Public Understanding of Space: Differences between the Apollo and Contemporary Eras through a Co-Production Framework

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Abstract

Only several hundred individuals have ever ventured into the last frontier, space. Despite so few having seen space, trillions of dollars, hundreds of companies, and too many hours of research to count have gone into making sense of it in the eyes of the public. Space, like many other technical and societal issues, has many inputs and outputs that guide present understanding of the unknown. In order to better understand how the public understanding of technical problems and innovations is influenced by various actors, a co-production framework is used to analyze how the relation between space exploration and the public understanding of space has changed over the last sixty years. The actors focused on in this paper include Presidents John F. Kennedy and Lyndon B. Johnson, early astronauts, NASA, and SpaceX, depicting the growing influence of economic actors over the American public understanding of space since the Apollo missions.

During both the Apollo era and present day, political and economic actors have greatly impacted how the American public views space. The role of the American government during the space race of the Cold War and that of private and commercial space companies, such as SpaceX, currently. The inertia of these actors has shifted in influence throughout the last 60 years. Through a combination of documentary research and discourse analysis, political actors are shown to determine the public's understanding of space during the Apollo era and economic actors presently. How has the present state of the public understanding of space changed since the Apollo era?

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Background on Political Actors During Apollo Era

The Soviet Union successfully launched the first spacecraft into space, Sputnik 1, on October 4, 1957. In response the United States launched several satellites that failed, starting with the Explorer 1. Contrary to popular belief the American space program had been in the process of developing satellites for space several years prior to the launch of Sputnik 1 with the aid of several Nazi rocket scientists, including the likes of Werner Von Braun (Gisler et al, 2008). It is important to consider why this may be the case. These scientists were put in charge of US military projects to develop rockets for war and later transitioned into developing rockets for space. The appeal of bringing on Nazi rocket scientists was due to their experience developing rockets and bombs during World War II for Hitler. This is a comparison that the US government would not want to be common knowledge due to the moral ramifications of employing rather than convicting scientists whose work killed many Americans. Due to the early launch failures of American satellites coupled with the success of several Soviet satellite launches the Soviets were viewed as having superior technology and knowledge. Likely, for this reason President Eisenhower refused to acknowledge the existence of a space race between the United States and Soviet Union, yet he established NASA as a civil agency that would pursue the exploration of space and develop the technology required to do so. While the actions of NASA and the missions they supported were beneficial to the exploration of space, they were also crucial for gaining a strategic military advantage over adversaries in the new space domain (Gisler et al, 2008). It is also important to consider Eisenhower served as the supreme commander of the allied forces in Europe during World War II and had fostered strong working relationships with the Soviets as a result (National Archives, 2016). It was a hope of the administration to strengthen relations with

the Soviets and may be a reason for the downplaying of the launch of Sputnik marking the start of a space race.

The need for the Apollo program became clearer when President Kennedy was elected. Kennedy held strong opinions regarding the strategic space race that the Americans were losing to the Soviets and ran on that stance. Although Kennedy spoke strongly on the need for America to make gains on the Soviets with regard to space technology, his actions for the most part were empty due to the large price tag that funding the Apollo program required. The rhetoric of Kennedy served to frame space dominance as a symbol of American superiority. However, due to the fallout of the events of the invasion at the Bay of Pigs and the Soviets successfully launching the first cosmonaut into earth orbit, Kennedy was placed under extreme pressure to address the concerns of the American public. Space presented Kennedy with the opportunity to overshadow prior setbacks during his administration while addressing the growing public fear of Soviet advancements. Kennedy envisioned two possible scenarios coming from pursuing space, either the demonstration of American superiority or the unification of the US and Soviets through collaboration in space.

Kennedy's initial attempt was to negotiate a joint American-Soviet space program with the goal of landing a man on the moon. The Soviets rejected this offer, likely due to the present advantage they held in the space domain (Gisler et al, 2008). With the public rejection by the Soviets, Kennedy was left with no option other than to fund the Apollo program and sell it to the American public, as their tax dollars would be footing the bill. Kennedy tasked Vice President Johnson with determining the particular area in which the American space program could be most competitive with the Soviets.

The options that were considered by Johnson and the scientists at NASA were the chances of beating the Soviets in establishing a space laboratory, being the first to flyby the moon, or being the first to land a man on the Moon (NASA, 2014). The consensus was that Americans had the best chance of beating the Soviets to the Moon. This consensus came after extensive investigation by Johnson through discussions with experts in NASA, industry, and the military where the collective view was that neither the Soviets nor the Americans were capable of developing a rocket powerful enough to reach the Moon and was a contest that did not put the US at an initial disadvantage (National Air and Space Museum, n.d.). As a result of this decision Kennedy gave his well-known speech at Rice University in 1962 where he declared "We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard", setting the stage for a space race between the Americans and Soviets, while inspiring hope in the American public towards space (Washington Post, 2017). Kennedy not only set the stage for American prestige to be recovered on the ability to beat the Soviets to the Moon, but framed this single act as the only meaningful metric in the eyes of the public.

As influential as Kennedy was in initially selling the Apollo program to the public, the main influencer of the Apollo program was Vice President Johnson, who would later become President. Johnson crafted the plan to sell space to the public and sold it not only to Congress, but also to the Kennedy administration when their faith wavered. Johnson worked on political and business leaders and helped Kennedy in signing several big contractors, such as North American Aviation Inc., to manufacture the spacecraft infrastructure and technology to support the Apollo program. The justification to the public for the price tag was the ability to provide jobs across the United States in areas with high unemployment and the technological and medical breakthroughs that would result in a higher standard of living for all Americans (Gisler

et al, 2008). Not only would this investment help to stimulate the American economy and revolutionize how Americans would live, but it would also restore American pride in the government through a sound defeat of the Soviet space program, arguably the main motivator for the investment in space. Although a large portion of the federal budget was allocated to NASA and through NASA to the Apollo program under Kennedy, it paled in comparison to the amount allocated by Johnson during his presidency. Johnson served as President following the assassination of President Kennedy in November of 1963 until 1969 when he failed to win reelection and was succeeded by Richard Nixon (Gisler et al, 2008). Following the high approval rating and landslide election win in 1964, Johnson invested heavily in the Apollo program through his tenure, especially early on when he allocated as much as 4.41%, 4.51 billion USD valued at the time, of the federal budget for NASA of which 67% was reserved for the Apollo program (Gisler et al, 2008). For comparison, currently NASA is allocated roughly 0.52% of the federal budget of which 45% is reserved for Human Spaceflight missions (Planetary Society, 2021). The difference in government investment shows the value that the American public placed on reaching the Moon. Johnson would never have been able to justify the massive investment in space over that of the military for the Vietnam War or in addressing the rising civil tensions brought up during the Civil Rights Movement had the American public not believed that an investment in space was most crucial toward accelerating America's rise to global prestige.

Drawing from this impact of Johnson on being able to leverage his success in gaining vast public support through his positioning and establishment of the Apollo program the creation of the Great Society, a collection of social programs to address marginalized populations and racial injustice in American society was possible. This was possible due to the strong public support of the Democratic party, because of Johnson. The Democratic party was also able to

secure a 2/3 majority in both houses of Congress, allowing for the passing of the Great Society (Gisler et al, 2008). Federal funding was allocated towards education, poverty, medical care, and transportation, much like it was for space exploration through the Apollo program (History, 2017). Funded programs included Medicare and Medicaid and resulted in new legislation regarding privacy and civil rights. Though many of these programs were not funded for long and were canceled due to the growing economic burden of financing the Vietnam War (History, 2017).

The political traction and credibility of the Apollo program, even before launching an Apollo space vehicle, allowed Johnson to build a platform to bring about societal change. It should also be considered that the funding granted to NASA for the Apollo program continued even after the passing of the Great Society. However, the funding did dry up due to the economic burden of the Vietnam War, but another cause is likely the accidental death of the Apollo 1 astronauts, Gus Grissom, Ed White, and Roger Chaffee, who died in a test exercise due to an electrical incident that resulted in sparking a fire, suffocating the astronauts (Chaiken, 2007). From this tragic incident came congressional investigations that revealed internal NASA documents describing potential manufacturer faults, in the famed Philips Report. Not only did this hurt the aspirations and core purpose of the Apollo program as the crewed operations of the program were grounded for a period of roughly 20 months, but the support of the people in not only the Apollo program, but arguably in Johnson too, was lost (Chaiken, 2007). As a result, not only was the federal funding allocated to the Apollo program lowered year after year, but the funding for several programs of the Great Society was also slashed. This also likely resulted in the lack of foresight for the continuation of the Apollo program, as 3 of the originally planned missions were cancelled (Chaiken, 2007). The impact of these events on the public perception of

space exploration can be best symbolized by the poor showing of Johnson in the following election. Republican candidate Richard Nixon, who strongly supported the Vietnam War and saw little benefit in continuing the pursuit of space exploration after the Apollo 11 landing, won the election in a landslide. The election of Nixon resulted in a loss of the momentum of space exploration that was generated by the Apollo program and Johnson in favor of military investments and supporting a joint NASA and Soviet space program.

Impact on Public Understanding of Space During Apollo Era

Having now considered the impact of Johnson and NASA on the ability to capture the public imagination through the political framing and shaping of the Apollo program, how society itself was shaped by the Apollo program must also be examined. One major influence over the American public was the selection and imaging of the first astronauts (Hersch, 2011). The first astronauts selected were chosen from military branches and almost exclusively were seasoned combat and test pilots. The reason for choosing experienced military combat pilots was their ability to test new craft, operate under extreme and fast paced environments, and the reduction in training time due to being screened by the military (National Research Council, 2011). NASA culture was not influenced greatly by the selection of white military astronauts as many NASA employees were white male scientists and engineers already. There was the establishment of the astronaut office which played into the political balance of power within NASA, especially during the Apollo program as they were the face of the program in the public eye.

Due to pulling candidates from the military all of the selected astronauts were white males, and it was not until 1978 that a non-white male astronaut was selected (Treat et al, 2020). The reason for the diversity of the 1978 astronaut class, which included several women and minority candidates, was because of the growing social change and pressure by civil activists and equal employment legislation. In 1973 NASA was investigated by Congress concerning their

astronaut selection and employee hiring practices and were found to be discriminating against women and minorities, likely forcing NASA's hand in diversifying their selection process (Ross-Nazzal et al, n.d.).The first astronaut group were the "Mercury 7" and they were viewed as being capable of performing under the harshest and most dangerous situations, essentially, they were viewed as being daredevils who enjoyed the thrill of living on the edge and performing in the face of danger. American astronauts were framed as the best America had to offer and were treated as such. These men were placed on a pedestal due to the publicity and depiction they received from the press and through many dramatized films and books. Astronauts became the face of NASA and the Gemini and Apollo missions. The role of an astronaut was equal parts preparing for space missions as it was doing interviews and press statements for the public (Hersch, 2011). The media created an image of astronauts in the public eye that could not have been further from the truth of who they really were.

The Apollo program and the multiple groups of astronauts that were in the public eye were a source of inspiration for many Americans, especially the youth. The false depiction of astronauts resulted in many benefits and consequences. The greatest benefit for society that came out of the Apollo missions and a core mission of NASA was the growth in education infrastructure in terms of quality and access (Spencer, 2016). NASA differed from its Soviet counterpart in that it did not operate behind closed doors, but prioritized making technologies and progress open to the public (Hersch, 2011). This worked in tandem with the growth in films and books depicting space as a grand and magical new frontier that captured the imagination and inspired many in the American public, and many future STEM professionals. With this came the growth of many nonprofits and public library systems that served as venues through which to address the curiosity of the public in a meaningful way (Spencer, 2016). The public library

system through partnership with NASA was able to more equitably reach and educate the public over racial, class, and gender divisions in ways that it could not priorly. The public library system was able to function more effectively and benefitted from the growth in desire of reading and personal research by the American public. This was done effectively through Rocket Reading programs where students who read more often were given space medals to track their progress (Spencer, 2016). NASA benefited from the ability to inform the public of their achievements and direct the youth towards pursuing both science and general education. Libraries also served as a means for NASA to assure public support of their missions, advocacy for space exploration, and inspiring the coming generations of aspiring astronauts, space scientists, and tax payers who would support their work (Spencer, 2016).

There are undoubtedly plenty of other benefits from the Apollo missions that are deserving of mention, but due to the scope of this paper cannot be elaborated on. The same holds true for the consequences of the outcomes of the Apollo program on the American public. With astronauts being the poster boys of NASA in the eyes of the American public, the systems and aspects that shaped their selection and framed their character came to hold weight in the eyes of the general public. The message depicted by astronauts was one of public advocacy for space exploration, but also for the ingraining of the social values of existing systems in America (Hersch, 2011). The selection of astronauts served as a means of extending the existing system of the military, where only white men were allowed to serve. Another interesting trend was that many of the initial astronauts selected lacked a degree beyond that of a Bachelor's, yet were viewed as being the best that America had to offer (Treat et al, 2020). As more groups were selected the education of the astronauts gradually increased to include Master's and eventually a Doctorate with the selection of Buzz Aldrin. This trend begins to show the need for more

qualified credentials in the hypercompetitive work culture of America and the shift towards a higher valuation being placed on higher education as a means of differentiation in hiring practices.

Gender roles were also further extolled through the media portrayal of astronauts and their families. The astronauts themselves were viewed as heroes and darlings who could do no wrong in the American eye. Being trained in the military these men were used to performing under hard circumstances and doing so without distraction, whether that be from home or other areas that take them away from the job at hand. This served as a way of depicting the necessity of work and was one piece that helped to establish the work ethic that is ingrained in American culture currently, the "American Dream". The occupation one does is the essence of their worth to many Americans. This message was also reinforced for women although in a very unfortunate manner. The wives of astronauts were also public figures in their own right, though much less prominent in the public eye. These women were framed to symbolize the caretakers of not only their own families but also the families of fellow astronauts, who would all lived in the same communities. The role of women was to devote themselves to domestic work as passionately as their husbands were towards the mission of getting America to space. This depiction of astronauts as family men also furthered the idea that the American nuclear family and the gender roles that went along with it were the ideal American family structure (Krenzer, 2011).

The main appeal that Kennedy played on to gain the support of the American public was that of the American Dream, which appealed greatly to many Americans, especially the white middle class. The framing of the need for America to explore space was depicted along the lines of past expansion and colonization efforts, where space was a new frontier through which mankind should strive to establish a permanent presence and overcome the presented challenges

like past explorers on Earth. *Life Magazine* wrote, “from a nation of 175 million, they stepped forward last week: seven men cut of the same stone as Columbus, Magellan, Daniel Boone, Orville and Wilbur Wright.”, with regard to the Mercury 7 (Krenzer, 2011). Following this with the public imaging of astronauts and the acceptance by the majority white American public, racial tensions were likely to crop up. Although this is purely speculation, it does seem reasonable that the social framing of race and gender in advocating for space exploration in contrast to the message of Kennedy’s revitalization of the American Dream, frustrated many non-white Americans and was likely viewed as an indirect reinforcement of racial constructs of the time. Especially, as much of this public imaging and media depiction occurred during the Civil Rights Movement and in the midst of the Jim Crow Era, which legally ended in 1968 (History, n.d.). This may be a reason for the ability of Johnson to enact his Great Society welfare programs. This also leads to the political motivations behind the Apollo program as following the success of Apollo 11 landing on the Moon and the restoration of American superiority over the Soviet Union established in the public eye, multiple Apollo missions were scrapped in favor of developing the Space Shuttle and the establishment of an orbiting space station in Low Earth Orbit (Chaiken, 2007). To further support this point, no American has set foot on the Moon since the Apollo 17 mission in 1972.

Another major benefit of the Apollo missions was the rapid development of technology that improved the lives of Americans due to massive federal and political investments as talked to earlier. A few of the many technological breakthroughs include the development of quartz crystals: used in wrist watches to accurately keep time, cordless power tools, pacemakers and heart monitors, seismology detection equipment, use of space suit materials for fire fighters, and many more (NASA, 2004). This is an aspect of space investment that is often overlooked in the

public eye, but is a huge reason for garnering political and economic support. Space innovation results in cutting edge technology that operates reliably in the hostile environment of space. The technology used is usually the lightest, cheapest, and most efficient and reliable technology that has been produced presently. This often yields products and technologies that are mass producible and better at meeting needs on Earth than prior technology. It has been estimated that for the Apollo program the payback for $1 invested in space was $8 and presently the payback is close to $40 due to the potential for the transfer of space technology and the creation of a spinoff market (National Space Society, n.d.). The topic of technology transfer and spinoff technology is worthy of a research paper in itself. Due to the limited scope of this paper examination will be left here, but the growing return on investment of space technology since the Apollo program shows the increasing importance of space not only to the national economy but to the structuring and operation of present society.

Background on Economic Actors During Artemis Era

Whereas the Apollo program was brought about through the action of political actors as detailed broadly priorly, current public understanding of space exploration is dominated by the economic ventures of private corporations and less reliant on the influence and capabilities of NASA other than through the competition they inspire for fulfilling their contracts. There are several key actors that influence the American public's perception of space. These actors include the economic potential of a space market through the available raw materials and potential of satellites and space operations, private space companies, including most notably SpaceX, making space affordable, and NASA through their contracts and management of government projects and research.

There are many reasons for these actors supporting going to space in 2021 and beyond. The main reasons being the potential for scientific insights, the colonization of space, and the

establishment of a space market. Of which the first two feed into the development of the latter. There are many pieces that lead into the development of this potential space market and because of this only so much can be discussed in this paper. The present state of the space market and the rationale for expanding a space market will be illustrated to understand why a space economy is desirable. The role of SpaceX in making space affordable and exciting and why it accelerates the timeline for establishing a space market will be discussed. Lastly, the role of NASA in providing a means for competition to establish a space market through contracts and why NASA is not suited to be the lead developer of space technology and equipment will be examined.

Why is it that space is invested in so heavily by not only the federal government through NASA, but also by several of the richest men in the world, including Elon Musk through SpaceX and Jeff Bezos through Blue Origin, among many others? This question, like any question in space, has several answers. The first is the large concentration of metals such as nickel, iron, platinum, and gold, all of which are very valuable and rare on earth, yet are used in some shape or form in most current technology (Physics World, 2018). Due to the high concentration of rare metallic materials in a single source, the potential to mine to the core of asteroids due to manageable temperatures and pressures, and the valuation of asteroids such as (16) Psyche at as much as $700 quintillion, space is viewed as a desirable investment (Chow, 2019). Now (16) Psyche is a rarity, but there are many asteroids in the asteroid belt that still carry a respectable price tag of raw materials. The options that come from this are two-fold, bring it all back to Earth or use it to develop space infrastructure to lower the cost of launches and accelerate the ability of space colonization to become self-sustaining. This is further supported by the ability to mine and store water which is the “gold of space” as it is crucial for life support, radiation protection, and rocket propellant production, all of which are needed for the establishment of space colonies and

are extremely expensive to bring from Earth (Physics World, 2018). The space economy as of 2019 was valued at $366 billion of which roughly $271 billion was accounted for by the commercial space industry, due to reliance of many sectors including communications, GPS, defense, and weather on satellites currently in orbit (Satellite Industry Association, 2020). Satellite technology is so crucial to the American economy and way of life that a new branch of the military, the Space Force, was established on December 20, 2019 and was charged with the protection of US space infrastructure (Farley, 2020).

Having established generally the economic draw of a space market either in its present state through satellite technology or in a larger sense the potential economic impact of space infrastructure and mining, why is investment in this market only gaining momentum recently? Traditionally, the cost of manufacturing rocket stages for orbital launches is the main driver of the high price tag. This is the result of a combination of developing a piece of technology for a single use, the amount of testing and evaluation that comes with the safety factors of sending rockets to space, and the large number of salaries that must be paid over long project lifetimes due to the decentralized design process of NASA and the companies they contract. Another problem with launches is the amount of usable payload that can be transported to space, the majority of the mass that is being lifted comes from the propellant that is needed to provide the required thrust to escape the atmosphere of Earth. A technique that is used to increase the amount of deliverable payload is rocket staging. Rocket staging is the combination of various engines and propellants in separate stages that provide a specific amount of thrust over a certain amount of time and then are detached and depending on the number of stages and timing during the ascent either fall back to earth or orbit around Earth until entering the atmosphere of Earth and burning up. Staging is where SpaceX comes in and makes space more accessible. Priorly, all

rocket stages were designed to be expendable and could not be reused, with most of them falling into the ocean where the saltwater would render the first stages unusable. What SpaceX has done is designed the first stage such that while falling back to Earth after the fuel is spent it can glide down to land on a barge at sea. This allows for the first stage to be reused in future launches (SpaceX, n.d.). This is not only impactful on the cost of rockets, but also on the timeline between launches. On March 14th 2021, SpaceX launched the same first stage for a record ninth time and landed successfully. The record turnaround time between landing a first stage and reusing that same stage is 38 days (Thompson, 2021). According to Elon Musk, the first stage, second stage, fairing, and launch costs account for roughly 60, 20, 10 and 10 percent of the $37 million cost to produce the booster (Brown, 2020). Meaning that roughly 60 percent of the cost of a rocket can be reused and the rockets pay for themselves every two launches. Another major benefit is the capability for SpaceX to develop and launch rockets from American soil due to the cost of buying a seat on a SpaceX launch vehicle being much cheaper than what NASA has been paying Russia for riding their Soyuz capsules, $55 million vs $80 million dollars per seat along with the money benefiting American innovation (McCarthy, 2020). Prior to the launch on May 30, 2020 of the SpaceX crew dragon capsule to the ISS, the last crewed launch from American soil was on the Space Shuttle in 2011 at $170 million per seat (McCarthy, 2020). There are many other private companies that have helped reduce the barriers of entry into space most notably with the ability to 3D print rocket components and engines, but by far the most impactful actor is SpaceX and their reusable Falcon-9 launch vehicle.

At last, the role of NASA and Congress will be touched on briefly. During the Apollo era space was privatized such that NASA and the government were the only actors capable of operating in the domain of space and the role of contractors was to provide the vehicles such that

NASA could operate them. With the federal budget allotted to NASA and the range of duties they are responsible for meeting, along with the needs to appease an ever-changing political agenda, the ability of NASA to operate efficiently and effectively is drastically hampered. This is likely the reason for the slow progress of NASA in the realm of crewed space exploration and the apparent focus on research, Low Earth Orbit (LEO) operations, such as the ISS, and unmanned missions (Greason, 2019). As demonstrated with the growth of SpaceX and the ability to provide services to military and commercial satellite companies alike, the role of private companies in space exploration has grown over the last 10 years. SpaceX has also provided services for NASA through ISS resupply missions. This trend is one that is likely to continue as is evident through the proposed Artemis program.

The Artemis space program is framed as a sister program to the Apollo space program with the goal of landing the first woman on the Moon by 2024 (NASA, 2020). NASA began developing a super heavy launch vehicle that has the capability to carry out the Artemis missions in 2011. That launch vehicle being the Space Launch System (SLS) was expected to be completed in 2016 along with the Orion spacecraft. NASA and Congress thought they could reduce the project costs by using existing Shuttle technology and contractors to develop the SLS and model the Orion capsule off the already designed and tested Apollo capsule, with $1.5 billion reserved for SLS and $1 billion reserved for Orion annually and any cost overruns being covered by NASA (Kordina, 2020). This however led to the timeline being extended and the budget being increased as a result due to poor project management. The strategy of NASA is one of extreme risk aversion and a decentralization of innovation, resulting in lots of wasted taxpayer funding over many years. The third technical component of the Artemis program is the lander which due to the ambitious timeline made it nearly impossible for NASA to develop the

technology in house. As a result, they put out a contract for a commercial human lander and selected Blue Origin, Dynetics, and SpaceX, with awards of $579 million, $253 million, and $135 million, respectively with the task of providing a well-established product to be evaluated for further funding over a 10-month period (Berger, 2020).

Considering SpaceX, the method of taking big risks and rapid prototyping and innovation has resulted in tremendous breakthroughs and has captured the enthusiasm of the public. As of 2017, the development of the Falcon- Heavy rocket, which is less powerful than SLS, cost $500 million over several years versus $23 billion over 7 years for the development of SLS which is currently still under testing (Gohd, 2018). For this reason, the role of NASA is likely to transition into a commercial system where NASA funnels funding through contracts to private companies for space infrastructure projects such as the Lunar Gateway, a refueling station on the way to the Moon, in place of developing the technology themselves. This serves to incentivize competition between private companies over the needed funding and accelerating technological innovation (NASA, 2020). This outsourcing of work allows NASA to assume a managerial role and coordinate research and scientific discovery of which NASA is particularly well positioned. The growing presence of humans in space also enables Congress to establish space policies which are currently lacking and poorly defined (Greason, 2019). Recently, only the Artemis Accords which broadly details the agreements supporting the Artemis program between coordinating countries, excluding Russia and China, has been signed (NASA, 2020).

Impact on Public Understanding of Space During Artemis Era

How have the actions and prevalence of economic actors influenced the view of space in the public eye? The dominating presence of satellite technology in the current space market has resulted in the growth of small satellites, CubeSats. CubeSats are small satellites that are easy to produce and cost a margin of the cost of many traditional satellites. CubeSats are highly

customizable and allow for greater access to space for more than just the government and private companies (NASA CubeSat Initiative, 2017). Many higher education institutions are able to design, build, and operate their own CubeSats for capstone projects such as the Libertas project at UVA. CubeSats have enabled university students to gain valuable experience in research and mission design for space systems before entering the workforce. This has also provided another means of research and funding for NASA to utilize on their mission of scientific discovery and research.

The reduction in size of satellites has also allowed for private companies such as SpaceX to start the ambitious endeavor of establishing a high-speed, low latency internet network using their Starlink constellation of an estimated 30,000 satellites, of which roughly a thousand are already in orbit (Space.com, 2021). This is only made possible by the timeline and reusability of Falcon-9 rockets, which are capable of launching 60 satellites per launch. This movement of the growing number of small satellites has raised ethical questions concerning the sustainability of satellites in space. Currently, there is a large amount of space debris in the form of decommissioned satellites and spent rocket stages, among other scraps and parts, orbiting around Earth. Over the six decades since the launch of Sputnik there have been roughly 9000 satellites launched into Earth orbit, of which approximately 5000 remain in orbit (Hattenbach, 2019). The benefit of global internet coverage is great, but is the cost of the cluttering of space in such a short period of time beneficial in the long run? Issues that stem from the actions of the Starlink constellation include the inability to launch other satellites in the occupied orbits, the need to track them all, establishing a system of assuring compliance and accountability for actions in space as space is viewed as international waters, and the military interests of which companies

get to operate in what orbits and for how long (Hattenbach, 2019). This is one of the reasons for the establishment of the Space Force.

NASA has spent most of the past 6 decades sending humans to LEO and currently has the objective of sending humans back to the Moon. SpaceX has the goal of sending the first humans to Mars and establishing the first human colonies in space. In December 2020, Elon Musk stated that the expected timeline for the first supply missions to Mars would occur in 2024 and the first crewed landing on Mars in 2026 (Cao, 2020). The hope for SpaceX is to use the currently under development fully reusable Starship to ferry up to 100 passengers to Mars per launch. To date there have been 11 tested models, of which the SN10, the tenth tested model did land successfully, but blew up several minutes after landing (SpaceX, n.d.). This of course has captivated the American public due to the potential to not only reuse a single rocket, but to do so while "hopping" between planets. This has resulted in the augmented valuation of SpaceX up to $74 billion and the establishment of an Exploration & Innovation ETF sponsored by renown innovation investment manager Cathie Woods (Liu, n.d.). This shows not only the confidence of the military and Congress in the potential of space, but also the stock market and their consumers, the American public.

There is room for much more discussion on the influence of space economic actors on society and the American public. Many of the influences are currently being formed and developed during the writing of this paper. A few areas worth further research include private space tourism, the potential for hypersonic transportation on Earth using "hopping" methods of ballistic rocket launches, and space debris cleanup. Space innovation through private companies is revolutionizing not only societies on Earth, but also forcing the need for discussion on how to establish societies on other planets.

Conclusion

The framing of the vision of space and its relation to society has been molded by the collective political and economic ambitions of the government, industry, and American public as much during the Apollo era as it is currently. With political actors, such as Lyndon Johnson, due to the political climate of the Cold War, being able to shape the Apollo space program to garner stronger support for the role of government in influencing society through broad expenditures and investments in large scale programs with grand objectives. Much of which have shaped many of the government institutions and systems that are still relied on in the present day. The framing of systems based on views held by the popular was also on full display during the Apollo missions' depiction of astronauts and space culture, magnified by the media. This is in contrast to the influence of economic actors, mainly that of private space companies through the commercialization of space and development of a national economy with a growing dependency on space investment and innovation.

Over 60 years, the relationship between space and the American public has shifted from that of government dependency to that of capitalism and the freedom of autonomy granted by the wealth and capacity for technological innovation of commercial ventures. As technology continues to improve and infrastructure is established in space, the role of private companies to influence the American public is likely to grow, though the need for political legislation and oversight of space leaves room for tremendous political influence over the future of space.

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