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The Corporate Occupation of the Final Frontier; Emerging Market Analysis of SpaceX and the Privatized Race to Space.

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Introduction/ Abstract

In the duration of the last decade there has been an emergence of the commercial space industry, lead by companies like SpaceX. This new industry has changed the way that we think about what it takes to get into space, and along with it changed the perceptions of the cost and benefit of space travel and opened this new market to investors all around the world. This paper takes a deep consideration into the history of sending technology into orbit, the conditions that lead to the emergence of the new commercial sphere of launching rockets and probes, the effect on the public sector's space programs, the cost and benefit of running such a business, and where this all could be headed into the future.

This project is important to allow a full understanding of the current environment of the emerging market of space transport and travel. As we continue to move into a more technologically advanced society, we will no doubt have more contact with companies looking to profit from the race to deliver the promise of satellite space to companies all over the world in a more cost effective and powerful manner. To this end, Google and Facebook have already begun cooperation with private companies to propagate the space around our planet, and in addition, the investment and return basis of this work is essential knowledge that must be understood. With the occupation of more and more technology within orbit around our planet will also come some very future oriented problems such as demand and market size potential that must be examined to gain a better understanding of the future for the new industry. The growth of commercial space companies is now burgeoning within the United States and soon the world, and with this poises a unique opportunity to examine both past and current events to illustrate the true nature of this emerging industry in a way that past work has not been able to; mainly in the realm of privatization.

To illustrate these aspects of the growing industry this paper first examines the history of achievements and legislation that lead to the population of the market by commercial firms for the first time in history. Next, the paper analyzes the depth of a new aspect of the market, space tourism, its major players, and estimates for demand and pricing information. After this analysis is a complete illustration of the competitive and general environment of SpaceX and NASA, showing the differences and similarities of the old and new participants in the market. To show the crucial aspects of these firms, multiple analysis are used, including an advanced SWOT, Porter's Five Forces, and a strategic mapping. Building on these differences brings the next portion of the research, the changes in cost and benefit provided by SpaceX affirming its foundation in the industry. Finally, the implications of this research are implored, followed by conclusions and potential future research that may come from this study.

History

In the 1970's with a history of unprecedented expansion of the government spaceflight entity in the United States, the National Aeronautics and Space Administration (NASA) started looking for outside privatized funding. To combat the billion dollar costs of running an orbital launch program, from rocketry, to human capital, to launch facilities, the organization recognized the opportunity to outsource some of the assets it had created to private buyers. Most of this outsourcing took the form of renting out launch facilities to companies with an interest in satellite technology, such as COMSAT, RCA, and Western Union. This realization of the usefulness of the great assets that NASA had created, and the increased focus on the applicability of the technologies to private companies all over the world was a strong affirmation to the future of increasing privatization in the space industry (Cook, 1990). Recognizing the strong position that the United States government had formed with the organization of NASA, soon the legislature was quick to create a legal system for the future of the aerospace industry. To this end, the House Science and Technologies commission eventually signed into Public Law 98-575** (**site), otherwise known as the Commercial Space Act of 1984. This act was the first public provision to offer the foundation of policy for what would be a booming private market. In addition to aiding the structure of privatization for the market, a key element of this act was that it encouraged NASA to encourage and foster private spaceflight wherever they could (Strom, 2017).

With the leaps forward into aerospace technology, missions, and theory taken by the organization of public space institutions, catalyzed by countless millions of dollars towards research and engineering on the new frontier of human expansion outside of our shared home, came a wildfire of entrepreneurial innovations in the newly emerging area of privatized spaceflight. The national spotlight of scientific progress created in the wake of the space race between the United States and Soviet Union brought to the forefront of minds all over the world the potential profitability and stability of new aerospace programs, the key events of which are still being written into our modern history. One of the first of these key developments came on April 5th, 1990 with the launch of the Pegasus rocket by Orbital Sciences Corporation, a Virginia-based space company. The Pegasus XL craft is notable for being the first air-launch craft in the world, releasing at 40,000 feet for launch after being carried into the air by a NASA B-52 aircraft. The rocket ignites its motor after release from the parent craft, hence the status as an "air-launched" craft, and can deliver a satellite into low earth orbit in a little over 10 minutes (Wilson, 2017). The system developed by Orbital Sciences Co. is most vital to the birth of non-federal space programs as it was the first commercially launched and privately developed space launch vehicle in history, as well as a clear example of the benefit of public and private space cooperation in the industry.

It would be 10 short years before history would repeat itself with a Russian answer to American's entrance into commercial space companies. On April 4th, 2000, with the backing of the Russian Space Federation by facility and crew use, Sergei Zalyotin, and Aleksnadr Kaleri launched into space to reactivate the uninhabited Russian Mir space station, which was nearing the end of its operable life with the Russian cosmonauts. The mission was run and funded by the

Russia's MirCorp, in hopes that renovation might mean the future of space tourism and a continued use of the aging station (Tepfenhart, 2017). The 27-day mission to launch, orbit, dock, and repair the station before returning the Russian soil was named Soyuz TM-30, and was an important event in space history as the first ever privately funded space station expedition. This launch was important in providing a clear financial obligation to more intricate space flights, as well as sparking international interest in the prospects of space tourism (Becker, 2018). Only 1 short year later, cooperation between an American company, the Russian Space federation, and the international space station fostered the next private advancement. This advancement meant the realization of a lifelong dream for Dennis Tito, a former NASA Jet Propulsion Labs employee, who left the organization in the beginning of the 1970's to pursue a career in finance. With the purchase of a seat from US based company Space Adventures, Tito scored the week-long vacation of a lifetime aboard a Russian Space Federation Soyuz rocket to the international space station (Jefferson, 2018). This trip would make Dennis Tito the first space tourist in the world, and the first private civilian to ever float into the international space station. The flight marked the complete inception of a new division of aerospace and spaceflight on a global scale, the creation of the market for space tourism.

The previous events that have been examined are vital to the burgeoning of the corporate world of spaceflight, but were only possible with the sponsorship of previously established space institutions such as NASA, the Russian Space Federation, or international partnership. This mutually beneficial relationship to progress was fundamentally changed and challenged on June 21st, 2001, with the success of the maiden flight of Scaled Composites' SpaceShipOne craft. Out of the sole sponsorship of investor and philanthropist Paul G. Allen, in participation with the company Scaled Composites came the creation and launch of SpaceShipOne. The vehicle, piloted by Mike Melville rose to almost 328,500 feet, a never before reached height for a privately created craft. This flight would make Melville the first civilian to fly a craft outside of earth's atmosphere, earning him the title of the first private pilot to earn astronaut wings for leaving earth (Mills, 2018). The expedition was also important in making Scaled Composites the first organization to reach space without asset, financial, or otherwise sponsorship from a government organization. "We have redefined space travel as we know it," said Scaled Composites founder and CEO Burt Rutan. "Our success proves without question that manned space flight does not require mammoth government expenditures. It can be done by a small company operating with limited resources and a few dozen dedicated employees" (Rutan, 2018).

The message that Rutan was preaching early in the 2000's was heard by established institutions and government bodies alike; the commercialization of aerospace was now barreling forward with or without the support of these major players in the industry. To respond to the new changes fermenting in the market, on December 23rd, 2004, President George W. Bush signed into law the house created Commercial Space Launch Amendments Act of 2004, building on the foundation of legislation put into place 20 years before by the Regan administration. This new act served a multitude of important purposes in allowing for the private market to grow, as well as to update the legal framework for space faring organizations as well as commercial spaceflight. As with prior legislation it was important for congress to conclude that the goal of opening space to the American people and to private commercial enterprises should be the guiding force of federal investment in the industry in the future. To this aim, it was recognized that the private industry had been greatly expanding, capable of commercial launches bringing people to space, and that this practice was inherently risky in nature. The new legal frame provided for the issuance of experimental permits to launch into orbit, as well as to allow the use

of reusable suborbital rocketry, and to allow for an unlimited number of launches during a growth period of the industry. The act also appropriated a so called "learning period" for the private space market in which the FAA (Federal Aviation Administration) would be restricted in its ability to produce regulations against the market for a specified amount of time, which was since extended multiple times, further allowing the expansion of the market (Rohrabacher, 2004).

In the wake of federal changes to open the horizons of the commercial space industry, the next few years offered many new opportunities for companies like SpaceX, Blue Origins, and Rocket Lab, who strove to change the mindset, pace, and cost of launch from every conceivable direction. On the 23rd of September one such feat was accomplished by Elon Musk's SpaceX Corporation with the ignition and travel of the Falcon 1 rocket. The Falcon 1 on this data became the first liquid-fueled privately developed vessel to reach orbit around the earth. This type of fuel system proved for the first time that private companies could create technologically advanced and sustainable rocketry that would be powerful enough to deliver the types of payloads that until this time were thought to only be possible from larger space organizations and federal programs (Musk, 2008). Creating a liquid-fuel rocket is nothing new, as even early predecessors contained similar fuel delivery systems in ICBM's and rocketry used in the public sector for many years. The stark difference in this feat was a complete system developed in a company in ways that had only before been instituted with massive grant and federal funding from the public.

Now with the issue of power having been deemed success for the SpaceX Company, the visionary team turned to a new craft to be perfected, the Dragon capsule. The Dragon was launched atop the Falcon 9 rocket developed by Space X, and the capsule itself traveled in two complete orbits of the earth, reaching speeds of near 17,000 mph while above the atmosphere. The spacecraft while in orbit launched eight free-flying payloads for various government space agencies, including a newly developed Army nanosatellite, the first of its kind to fly in 50 years. The culmination of the company's efforts was the return of the Dragon back to the earth, splashing down in the Pacific Ocean 3 hours, 19 minutes, and 52 seconds after liftoff. With a reentry, less than a minute, and less than one mile of deviation from the expectations of the SpaceX team, the Dragon capsule became the first ever commercial vessel to be successfully returned to earth, a feat that had only been accomplished by six nations or government programs before, being the United States, Russia, China, Japan, India, and the European Space Agency (Musk, 2010). In completion of this historic flight thanks was whole-heartedly given from the CEO of SpaceX, Elon Musk to the continued mentorship, expertise, and advice given to the team by NASA. Musk writes, "SpaceX would like to extend a special thanks to the NASA COTS office for their continued support and guidance throughout this process. The COTS program has demonstrated the power of a true private/public partnership and we look forward to the exciting endeavors our team will accomplish in the future" (Musk, 2010).

The Dragon capsule also has one other major historical accomplishment to its name, which came shortly after its incredible reentry, on May 25th, 2012. On this date in history the Dragon completed a successful rendezvous with the most infamous orbital in human history, the International Space Station (Musk, 2012). To successfully attach to the ISS is an incredibly complex technological process which had previously only been completed by four government organizations ever. To do as such with a private company had only been dreamed of until this day, when SpaceX spoke directly to the world the prowess of potential of the company and its impact into the future. This was another step by the organization to say that anything that could

have been done by a federal program could also be done more efficiently, and quicker in development by a private venture.

With powerful statements being made for history by the SpaceX company, the truest burgeoning of a complete privatized industry was fostered by Blue Origin, in one key element of any market; that of competition. On the 23rd of November, 2015, about half a year after the Dragon docking of the ISS came a major development for another private company, and an absolute leap for the industry, the first vertical landing. The craft New Shepard was instrumental in opening a new type of technology into the field of aerospace transportation, the VTVL, or vertical takeoff vertical landing, rocket. The New Shepard vessel takes off with its large BE-3 engines producing 110,000 pounds of thrust to carry the craft to the skirts of space about 330,000 feet above the surface of the earth. Designed particularly for the growth of space tourism, the rocket boasts the deliverance of the thrill of launch, the freedom of weightlessness, and the largest viewing windows on any space-faring vessel in history (Blue Origin, 2015). Other than these incredible accomplishments, the most vital asset of the New Shepard is its ability as proven in November of 2015 to after ascent fall safely with the use of return thrust and parachutes back to a vertical landing position on earth, something that had never been completed before. Even more compelling, this type of launch allows the rocket to be reused, drastically affecting the cost of such an adventure. Fly again the New Shepard did as well, when on the 22nd of January, 2016, the rocket completed a second successful flight landing crew and all, back to the complex in Texas. This made Blue Origins LLC, a company owned by Amazon's Jeff Bezos the first to reuse a VTVL rocket, changing the cost structure of space tourism in less than 3 years.

Never to be outshined in pushing the boundaries of the commercialization of space, SpaceX was quick to retort the successes of the New Shepard crew by extending the limits of what was deemed fiscally and technologically possible to do with rocketry. Having a spacecraft rise and fall to be used again was something incredible, but what was done on December 21st, 2015, shortly after the Blue Origin successes, changed the game once again. Using the falcon 9 rocket that had been developed by SpaceX, the company made their own spin on the VTVL idea, this time launching, orbiting, and landing a craft for the first time in human history (Shanklin, 2018). The idea of space tourism by safely taking people up out of the earth's atmosphere and returning to the ground all in one journey was great for allowing people the chance to feel like an astronaut if they can afford the trip, but orbiting and landing is a whole different game. To be able to send a large vehicle able to dock, transport satellites, orbit, and at the end of the mission can return efficiently to earth affirmed the fact the SpaceX and companies like it could actively compete with large, well-funded, and well established federal space programs. Utilizing the cost saving properties of this technology, SpaceX eventually completed a second launch, orbit, and landing of the vessel on March 30, 2017, becoming the first to do so. The use of either of these vehicles multiple times was an idea that significantly changed the pace of exploration and drastically cut the costs for any organization to launch and operate a satellite, the most profitable of international space organization's functions.

Taking heed of the government response in supportive legislature starting as early as the mid 1980's, its seems that in our recent history the growth of the progress completed by relatively young private space organizations was incredibly drastic, moving leaps forward both in conjuncture with and without prior established federal organizations. To make sure that the federal legislation could keep the pace with these quickly expanding companies came the signing of the Spurring Private Aerospace Competitiveness and Entrepreneurship Act, or the SPACE Act of 2015, on November 25th, 2015. The act, signed by President Barrack Obama contained two

key parts in changing the climate of privatization. First, the act extended a system of indemnification of US launch providers to any extraordinary catastrophic third-party losses of a failed launch through 2025. This served as an extension of the indemnification in place that would have expired in 2016, as well as extended the “learning period” of low legislative activity against the industry from the Federal Aviation Administration. Secondly, the SPACE Act of 2015 allows for US citizens to "engage in the commercial exploration and exploitation of 'space resources' [including ... water and minerals]." It is important to note both that this does not extend in legislation to any biological life, and that it is the first time that the idea of extracting resources from celestial bodies outside of our earth had been expressly allowed to private organizations and citizens (McCarthy, 2015). Some scholars say that this provision may directly conflict with the international Outer Space Treaty if the act is an allowance of a citizen or organizations ability to claim sovereignty outside of our home planet. The future may raise more questions to the ethicality of this apparent overlap, but for now we should see this as a provision that may be to the benefit of not only humanity, but the potential profitability that drives the privatization of spaceflight.

As a final historic mark to the new industry, on February 6th, 2018, SpaceX again made headlines with the launch of the new Falcon Heavy rocket. The Falcon Heavy is not only the crowning achievement thus far for Musk and the company, it is breaking records set by only government space agencies. The rocket is the most powerful ever developed in history by a factor of two, as it is capable of carrying all the way into orbit almost 141,000 lbs. of payload. To give a better approximation for those who might not be familiar with the capacity of a space vessel, this proportion system could launch into space the weight of a 737 jetliner with crew, passengers, luggage, and fuel without breaking a sweat. In dramatic fashion, the actual payload of the launch was a personal cherry red Tesla convertible of Tesla and SpaceX owner, Elon Musk. The car, fixed with a dash cam that you can access online, a dummy driver, and the cool musical stylings of David Bowe playing are set on a course to begin an orbit with our sun (Oberhaus, 2018). With an abundance of showmanship, savvy, and a true maverick spirit, SpaceX demonstrated on this date that it could not only compete, it could surpass its only real competition, the multinational United Launch Alliance, for less than a quarter of the price.

Space Tourism

With the incredible growth period for private space companies extending into the near future these firms are changing more than the cost structure of the industry. Several companies are evolving the place of consumers in the market, opening new revenue streams other than classic government and satellite contracts to provide revenue in an industry where the cost of assets can be astronomical. For the first time in history there may be a service offering for properly trained citizens with enough money to purchase a pass to what has only been experienced by highly trained astronauts. Several companies have announced that they will be offering a new experience of space tourism. This tourism idea has quickly become a race of the most prominent private firms to provide incredible adventures to those who can afford the price tag with unique suborbital and even space voyage experiences. Tourism has been slated to begin before the end of the year for serval large space companies, including SpaceX, and Richard Branson's Virgin Galactic. The possibility of this new consumer purchase is even being attempted by a few smaller competitors moving into the industry specifically to offer these rides to customers. The journeys come at different price points, required experience levels for the consumers, and different experiences and durations.

(Table 1.1)

Future Space Tourism					
Company	***Craft***	***Cost (per seat)***	***Journey Type***	***Trip Duration***	***Expected Program Start***
SpaceX	Dragon II	$80,000,000 - $175,000,000	Moon Orbit	3-5 days	Late 2018
Virgin Galactic	SpaceShipTwo	$200,000 - $250,000	Suborbital	30 min	2018
Blue Origins	New Shepard	N/A	Suborbital	N/A	2019
XCOR Aerospace	Lynx	$150,000	Suborbital	N/A	2020
Space Adventures	Soyuz	$15,000,000	Suborbital/ISS	1 hr / 7-10-12 days	started in 2004
World View Enterprises	Balloon	$75,000	Upper Atmosphere	5-6 hours	2018
Zero Gravity Corporation	Modified Boeing 727	$5,000	Upper Atmosphere	2-3 hours	2006

Although there has been talks from the Blue Origins company about the possibility of orbital flights in the future, the most attainable orbit flight option comes from SpaceX. The company is looking to shock the world once again attempting a first for the industry. By the end of this year the company has said it will be ushering two individuals capable of paying an enormous 80-175 million dollars for a trip on the Dragon II capsule. These paying customers would be the first private citizens to complete an orbit of our nearest celestial body; the moon, before returning to earth after the fly-by. This trip is expected to take the crew about 3-5 days after launch, a similar timeframe as that of the infamous Apollo missions carried out by NASA and the United States government (Shanklin, 2017). This would be a one-of-a-kind adventure for the participants, exemplified in a statement by Elon Musk himself. "Like the Apollo astronauts before them, these individuals will travel into space carrying the hopes and dreams of all humankind, driven by the universal human spirit of exploration."

If you are thinking that shorter, cheaper, and less risky attempt at spaceflight is more your speed, then a suborbital trip aboard Virgin Galactic's SpaceShipTwo may be just what you are looking for. SpaceShipTwo will be launched into near space after being carried into the upper atmosphere attached to a jetliner. Richard Branson's space company Virgin Galactic will be

offering customers the opportunity to experience the thrill of travelling to the edge of our atmosphere far enough to see the curvature of the earth and the immense black of outer space. The crew will be able to experience a prolonged period of weightlessness while making a low earth orbit in addition to the views before descending to a vertical landing back on earth, for a total trip duration of about 30 minutes. The trip will cost about $200,00-$250,000 per seat, and seats have already been repurchased for the first few explorers (Mann, 2017).

Not to be outdone by the new competition in the industry, Jeff Bezos's Blue Origins has announced plans for a vertical takeoff vertical landing (VTVL) passenger launch slated for 2019 amid continued testing of vehicles and launch systems. The price of their trip has not been released to the public, nor has the duration of the flight although we can safely assume a rather short duration based on a launch, a few minutes of peak altitude viewing, and a decent (Chow, 2016). The plans for the New Shepard craft are specifically designed for the emerging market of space tourism, boasting space for six passengers, a "classic" parachute landing, and the largest viewing windows of any spacecraft ever developed.

Another smaller firm that is attempting to compete in the space tourism market by beginning flights (hopefully) sometime in 2020 is Midland, Texas based XCOR Aerospace, a company that specializes in new propulsion technology. XCOR has taken a different route to offering affordable space tourism by attempting to develop their Lynx spacecraft, which will be able to launch from an airstrip and ascend into the upper atmosphere without being carried by a larger aircraft. The company has said the journey will cost about $150,000 per passenger, but with talks of the firm possibly filing soon for bankruptcy, who knows if this will be an active option in the market anytime in the near future (Chow, 2016).

In separation from the development of rocketry and spacecraft being used by the larger private firms in the industry, the Space Adventures Company has taken to forming critical partnerships with national space organizations such as the Russian Space Federation to support tourism since 2004. The company uses the infamous Soyuz rocket to take participants on an orbital trip similar to those being offered now by larger companies. The next great venture is to allow customers to dock and visit the International Space Station (ISS) before returning to earth. This new trip will cost upwards of $15,000,000, and should last around 10-12 days in conjunction with regular maintenance and scheduled trips to the space station. The direct partnership with established national organizations has allowed this company to situate themselves in a profitable and favorable position in the burgeoning industry of space tourism, and these efforts will no doubt last for many years to come.

While not offering the full space exploration experience like launching into the sky onboard a rocket, or orbiting the moon on a SpaceX vessel, there are other options in the market of space tourism for the adventurous type with enough money in the bank. One such avenue is to purchase a ride to 100,000 feet aboard a luxury gondola attached to a massive helium balloon. This experience is the offering of World View Enterprises, a Tucson, Arizona based company who seeks to offer the visible spectacle of near orbit spaceflight, seeing the curvature of the earth and the black of space in a comfortable environment for a fraction of the cost of spaceflight. The company hopes to charge about $75,000 for the experience beginning after manned testing in 2018. The idea of a more "sophisticated" spaceflight is prevalent in the trip with the serving of champagne, "picture frame" windows, and the availability of in-flight Wi-Fi (Mann, 2017).

A final alternative to launch that you can purchase if you want a similar experience to the weightlessness of space travel is a ride on a modified Boeing 727, aptly named G-Force One with the Zero G company. To simulate zero gravity weightlessness the plane flies in carefully

executed parabolas starting at 24,000 feet, rising to an incline of 45 degrees to the horizon until reaching 32,000 feet. At this point the aircraft turns downward towards earth slowly creating about 20-30 seconds of simulated weightlessness for the patrons onboard. This parabolic motion is repeated 15 times during the duration of the flight, offering the experience many times in one trip. A ride with Zero G costs about $5,000 per person and they have been offering flights since 2006. The 2-3 process is the most cost-effective form of space tourism available, although it simply does not offer the same caliber of experience as some of the more expensive options presented (Green, 2017).

Demand Estimates for Space Tourism

In a study published in March 2013 by Ipsos, a marketing research firm from Paris France, in contract from newly emerging space tourism company Astrium; global potential demand rates were estimated to show the possibility of profitability in the sub-industry of space tourism. In this examination, in-depth interviews of those wealthy enough to support the spending required to potentially purchase these trips was coupled with intensive surveying and formulaic demand estimation to determine the total market potential the numerous space tourism firm could be expecting in the upcoming years. This data collection was separated into a qualitative stage consisting of 12 in-depth one hour interviews of high net worth individuals that had shown prior interest in the opportunity of a sub-orbital trip, and a larger quantitative stage where 1,850 high net worth individuals completed a questionnaire that was structured to illustrate their purchase preferences and factors affecting willingness to pay for such an experience. For the purposes of this study, high net worth individuals were defined as those whose households amass more than about $250,000.00 US per year, limiting the observation to those most likely to align their preferences with those of the target consumer market for these services.

In the qualitative interviews stage of the study a global approach was taken to ensure that cultural customs and perceptions that may drastically impact the feasibility of consumers in the future was considered. Of the 12 interviews, six were conducted in the United States, two conducted in the United Kingdom, two in France, and the final two in Germany. The results of the interviews with these high net worth individuals showed firstly that the idea of a suborbital or even orbital trip for most all respondents was something that drew much interest, although the specifics of such a venture were vague and mostly remote to the potential clients. Many of the people interviewed remembered when in 1969, the first footprints of man were pushed into the lunar surface, and recounted on this event as a mental impression of exploration that existed in part in the potential to be a part of the first generation of space faring consumers. In completion of the interviews, many attractive features of suborbital tourism were found from the selected respondents, like the ability to use the most cutting edge technology of the generation, the ability to photograph the experience, getting to know other adventurous passengers, and the luxury of such a unique experience. Those interviewed harped on the necessity for training conducted by the company offering the voyage, and that the company ensure the safety of the passengers by preparing as well as holding responsible for all participants. The most attractive feature of the sub-orbital trip for almost all questioned was the experience of the flight itself, being able to take part in something monumental over a simple purchase, only second to the most compelling

aspect for most, simply the view from space. The experience and the opportunity to look at the curvature of our home world in the cosmos is what the firms who are entering the market will be pushing most as the keys of the expenditure if they wish to properly align with the expectations and emotions of the potential target market. The negatives that were concerning for those questioned were very limited, mainly involving the safety of the flight itself. Three out of four of those who were questioned in the study said that they would be apt to wait until the market has experience and has grown further, ensuring a track record of feasibility and safety of taking people into the upper atmosphere before being willing to make the purchase themselves. While this is something that may seem like a highly logical perception in the target market, it does offer some important information for the companies looking to provide this service in the future. To be successful within the ideology of the market will likely mean that whatever company moves into the market as one of the industry mavericks, and can do so while maintaining a track record of safety for its consumers will have a large advantage on the many firms who have yet to prove this proficiency. This first mover advantage combined with the high price of purchase will mean that those companies who offer the service first may be able to execute market control while also charging a premium over new entrants, that the value of experience may vastly outweigh any minor cost savings.

The second stage of the study maintained a qualitative survey that was given during two separate periods of time and in several different counties. The survey was given in distinct times, before, (2007) and after, (2010) the global financial crisis, to control for the possibility of changes in consumer opinions and perceptions resulting from the turbulence of the economic climate. Of the 1,850 surveys sent out to high net worth individuals, 400 respondents were from the United States, 300 from Japan, 150 from each Germany, France, and the UK, 50 from Italy and Spain, and another 150 each from China, Hong Kong, Singapore, and Australia. The wide expanse of the nations consumers surveyed allows the study to make observations of the complete global climate and not simply one culture's perceptions of this potential market. The survey itself measured the respondent's eligibility and willingness to participate in a suborbital flight, as well as demographics of interviewee, wealth and belongings, length of previous vacations and expenditure, awareness of suborbital flights, and demand based on pricing options of suborbital flights. From this information, the respondents were divided into groups based on income and expenditures, marked by their likeliness to make such a purchase in the future, and controlled for economic climate by surveying at two distinct times. These groups of consumers were categorized *Enthusiastic Elite*; the wealthiest and most enthusiastic of the respondents being most likely to purchase, *Blasé Group*; almost as wealthy as the previous group but less interested in making this type of purchase, which would just be another way to spend money, *Adventurers,* who maintain similar enthusiasm to the idea as the first group, but have much less discretionary income for such things, *The Risk Adverse,* who are similar to the Adventurers, but are more concerned about the safety issues, and would likely enter the market later, and finally *Low End Consumers,* who for lack of capital, wealth of concerns, or other barriers have been assumed to likely not be a part of the market. Based on survey results consumers that fit into *Enthusiastic Elite*, or *Adventurer* subgroups will be the most prominent target market for the companies that seek to offer an avenue of space tourism in their portfolio for a profitable edge on the competitors in the commercial race to space. Several other insights were gained through the global scope of the study, providing cultural perceptions and shortcomings of future customers from many different nations, and giving a lens through which we may understand what the landscape of marketing and promotion to space tourists will likely be. American and European

(other than German) respondents were overwhelmingly attracted to the adventure of the journey into space as a key driver of purchase, while Germans favored the adventure as much as being the elite few to attempt such a trip. Japanese consumers surveyed did not care much for the adventure aspect of the journey as they were driven by the ability to be a pioneer. For Europeans, concerns of the environmental impact, safety, and self-indulgence were possible barriers to entry, while these factors had little impact on purchasers in the US or Asia. Americans and Chinese were the most enthusiastic respondents about the opportunity, with an estimated 20% of US citizens with net wealth between 25-50 million dollars indicating they would be interested in a suborbital trip purchase. For even more wealthy Americans, amassing above 50 million dollars, more than 50% showed the likelihood of being a potential customer in the future. In the same wealth levels for Europeans and Japanese, the figures were astoundingly lower, at about 10% and 20% respectively.

This information leads to the inevitability that there is a large potential market for space tourism that can be captured, not only in the US, but on a global scale. To effectively scale up this study, LeGoff and Moreau applied the spending probability and demographics of the respondents to create estimates of total world demand using the Capgemini & Merryl Linch World Wealth Report of 2009. With this calculation, it was found that the market potential for the year of inception of space tourism would be around 600-750 consumers, assuming a low end and higher pricing model. Eight years after market creation, there was estimated to be 14,700-21,700 potential consumers in space tourism. Finally, after 16 years, the estimated market size is between 45,000-85,500 patrons each year. Upon analysis of the current market share penetration being little to none, the future of this market will be ahead of us, with industry leaders preparing for the race to capture the future of tourism already beginning.

SpaceX vs NASA

The following sections of this research show a complete advanced SWOT (Strengths, Weaknesses, Opportunities, Threats) for the public and commercial space faring organizations, through the lens of NASA and SpaceX respectively. A SWOT analysis is one explanatory way of offering a complete evaluation of the industry and corporate structure that each firm operates apart of as well as the differences and similarities between the two firms. In addition to the SWOTs, the other analysis concluded on these organizations is Porter's Five Forces Model, showing the threat of new entrants into the market, bargaining power of suppliers, bargaining power of buyers, threat of close substitutes outside of the market, and the intensity of rivalry within the industry. Each section of the Porter's Five Forces Model after analysis is surmised as offering high, medium, or low strength of that aspect of the market, as well as the same indications for the overall model. This examination is in integral part of the analysis of the competitive industry that is operated in by the firm, and by completing this study for both SpaceX and NASA, observations of the differences and similarities of the breadth, scope, and direction of the organizations can be easily illustrated. As a final snapshot of the two firms, a strategic map is completed for each, explaining their position within their respective divisions in relation to key metrics of the industry. In the conclusion of these analysis will come a greater application for the differing factors of operation and execution that have allowed these two organizations to thrive and which will propel many strategic organizational decisions in the time to come.

Analysis of Public Space Industry (NASA)

(Table 2.1)
SWOT Analysis

Strengths (Internal)	**Weaknesses (Internal)**
• Human Capital/ Expertise • Leadership in Collaborative Innovation • Resources and Resource Management • Historical Reputation	• Ageing Organization • Public Funding • Outreach • Risk Aversion
Opportunities (External)	**Threats (External)**
• Collaboration, Private Market Growth • Leadership, Policy Development • Funding Streams • Image	• Competition from commercial space • Government Intervention • Cost Aversion

(Table 2.2)
Advanced SWOT Chart (NASA)

Strengths and Weaknesses	**Opportunities and Threats**
Strengths	**Opportunities**
(1) Human Capital / Experience Importance = 0.20; Rating = 3; **Score = 0.60**	*(1) Private Market Growth* Importance = 0.24; Probability = 3; **Score = 0.72**
(2) Resources / Resource Management Importance = 0.18; Rating = 3; **Score = 0.54**	*(2) Policy Leadership* Importance = 0.17; Probability = 2; **Score = 0.34**
(3) Leadership in Collaboration Importance = 0.16; Rating = 2; **Score = 0.32**	*(3) Funding Streams* Importance = 0.14; Probability = 2; **Score = 0.28**
(4) History / Reputation Importance = 0.09; Rating = 1; **Score = 0.09**	*(4) Image* Importance = 0.10; Probability = 1; **Score = 0.10**
Weaknesses	**Threats**
(1) Ageing Organization Importance = 0.16; Probability = 2; **Score = 0.32**	*(1) Competition* Importance = 0.20; Probability = 3; **Score = 0.60**
(2) Public Funding Importance = 0.11; Probability = 2; **Score = 0.22**	*(2) Cost* Importance = 0.10; Probability = 1; **Score = 0.10**
(3) Risk Adversity Importance = 0.06; Probability = 1; **Score = 0.06**	*(3) Government Intervention* Importance = 0.05; Probability = 1; **Score = 0.05**
(4) Outreach Importance = 0.04; Probability = 1; **Score = 0.04**	

Advanced SWOT Chart Explanation

Displayed on the previous page is Table 2.2, which shows specific strengths, weaknesses, opportunities, and threats for NASA. Each strength, weakness, opportunity, and threat is listed in ranking order for each respective category. A higher overall score indicates that a specific strength, weakness, opportunity, or threat has a greater impact on organizational performance compared to lower scoring attributes. For strengths and weaknesses, scores were determined by multiplying the level of importance for an attribute by the rating for an attribute. Importance indicates how important a strength or weakness is to the company and is scored on a scale from 0.01 through 1 with 0.01 being not important and 1 being very important. Importance ratings for strengths and weaknesses combined should add up to 1 exactly. The rating for each attribute deals with whether a factor is deemed to be major or minor based on a scale from 1 to 3, with 1 being minor and 3 being a major factor. The score calculation method for opportunities and threats is very similar; however, instead of multiplying the level of importance by the rating for each attribute the score for opportunities and threats are determined by multiplying importance by the probability of each factor occurring. This leaves a major impact on the business. Probability is based on a scale ranging from 1 to 3 with 1 meaning low probability and 3 meaning high probability of a given event or trend impacting the market.

Analysis of Advanced SWOT Chart

Strengths-

Insights about the competitive advantages of NASA from an internal perspective are gained through the understanding of the key strengths for the organization which have been scored appropriate to their overall impact for the firm. Starting from least important by rating and moving to the most influential, a closer view of the strengths begins with the reputation and history surrounding the organization. NASA from its early beginnings has maintained a position on top of the science and engineering of the aerospace field and continued to fund missions and experiments testing the limits of what we consider our place in the cosmos. To appropriately conclude what the strengths will be in the future means understanding how the prestige of one of the world's largest space institutions will develop its relationships yet to come. Holding the NASA name means holding a part of the mindset for space travel in the United States for the foreseeable future. Using the historied past of the organization and the strong brand that has been created is a strength that this firm holds, although it may not be as influential as the other aspects for growth with more competition in the market than ever. The next most influential strength to NASA is its prowess in creating and maintaining strong collaborative partnerships. These partnerships have allowed the reach of the organization to grow exponentially both domestically as well as internationally. In creation of steady partnerships, NASA coordinates with 1,148 other businesses or firms in the United States, and 736 organizations internationally (Harbaugh, 2015).

In the global market this means that NASA is one of the most well connected entities in the industry, working for the advancement of scientific exploration on more than an internal focus. Keeping and even growing these strategic partnerships that span both competition, suppliers, research organizations, and foreign governments is an integral part of the global power of the institution. To incentivize the demand for these partnerships comes the next great strength that NASA possesses. This second most important quality of the firm is the accumulated resources and management of these resources that allows for the support of not only the cooperative efforts of the business, but also the use of assets in scientific progress in many regards. NASA has accumulated many different facilities including the Consolidated Information Technology Center, Dryden Aeronautical and Test Range, Testing and Launch center 703 in Palmdale, California, Experimental Fabrication Center, Flight Load Test Labs, and the Research Aircraft Integration facility. Combined with these various facilities is the Edwards Flight Test Range and Air Base located in the Mohave Desert, and many aircraft platforms and experimental hangars located in various parts of the US (Dunbar, 2017). Using these assets of the business is massively influential in allowing the organization to maintain its position as a research and technology leader in the avenue of aerospace, as well as supporting many of the other strengths of the business. The final internal advantage that the firm employs is the advanced level of human capital throughout the business. The fostering of highly educated and knowledgeable staff is the key to the sustainable competitive advantage ensuring the longevity of NASA's place in the market. Without the highly trained and motivated individuals that continue to push the frontier of space closer to the grasp of the average citizen, the organization would have perished a long time ago. In the discipline of space travel, questions are great, problems are even greater, and expertise to tackle either requires a group of employees with training and skills like no other. The appropriate utilization of the human capital of the business is the strength that fosters all the others discussed prior, consequences of the single greatest entity to NASA, the people (Richard, 2012).

Weaknesses-

The other side of the internal environment, aside from the many strengths of the business, are the weaknesses that the firm must monitor and control, adapting in the future to make certain that a simple weakness does not become the downfall of the whole organization. One such issue for NASA, least important of those that will be discussed, is outreach. Outreach is an absolute requirement to successfully run a publically funded organization and is something that should be accounted for more closely. In the distant past NASA captured the hearts and minds of the world with the strong publicity of the first moon landing, and other Apollo missions. These are the types of stories that pushed the next generation of dreamers looking up at the stars and knowing there is more adventure in the black. Appropriate outreach means not only publicizing historic events, but also continuing to provide information about scientific discovery in other avenues of research. This is not to say that outreach has not been done by NASA, rather, continuing to provide and increase the outreach will ensure that the public understands the necessity of the organization to the country, and that the great minds of the future will hope to work for such an organization. Although there have been tragic failures in the past, the next weakness the firm must overcome is an adversity to risk. There must be a balance of risk and reward for any space faring organization, and making sure to take the appropriate risks when they come is something that NASA must control. The reason that this is a current weakness for the firm is the fact that

there are so many more entrants into the market competing with the organization that are privately owned. To ensure that the next great achievements are not avoided by NASA and taken up by other businesses there must be oversight that is willing to take certain risks. These risks will come in the form of capital investment, partnership, and even safety at times. This is the nature of any business that intends to launch anything, especially people out of our atmosphere and into our near cosmos. The balance with this ability to take risk brings us to our next major weakness of NASA and other public space organizations, funding. To simply operate in any manner the United States government must subsidize the work that NASA plans to do, and this means traversing bureaucracy at every step. Appropriately acquiring funding for every aspect of the business means properly showing the need for the organization to continue. As budgets get tighter and more achievement flows from private entities it will become tougher to provide adequate reason to invest in this storied institution, and knowing this is something that NASA must do to survive. Part of maintaining a need for the funding will come from tackling the final most important internal weakness of the firm, the ageing status of the organization. The maintenance cost of assets is only one piece of this problem NASA is facing. In addition to rising costs of keeping the facilities they operate; the organization will need to continue to push the scientific frontier to make sure they do not become a figment of the past (Hunter, 2017). Numerous incredible achievements have been pursued out of the laboratories, mission stations, and launch pads of the National Aeronautics and Space Administration, but the landscape of their industry is rapidly changing. To remain a top tier aerospace firm will mean not only holding onto the accomplishments of the past but making sure to create new ones, all while procuring newer technology, knowledge, and assets while maintaining those already owned.

Opportunities-

In addition to the internal factors of operation, any company trying to elevate itself within its prospective industry must observe the positive and negative aspects of the external environment. The opportunities of the external environment offer an insight into the potential benefits the changing microcosm of the industry will have on the firm. The first of these opportunities, beginning with least important for NASA, is image. Image of NASA as a renowned and tested aerospace firm will come to provide benefit for the organization as the industry grows. Using the popularity of the brand name held will insure that other firms seek long-lasting partnerships with the prominent figure in the market using complete public knowledge of the successes of the past. Although this is a minor feature of the opportunities from an external perspective, it ties in closely with other aspects of the outer industry (Richard, 2012). Using the image and reputation of the organization will be vital to attaining positive returns on the next major prospect, that of new funding streams. With advances in technology, nations and private firms all over the world are buying launches more frequently, sending satellites, probes, and running new missions. As previously discussed in the weaknesses section, funding is an imperative facet of running NASA, and the emergence of increased demand in the market will offer the chance to gain funding from many sources. These new sources will be domestic as well as international in nature, providing research, launch facilities, and support to the new users of the market for high tech aerospace equipment. The unique position of NASA in the industry as a government organization supports the next unique opportunity, that of policy leadership. Being a national institution slows the responsiveness of the organization but does offer a clear external benefit of future policy control. NASA has been an industry maverick in many ways, and gains

from not only being able to concisely oversee new legislation coming to the industry, but also have a hand in creating and controlling any new legal changes taking effect. Using this to ensure that there is a use for the firm as the market changes offers the opportunity. Getting out in front of the understanding of new legislation makes NASA a potential policy leader at every step, and this proximity to changes gives an advantage of allowing for influence of new regulations as well as the empowerment to support other firms with this knowledge. These opportunities are dwarfed in importance to the final opening in the marketplace. The most vital change in the external environment coming is the emergence of the private industry. This growth in a burgeoning market for privatized space launch capabilities may come as a threat that will be discussed later, but because of the integration that NASA has fostered with all the other organizations, both new and old, there is also a sizeable opportunity here. In the industry where only the best technology can be used, where information lies key to success, and knowledge precedes every step along the way, using this growth to continue the perpetuation of this government program remains fundamental. Much has been done to make sure that strong partnerships are formed, information shared, and costs split between even competitors creating a markedly cooperative environment for competitors. Utilizing these ties to each other will truly strengthen the organizations that choose to work well with others, and as the private market continues to grow, maintaining a strong support base may ensure that NASA is not sidestepped by leaner companies.

Threats-

Not all the potential external changes in the industry will serve to benefit the organization, and various features may prove to come as threats to longevity of existing firms. The least important of the threats found in table 2.2 to analyze is government intervention. As the development of the industry grows privatized there may be a push for government policy, especially republican, to convert the cost of subsidizing a group as large as NASA into supporting private companies. This risk is currently feasible although minute, however its underestimation could prove fatal. To traverse this obstacle means providing impactful insights through research, irreplaceable support for both national and private companies, and remaining cost effective so that the essential nature of the body remains steadfast. Making sure to promote the potential opportunities supports the need for continuation by the national government, a large motivator for a group such as NASA. The next major threat that may come to fruition is a strain of cost. With the uptake of companies like SpaceX, the cost structure of the market is quickly evolving. The realization of this fact will push larger national space groups to justify what have been in the past rampant costs. The focus on the fiscal is something that the market has lacked for a very long time, and as things progress certainties will need to come that the cheapest way to do things is not always the best. When it comes to funding NASA has had no problem in procurement, but the bargaining power will decrease if entrants can start to provide similar functionality at a reduced price point. Navigating this may mean restructuring parts of the business to account for cost in ways that have been overlooked in the past. The final threat that is coming for the aerospace industry is closely related to the prior two, and is the emergence of true competition. The global launch market has traditionally been very small, and over the full history of NASA, the firm has had the unique opportunity to operate in an environment with one or a few competitors. These past competitors were often groups of a similar scope such as the Russian Space Federation. This is not to say that opponents in the past were insignificant, just that the total growth of the market has never seen as numerous the entrants as are now entering

the field. To succeed NASA must gain an understanding of its place in the market, which it is doing through the utilization of its own strengths. There may not yet be private companies that parallel in scope to the large multinational partnership organization that is NASA, but this is not a feature of the market set in stone in any way. As competitors grow the place for NASA may be furthering itself as a support organization rather than conducting active missions, a sizable change for the strategic orientation of the organization (Klotz, 2017).

Competitive Environment (Porter's Five Forces Model)

1. *Threat of New Entrants- Medium:*

The launch and satellite programs of the past have had very little issue with corporate infiltration because of the steep barriers to entry in the industry. The capital requirements to maintain and operate a successful manufacturing process, launch initiative, or any facet of the space industry are immense. NASA, although not in any way a new entrant to the industry, spends anywhere from $300-$400 million dollars each year of operation just to maintain facilities and allocate cost of construction of new assets. In addition to the cost of creating a space exploration company, the public companies that are established have weathered and been incorporated into years of government policy regarding the landscape of the industry (Hunter, 2017). Without extensive government financial support, no matter the size of the company, there is no hope of success in the aerospace industry. The public companies around the globe are intimately tied in with national governments to fund their operations, allowing for the firms to undertake massive exploratory tasks without having quarterly profit to worry about.

2. *Bargaining Power of Suppliers- Low:*

For organizations like NASA, a supply chain moves the idea of something like a trip to the International Space Station all the way through the mission occurring is an extensive, multilayered process with many supplier steps. Dealing in the procurement of space faring technology is a high cost and quality intensive process that rarely focuses on cutting expenses at any step. When NASA is producing technology they often will need to contact a supplier for components of the final product, and in most cases this supplier will also be reaching out to its own suppliers for key parts of those components, and so on from several other firms culminating in the complete creation of something like an orbital rocket. In this horizontally integrated supply chain of high cost products there is little room for anyone in the chain to change cost or gain much of an advantage over each other at all. There is low supplier power in the industry mainly for this reason, but also because the advanced technological components used by firms like NASA are only demanded by a few large space organizations at lower quantities than almost any supply chain for a finished product, as well as the fact that there is almost no opportunity for suppliers to ever integrate forward as the costs and knowledge to do so are immense.

3. *Bargaining Power of Buyers- High:*

While NASA draws most of its major components from outside companies in a multi-layered supply chain, the low power of these suppliers does not translate to low buyer power from the purchasing organizations of the utilities of public space firms. Enjoying an industry which

recently has grown larger from only a few producers with high costs on all sides has afforded a high bargaining power to the buyer's side of the equation. Whereas in the past if you wanted something such as a satellite launched there were only a few possible players to consider, this has largely changed recently. With the emergence of private companies has also been an increase in the number of national institutions around the world offering launch facilities and services. This new availability of choice is the largest cause of high buyer power in the market. NASA's buyers including private companies looking for purchases of satellites, launches, and other technical services have more options than ever at their disposal.

4. *Threat of Close Substitute Products- Medium:*

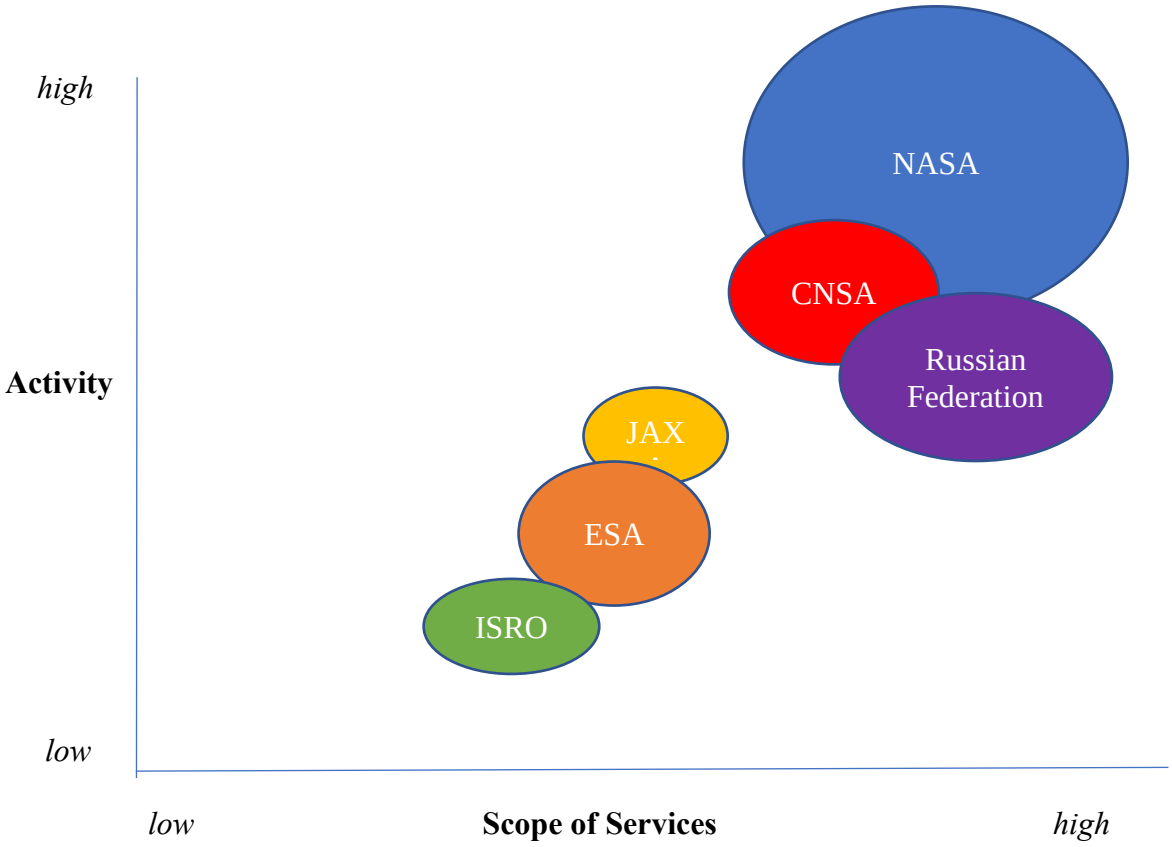
The scope of offerings from products and services that NASA implores in their operations are numerous. Many assets have been procured and used by NASA to gain prominence in the field, and these are not easily substitutable by similar sized organizations or the much smaller private firms. In the past, there was much less threat of close substitutes, but the emergence of other companies has brought other avenues of scientific exploration. As more firms grapple with the immense costs of holding a position in this market they will no doubt continue to change the way that things that NASA specializes in are done. One such example of this is the emergence of reusable rockets, which has drastically decreased the potential cost of sending anything into orbit. The fact that there are new ways to counter the tasks that the organization has historically combated means that the threat of substitutes even in an industry as large as that of aerospace are growing now more than ever. Many of the supporting features of NASA will remain without a close possible substitute for a long time, such as complete launch bases or vested interest in such technology as the international space station, but other aspects of the business will see options grow in the future that were never considered or even though feasible in the past. Controlling for these changes will be imperative to the continued successes of NASA.

5. *Intensity of Industry Rivalry- Medium:*

Finally, as the market grows for space technology companies the intensity of industry rivalry will continue to develop as well. From the race to space in the 1960's between the United States and the USSR, all the way to today, there has always been a storied past about competition between rival organizations seeking to claim to be mavericks in scientific advancement. In its earliest forms this intense competition was the nature of nations and national pride, and has evolved into a full-scale market with private entrants. It should be noted that the utilization of cooperation has never been as pronounced as it currently is, and this does much to decrease the contention between industry firms. On the other hand, the immense capital requirements and high fixed costs associated with the companies mean that there are significant barriers to exit from the industry, adding to the change of rivalry. As one of the largest and well known of its kind, NASA has been fortunate in history to be on the top of controlling factors of the market, although the pressure is rising to prove capable in their competitive advantages and utilize strengths to make sure that competition does not raise the bar above the industry giant.

Overall competitive environment: MEDIUM

(Figure 1.1)
Strategic Map (Public Space Organizations)



In the strategic map, above (fig. 1.1) are the largest competitors to NASA from other national space institutions. The vertical axis of the map is activity, referring to the amount of launches per year for each organization. The horizontal axis denotes scope of services, and this includes the organizations capacity for operating a space station, satellites, launch capabilities, human spaceflight, and the operation of extraterrestrial probes. It should also be noted that NASA is the space organization of the United States, CNSA of China, JAX of Japan, ESA of the European Union, and ISRO from India (Nelson, 2017).

Analysis of Private Space Industry (Space X)

(Table 3.1)
SWOT Analysis (SpaceX)

Strengths (Internal)	**Weaknesses (Internal)**
• Cost Structure Changes • Vision • IP and Innovation • Partnerships	• Scale • Profitability • Required Investment
Opportunities (External)	**Threats (External)**
• Market Growth Potential • Aging Government Organizations • Space Tourism	• Threat of New Entrants • Risk • Contract Dependability

(Table 3.2)
Advanced SWOT Chart (SpaceX)

Strengths and Weaknesses	**Opportunities and Threats**
Strengths	**Opportunities**
(1) Cost Structure Importance = 0.24; Rating = 3; **Score = 0.72**	*(1) Market Growth Potential* Importance = 0.21; Probability = 3; **Score = 0.63**
(2) Vision Importance = 0.19; Rating = 3; **Score = 0.57**	*(2) Space Tourism* Importance = 0.18; Probability = 2; **Score = 0.36**
(3) IP and Innovation Importance = 0.10; Rating = 2; **Score = 0.20**	*(3) Aging Government Organizations* Importance = 0.17; Probability = 2; **Score = 0.34**
(4) Partnerships Importance = 0.06; Rating = 1; **Score = 0.06**	
Weaknesses	**Threats**
(1) Scale Importance = 0.20; Probability = 3; **Score = 0.60**	*(1) Threat of New Entrants* Importance = 0.20; Probability = 3; **Score = 0.60**
(2) Profitability Importance = 0.11; Probability = 2; **Score = 0.22**	*(2) Risk* Importance = 0.17; Probability = 2; **Score = 0.34**
(3) Required Investment Importance = 0.10; Probability = 2; **Score = 0.20**	*(3) Contract Dependability* Importance = 0.08; Probability = 1; **Score = 0.08**

Advanced SWOT Chart Explanation

Displayed on the previous page is Table 3.2, which shows specific strengths, weaknesses, opportunities, and threats for SpaceX. Each strength, weakness, opportunity, and threat is listed in ranking order for each respective category. A higher overall score indicates that a specific strength, weakness, opportunity, or threat has a greater impact on organizational performance compared to lower scoring attributes. For strengths and weaknesses, scores were determined by multiplying the level of importance for an attribute by the rating for an attribute. Importance indicates how important a strength or weakness is to the company and is scored on a scale from 0.01 through 1 with 0.01 being not important and 1 being very important. Importance ratings for strengths and weaknesses combined should add up to 1 exactly. The rating for each attribute deals with whether a factor is deemed to be major or minor based on a scale from 1 to 3, with 1 being minor and 3 being a major factor. The score calculation method for opportunities and threats is very similar; however, instead of multiplying the level of importance by the rating for each attribute the score for opportunities and threats are determined by multiplying importance by the probability of each factor occurring. This leaves a major impact on the business. Probability is based on a scale ranging from 1 to 3 with 1 meaning low probability and 3 meaning high probability of a given event or trend impacting the market.

Analysis of Advanced SWOT Chart

Strengths-

Again, moving from lowest ranking of overall importance to the most important factors, there are several internal strengths that have allowed SpaceX to thrive in the new market. The first of these factors is the partnerships that the company has created. SpaceX could not exist without the support of key players within the industry itself. These relationships have given the firm an edge in breaking into the market, removing several barriers to entry such as limited capital, facilities, and missions to run on their own. One such example of the power of partnering has been the coordination of the company from its emergence with the Kennedy Space Center of NASA (Engler, 2016). From Kennedy SpaceX, has utilized launch facilities, landing locations, and NASA control oversight to complete some of the companies most prominent missions. Without engaging with NASA, SpaceX could have never accomplished the feats that it has thus far. More so, without strategic partnership the company would have failed to cover the cost of creating the assets needed to run their missions. In the future, key partnerships will be an avenue used for the advancement of the firm in execution and knowledge base. Drawing upon these resources has allowed the company to accomplish great things with using their next greatest strength, IP and innovation. SpaceX is focused on creating value for the company by challenging the status quo through compelling innovations and influential intellectual property. To surpass the giants the likes of NASA, Chinese, or Russian Space agencies has required the firm to constantly be looking for ways to produce formidable high tech equipment and create products that translate into value for the firm. The products that SpaceX has focused innovation into are

launch vehicles, their own state of the art rocketry, and engines. Not contracting out the production of these items have allowed SpaceX to differentiate themselves from new competitors, building a brand of mission accomplishments centered around the use of their own equipment and development teams. Maintaining the IP for such innovations allows SpaceX some bargaining power against other would be competition, who now must find better complete vehicles or try and produce at the quality of SpaceX's technology. All this innovation stems from the next strength that the company possess, a vision unlike any other. From the earliest premonitions of the Space Exploration Technologies Corporation there was but one driving factor pushing Elon Musk into business; taking humans to mars. Everything that has been done by the firm stems from the push to the red planet that has so enthralled the CEO. It was quickly understood that this goal could not be the beginning and end for the company, that there needed to be growth to that point, and this is still pushing the organization today. To try and succeed where others said only failure would exist has been a constant endeavor for SpaceX, a firm that seems to relish in doing what others say cannot be done. It is this vision that has made the company into what it is today, a formidable force in a market that did not exist fifteen years ago (Kluger, 2018). This vision, the drive to go where no others have gone in a way that was not considered prior has brought SpaceX its greatest asset and competitive advantage, changing the cost landscape for launch. Although this concept will be explored further in the latter portions of this report, it is the most important strength the company offers because of how when utilized, SpaceX has effectively taken the global launch market over in the last ten years because of this progress. With in-house creation of most components used by the firm, as well as reusable rockets, SpaceX has been able to effectively steal away launch contracts all over the world by exploring the concept of cutting costs in an industry that has long considered extensive costs of missions to be nothing more than consequence of business.

Weaknesses-

Coupled in the internal environment of the firm's strengths comes the weaknesses that the company must overcome to continue operations into the future. The first of these weaknesses explored for SpaceX is the incredible amount of capital required to run the business. In the first ten years (2002-2012) SpaceX operated on around one billion dollars, 300 million dollars of which was raised from private funding including an estimated 100 million dollars from CEO Elon Musk himself. The remaining 700 million dollars came from government subsidization and a 500 million dollar contract with NASA. This may seem like enough capital to run any business, but in the space vehicles and launch market this is enough to bet by. The immense costs of spaceflight and required technologies mean that growth comes at a high price point, and others have joined to help pay for these rising costs. In January of 2015, the company created another round of funding and gained support from Google, and Fidelity at the expense of 8.33% of the ownership of the company. The complete list of financial supporters now includes these two capital giants, as well as Draper Fisher Jurvetson, Founders Fund, Valor Equity Partners and Capricorn. Maintaining these fiscal partnerships is a necessity for the operation of the firm, which for now remains completely private, avoiding the pressures of quarterly profits. This possible emphasis on profits is the next weakness of the firm, as profits have ranged from those of a sinking business to one of the largest capital creators in the country. The massive expense required and massive profits from successes have made this a tough topic to accurately portrait for the company, although there are a few things to know for sure. First, through the analysis

done to answer this very question of profitability, the Wall St. Journal found that SpaceX earned about 0.02% net profit from the estimated own billion dollars in revenue seen in 2015. This figure remains far below the posted results of some key competitors such as Boeing Aerospace, and Lockheed Martin, both with profit margins over 10% (Smith, 2017). With a few launch failures, the 2015 fiscal year ended with SpaceX showing possible losses of about 260 million dollars, although 2016 showed signs of a small profit margin again. It may be too early to tell for sure but it is known that the longevity of the company will require moving margins closer to those of much larger competition. This point brings us to the final weakness of SpaceX, scale. As the firm grows in the marketplace things will not get easier for the company. Currently the relatively small scale organization can effectively produce many of their own materials, chose what projects they want to engage in, and create value through headlines of technological advancement. As the organization grows these capabilities will be stretched, budgets tighter, operations less lean, and competition fiercer. Traversing these obstacles will be much harder when plants need to be added, more employees hired, and the excitement that currently surrounds the company has dulled to an echo. To do so will entail creation of new value and a renewed emphasis on cutting costs without sacrificing quality or safety. This is no simple task, and one that will test the resolve of the duration of operations.

Opportunities-

Taking advantage of the changes in the market that can increase the position of the firm is one way that SpaceX can fight against its internal weaknesses. The first of these potential opportunities is the aging status of the larger public space institutions. While new entrants are coming quickly into the market there are also large government run space organizations that offer potential rewards to those who can work with or against them. One way that SpaceX has sought to control its value in the market is by strongly contracting with NASA. It is recognized that the much younger and leaner organization can be of great benefit to NASA, and this focus has propelled SpaceX to its status today. As many innovations have grown from SpaceX they have created great value in working with government bodies all over the world to achieve communal goals. Leveraging these larger organizations is what SpaceX needs to do to affirm its position in the market and usefulness for other partners that have seen funding cuts and industry decline. More external cooperation will be a strong path into the future for the company taking advantage of the capabilities and knowledge of other institutions. Aside from helping the larger firms with their missions, SpaceX is incorporated at the emergence of a new market which they can hope to take a large share of, space tourism. Space tourism planning is already underway for the company, and using this new demand around the globe may help to establish a profitable consumer division of the firm. As discussed the market for launch tourism could explode in the next twenty years, and although there is competition licking their chops to become a player in the new market, there may not be any firm better suited than SpaceX. With extensive vehicular and launch capabilities, there is no doubt that people will be going to the company to purchase a ticket out of our atmosphere, and if this can be done at a profit the potential for offerings are endless. Finally, the greatest opportunity on the horizon for SpaceX is the growth potential in their own market. As more and more of the world gains advances in technology the need for satellite launches will be higher than ever. As more companies look to establish communication and internet capacity in remote locations thought unreachable, they will look to the space we have in the orbital area surrounding our planet. As more governments use drone and satellite

imaging technology there is a mandate never seen for countries to establish a cosmological presence. These potentials for the future poise a company like SpaceX to take hold of making these visions a reality, and this opportunity is greatest of all.

Threats-

The final portion of the external analysis of SpaceX are the potential threats the company may face in the years to come. Threats must be understood so that there is a potential to restructure or reassess capabilities to alter or avoid the possible pitfalls. The first threat by least importance to most for the firm is contract dependability. Over the last ten years SpaceX has been fortunate to be able to swallow up much of the international market for launches by cutting the traditional costs of the service, but as others seek to meet this new price range, contracts will become harder to ensure the security of (Blau, 2016). If there are launch failures this will also take a large toll on the chances of keeping contracts with larger organizations such as NASA. These contracts and their dependability are a key to the capital funding of the organization, and without assurances that these contracts will continue and new ones will be found, the value of SpaceX decreases dramatically. Making sure to keep the dealings that have been made with other groups is integral to the continuation of operations. Avoiding failures may be a piece of holding these obligations, and brings us to the next threat facing SpaceX and any company trying to grow in the industry of launch or space travel, risk. There is no guarantee within the aerospace industry that everything will always go right, and in fact sending anything outside of our atmosphere onboard a rocket is a dramatically dangerous procedure. The risk associated makes investment a tough topic when things do go wrong, as they will for anyone trying to launch into space. In fact, it is so tumultuous and tedious to do so that the adage of rocket science being the premier of solvable problems is a common statement. The risk that is incurred in operations is much higher than in almost any business in the world, yet there are profits to be made and frontiers to discover, which is why the education of future risk is still a threat ranked so highly for SpaceX. The final and greatest threat facing the future of SpaceX is the emergence of new competitors. So early in the emergence of the private market has SpaceX come, and right now there are very few major competitors of similar focus and scope to the company (Mosher, 2018). As the market starts to show more potential for success and profit, new entrants will come and those already coming will advance their tactics. Understanding the increases in the competitive environment that are coming in the next twenty years is what SpaceX must do to ensure growth. To combat new entrants the firm will need to leverage its strengths, reduce the impact of weaknesses, prepare for the utilization of new opportunities, and traverse possible threats better than the new players in the market. Only in doing this will SpaceX continue to be able to lengthen our reach into the heavens and foster knowledge of what is now the unknown.

Competitive Environment (Porter's Five Forces Model)

1. *Threat of New Entrants- Low:*

With the current structure of the private market for spaceflight and launch SpaceX will have very little to worry about new entrants in the immediacy. One reason for the low threat level of completely new entrants into the market is the immense capital requirements that any prospective company must have to be able to move into the market for aerospace. This extends past just the cost of production, and into the requirements of partnership, extensive and proven record of research and development, and formulation of differentiating factors from the companies already established in the market. To avoid another large barrier to entry SpaceX controls much of its own production and parts used in manufacturing, something that a new entrant into the market would have to imitate at great cost or find suppliers to reinforce.

2. *Bargaining Power of Suppliers- Low:*

SpaceX is unique in the industry as a company that uses its own production to provide the technology for the business, while others rely heavily on sourcing high quality products. Learning to create their own equipment even in the simplest forms like the machining of hardware later used the assemble rockets allows the company to drastically decrease the power of suppliers of the business. Another facet of the market that leads to a low supplier power is that aerospace companies have little threat associated with suppliers integrating forward. Aside from the fact that there are as few suppliers used as possible, the notion of a firm in the supply chain for equipment like rocket components integrating forward into a full-scale launch organization is infeasible at best. These high-tech suppliers also have a disadvantage in bargaining because of the low number of companies that regularly purchase their components. These companies are largely dependent on continuous contracts with few large aerospace organizations, meaning they require commitment to the contracts available more than they have options for other possible buyers.

3. *Bargaining Power of Buyers- Low:*

The buyers of SpaceX are concentrated into the purchase of large launch contracts that can span years into the future and provide much of the current revenue of the business. These buyers are often large government groups such as NASA, smaller national space agencies, or other companies who seek to send their products outside of earth's atmosphere and choose SpaceX contracts because of the differentiation of the offer that SpaceX makes. The structure of the business allows for SpaceX to separate itself from competitors by redefining the traditional launch costs offered by other firms. The cost of launch by SpaceX is much lower than the traditional market leader for launch contracts allowing the company to decrease the power of buyers by reducing the incentives of choosing another firm. This market power leads to the conclusion of very low buyer power against SpaceX, although the necessity to secure these contracts does favor the buyers point of view.

4. *Threat of Close Substitute Products- Low:*

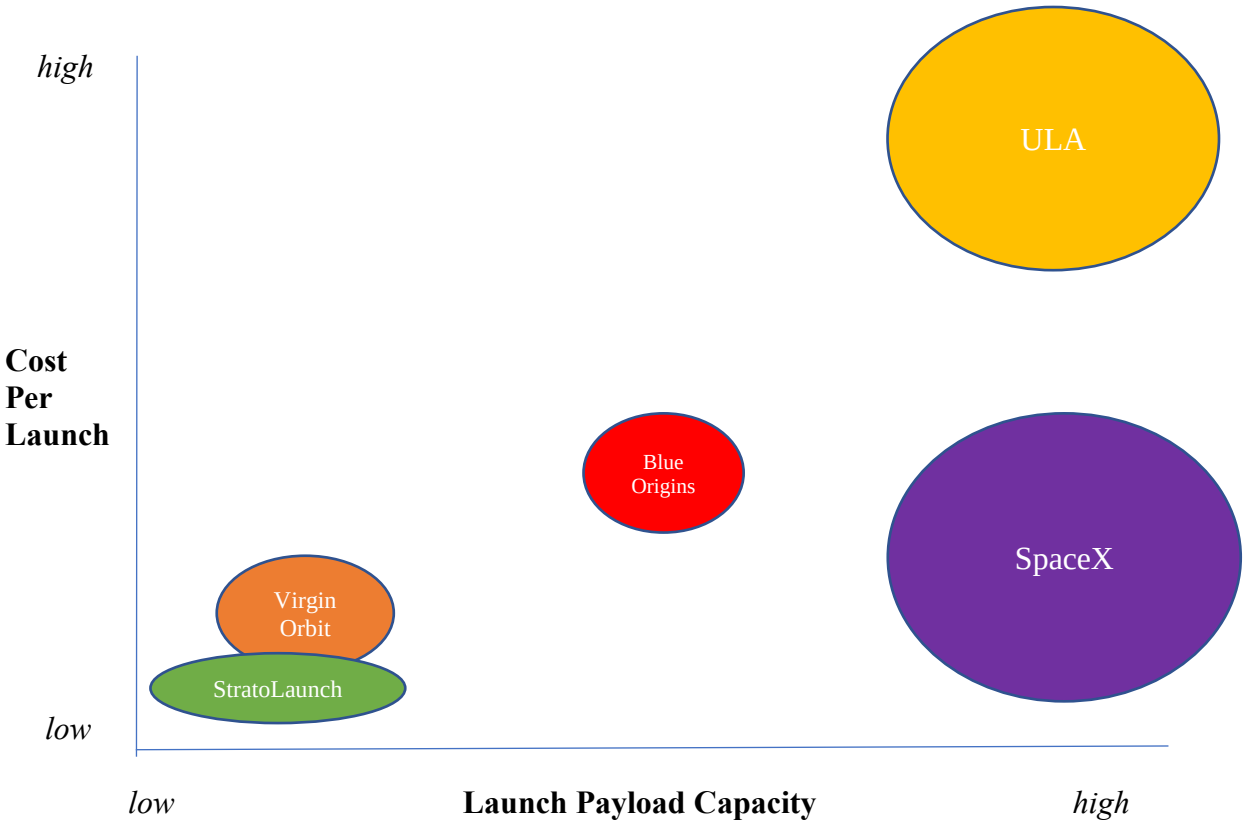
In such an advanced technology market for production and use of orbital launch vehicles that SpaceX operates in there are very few possible substitutes outside of the industry. The operation of launching satellites and other equipment outside of our atmosphere entirely lacks substitutes offing any aspect of price-performance trade off that still accomplish the services offered by a body similar to SpaceX. This does not mean that there are no participants of the market analogous to SpaceX, as there are several that offer services like the company, rather that these competitors are inside of the industry. This internal natured obstacle is observed apart of regular environmental scanning by the company.

5. *Intensity of Industry Rivalry- Med:*

SpaceX has several serious competitors in major markets for space tourism, satellite launch, and government contracts for space missions that it must fight for launch contracts. Of these competitors, the most prominent are The United Launch Alliance (ULA) which has in the last twenty years enjoyed most of the spoils of US launch contracts, Blue Origin, which has focused recently on space tourism but plans to as soon as 2020 start launching larger commercial and government payloads, and Virgin Orbit who specializes in low weight launch capabilities using a high-altitude jet to launch orbital rocketry (Mosher, 2018). The most similar in size to SpaceX is the ULA, but the lower cost of production and lesser ticket price per launch weight allows the company to effectively beat the ULA out in contracts of its choosing. Blue Origin does not yet possess the capital or high weight launch capabilities of SpaceX and thus again the SpaceX comes out on top for the time being. Virgin Orbit is a minor contender for the same reasons as Blue Origin, so the intensity of the rivalry within the commercial industry is growing but still for the time slight at best.

Overall Competitive Environment: LOW

(figure 2.1)
Strategic Map (Private Industry)



In the strategic map, above (fig. 2.1) are the largest competitors to SpaceX from private space companies. The vertical axis of the map is cost per launch, meaning the ticket price of taking any payload to its destination. The horizontal axis denotes launch payload capacity, meaning the amount of cargo in size and weight that the company can take outside of earth's atmosphere.

Cost Analysis;
How SpaceX is changing the launch industry.

When analyzing the space industry, the most influential driving factor in the value chain is cost. Pushing human advances, exploration, and conducting scientific experimentation in space is arguably the costliest business system in the world, all the way from production to transportation, challenges are endless and expensive. When an organization wants to launch a satellite or other piece of technology into orbit or elsewhere, they must work with an extensive network. Luckily, if you are a large firm such as NASA, you may own several of the assets required to launch even one time into space. These provisions are items such as mission control headquarters and staff, engineers, pilots, launch facilities, rocket transportation equipment, and other mission supportive materials. Aside from the provisions required to make a launch happen the component pieces of the rockets themselves are a large driver of the cost of operations (Swarts, 2017). To construct a complete and ready to fly rocket is not a manufacturing capability of most space launching organizations, whether public or private themselves, but rather these bodies act as aggregators, combining the knowledge required to construct these machines with the purchased parts necessary to build the vehicle. These pieces are major components of electrical, mechanical, software, or hardware systems that the rocket must have to complete its launch or mission. Guidance systems, completed engines, physical body parts of the rockets themselves, and many other products are purchased by launch groups from suppliers who often rely on a similar relationship. These suppliers are in most cases also component aggregators as well, purchasing the parts to, and then building rocket engines or electrical systems to later sell to firms like NASA. In this system, concerning products where the quality, durability, and reliability may mean the difference between the success and failure of multi-million dollar missions to the most uninhabitable places known to man, there is no margin of error, no shortcuts taken, and no costs avoided that may prove to serve the result for the better. In the end, costs are astronomically high for the industry, and the knowledge required to complete, immense.

In this environment, it may seem that a private company would never be able to grow and be successful, and this is exactly the perception that Elon Musk was trying to challenge by taking advantage of the landscape of the current system, leveraging an incredible ability to form key partnerships, to learn, and to find the ways to cut the immeasurable costs. The first way that SpaceX is navigating costs is to produce an unheard-of proportion of their own rocketry components in-house. SpaceX uses manufacturing facilities to make around 85% of the necessary parts of their space exploration equipment, far surpassing any other launch company, commercial or otherwise, and drastically reducing the cost of components. For instance, the radios that the company uses in their vehicles are not purchased from other supplying firms for $50,000-$100,000, rather, producing the equipment internally only costs about $5,000, meaning a SpaceX radio costs 5-10% of the cost for its major competitors in the market (Dinerman, 2018).

Another way that SpaceX is changing the traditional cost structure of the commercial launch market is advancing the technology of reusable rockets. The company has had a pair of landing successes with their Falcon 9 platform pioneering vertical takeoff vertical landing (VTVL) rockets in a commercial capacity in 2016, raising the interest of many launch buyers around the world. To land the rockets after an effective ascension, the Falcon 9 reignites its nine engines at a predetermined altitude using thrusters to right the vehicle while returning to the surface. Although this means that weight in fuel for landing must be launched and carried the

extent of the flight to complete each mission, the cost savings are tremendous (Stross, 2018). The expense of rocket fuel used in launches is typically around 1% of the cost of the rocket itself through production and maintenance so the reapplication of a rocket after a flight is a massive cost advantage to any launch firm. In traditional launches the rocket is scrapped or destroyed upon competition of the predetermined mission dragging the capital of each completed contract and limiting the speed and availability to launch with complete reproduction time. This is essentially the same thing as if every time you drove your car you had to purchase a new one. It would be a pain as well as a large limitation on progress. Using reusable rockets will allow SpaceX to massively reduce costs and the company has hinted that the price tag for second use rocket engines may be as low as around 43 million dollars, a reduction of close to 30% of the first flight cost. Reducing the costs of launch through production and launch execution is the largest single factor for the current and future prosperity of SpaceX, defining their place in the market, and allowing for SpaceX to capture a large portion of the market share for launches.

Implications

As the growth in the private market for commercial space launch continues many things that were infeasible in the past will come to fruition. There will be more opportunity for space exploration, visitation to other terrestrial bodies, and further occupation of the orbital space around the planet by satellites and other technology than there has ever been before (Shi, 2016). Costs will decrease as the private market growth increases the competitive nature of the market and the opportunity for more new firms to come in using the industry mavericks' organizational precedent. It is the hope of many including SpaceX CEO Elon Musk that these advancements will bring us closer to the potential colonization of terrestrial planets in our solar system. This is a long way from a possibility at this time, but the vision of these companies and their creation of mutually beneficial relationships with existing public organizations may yet bring us all closer.

Conclusions and Future Research Areas

In reading this paper you should gain an understanding of the historical events that have severed as stepping stones to the growth of private firms within space launch, space tourism, and other aerospace markets on a global scale. The emergence of the new service of being a space tourist will be furthered by this research as well as the potential market costs and demand of this service. With the analysis of both NASA and SpaceX though an advanced SWOT, Porter's Five Forces Model, and strategic map you should notice the foundations of these representative units to their industries, public and private, and see how these features may impact the businesses. To reinforce the conclusions drawn about how the emergence of commercial companies in aerospace is changing the structure of the market a final section was included on the changes instituted by SpaceX in the industry relating to the cost side of the equation. Finally, the implications of this information as it pertains to our society are explored to offer a larger view of the presented evidence.

If there were more available time this study could have been expanded to include the potential demand changes the emergence of private companies is having on the overall industry. With the increase of the publicity for space organizations burgeoning from firms like SpaceX the market is changing in numerous ways that could be understood in more detail. It would have also been interesting to build off this work by examining a few of the theoretical options for replacing the traditional launch industry, such as the potential of a "space elevator". A device like this could drastically impact how these companies do business, yet for the time being remains a purely theoretical topic of study. Lastly, the public perception of these organizations from consumer groups who are those other than potential space tourists would have been an interesting topic, delving into the changes that privatization has had on the public's image of space organizations.

Works Cited

Achenbach, J. (2013, November 23). Does the future of space travel lie with NASA or space entrepreneurs? Retrieved from http://www.washingtonpost.com/sf/national/2013/11/23/which-way-to-space/?utm_term=.d7407c0bd7a6

Becker, J. (2018, April 20). Soyuz TM-30. Retrieved from http://www.spacefacts.de/mission/english/soyuz-tm30.htm

Blake, C. (2017). Schedule and Pricing. Retrieved from http://spaceflight.com/schedule-pricing/

Blau, P. (2016, December 31). 2016 Space Launch Statistics. Retrieved from http://spaceflight101.com/2016-space-launch-statistics/

Blue Origin Makes Historic Rocket Landing. (2016, January 23). Retrieved from https://www.blueorigin.com/news/news/blue-origin-makes-historic-rocket-landing

Chow, D. (2016, March 08). Future of Space Tourism: Who's Offering What. Retrieved from https://www.space.com/11477-space-tourism-options-private-spaceships.html

Cook, C. (1990). History of the Aerospace Industry. Retrieved from http://teachersinstitute.yale.edu/curriculum/units/1990/7/90.07.06.x.html

Dinerman, T. (2018, February 06). Space Exploration May Take Off in 2018. Retrieved from https://www.wsj.com/articles/space-exploration-may-take-off-in-2018-1517876693?mod=searchresults&page=2&pos=15

Dunbar, B. (2017, April 20). Facilities, Resources, and Assets. Retrieved from https://www.nasa.gov/centers/armstrong/capabilities/CodeZ/facilities/index.html

EconomistMagazine. (2017, November 08). Space tourism will lift-off in 2018 | The Economist. Retrieved from https://www.youtube.com/watch?v=-R2x02n-o64

Engler, T. (2016, October 20). Key Strategic Partnerships- SpaceX. Retrieved from https://kscpartnerships.ksc.nasa.gov/Success-Stories/Partnerships/SpaceX

Frost, R. (2017, April 04). The Pros And Cons Of Privatizing Space Exploration. Retrieved from https://www.forbes.com/sites/quora/2017/04/04/the-pros-and-cons-of-privatizing-space-exploration/#20a9fc503319

Goff, T. L., & Moreau, A. (2013). Astrium suborbital spaceplane project: Demand analysis of suborbital space tourism. *Acta Astronautica,92*(2), 144-149. doi:10.1016/j.actaastro.2013.03.025

Grady, M. (2017, October 3). Private companies are launching a new space race – here's what to expect. Retrieved from https://phys.org/news/2017-10-private-companies-space.html

Green, C. (2017). Zero Gravity Corporation. Retrieved from https://www.gozerog.com/index.cfm?fuseaction=about.history

Green, C. (2018). Zero-G History. Retrieved from https://www.gozerog.com/index.cfm?fuseaction=about.history

Hampson, J. (2017, January 25). *The Future of Space Commercialization*(Publication). Retrieved https://science.house.gov/sites/republicans.science.house.gov/files/documents/TheFutureofSpaceCommercializationFinal.pdf

Harbaugh, J. (2015, October 02). NASA Space Act Agreements. Retrieved from https://www.nasa.gov/partnerships/about.html

Hunter, A. (2018). *Agency Financial Report*(pp. 1-149, Rep.). Washington DC, MD: National Aeronautics and Space Administration. doi:https://www.nasa.gov/sites/default/files/atoms/files/afr_fy2017_final_11_15_17.pdf

Jefferson, M. (2018, January 12). Dennis Tito. Retrieved from http://www.spaceadventures.com/clients/dennis-tito/

Klotz, I. (2017, July 14). NASA Could Reach Mars Faster with Public-Private Partnerships, Companies Tell Congress. Retrieved from https://www.space.com/37491-nasa-to-mars-faster-with-private-partnerships.html

Kluger, J. (2018). SpaceX: 10 Facts to Know. Retrieved from http://time.com/space-x-ten-things-to-know/

Krenz, W. (2016). *Aerospace Corporation Annual Report 2016*(Rep.). Retrieved from http://www.aerospace.org/wp-content/uploads/annual-report/TheAerospaceCorporation-2016AnnualReport.pdf

Lin, J. (2016, October 07). China's Private Space Industry Prepares To Compete With Spacex And Blue Origin. Retrieved from https://www.popsci.com/chinas-private-space-industry-booms-prepares-to-compete-with-spacex-and-blue-origin

Luxton, E. (2016, January 11). Which countries spend the most on space exploration? Retrieved from https://www.weforum.org/agenda/2016/01/which-countries-spend-the-most-on-space-exploration/

Mann, A. (2017, July 21). So you want to be a space tourist? Here are your options. Retrieved from https://www.nbcnews.com/mach/science/so-you-want-be-space-tourist-here-are-your-options-ncna784166

McCarthy, K. (2015, November 25). Text - H.R.2262 - 114th Congress (2015-2016): U.S. Commercial Space Launch Competitiveness Act. Retrieved from https://www.congress.gov/bill/114th-congress/house-bill/2262/text

Mills. (2018). Our Approach to Technology. Retrieved from https://www.blueorigin.com/technology

Mills, T. (2018). Portfolio of Scaled Composites. Retrieved from http://www.scaled.com/projects/tierone/spaceshipone_makes_history_first_private_manned_mission_to_space

Mosher, D. (2018, March 07). SpaceX's list of competitors is growing - here are 9 futuristic rockets in the pipeline for the new space race. Retrieved from http://www.businessinsider.com/spacex-elon-musk-competition-companies-rockets-2018-3

Musk, E. (2008, October 07). FLIGHT 4 LAUNCH UPDATE. Retrieved from http://www.spacex.com/news/2013/02/11/flight-4-launch-update

Musk, E. (2010, December 15). SPACEX'S DRAGON SPACECRAFT SUCCESSFULLY RE-ENTERS FROM ORBIT. Retrieved from http://www.spacex.com/news/2013/02/09/spacexs-dragon-spacecraft-successfully-re-enters-orbit

Musk, E. (2012, May 25). SPACEX MAKES HISTORY. Retrieved from http://www.spacex.com/news/2013/02/08/spacex-makes-history-0

Nelson, N. (2017, May 22). Which Space Agencies Are Considered The Best In The World? Retrieved from https://www.forbes.com/forbes/welcome/?toURL=https://www.forbes.com/sites/quora/2017/05/22/which-space-agencies-are-considered-the-best-in-the-

Oberhaus, D. (2018, February 07). What's Next for SpaceX? Retrieved from https://motherboard.vice.com/en_us/article/evmnaw/whats-next-for-spacex

Richard, E. (2012, July 1). *Human Health and Performance Strategy*(Rep.). Retrieved https://www.nasa.gov/sites/default/files/atoms/files/nasa_human_health_and_performance_strategy_2012.pdf

Rohrabacher, D. (2004, March 08). H.R.3752 - 108th Congress (2003-2004): Commercial Space Launch Amendments Act of 2004. Retrieved from https://www.congress.gov/bill/108th-congress/house-bill/3752

Seedhouse, E. (2013). *SpaceX: Making commercial spaceflight a reality*. New York: Springer.

Shanklin, E. (2017, February 27). SpaceX to Send Privately Crewed Dragon Spacecraft Beyond the Moon Next Year. Retrieved from http://www.spacex.com/news/2017/02/27/spacex-send-privately-crewed-dragon-spacecraft-beyond-moon-next-year

Shanklin, E. (2018, February 07). Falcon Heavy Test Launch. Retrieved from http://www.spacex.com/news/2018/02/07/falcon-heavy-test-launch

Shi, L. (2016, December 12). The Implications of the Privatization of Space Exploration. Retrieved from https://publicpolicy.wharton.upenn.edu/live/news/1619-the-implications-of-the-privatization-of-space

Smith, R. (2017, February 05). How Profitable Is SpaceX, Really? Retrieved from https://www.fool.com/investing/2017/02/05/how-profitable-is-spacex-really.aspx

Strom, S. (2017, August 17). History Beckons Commercial Space Industry | The Aerospace Corporation. Retrieved from http://www.aerospace.org/news/highlights/history-beckons-commercial-space-industry/

Stross, R. (2018, April 15). Stargazers See a Business Plan. Retrieved from https://www.wsj.com/articles/stargazers-see-a-business-plan-1523817375?mod=searchresults&page=1&pos=1

Svetlik, J. (2018, April 12). Everything you need to know about Space Tourism: Richard Branson, Elon Musk and Jeff Bezos' planned flights into space. Retrieved from http://home.bt.com/tech-gadgets/future-tech/what-is-space-tourism-space-flight-cost-spacex-virgin-galactic-blue-origin-11364163509098

Swarts, P. (2017, May 10). Military could have truly low-cost launch market in five years - if government puts in the effort, experts say. Retrieved from http://spacenews.com/military-could-have-truly-low-cost-launch-market-in-five-years-if-government-puts-in-the-effort-experts-say/

Tepfenhart, O. (2017, May 17). History of Private Spaceflight Companies. Retrieved from https://futurism.media/history-of-private-spaceflight-companies

The world's largest space agencies. (2015, December 15). Retrieved from http://www.aerospace-technology.com/features/featurethe-worlds-largest-space-agencies-

Wilson, S. (2017). Pegasus. Retrieved from https://www.orbitalatk.com/flight-systems/space-launch-vehicles/pegasus/default.aspx

XCOR Aerospace. (2018). Retrieved from https://xcor.com/