fellow enthusiasts. (Belfiore 2009) Mueller’s unique moonlighting caught the attention of Internet multimillionaire Elon Musk, who was seeking staff for a new space company. (Belfiore 2009) Today, SpaceX has more that 700 employees with the goal of revolutionizing the way NASA conducts missions, and to one day send paying customers to space. But the science of SpaceX relies heavily on its designers to create the rockets that drive the company. Designed by a team led by Tom Mueller, the Falcon 9 rocket is unique because it

is a reusable, two-stage rocket that can be used to fly people and payloads into the Earth's orbit and beyond. This sustainability effort is used to drive down the cost of space access, which relies heavily on the partnership of art and science. (SpaceX.com 2021)

When considering the advancements of SpaceX, other ways in which art and science interact are revealed. It is a relationship that fuels innovation and future developments in the scientific world.

2.2 The Art of Heads-up Displays

Art and science have worked together since the Italian Renaissance period and especially in the entertainment industries since the late 19th century. Since the beginning of the film industry in 1895, stories of science and science fiction have developed in the landscape of filmmaking. This emergence has often caused a fine line to form between science fact and science fiction. Often, the two sides are an influence on each other, though science fact is commonly an influence on how science fiction is designed, written or created. Inversely, science fiction is often an influence on how the boundaries of science are pushed. One example of this is NASA's current mission to Mars, which is influenced by the countless motion pictures that take place on the red planet, such as 'Mission to Mars,' 'Red Planet' or 'The Martian.'

Science and art interact in a variety of ways; in *The Curious Life of a Mars Rover* (National Geographic 2015), on National Geographic's YouTube channel, animation show what will happen when NASA sends their rover to Mars.

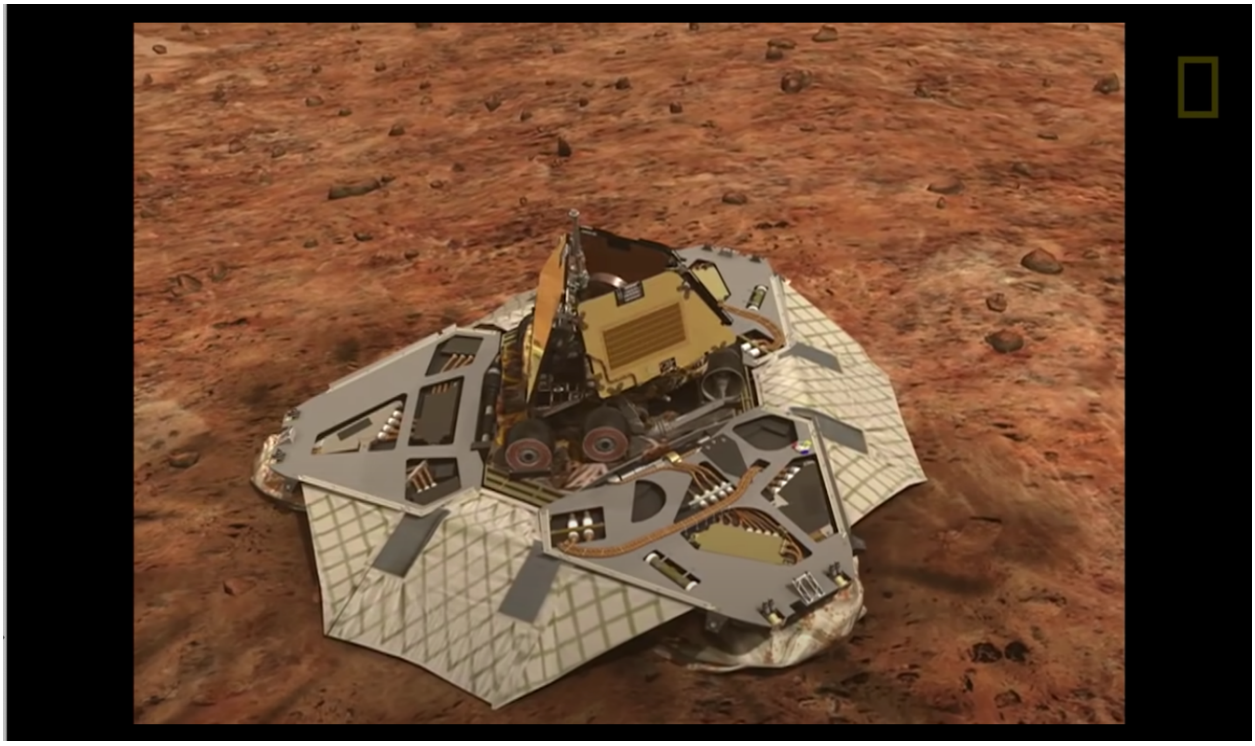

Figure 2.2.1 A still frame from *The Curious Life of a Mars Rover.* (National Geographic 2015)

These illustrations show how everything will happen in the mission from the moment it leaves Earth to the second the rover is up and moving on Mars. The video is inspiring to watch, plus the artistry, which was designed in a 3D modeling software package, helps the imagination to envision how the mission will go later once it is launched in 2020. The artistic renderings are so important to the mission, helping to foresee problem areas, therefore the animation is a part of the scientific presentation. In that way the science is dependent on the art, but in what other ways do science and art interact?

After defining the types of art used to depict science, I will conduct a deeper examination of several other types of art used to illustrate science. By doing so, the important role art plays in the scientific realm will become more evident. One of the more interesting areas to look at in this

area is the art used in entertainment, to illustrate science, and more importantly the art of heads-up displays.

One of the more popular forms of science and art interactions is in heads-up displays (HUDs), which are often featured in movies or television programs. HUDs are often a way for science to influence art.

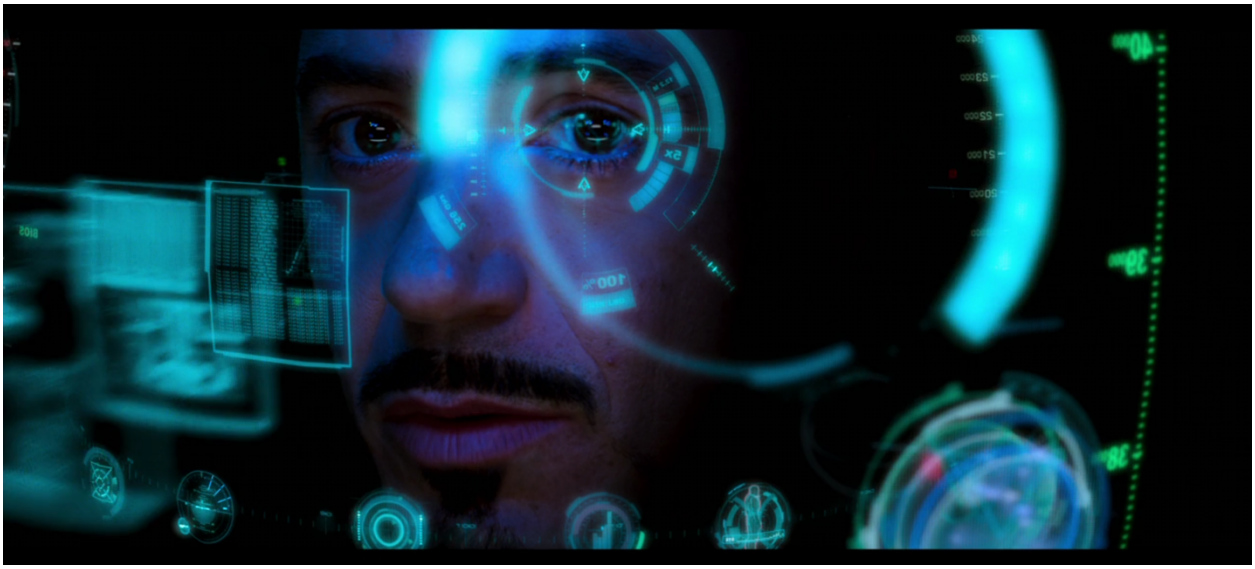

Figure 2.2.2 A still frame from *Iron Man* (2008) (Favreau, Jon. *Iron Man*. Paramount Pictures, 2008.)

Whether Tony Stark's suit in *Iron Man* (2008) or the film *Oblivion* (2013), heads up displays can be highly technical animations that deliver very specific sets of information to the audience. Therefore, it is important to look at the history of heads-up displays and what their place is in the science/art debate.

What is a heads-up display? "Originally a military technology, a heads-up display is a device which projects supplemental information onto the surface reflection of a transparent panel." (TV Tropes 2020) When it comes to a fighter pilot, this information is everything from their altimeter to systems that show targeting information. Systems displaying this technology are referred to as Augmented Reality, because it augments the user's point of view, providing

additional information that normally would be displayed elsewhere. While heads-up displays are used in a variety of ways in the entertainment field, in reality there are only two places where you will see real, true to life heads-up displays, in airplanes and in the not-so-distant future automobiles.

The first concepts for heads-up displays were first implemented during the height of World War II when pilots were struggling to locate their targets in hostile skies. Early prototypes were static, which made it difficult for pilots to shift their focus from bright displays to dark skies when flying at night. According to BAE Systems, “It wasn’t until HUDs were developed that pilots were able to access information hands-free, with their head positioned up and forward.” (Bae Systems 2020) The first plane with a built in HUD was in 1961, with the launch of the Blackburn Buccaneer made by Elliot Flight Automation, which later became BAE Systems.

Some of the basic information included on a heads-up display is general information from the front panel of the aircraft, which is airspeed, altitude, the horizon line, heading, turn/bank and slip/skid indicators. These indicators represent powerful information to the pilot in order to allow them to see this information without removing the view from the front, creating a safer and more productive flight process.

Figure 2.2.3 An example of a HUD in a Bombardier CRJ-200 aircraft at 1000 ft.
(Radiant Vision Systems 2021)

BAE Systems has been the leader of HUD innovations with breakthroughs such as night vision, diffractive optics, computer generated holographic technology and waveguide optics. Across the aeronautics industry BAE Systems continues to provide the HUD Systems in modern jets, including the F-16, F-22, C-17 military transport and business jets. (Bae Systems 2020) As a result there are prominent HUDs used in a variety of aircrafts today. But is that the only place where Heads-up Displays are seen?

Besides the advancements in Heads-up Display technology in the aeronautics field, there are a few more places using HUDs. As technology advances the use of HUDs in automobiles are likely to become common. According to Christopher Neiger and *howstuffworks.com*, "General Motors introduced the first heads-up display in a car in 1988 and the systems were originally

used for showing speed, tachometer and other basic readings from the dashboard." (Neiger 2020) As HUD technology advances, the system will begin to be increasingly safer. The heads-up displays will continue to evolve as technology advances.

One-way HUDs will advance is in the area of navigation. Imagine you are on a long road trip in a different area of the country. It would be useful to have the turns highlighted on the HUD. That way the driver wouldn't have to look down at another device to see the directions. Instead, they will be highlighted on the windshield for convenience. Other information will also be displayed, such as gas prices or restaurant ratings. This would make the overall experience of driving more informed and productive, while also being safer.

In actuality, a HUD system could be categorized as a safety feature like seatbelts, brakes, airbags and others, especially when paired with an on-board camera and adaptive cruise control. Imagine trying to drive in dense fog, newer HUD systems can use infrared cameras to detect where the lines on the road are and project them on the windshield where they appear in real life. (Neiger 2020) Overall, the HUD makes for a safer driving experience. The days of missing turns because of a confusing GPS or dealing with unforeseen weather will soon be a thing of the past. HUDs will be a helpful technology in the not-too-distant future, which is a good example of science fiction becoming science fact.

It could be argued that the heads-up display for planes and cars is a technology that does a lot of good in the world. Without HUDs, both modes of transportation would be a lot less safe. But there is one more type of HUD that is often overlooked and that is HUDs that are created for entertainment purposes, especially for movies or video games.

When it comes to HUD graphics that are created for entertainment, the UI or user interface designer will design the graphics to look useful for the character.

Figure 2.2.4 A still frame from *Iron Man* (2008) (Favreau 2008.)

From inside of Tony Stark's suit, we see the controls to a suit that could probably do just about anything, with the right motivation. In a recent conversation with UI designer and motion designer for the studio MK12, Ben Radatz, I asked him what goes into good UI design and he said, "We're all hard-wired to respond to very basic movements, patterns, shapes and colors, and manipulating those combinations is what leads to a fundamentally-pleasing and "correct" UI experience. And even though UI in film is fictitious, I think that we still look for those same cues, and I treat them as vowels in my toolkit." (Radatz 2020) With that in mind, the design of imaginative HUD design is sometimes better than real life HUD design.

Utilizing good UI design heads-up display animations can serve as an effective representation of the bringing together of art and science. Art and science drive the discovery of new areas of research; therefore, it is important to keep this rich interaction strong.

After considering the emergence of heads-up displays, is it possible to see examples of the good that can come from using art to illustrate science and vice versa. Considering this, it

will be important to look at science and art to further understand technology in the move towards the future.

2.3 Artists Inspired by Science

In the modern era, science and art are in a symbiotic relationship, with each benefiting greatly from the other. One only has to look to modern day artists that are inspired and motivated by science and decipher that the relationship between the two are complex and profound. In a 2018 Cosmos Magazine article entitled, “When Science Meets Art” a modern-day fine artist is reviewed whose art stems directly from science, while creating works of art that are more poignant than typical forms of fine art. (Cosmos Editors 2018)

The artists in the article speak to the scientists that inspired their art. For example, the painter Lia Halloran speaks of her study of the works of the 18th century French astronomer Charles Messier. Messier basically drew what he saw through his telescope as he surveyed the sky. He created a catalogue of 110 objects that were each credited in his journals. (Cosmos Editors 2018) The drawings were a type of art used to teach the world what could be seen in the sky and it inspired the further exploration of science.

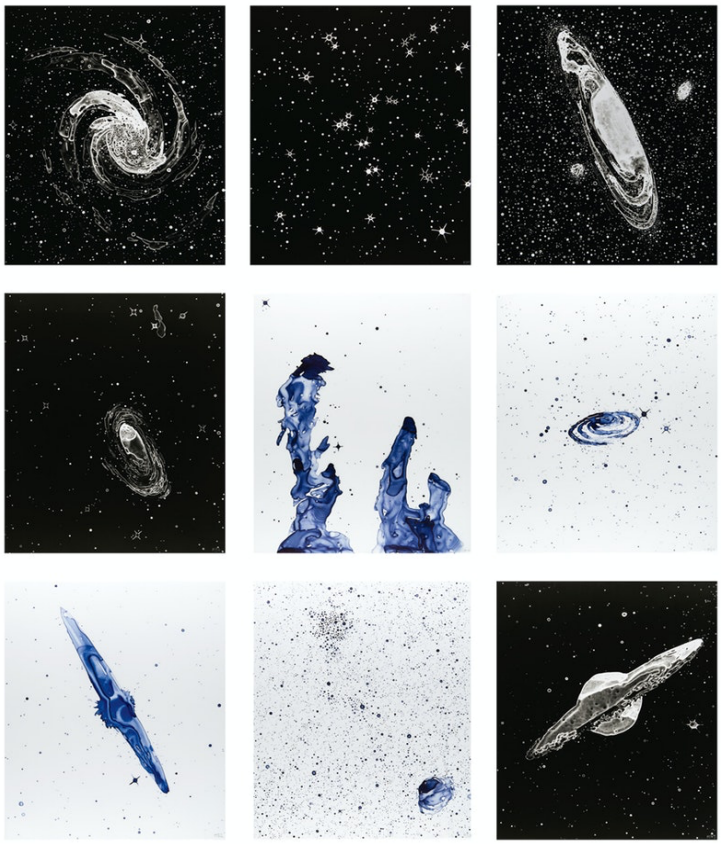

Figure 2.3.1 Lia Halloran series “Deep Sky Companion,” Ink on drafting film, 2013.
(Cosmos Editors 2018)

Lia Halloran created her “Deep Sky Companion” 2013 series, which was a collection of ink drawings and photographs depicting Messier’s work. The series is definitely in the realm of fine art, but it also brings attention to the fact that science is an inspiration of art as well.

So far, this paper has looked at many aspects of the relationship between art and science. From the various types of art used in science to the art of heads-up displays, as well as the combining of sleek designs in the creation of art that is used as reference for creative endeavors. What is there to be said about the relationship between art and science? Could that also be a solid indicator of the future that is to come? Art’s relationship to science isn’t just about the

objectification of facts in a form that is pleasantly digested. Art can also be used as fantasy, to help scientists envision future possibilities.

3. The Art of Science-fiction

Long before astronauts set foot on the lunar surface, on July 20, 1969, a French man named George Méliès was directing *A Trip to the Moon* (1902), one of the earliest silent science fiction films. The film was created in 1902 and was based on the 1865 novel by Jules Verne, *From the Earth to the Moon*. This demonstrates that long before man ever stepped foot on the moon, art was inspiring the pursuit of the endeavor. Science fiction books and movies are examples of art that utilizes science as a sort of a 'fantastical magic,' capable of solving the world's problems and able to help to ease transitions into the future.

3.1 The Martian Chronicles

To better illustrate the role science fiction plays in the world of science and art, I will be breaking down three notable pieces of science fiction. These three science-fiction works of art are *The Martian Chronicles* (1950) by Ray Bradbury, *2001: A Space Odyssey* (1968) by Arthur C. Clark and Stanley Kubrick, and *Contact* (1985/1997) by Carl Sagan and Robert Zemeckis. All three of these artistic works or stories deal with science in a unique way, and I believe each work has had an impact on the world. While discussing the details, summaries and highlights, I hope to shed more light on the relationship between art and science when it comes to science fiction.

For a significant example of science inspired art or science fiction, I chose to focus my attention on the novel *The Martian Chronicles* by Ray Bradbury. Written in 1950, *The Martian Chronicles* is a collection of short stories chronicling the fictional colonization of Mars. Most of the stories are bizarre in nature and show Earthlings as self-absorbed, selfish and detrimental to the life of the Martians. It begins with the dreams of a Martian woman envisioning a rocket

coming down from the sky and a light skinned blue-eyed man named Nathaniel York. Her husband grows weary and shoots the men as they arrive. All over Mars the inhabitants begin to hum Earth tunes and have strange dreams. So, when the second rocket lands and the men begin to explore, the Martians are convinced that the men are crazy, and they are hallucinating having a rocket. Over the course of the book, there are a series of stories about men coming to Mars, the Martians dying of chickenpox and eventually returning to Earth as a nuclear war rages on Earth. (Bradbury 1950) There are several bizarre stories that tell the story of the 1950s era of man as the colonizer of the planet in a similar post-war industrial age that occurs in America at the time the book was published.

One interesting aspect of *The Martian Chronicles* is the fact that as the Earthlings arrive to colonize, they end up destroying all the Martian cities and build cities that resemble those found on Earth. But then after hearing news of a war breaking out on Earth, all the Earthlings go back to home, leaving the Martian neighborhoods and cities abandoned. In another story from *The Martian Chronicles*, a character named Sam Parkhill opens up a hotdog stand on Mars and is very proud of it, but the problem is that there is barely anyone still living on Mars at that point. Due to this, Parkhill's excitement is a little off putting.

As a whole, *The Martian Chronicles* encapsulates how Bradbury expects Earthlings would act if they were to ever travel to Mars. While the story does a great deal of illustrating the science of how the Martians live, the book comes across as more fictitious than factual. But whether it is commentary on human society in the 1950s or Bradbury's actual prediction of life on Mars, it is hard to say. Nevertheless, the story does a good job of inspiring science. One wonders what Bradbury would think of the fact that in the year 2021, we have rovers photographing the surface of Mars, with plans having been made to send astronauts to Mars in

the coming generations. But it reigns true that the stories of *The Martian Chronicles* serve as a good bridge between the world of art and the world of science.

During the Space Age (1957-present day), Ray Bradbury became known as a leading futurist through his stories, articles and lectures. Editors of RayBradbury.com say, “His stories transcended the boundaries of fiction and became the real-life dreams of astronomers, astronauts, planetary scientists, and mainstream readers of all age.” (Raybradbury.com Editors 2021) In Ray Bradbury’s honor, rocks on Mars were named *The Martian Chronicles* by the Spirit and Opportunity Mars Exploration Rover scientific teams (Raybradbury.com Editors 2021), which goes to show that, even though Bradbury was a bit loose in the science he describes in the book, his book published in the year 1950, was still an inspiration when the first rover got to Mars in 2004. This proves the importance of art to the scientific world.

3.2 2001: A Space Odyssey

The next book and movie adaptation to be considered with regards to the importance of art to the scientific world is the fictional work *2001: A Space Odyssey* (1968) the first of a novel series was created in conjunction with a film version, by writer Arthur C. Clarke and the filmmaker Stanley Kubrick, respectively. The film would go on to being the most famous science-fiction film of all time. Published in 1968, the film and book tell the story of the dawning of mankind and the interactions of primitive man with a mysterious monolith that inspires the man-ape to walk up right, develop tools and weapons and evolve into humans of the not-so-distant future, who travel and study in space. Over the course of the story, we are introduced to many scientific ideas, like a gyroscope designed space station, that provides stability as they travel to Saturn, as well as a space station on the surface of the moon, and an artificial intelligence system named HAL, that begins to malfunction as it tries to do the astronauts’ harm.

2001: *A Space Odyssey* is an epic story filled with characters that interact with science to further the reaches of man's exploration of space and our solar system. There is a lot to be said about the science that is depicted in the story.

Figure 3.2.1 A still frame from *2001:A Space Odyssey*.

At the time of the film's release in 1968, NASA was racing to put a man on the moon. Due to this fact, all the sets and props in *2001: A Space Odyssey* had to be better than NASA, or they could risk being outdated or wrong whenever NASA was to succeed. This forced Kubrick's team to conduct deep, meticulous research, which is why a lot of the set designs accurately forecast how humans live with technology today. (Rhodes 2015) In order to create a space-age world, unlike any other, and unlike other sci-fi films of the 1960s, Kubrick employed Aerospace engineers, instead of prop makers to design the switches, display systems and communications devices for the spacecraft interiors, which really added to the scientific realism of the film. (Rhodes 2015)

Many in the modern space era even credit Kubrick and Clarke as inspirations for what became the International Space Station. Serving as a model for what life would be like in space, *2001: A Space Odyssey* was honored by NASA during the film's anniversary in 2008. When a

message from orbit was sent down to a special screening at the Academy of Motion Pictures Arts and Sciences. (NASA 2014) Seeing NASA, an agency centered around science itself giving credit to a piece of art, created for entertainment, was a grand gesture that helps validate the importance of art to the world of science. This gave more evidence to the support of the goal of this venture.

3.3 Contact

In a further examination of works of art that deal with science in an elusive manner, I will focus on the film adapted from the book of the same name, *Contact*. (1985/97) Unlike previous examples, *Contact* was a science-fiction novel written by the famed astronomer and physicist Carl Sagan. The overarching theme of the book is extraterrestrial contact or how the human species will make contact with something not of this world. The story follows Ellie Arroway as she detects a signal from a nearby star, of a repeating sequence of the first 261 prime numbers, which she deduces could only be sent by an intelligent civilization. (Hall 2017)

> *It turns out that the message is more complex than initially realized; it actually contains a blueprint for an advanced space traveling machine. Religious fundamentalists, scientists and governments argue over whether to build it and, in the end, a multinational team is chosen to make the trip.* (Hall 2017)

Throughout the book, Sagan mixes complex mathematics with fiction and, in between everything, there is a commentary on religion and spirituality, humanity and social consciousness, as well as real philosophies that dominate the exploration of science.

One interesting aspect when studying the relationship between science and art is the realization that artists and scientists live in two different worlds, governed by different sets of rules. Perhaps it was easier for Carl Sagan, one of the world's top scientists, to ask certain

questions in the context of art rather than science. Through art, it can be argued that it is easier to ask questions of our society than it is for a scientist. I believe that this is the reason why *Contact* was written in the first place. To quote Jeff Goldblum's character from the 1994 film *Jurassic Park* (1994), "You spent so much time wondering if you could, you never stopped to think if you should." Society can often get so wrapped up in the possibilities that science presents to the world, that sometimes it forgets about the ramifications of such discoveries. Perhaps that is another reason why science needs art to thrive.

Questioning the ethics and the morals of certain studies is sometimes hard to do. Science doesn't have the same ability to question society the way that art does. But that aspect is complex and hard to pinpoint in the study of the importance of art to the scientific world.

This section considered three examples of art and their relationship to the world of science. *The Martian Chronicles* loosely represented science in a fictional sense, but inspired generations of Martian explorers. *2001: A Space Odyssey* made huge strides to represent how the science of the future would look and function. And finally, *Contact* encouraged society to question how it would actually respond in the event of receiving communications from an extraterrestrial. Each work of art deals with the science of its story in vastly different ways, but they still do an effective job of elevating the science that is being portrayed. They certainly raised interest in science as a result of the art.

4. The Art of Scientific Educational Media

So far, this paper has discussed the different ways in which art can illustrate science and also art, whose purpose is to imitate science. Another aspect of this examination of art and science would be to look at the way in which art is used to explain or educate people about science. Perhaps this is similar to the art of illustration, but when it comes to educational

scientific media, art definitely aids in the development and presentation of that science; one of the most common ways people learn about science today.

4.1 TED Talks

When it comes to educational programs on science there is an endless catalog of examples that we can examine. While didactic in nature, most programs utilize art to convey science to its viewers. Some of the more well-known videos in the past fifteen years are those that are more commonly known as TED Talks. In the beginning, TED Talks were audio and video podcasts that shared the best content that came out of the TED Conference. The TED Conference was started in 1984 by Richard Saul Wurman and motion designer Harry Marks, after observing a powerful convergence of three fields: technology, entertainment and design. The TED Conference became an annual lecture series event in Monterey, California, attracting a growing and influential audience from many different disciplines, united by their curiosity and open-mindedness. (TED.com Editors 2021) The roster of presenters included scientists, philosophers, musicians, business and religious leaders, philanthropists and many others. The first six TED Talks were posted online on June 27, 2006. (TED.com Editors 2021) Within three months of launching, the free podcasts had reached one million views. This proved to the organizers that the need for content of a scientific or cultural significance was strong. The TED Talks continued to create audio and video podcasts that reached out to audiences around the world. According to the TED Talks website, there are now over 3600 TED Talks with over a billion views since its inception. (TED.com Editors 2021)

TED Talks combine the art of video and audio to create pieces that elevate each subject to a level that is understood by many people. By educating the populous as a culture, people can benefit from the result. Thus, leading to the conclusion that the art of the video podcast has done

as much good for the world of science as any art could. But when one thinks of the positive impact that TED Talks have had on the world, it is important to consider the educational science television programs that predated TED Talks.

4.2 Mr. Wizard

Before the dawning of the internet in 1991, television was the canvas on which many science-based programs were presented. There were many high-quality science-based educational programs, but the one man in particular who deserves recognition in the realm of educational science is Don Herbert or as most American children knew him as "Mr. Wizard."

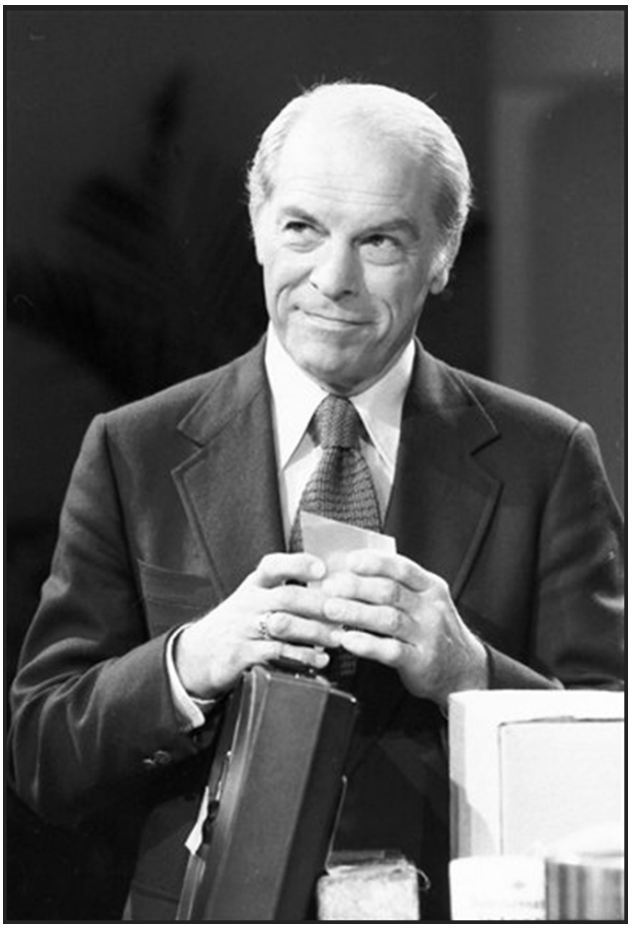

Figure 4.2.1 Don Herbert, *Mr. Wizard,* shown in 1978. (David Pickoff/AP)

Airing on NBC from 1951 to 1965, 'Watch Mr. Wizard,' featured Don Herbert performing a series of physics experiments using everyday objects, such as glass bottles, cans, aquariums and matches. (Rossen 2018) Examples of the experiments included eggs that were sucked into bottles or water that was boiled using ice cubes. All the pseudo-magic tricks were performed and then explained using science, while Herbert satisfied the audiences' curiosity and built interest in science for many kids. (Rossen 2018)

Nearly 20 years after its cancellation in 1965, Herbert was given the opportunity to captivate a brand-new generation of kids with *Mr. Wizard's World* that aired on Nickelodeon from 1983 to 1990. (Rossen 2018) Bringing the magic of science to children across America relied heavily on Herbert's ability to take the complexities of science, and turn it into something truly amazing. In itself, this was an artform that science heavily benefited from.

> *Following Herbert's death at age 89 in 2007, a National Science Foundation official claimed that, more than anyone, Herbert may have been the person most responsible for getting people interested in science. In the 1960s and 1970s, applicants to the Rockefeller University, a science research center based in New York City, were asked what inspired them to get into science. In the space allotted for an answer, half of them wrote: 'Mr. Wizard.'* (Rossen 2018)

The impact that Don Herbert had on the world was a testament to his art form of the television show. If the television program didn't exist many people would have had to live without the enjoyment of entertainment with science. Much like the TED Talks, Don Herbert's television programs delivered the need to understand the world, making the complex ideas understandable and entertaining. In many ways the art made the science more enjoyable to understand.

Another TV show that made the art of making learning about science more enjoyable is the children's program '3-2-1 Contact.'(1980) The show was a production of the Children's Television Network and was built around removing classroom lessons from the school or lab environment. (Lafrance 2016) They wanted to show that all scientists weren't only middle-aged white males in lab coats, but instead women and minorities who were also using science in their daily life. (Lafrance 2016) Overall, '3-2-1 Contact' was a show that elevated the science in interesting ways, making it understandable and interesting to children in American households.

5. Thesis Project: The Martian Chronicles Interpretations

The relationship between art and science is one that is profound and significant. From educational programs to science-fiction movies one can easily see their influence on the world. Therefore, for my visual thesis, I created a series that represents the relationship between art and science.

The Thesis Project that I have created to coincide with this document was intended to show how art can be used to illustrate a science-fiction story, using scientific designs and principles to create an experience that inspires a sense of wonder in the viewer. The project is comprised of three animated videos of various lengths, showing an homage to the stories of Ray Bradbury's 'The Martian Chronicles.' The videos were in a format that can be shared on Instagram and other social media platforms. With the goal of forming a connection between 'The Martian Chronicles Interpretations' and today's world.

How a piece of art connects with the world is an important aspect of art. Dealing with social media connections to creative projects like 'The Martian Chronicles Interpretations' will initially be quick, but if I do my job well the time each viewer spends interacting with the project will be stronger and more in-depth.

How art and science relate to one another is a concept that also relates to my own art. Beginning as a storyteller, I developed a language for representing ideas that are understandable and relatable. One of my jobs, many years ago, was creating video podcasts for the agricultural science community. I was often charged with the task of explaining science in a way that was simple and effectively communicated. These video podcasts were how I first began using Motion Media to represent science, which ultimately led me down a path to this Thesis.

Since the time of the Italian Renaissance, art has had a powerful relationship with science. It allows for understanding and comprehension unlike in any other partnership. For me Motion Media Design is an artform that harnesses that power and can make an impact on the world. Therefore, it's important to study this relationship between science and art.

How we impact the world is important to consider. Motion Media Design is about making an impact and taking the viewer on an experience unlike any thing they have experienced before. It has been my experience that how it impacts culture and society is important for the well-being of the culture in general. It is hoped that the connection of my art to the world will help, in the end, to create a legacy.

6. Conclusion

Whether talking about the purpose of the art being for education or for entertainment, scientific art has the sole purpose of interacting and inspiring society. Therefore, it is important to consider just what implications scientific art has on society. As the world continues to evolve, how information is attained is ever enhancing and as this transformation occurs, so art and media also change.

Appreciation is merited for the way in which the world has grown smaller and more connected as time progresses, which is due in part to the way people interact with technology.

One could say that technology is a byproduct of the relationship of art and science. Therefore, it's important to consider where the future of technology, art and science lie.

In the next 100 years, science can be expected to evolve in many ways. New technologies will be discovered in the realm of renewable resources, space travel could become as ordinary as cruise ships, and quantum computing could make computers powerful enough to support more struggling areas of the world. But as these new changes emerge so will the art that coincides with it. Without art, science could not communicate with the world. One could say, without art science would not evolve as effectively. It could even be argued that the future of the human species depends heavily on the positive relationship between art and science.

In the New York Academy of Sciences' website entitled, 'Imagining the Next 100 Years of Science and Technology,' George Church Ph.D. says, "Humans are possibly the only species that can comprehend events 13.8 billion years ago and 100 trillion years from now…" (Church 2021) With the dawning of technologies like virtual and augmented realities, the world of science and art will continue to evolve as education and technology continue to merge.

When the inception of this idea first emerged, I had noticed a rift in the world between creative people and intellectuals. This rift is very minor, but it's simply a divide that has caused evolutions in the world. These changes can be the idea that scientific laboratory studies have nothing to do with the art of creating a comic book. But both endeavors create something from nothing, so in a way, the two processes are similar. But they are most often thought of as two separate things. It was curiosity into this divide in our culture that ultimately led me to the topic for my Thesis study and exploration.

The relationship between art and science is a partnership that is dependent on each other. One only has to look at history to see examples of moments in which art and science have

merged. In the realm of fine art, art that imitates science can be seen. This is evident in the work of Norman Rockwell, Robert Rauschenberg, Andy Warhol and Annie Leibowitz in the NASA Art Program. Also, art is used in many more ways in the scientific world. In illustration work, art is used to depict science in a way that is easily understood. Consider high school level biology textbooks. In order to see a collection of illustrations representing the various topics and subjects that are necessary to understand the science. When thinking of illustrative science and concept art, it's difficult not to think of science-fiction and the way the art uses science to mesmerize its audience. That is the power of the unique relationship between art and science. A power that is also apparent in the successful and wildly popular TED Talks and the years of programing on Mr. Wizards science shows. This powerful relationship has helped our culture to evolve and to accept new scientific breakthroughs.

Appendix A – Communication with Ben Radatz

Message from Ross Macartney to Ben:

Hello Ben,

My name is Ross Macartney, and I am a Motion Design Graduate Student at SCAD Atlanta focusing on possibly creating a science-based HUD style animation for my thesis project and I was wondering if you could answer a couple questions. My first question would be to ask if you could recommend any books or resources that would help me create my heads-up display? Thank you - Ross

Response from Ben Radatz, Feb. 25, 2020:

Hello Ross! It's nice to meet you.

Interesting thesis project you have going on over there. Science based? I'm curious to know more about your thinking.

To give you an indirect answer to your question (but perhaps direct given your foundation in science), I always see UI design as cognitive design. We're all hard-wired to respond to very basic movements, patterns, shapes and colors, and manipulating those combinations is what leads to a fundamentally pleasing and "correct" UI experience, and even though UI in film is fictitious I think that we still look for those same cues, and I treat them as vowels in my toolkit.

About a decade ago I came across a white paper at an estate sale called “How To Manipulate People”, written for marketing departments at ad agencies. It included a lot of deep studies into why people make the choices they do and how you can steer them to make new ones. In a commercial context of course that’s a disgusting practice but that paper became a goldmine for me in building foundations for my UI’s, because it talked about things like how different shape and color combinations can affect mood and reenforce specific neural pathways.

Sorry I know that doesn’t help on your quest for books, but I’d peruse the cognitive sciences section of your bookstore and see what speaks to you. Josef Itten’s ‘Elements of Color’ and ‘Design and Form’ have been inspirational to me too.

Happy to answer any other questions!
Ben

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