The Evolving Frontier:

Comparing the Historical Dynamics of

Private Enterprise in Earth and Space Exploration

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Introduction

On January 10, 2015, a Falcon 9 rocket launched from Cape Canaveral, carrying a Dragon cargo capsule destined for the International Space Station. After spending most of its fuel, the first stage separated from Dragon and the second stage, and sailed through rarefied air. Four fins mounted to the side of the first stage deployed, as reaction systems flipped the 14-story structure. The stage's engines were re-ignited, reversing its course. It flipped on end once more, pointing its engines towards the Earth, and began to fall.

Plummeting through ever-thickening air, three of the nine booster engines ignited, slowing the descent of the first stage rocket. Sill moving faster than sound, the fins carefully actuated to control the trajectory of the vehicle. Its target was a tiny point in the vastness of the Atlantic Ocean—a sweeping "X" painted on an autonomous barge. It raced closer and closer, and the center engine burst to life for the last time, as legs unfolded like flower petals at the bottom of the giant cylinder. Then, the fins stuck. The engine attempted to compensate, moving the booster towards the barge. Tipped dramatically to its side, the vehicle made hard contact, burst apart into a fireball and shot overboard into the ocean. This is not the normal fate for a first stage rocket booster.

This elaborate, choreographed performance was completed with the aim of recovering the liquid-fueled rocket. It was part of the bid by Space Exploration Technologies (SpaceX) to develop a completely reusable space launch system. Success in this endeavor would dramatically reduce the cost of launching payloads into space. The near-landing described is just one in a series of important steps toward achieving that goal. With the next attempt, they

might make history.

SpaceX's progress is evidence of a sea change within the American space industry. Since 2004, this change has been accelerated, due in part to an announcement made by President George W. Bush. He described a new future for the United States space program, including the completion of the International Space Station, a return to the moon, the initiation of a new spacecraft program called "Constellation," and the retirement of the Space Shuttle.[1] At this time, only the first and last events on that list have come to pass, but they both have set the stage for an evolving program based on commercially developed and directed systems for sending humans to space.

Stimulation of private sector space activity has a long history. It was looked into by the Reagan administration, and during the Clinton administration this strategy was explored further.[2] By the beginning of this decade, the space access maintained by the United States for fifty years swiftly disappeared. Not only was the Space Shuttle retired, but the Obama administration canceled the Constellation program, citing cost overruns and the potential for massive delays. In the termination report, they set a new course for the manned space program, based on commercial partners NASA had been developing. "In place of Constellation," it said, "the President's budget funds a redesigned and reinvigorated program that focuses on leveraging advance technology, international partnerships, and commercial capabilities to set the stage for a revitalized human space flight program for the

[1]"President Bush Announces New Vision for Space Exploration Program," http://history.nasa.gov/Bush%20SEP.htm

[2]"Fact Sheet, National Space Policy" http://www.fas.org/spp/military/docops/national/nstc-8.htm

21st century."[3] In April of 2010, President Obama detailed his new plan in an address to NASA, which included among other things reliance on private companies to deliver astronauts to the International Space Station.[4]

After the President presented his vision for NASA in the 21st century, legends from the 20th century protested. Representing the old guard of American space exploration, astronauts Neil Armstrong and Gene Cernan (the first and last humans to step on the moon, respectively) spoke before Congress a month after the President's address, denouncing the new direction. Armstrong, while pointing out that he supported newcomers in aerospace, expressed little confidence in their abilities. Gene Cernan characterized the President's plan as a "pledge to mediocrity." They each gave several reasons for their doubts about commercial space companies. But their primary concern seems to have been encapsulated in Armstrong's comment that "if the leadership we have acquired through our investment is simply allowed to fade away, other nations will surely step in where we have faltered."[5] Important figures from our nation's space history are worried that this new direction will diminish our stature—that private companies are not up to the task of creating respectable space operations.[6]

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[3]"Terminations, Reductions, and Savings. Budget of the U.S. Government. Fiscal Year 2011." http://www.whitehouse.gov/sites/default/files/omb/budget/fy2011/assets/trs.pdf

[4]"Remarks by the President on space exploration in the 21st century" http://www.nasa.gov/news/media/trans/obama_ksc_trans.html

[5]Neil Armstrong, Gene Cernan. Statement to the Senate, Committee on Science and Transportation. *NASA Human Space Flight Programs*, Hearing, May 12, 2010 Available at: http://www.c-span.org/video/?293473-2/future-human-space-flight-apollo-astronauts

[6]This seems to be supported by Chris Kraft, the original NASA flight director, who in a letter to the Houston Chronicle saying that the past space leadership is worried that "unless the U.S. Continues to advance the state of the art and invest the taxpayers money in a rational and affordable Space Program we will become a

This is the tip of the iceberg that is a debate over the shape and direction of NASA. A flurry of activity has recently made this debate more relevant and more pressing. In 2008, two years before Obama's address, commercial space became an integral part of NASA operations, when it announced that SpaceX and Orbital Sciences would take cargo to the International Space Station as a part of the Commercial Resupply Services (CRS) program.[7]

Less than a year after the NASA veterans' vote of no-confidence, SpaceX successfully retrieved their Dragon capsule from orbit for the first time. Since then, Orbital Sciences has completed two missions for the CRS program, and SpaceX has completed five missions. On their fifth CRS mission, SpaceX successfully returned their first stage booster back to a floating barge in the Atlantic Ocean, where it crashed. While the booster was not recovered, the attempt demonstrates how far the company has come.

In 2014, NASA made their final selection in a process that began with several "Commercial Crew Development Rounds" (CCDev), in which it funded the development of spacecraft from several aerospace companies including Boeing, Sierra Nevada Corporation, Blue Origin, and SpaceX. The final project, called the Commercial Crew Transportation Capability (CctCap) contract, worth a total of $6.8 billion, was awarded to Boeing and SpaceX in September of 2014.[8] The next astronauts traveling to the International Space Station on an

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second rate nation and be left behind by those who recognize what is required." http://blog.chron.com/sciguy/2012/06/nasa-heroes-spacex-still-at-odds-cant-we-reach-a-detente-here/

[7] "NASA Awards Space Station Commercial Resupply Services Contracts" http://www.nasa.gov/home/hqnews/2008/dec/HQ_C08-069_ISS_Resupply.html

[8] "Commercial Crew Program-The Essentials" http://www.nasa.gov/content/commercial-crew-program-the-essentials/

American spacecraft will do so under the logo of one of these companies. Whichever company achieves this first will have the honor of bringing back an American flag left on the station by a Space Shuttle crew for this exact purpose. It will be the culmination of a long march towards commercial space services that began with the Reagan administration, was furthered by the end of the Cold War, and has dramatically accelerated with the help of the Obama administration, CRS and CCtCap.

The questions surrounding these momentous developments will not be resolved easily. But we can investigate the viability of the Obama administration's new direction for NASA. While veterans of the American space program often appeal to the United States' history as a leader in space, individuals within the space industry often bring a different perspective. Jeff Greason, founder of XCOR, has argued that history is on the side of private enterprise:

> If we as a nation want to have centrally planned kinds of results, we should do central planning. And if we as a nation want to have free market kinds of results, we should have a free market. I think history shows rather clearly which of those approaches works the best.[9]

But when investigating the history of exploration and frontier development, and the history of spaceflight, whose analysis is borne out? Often it seems like these two sides are even talking about completely different things—NASA veterans concerned with noble exploration,

[9]Jeff Greason, interview by Eric Berger, *Houston Chronicle.* August 21, 2014

and private industry concerned about the development of the low Earth orbit frontier.

When investigating the history of these processes, two identifying qualities stand out. First is that frontier development and exploring beyond the frontier are nearly inseparable. As European countries slowly and procedurally moved forward into the unknown, they settled in new areas that then acted as springboards for further exploration. This sort of hybrid process involving development and exploration might rightly be called expansion. The second quality is that expansion is almost never solely driven by states or markets. Like expansion itself, the driving forces of expansion are nearly always hybrid. With this in mind it seems as though Greason, Armstrong and Cernan are all off the mark.

Attempts to analyze this push towards commercial space development through historical analog do exist. Roger Launius, former chief historian for NASA, has undertaken a thorough look at historical episodes in American history that might help us when evaluating policy matter surrounding commercial development and exploration of space.[10] He mainly looks at instances of public-private partnerships in the development of communications and transportation infrastructure, whereas this paper will focus on the role of private industry in instances of frontier development and exploration. His approach to using analogs has informed my approach.

Another relevant project has been undertaken by Alexander MacDonald, an economist with NASA, who takes a fresh look as U.S. space history in his thesis *The Long Space Age*.

[10]Roger D. Launius, *Historical Analogs For The Stimulation of Space Commerce*, Monographs in Aerospace History, no. 54 Washington, D.C., 2014

While most of the secondary literature uses the Cold War space race as the beginning of the "space age," MacDonald argues that the space era began long before. He documents the numerous observatories that for centuries served as our only means of exploring space. Most of these observatories, he points out, were privately funded, attracting investment comparable to modern robotic space exploration projects. Taking this long perspective, he argues, the state-centric model of expansion appears to be an anomaly created by unique economic and geopolitical circumstances. From this vantage point, the emergence of a new space economy seems less like upsetting the established order and more like a return to business as usual.[11]

This analysis may be supported by similar episodes of expansion throughout history. If so, it could mean that we have some evidence to support MacDonald's assertion that the old space leaders are pursuing an alignment of the planets that does not come along very often. Two episodes in particular will be the focus here: the Spanish conquest of southern North America, and the British experience on the northern end of the continent by way of the Hudson's Bay Company. Each of these provide us with an example of a powerful state moving swiftly to explore large, far-off territories, and the role of private enterprise in their expansion. Our government has expressed intentions to send humans to Mars. The reason SpaceX exists is to make the settlement of Mars a realistic prospect, and they are now providing launch services for our government. The United States seems to be in a similar

[11] Alexander MacDonald, 'The Long Space Age: An Economic Perspective on the History of American Space Exploration' (University of Oxford, 2013) passim

position to that of the European powers, at least superficially. The circumstances and progression of their experience might give us insight into our own, providing us with a deeper comparison.

After this, the history of American space expansion will be investigated. This section will look at the history of spaceflight with a particular focus on the launch industry. There are numerous reasons for this. Launch vessels have historically been built by contract with commercial aerospace companies, and with NASA's new direction, the nature of those contracts is changing dramatically. Following these companies provides us with a rich opportunity to see how private spaceflight operations have been evolving—what their role has been in the American expansion into space, and what their role might be in the future. Additionally, many of the non-launch industry space companies currently seem to be waiting in the wings, until someone or something brings down launch costs. Whoever can bring down launch costs will get access to this untapped market, which will necessarily be the foundation of both space development and exploration. The combination of their historical legacy and fundamental nature makes the nascent launch industry an ideal focus for the purposes of evaluating the future of American space expansion.

All of these topics have been covered extensively in the secondary literature, with the exception of the launch industry's recent history. The purpose here is not to contribute something new to the vast amount of information we already have. Rather, it is to discover if there are common threads between these episodes of expansion that can generate new insights into the nature of the process in general, as well as the frontier's relationship with

private interests, states, and science. Because of this, each chapter will primarily be a general overview of one particular instance of expansion, with details that might be relevant to the investigation.

In Obama's speech to NASA, he was quick to point out to critics that "NASA has always relied on private industry to help design and build the vehicles that carry astronauts to space." But this does not necessarily indicate that their role should change, or how that role should change. Forming a comprehensive strategy for the development and exploration of space involves looking at the many different factors involved in pushing a society's boundaries into the unknown. Perhaps we can learn from the experiences of those who embarked on such audacious journeys before us.

Part 1: The New Continent

I. Spain, Portugal, and America

The Spanish conquests in America are well known. They were an integral part of a massive increase in the European understanding of the globe. After the voyages of Columbus, the Spanish discovered an entire continent unknown to Europe and the civilizations surrounding the Mediterranean Sea. The expansion of their empire coincided with developments in navigational equipment and geographic understanding, but the proto-scientific advances that occurred were not the reason the Spanish people sailed across the Atlantic. The reasons normally given are summed up in the common phrase "God, gold, and

glory." J.H Parry calls the powerful drives that motivated the Spanish "acquisitiveness and religious zeal."[12]

But these motivations were not conjured from thin air, and could not themselves motivate a country to invest resources into large projects of discovery and settlement. The sources of the Spanish expansion into America are revealed by the circumstances of their first expeditions. The history of the Iberian Peninsula, especially the activities of both Spain and its neighbor Portugal, is essential context.

The centuries preceding Christopher Columbus' famous voyage were dominated by a crusading culture within Europe. This was especially true in the Iberian Peninsula, which had been nearly engulfed by the Muslim empires during the middle ages, until the Spanish "Reconquista." This centuries-long process slowly pushed the Muslim occupants back towards North Africa. The Spanish moved in waves, from frontier to frontier, reconstituting occupied territory.[13] This reconquest forced the Christian kingdoms of the peninsula to develop prowess in several key areas, including mining, the use of ships for transport and warfare, as well as heavy cavalry and associated combat tactics.[14] It built up a militaristic momentum, fueled by greed and religion, that eventually found a new outlet.

In the 15th century, as the Reconquista was drawing to a close, politics on the Iberian Peninsula were shifting dramatically, buffeted by the winds of war, and new Portuguese

[12]J.H. Parry, *The Age of Reconnaissance* (London, 1963), 19
[13]Joseph O'Callaghan, *Reconquest and Crusade in Medieval Spain*, (University of Pennsylvania Press, 2003) 19
[14]Bishko, Charles Julian "The Spanish and Portuguese Reconquest, 1095-1492," in *A History of the Crusades, Volume III* ed. Harry W. Hazard (The University of Wisconsin Press) ,400-433

developments. In 1415, the Portuguese crossed the Strait of Gibraltar into Ceuta. This carried the reconquest (if it could still be called that) into Northern Africa, and catalyzed the next century of expansion in two very important ways. First, it served as a formative experience for a young Portuguese prince named Henry. Second, according to the Iberian historian Charles Bishko, it "aroused the Castilian monarchy to renewed consideration of its own Granadan and African expansionist possibilities."[15] At this point Spain was for more stable and powerful, as well as more capable of following through with such ambitions than in the preceding centuries. However, expanding would not be so easy.

There were many factors that contributed to both Spain and Portugal's desire to expand beyond the peninsula. Throughout the expansionary process, religion was used as a primary justification, a legacy from the Reconquista. But the other, possibly more important factors were economics and geopolitics. Venice had maintained a choke-hold over Mediterranean trade for some time, which meant that the small republic controlled trade coming from the East—particularly spices, ivory, and minerals. The west African coast promised an alternative source for many of these goods, and was largely populated by non-Christians, providing a perfect excuse for territorial acquisition and exploitation in the spirit of the Reconquista. The movement of Portugal down the African coast in the middle of the 15th century was largely due to these circumstances.

Alternative sources for gold were a major motivation for Prince Henry to personally

[15]Ibid., 444-449

sponsor a series of such expeditions.[16] These expeditions were an early model for expansion, and the foundation of a Portuguese presence in Africa. Most of the trade along the coast of Africa after these expeditions was conducted by firms and private individuals, operating under license from the crown. When the Succession War between Spain and Portugal erupted, Castilian power on the peninsula ensured a Portuguese defeat and the rise of Queen Isabella. When the Treaty of Alcáçovas was signed in 1479, it eliminated Portuguese claims against Castile, but at the same time gave the Portuguese a monopoly on the overseas trade in Africa.[17]

However, because John II did not trust the Spanish to abide by the treaty, he decided that the Crown should become more involved in overseas trade than it had been during Prince Henry's expeditions. John II made the defense and regulation of trade near Guinea a top priority, and directly sponsored several voyages of discovery to further develop trade routes and knowledge of the African coast. As the first voyages were bringing back information, rumors began flying around Europe that the Portuguese had encountered the Indian Ocean. Such a feat would have been a massive coup for the Iberian trade, if it were true, giving them direct access to Asian trade goods. When Bartolomeu Dias returned to Lisbon in 1488 after rounding the Cape of Good Hope, the prospect of a southwesterly route to Asia became all the more real.[18]

By the 1480s, the Castilians had made progress in Granada, the last frontier of the

[16]Parry, 20-21, 134
[17]Ibid., 134
[18]Ibid.. 136-138

Reconquista. Eventually, thanks to a rapid increase in militarism, Spain became victorious. With the last portion of the peninsula nearly under Spanish control, Ferdinand and Isabella were considering taking advantage of the new momentum to continue the conquest beyond their borders. However, they found themselves between a rock and a hard place. To the east, the Muslims were proving to be a roadblock against conquest on the coast of the Mediterranean. The Mediterranean trade itself was still locked down by Venice. And to the south, the Portuguese were taking full advantage of their new monopoly along the coast of Africa.[19] There seemed to be no place to go. Spanish prospect changed when a Genoese named Christopher Columbus approached them with claims of a western route to Asia.

The story of Columbus is well covered in other literature, so detail here is not necessary. However, the importance of his expedition, especially to the international politics of Europe, is hard to overstate. If his claims were true, it meant that not only could the Mediterranean trade giants be challenged by a Spain's proverbial David, but that the Portuguese monopoly over west African trade could be made obsolete. This last point was particularly important to the Spanish, considering the promise of Dias' expeditions for the Portuguese. Despite any reservations they may have had about the practicality of Columbus' proposal, they agreed to sponsor him in 1492, the same year the Treaty of Granada officially ended the reconquest of the Iberian Peninsula. The ocean race for Asia had begun.

While they did not anticipate finding entirely new continents, Columbus' contract with

[19]Ibid., 134

Spain did provide provisions in the case of newly discovered territory. Using a system with roots in the Reconquista, Spain granted Columbus commercial and political rights in territory discovered on his voyage. On his first mission, he coasted the Bahamas and Cuba before setting up a small colony of forty people on the island of Hispaniola.[20] After being captured and released by Portugal on his return journey (an ordeal during which Portugal became inspired to pursue their own route to India more fervently), Columbus embarked on three more voyages sponsored by Spain with the express purposes of both colonization and discovery. Throughout the decade after Columbus' first voyage, Spain commissioned more expeditions in the same fashion, increasing its knowledge and presence in what was finally recognized as a "New World" by 1504.[21] Spain had finally found a new way to compete with Portugal's southerly expansion.[22]

Spain and Portugal battled, by means of Papal authority, over the rights to colonize and exploit the people and lands of the New World. Both commissioned voyages of discovery to America, and as they did so a picture of the continents emerged.[23] Most of these voyages occurred in a relatively small window of time between 1487 and 1521. Historian Charles Gibson characterized this rapid process of discovery as part of a "concentrated Iberian historical process," rooted in the Reconquista.[24] This established the foundations for a larger economic and political expansion into America, which would eventually be driven more by

[20]Charles Gibson, *Spain in America*, (New York, Harper: 1966) 7
[21]Miles H. Davidson, *Columbus then and now: a life reexamined*, (University of Oklahoma Press: 1997), 417
[22]Gibson, 8-14
[23]Ibid., 16-20
[24]Ibid., 23

the actions of individuals and local governors than by states and monarchs.

The Spanish conquests in Mexico have also attracted substantial attention in historical texts. However, certain details of some conquests and exploratory expeditions show a trend that receives limited attention. The Spanish Crown initially attempted to operate trade across the Atlantic on its own, but was quickly forced to transfer this operation to a private monopoly based in Seville. As trade expanded, shipowners trading on commission bent the rules to allow foreign goods and capital (mainly from Genoa and Germany) to enter the trans-Atlantic trade. One of the reasons for this was the inability for the Spanish Crown to financially support such an endeavor on its own.[25]

Just like the development of trade and settlement, Spanish exploration into the mainland took a turn sharply away from Crown-sponsored voyages to privately funded and directed missions, with goals that had nothing to do with international geopolitics. J.H. Parry described the period after 1520, marked by numerous expeditions to the mainland, as a period of rapid change:

> These expeditions, however, were not single-minded searches for a sea route to Asia, not maritime explorations financed and ordered to serve the long-term ends of a European government, but private ventures, undertaken, it is true, under Crown license, but for predominantly private ends.[26]

In this way the citizens of Spain gradually took over the burdens of both colonization and

[25]Parry, 51
[26]Ibid., 163

exploration from their government. The Spanish Crown still maintained a prominent role, however, authorizing settlements and other activities. But it no longer directly sponsored the expansion of its frontiers.

Probably the most famous of the early conquistadores was Hernán Cortés. His original mission into the North American mainland was initially commissioned by Diego Velázquez, the governor of Cuba. Velázquez and Cortés partnered financially to support the mission, the primary purpose of which was trade, exploration, and the establishment of contact with Montezuma. Their project attracted an army of 600 volunteers. After landing, the mission took a fateful turn, as Cortés took direct personal control. He destroyed the ships the arrived on, and wrote to the Crown to establish governmental support of his expedition independent from Velázquez and Cuba. How much he was really concerned about official sanction is an open question, considering that he asked for permission after he had already initiated the process. Regardless, the initial conquest of Mexico was done under Cortés' command and with his capital.[27]

To satisfy those working for him and to support further activity in Mexico, Cortés granted himself and other encomienda. The encomienda system built off existing power structures among the Aztecs, mixed with the feudal traditions of Spain. Villages were ruled by encomenderos, who protected the villagers and maintained missions. In return, they could extract tribute from the village, usually in the form of labor, food, or other commodities.[28]

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[27]Parry, 166
Gibson, 27
[28]Parry, 168

Further exploration and settlement on the mainland followed a similar pattern, and Spaniards eventually explored far north into what is now the United States, financing their efforts through encomienda.[29]

This pattern of private individuals settling and exploring under government license would be continued by other nations as well. Charles Gibson describes the pervasiveness of this pattern, and the reason for it:

> An analogy may be made between Spanish encomienda and the later institutions by which other imperial nations compensated the private agents of their expansion: the proprietorship of the British, the patroonship of the Dutch, the seigneury of the French, and the captaincy of the Portuguese. Each of these differed from the other in important ways. What they had in common was an official award of authority issued to a private individual in return for specified contributions to an imperial end. In no case was a monarchy prepared to undertake imperial projects of its own.

Each of these nations expanded swiftly into far-off, unknown territories, pushing out their frontiers with the same pattern of settlement, development, and exploration. Such a project, as demonstrated by these examples, was almost always more effectively accomplished by a network of independently operation individuals with official sanction and support.[30] Of course in the case of the Spanish encomienda system (and as we shall see in the case of the

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Gibson, 49

[29]Gibson, 29

[30]Ibid., 49-50

English system) the government maintained a healthy presence in the affairs of expansion. They stepped in to extract wealth for their empire, and to provide stability if the situation went awry, as it often did.

Evidence of this presence can be seen in commerce between the New World and Spain. As trade with America expanded, Seville began to see a huge inflow of gold and silver, propelling it into wealth and prosperity that rivaled any other European city. While most of the wealth traveled through private hands, the Spanish government received about forty percent of the metals from the trans-Atlantic trade, acquired through royal taxes and mine yields and commerce.[31] This was the fulfillment of Spain's mercantile aims: a healthy trade, operated by others, that they could leverage through taxation.

The amount of money received by the Crown is indicative of its role in this new market. While the monarchy did not conduct trade directly, it did regulate and monitor the trade, attempting to ensure that it was as lucrative as possible for itself and certain citizens, all the while encouraging expansionary practices. The Casa de Contratación, or House of Trade, became a crucial part of this strategy starting in 1503. It was primarily the means of collecting royal taxes, but it possessed other powers and responsibilities as well. It often trained pilots, recorded the progress made in geography on a “master map,” and even conducted weapons testing. It also provided the means of establishing and protecting a Crown-sanctioned monopoly—the merchant guild of Seville. The guild provided funds for trade to the merchants of Seville, and any other Spanish merchants wishing to engage with

[31]Ibid., 103

the American trade had to consult with the guild.[32] Although the Spanish Crown did not provide the capital for the development of the frontier and trade, the entire process was still very much connected to the Spanish mercantile goals. The House of Trade was the central cog in a machine that churned out elite private merchants and guaranteed sources of income for the state.

The Spanish example provides several lessons when considering the expansion of a state. The original voyages of discovery, funded and controlled by the government, were not the norm over the course of Spanish activity in America. They are the most famous, largely because they were the first, but they did not constitute the bulk of Spanish exploration and settlement. These voyages were only possible because of unique geopolitical, economic, and historical circumstances. They were able to utilize the technologies and experience gained from a major period of warfare to propel themselves into a new era of expansion. They had strong motivations built on rivalries with other European powers, and an ideological framework that had been established by the reconquest of the Iberian Peninsula.

This confluence of events and pressures resulted in a short period of state-sponsored exploration from the 1490s to the early 1520s, which laid the foundations for Spaniards acting in their own interests to establish settlements, conduct trade, and discover new territory. The Crown could not have sustained such a project on its own—it had neither the political will nor the required capital. But by providing regulation, granting licenses and monopolies, and

[32]Ibid., 100-102

establishing a system for taxation, it stayed very much connected to the new economy they had helped create, using the profits to subsidize other endeavors in Europe.[33]

Eventually this new economy would rival that of its mother country. Goods flowed into private hands in Spain in ever larger proportions, and production of goods in the colonies began to outpace that of Seville. Even foreign goods and capital wriggled their way around Spanish regulations. British, French, and Dutch players became increasingly prominent investors in the Spanish-American trade.[34] Eventually these nations became rivals themselves to the Spanish empire, perhaps inspired by the success of the Iberian powers' expansion into the new continent.

II. The British in the Frozen North

The Spanish narrative provides us with an excellent example of the circumstances required for a state to use its resources for projects of exploration, as well as the relative prominence of private expenditure and participation in the expansion following state-driven endeavors. However, the structure of private merchants and guild monopolies is relatively foreign, and is harder to bring into parallel with the current forms of private enterprise. The British experience in North America provides a slightly more familiar model. The Hudson's Bay Company and its experience in the frozen north is the narrative of a start-up that helped pioneer the joint-stock model, and eventually became part of a race to explore what we now

[33]Gibson, 103
[34]Ibid., 105-106

know as Canada. It will be useful to look at the context of English interest in the region.

Before approaching Spain, Christopher Columbus' brother had approached several European powers with their proposal, only to be shot down time and time again. One of these refusals came the English king Henry VII. Not five years after Columbus' voyage proves successful in its own way, Henry VII got in on the action—he sponsored a similar venture proposed by the Venetian explorer John Cabot. In late spring of 1497, Cabot's ship found land near Newfoundland, claiming the territory for England. When he returned to Bristol he was greeted with a crowd of admirers standing on the docks. The way Canadian journalist Peter Newman described this welcome evokes images of a ticker-tape parade.[35] The English had officially joined Spain and Portugal in the ocean race to Asia. They were soon joined by France and the Netherlands.

Over the course of the next century, several companies searching for passages to Asia were granted charters by the English, including the Muscovy Company. The Muscovy Company hired an enterprising man named Henry Hudson to search for a northeast passage around Europe. Inspired by these charters, the East India Company began their own independent search in the opposite direction. They eventually hired away their rival's explorer Henry Hudson, and sent him on voyages to the northern coasts of the American continent in search of the fabled northwest passage. On his last voyage, funded by the East India Company along with several wealthy patrons, Hudson found open water. Thinking he had found an ocean at the top of the continent, Hudson sailed west, only to realize he had

[35]Peter C. Newman, *Company of Adventurers*: *Volume I*, (Canada: Penguin, 1985), 25-26

simply found a large bay. In a dramatic turn of events, Hudson's crew returned to England without their captain, to be tried for his murder. But in the end his expeditions led to a permanent presence on the bay named in his honor.

The exploration of Hudson Bay had been initiated by this search for a passage to Asia by the English government, a search that was in large part pursued by private companies. Continuing this trend, the bay became the center of a new fur trade, perpetuated by English companies that saw their beginnings not long after Hudson's expedition. They were forced to contend with a forbidding environment, and the budding colony of New France to the south.

In the mid 17th century, two French fur traders, Pierre-Esprit Radisson and Médard des Groseilliers, began to cause trouble for their mother country. Together, they pressed north from New Franc into the area surround Hudson Bay, where they found the Native American populations to be in possession of high-quality beaver pelts. For the colonies of New France, beaver was by far their most profitable trade good in the areas surrounding the St. Lawrence and Ottawa rivers, mostly acquired through trade with the Hurons and other indigenous peoples.[36] Concerned that a new source farther north would threaten New France's St. Lawrence trade, the French spurned the two traders upon their return, forging the first link in a fortuitous chain of events for England. The two men were forced to look for patrons in New England, where the succeed in obtaining sponsors from Boston. The connections they found there eventually brought them to talks with the English king Charles II, talks which inspired his cousin Prince Rupert from Germany to pursue the prospect of exploiting the

[36]Harold A. Innis, *The Fur Trade In Canda*, (Canada: University of Toronto Press, 1956) 27-28

Hudson Bay area.[37]

Rupert entered into a period of intense cooperation with Radisson and Groseilliers, with the aim of competing against the French in the New World fur trade (and perhaps with gaining control of rumored sources of gold and copper in the interior). Rupert gathered other wealthy patrons, some with connections to the banking and financial community of London, to form a company capable of pursuing this possibility. They lease two ships from the Royal Navy, and stocked them with goods to trade with local populations. Radisson and Groesilliers were on the ships, although Radisson and the *Eaglet* were forced back to England by bad weather. The expedition made contact with the Native Americans living on James Bay, and conducted the first English fur trade. By the time the ship returned to London after several months, no profit had been accrued, but the voyage proved to the initial investors that their plan was certainly feasible. In the tradition of so many start-ups, a failure on paper simply spurred those who had a larger vision.[38]

After sending an additional expedition, and being sufficiently convinced of the prospects Hudson Bay promised, Rupert's company sought a state-approved monopoly. They were granted their wish by Charles II on May 2, 1670, with a famous charter that proved essential to the Hudson's Bay Company (HBC) operations. It granted them the waters and land surrounding the bay, as well as the drainage system connected to it—a truly massive territory. Peter Newman describes the reasons for the charter and its historical

[37]Newman, 65-69
[38]Ibid., 80-83

precedent:

> Its purposes fitted in precisely with the objectives of the English mercantilism of the day: to direct trade policies in a way that would allow private investors to minimize their risks and maximize their profits. They, and not the state, would bear the costs of developing markets for British goods in barely accessible colonies with inhospitable climates and independently minded natives. Similar gifts had been granted to slave traders and gold hunters of West Africa, and only two years earlier Charles II had transferred the Indian island of Bombay (part of the dowry received when he married Catherine of Braganza) to the East India Company for an annual rent of £10.

With this generous charter Hudson's Bay Company put itself in a perfect position to establish consistent trade with North America. Within fifteen years, the company established five forts near rivers connected to Hudson Bay.[39]

Meanwhile, the rival French fur trade to the south was maturing. Developments in New France had led to a similar monopoly granted to the Company of New France in 1627, which had precedent in French experience in the previous thirty years. Monopolies were desirable for many different reasons. The high overhead involved in sending voyages, exploring new territory, and establishing settlements meant that if other merchants stepped in after the bulk of the work was done, those who took on the most risk would sometimes

[39]Innis, 120

receive the least reward.[40] This sort of situation worsened under competition due to the way furs were acquired—through trade of European good for furs harvested by Native tribes. Economic historian Harold Innis explains that the problem was the result of "an inelastic supply of furs which was to be exchanged for an inelastic supply of European commodities."[41] Competition meant that as the supply of European products expanded due to new entrants, the profits gained from the furs acquired diminished greatly.

However, state-granted monopolies also meant the possibility of accepting demands from the state in exchange for the privileges they granted. The result in New France was the militarization of posts in Quebec near the St. Lawrence river. The establishment of the Dutch to their south furthered this militarization. Then, New France's worst fears, when they originally drove out Radisson and Groseilliers, were realized with the arrival of the Hudson's Bay Company.

The arrival of the British disrupted French supply lines. Due to internal politics, many of the native tribes had been forced to trade with the French through other, stronger tribes that acted as middlemen. In 1673, the Assiniboines and other tribes were suddenly gifted with a route around these middlemen—the newly arrived English trader of the HBC. The English company snatched the supply of the finest beaver furs right out from under the French, using their new posts around James Bay. The success of the HBC in this capacity prompted attempts from New France to bring Radisson and Groseilliers back into their fold,

[40]Ibid., 32
[41]Ibid., 31

attempts which eventually succeeded. The French also responded by creating new posts north of the Great Lakes, one of the first examples of competition forcing expansion.[42]

The competition between the French and the English turned violent a decade later, when the French succeeded in capturing three of the five HBC ports in 1686. Radisson and Groseilliers, working for La Compagnie du Nord, were leading the charge to wrest control of the fur trade away from their former patrons.[43] The situation led to direct involvement from the respective governments in an attempt to clean up the mess. While the companies on both sides largely paid their own defenses and assaults, the governments of both France and England did send fleets to the bay in the late 1690s, resulting in a French victory. After this, defense of their positions was undertaken solely by the HBC, and it became a large portion of their business overhead.[44]

The limitations imposed by their weakened position prompted the company to begin exploring tentatively into the interior of the continent. In pursuit of this, they ordered Henry Kelsey down the Churchill River on the western edge of the bay, to establish contact with more remote tribes and discourage them from their wars.[45] However, this effort proved to be redundant when the company forts on Hudson Bay less than twenty years later with the 1713 Treaty of Utrecht (the result of yet another war of succession in Spain). And with that

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[42]Ibid., 47-49

[43] Newman, 109-125 The two men led the charge into the bay, only to be rewarded by New France with a large duty on the furs they returned, and the confiscation of their ships. Frustrated by being slighted by New France a second time, Groseilliers retired and Radisson pledged himself once again to the HBC. His and Groseilliers' stories are evidence of the complicated competition raging between the companies during the decades after 1670.

[44]Innis, 130

[45]Ibid., 120-121

competition and aggression with France slowed, as did HBC momentum into the interior.[46]

After these initial growing pains, the company firmly established itself. It quickly became the primary source of furs for the Dutch who dominated the European fur trade, and made a yearly profit of "200 percent on invested capital."[47] It was organized in a similar fashion to modern corporations. It possessed headquarters in London, and new stockholders were allowed to join with a £300 payment. They held annual stockholder meetings in November, where each £100 pounds of stock owned granted a vote. There were set wage schedules, insurance policies, and a sales department. The most striking different was the rigid enforcement of the monopoly, imposing fines and other punishments for any trade conducted outside of company affairs.[48]

The company's operations on-site were largely informed by the French experience. It imported commodities for trade, including guns and powder, Brazil tobacco, knives, hatchets, and other processed goods. These were given to native tribes in exchange for the furs. As a result, the costs of the company existed primarily in the long and dangerous voyages required to bring these good to America, voyages of discovery stipulated by their charter, and military fortifications required by the same. Their primary focus in the early part of the 18th century, therefore, was reducing the costs of these voyages and increasing their cargo capacity.[49]

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[46]Newman, 125
[47]Newman, 98, 102
[48]Innis, 126-128
[49]Ibid., 128-131

Costs on the continent were kept to a minimum by promoting self-sufficiency. Large colonies were not established, instead personnel was limited to only essential persons. Employees would usually be sent for stints of three to five years.[50] The conditions on the bay were so forbidding that some recommended using it as a place to send convicts. But "the HBC posts were not prisons..." Peter Newman explains, "they were more reminiscent of lunar colonies."[51] Each was fairly isolated, relying on themselves and the seasonal ships from London while conducting their trade. For nearly a century after their tumultuous beginnings, the company slowly settled into an impressively resolute but uneventful routine.

Until the latter half of the 18th century, the HBC sent only a few expeditions beyond the confines of the bay. Newman chose a passage from company man Joseph Robson's firsthand account that beautifully describes their situation during this century:

> The company have for eighty years slept at the edge of a frozen sea; they have shewn no curiosity to penetrate farther themselves, and have exerted all their art and power to crush that spirit in others.[52]

The company sent one expedition already mentioned, led by Kelsey, in 1690. It did not send another major expedition until 1754, when a decline in the supply of furs due to French competition prompted the company to task Anthony Hendry with penetrating the interior to establish trade with the northern Plains Indians. Then, in 1769, Samuel Hearne was sent on a

[50]Innis, 134
[51]Newman, 143
[52]Ibid., 141

similar mission northwest.[53]

This last expedition did not achieve its goals, however, because of a new development that finally woke the Hudson's Bay Company from its slumber. In 1760, the Seven Years War resulted in the British taking control of Montreal.[54] Subsequently, traders from Montreal and the Great Lakes moved northwest, establishing contact with the sources of the HBC's trade beyond the monopolized territory, interrupting the supply lines. Before Hearne even returned, the company sent expeditions west to being the process of establishing forts. Thomas Curry moved as far inland as Saskatchewan, and Matthew Cocking was sent to discourage various tribes from trading with the Canadians from Montreal. Over the next twenty years, the HBC established several forts in the interior of the continent.[55]

However, what was once a smattering of individually funded and directed Canadian traders was amalgamating into something even more troublesome for the HBC. After several trade agreements, a loose coalition of traders from Montreal formed the North West Company in 1783, led by Joseph Frobisher and Simon McTavish.[56] The company was pressured by the presence of the United States to the south and the HBC to the north to press rapidly into the interior with the whole of its efforts. North West Company explorers pressed all the way to the Pacific, accomplishing a great deal of the exploration of Canada.[57] This

[53]Innis, 138,149
[54]Gordon Charles Davidson, *The North West Company*, (Berkley: University of California Press, 1918), 3
[55]Innis, 151-154
[56]Davidson, 9-11
[57]William H. Goetzmann, *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West*, (Toronto: Knopf, 1966), 9

process included partnering with one of the foremost explorers in Canadian history, the great Alexander Mackenzie.

The fact that this loose organization caused so many problems for the giant Hudson's Bay Company is both extraordinary and foreshadowing. Largely due to the rigid organization that developed during its slumber on the bay, the HBC had a difficult time adapting to the rapid introduction of fervent competition. It underwent strikes and even bouts of scurvy. However, it quickly attempted to adapt, restructuring the company, increasing personnel, and abandoning canoes for boats capable of taking large payloads down rivers.[58] They also began more rapidly dispatching explorers to preserve their supply lines and map their territories, though in the early days some of these explorers were stolen away by their competition.

This period, from Hearne's expedition to the late 19th century, marked a race for the interior. A lion's share of the North West Company's activity was initiated by its director McGillivray. Historian William Goetzmann explains that after being persuaded by Alexander McKenzie, McGillivray "launched a series of probes into the Canadian Rockies and beyond to the Pacific Ocean." David Thompson was a major part of these efforts. He had spent some time as an explorer for the Hudson's Bay Company, traveling over 9,000 miles in an attempt to map the extent of the Company's territory and make astronomical observation, which amazingly hadn't been done since the Company's charter was granted a hundred years earlier. In 1797, frustrated by the HBC's policies and inflexibility, he joined the North West

[58]Innis, 154-160

Company. At the behest of the company he penetrated deep into the Canadian interior, crossed the Rocky Mountains, and completely mapped the Columbia River and its tributaries. He established trading posts along the way, and even ran into the HBC explorer Joseph Howse who was scouting for sources of fur along the Columbia.[59]

The extensive and effective projects of exploration initiated by the North West Company into the territory beyond that granted to Prince Rupert forced the HBC to continue its own projects of exploration. This included sending Philip Tumor west in 1790, to survey the route to Lake Athabasca. David Thompson and Peter Fidler were also sent to the area around Athabasca and Reindeer Lake, where forts were established. By 1803, the company had posts as far west as Slave Lake and Peace River, though many of these were eventually abandoned.[60] The subsequent history of the HBC and its exploration of the American continent is probably best told through the story of one Peter Skene Ogden.

Ogden was born in Quebec, the same year the great David Thompson left the HBC for the North West Company. At the height of the often bloody competition between the two companies, Ogden joined the North West Company and became infamous for his daring and cruelty. Eventually he was forced to flee the company in 1820.[61] The next year, a momentous event occurred in the history of the Canadian fur trade—the Hudson's Bay Company and the North West Company merged, keeping the former's name and organization.

During their intense competition, both companies had suffered greatly. The HBC was

[59]Goetzmann, 10-11
[60]Innis, 153-154
[61]Goetzmann, 92

had been forced to dramatically restructure its operations to remain in business, but had adapted effectively. The North West Company, on the other hand, was finding it difficult to adapt to a more permanent mode of operations as the main period of expansion was waning. Both companies were effected by the dramatic decline and beaver and the rapidly increasing price of transportation. After the North West Company regained some stability by merging with the short-lived XY Company, several more violent clashes occurred with the HBC.[62] In 1821, due to unsustainable conditions and pressure from the British government to maintain order, an amalgamation was arranged, combining the assets of the two companies. With this, the Hudson's Bay Company took on an entirely new character.[63]

Despite the merger, the HBC did not find itself free from competition—the Americans had entered into the fur trade. The focus of their new clash was the Columbia and Snake rivers. The new governor of the HBC, George Simpson, established posts near the Pacific coast, at Frazier River east of Vancouver Island, and farther south Fort Vancouver was placed near the Snake River. In order to gain a stronger foothold, Simpson turned to Ogden, a move that Goetzmann describes as a highly strategic maneuver: "This, when Simpson personally saw to his reinstatement and assignment to the Snake River Brigade, it was clear that the 'Honorable Company' meant to turn its 'ultimate weapon' loose on the Americans." With this purpose in mind, Ogden began his push into what is now the American northwest.[64]

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[62]Innis, 263-280

[63]John S. Galbraith, *The Hudson's Bay Company As And Imperial Factor 1821-1869,* (Berkley: University of California Press, 1957) 8

[64]Goetzmann, 91-93

Ogden's expeditions for the HBC are extraordinary. After pushing south through present day Montana, he passed through Idaho. Shortly after he made one of the first observations of the Great Salt Lake. Following tips he gained from the natives, he stumbled upon the Humboldt River of Nevada in a search for the non-existent Rio Buenaventura. His expeditions led to the first maps of the Snake River area and one of the first maps of the Salt Lake. In five more expeditions, Ogden pressed even further south. His travels took him through much of Oregon, and past Mount Shasta in California. His last journey took him past the Colorado river near Needles on the California-Arizona border, all the way down to the Gulf of California.[65]

The incredible extent of his expeditions led Goetzmann to dub him "the greatest of all the British fur-trader explorers."[66] Indeed, the significance of his contribution to the exploratory endeavors in the American west is incalculable. This significance is due in no small part to his association with the Hudson's Bay Company. Unlike much of the information gleaned by independent traders and trappers, the surveys made by Ogden were put to broader use. His discoveries were sent back to Europe, to be used in maps by Aaron Arrowsmith in London and A.H. Brue in Paris, which were utilized by commercial venture for decades to come. Goetzmann places Ogden among Lewis and Clark, and David Thompson in the "select company" of explorers who formed the bulk of Europe's original knowledge about the American northwest.[67]

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[65]Ibid., 92-99
[66]Ibid., p. 92
[67]Ibid., 99-101

Ogden's adventures were by no means the only nor the last of latter explorers for the Hudson's Bay Company. They do, however, mark the incredible extend of the company's expansion. It managed to extend its vision from the very northeast top of the American continent all the way to the Gulf of California. Although the bulk of their opertations never went much farther south than Oregon, they contributed a great deal to the exploration and mapping of both the American north and west. None of this would have been occurred without the development and settlement of Hudson Bay.

The company's narrative is a long one. Following state-led voyages of discovery, it quickly took up the exploration of a new continent on the back of wealthy patrons and private traders. With its development and trade, it played a crucial role in the mercantile ambitions of its mother country. The state helped to mitigate the initial risk of such a project, and afterward only became directly involved when it fit into their geopolitical strategies and conflicts. Almost all of the exploration and exploitation was done on the initiative and resources of the company itself.

This narrative also reveals the driving force of exploration in this particular episode: competition. The HBC's long period of indolence was that of a comfortable monopoly. Only when that monopoly was threatened by outside forces did the company push outside the frontier. This competition came at the expense of profits and stability, and therefore the mercantile ambitions of England, but it meant the acceleration of innovation and exploration. Although the company still exists, it is not primarily remembered for its contribution to British mercantilism. It is remembered for surviving and thriving as a start-up venture on

Hudson Bay, for David Thompson and Peter Skene Ogden, and the mapping of a massive portion of the North American continent, from the Arctic Circle to the Sonoran Desert.

Part 2: The New Frontier

I. Volatile Launch

The current state of America's expansion into space is not quite as developed as our other examples. However, there have been several human voyages over discovery, numerous robotic voyages of discovery, and recently the frontier of low Earth orbit (LEO) has undergone rapid development to facilitate earthly communication and commerce. With the International Space Station, one of the first few outposts in orbit, several nations have cultivated a permanent human presence in space. We are just now beginning development of the frontier in the same manner as our predecessors. If expansion into space follows a similar trajectory to historical expansion experiences, further development of LEO will be a likely first step before larger scale human exploration into deep space[68]. To establish where a comparison can be drawn, and where it breaks down, we will investigate the history of the American expansion so far. In particular, we will look at its first human voyages of discovery, and the role of private industry. If development of LEO occurs, it will have to be on the

[68]Some might even consider this development to be a form of exploration. While the ISS would be rightly classified as a frontier outpost, with all the challenges of a new and forbidding environment, astronauts on the station can probably be considered explorers in their own right. Like always, the distinction is not clear-cut.

rockets of launch industry companies. Their evolution throughout the history of American spaceflight, and their interplay with government interests, will help us better understand their current role. It will paint us a picture of the current opportunities for frontier development, with all its unique challenges. As with the other expansionary experiences, America's entrance into space can not be fully understood without knowledge of its context and motives.

As World War II was in full swing in Europe, the nascent field of rocket science was beginning to attract a lot of attention. In Germany during the mid 1930s, rocket scientist Wernher von Braun was experimenting with sounding rockets. The first practical research for this type of rocket had been conducted not long before, by Robert Goddard. Goddard had plans for such rockets—he thought they would be perfect for scientific research, and placed barometers and thermometers on his test vehicles to conduct tests in the upper atmosphere. His work led to a small but thriving community of rocket science in America. In 1936, the Guggenheim Aeronautical Laboratory at the California Institute of Technology (GALCIT) began work on rocketry, primarily experimenting with solid fuels. Their aims mirrored the scientific motivations of Goddard, focused on the boon rocket access to the upper atmosphere would bring to studies on weather and cosmic rays.[69]

The rockets von Braun was developing in Germany were similar to those developed by the Americans, but rather than being equipped for science, they were equipped for war. Von Braun's program culminated in the creation of the V-2 rocket, a highly advanced long-range

[69]Corliss, William. "NASA Sounding Rockets, 1958-1968: A Historical Summary." Section II

liquid fueled vehicle. It was large and capable of delivering a considerable amount of force. In 1943, Adolf Hitler gave von Braun's program the highest priority, and a year later, V-2 rockets were launched that flew to London, killing thousands. The ultimate goal for this program was to create an intercontinental ballistic missile (ICBM) that could reach North America from Europe.[70]

The Germans were only be able to test their ICBM once. A few months later, in 1945, Allied victory was achieved. In a foreshadowing series of events, the Soviet Union and the American Army scrambled to pick up the scraps of Germany's rocket program. On May 5, Soviet forced captured Peenemünde in northern Germany, where the V-2 was being developed. Most of the Germans involved in the production of the rockets fell into soviet hands, while the engineers who developed the machines were transferred to America. Then, in a coup for America, the Army captured the V-2 factory that lay underground near Niedersachswerfen, despite the fact that it was technically in territory occupied by the Russians.[71]

One of the most important acquisitions made by the Americans was the person of Wernher von Braun, who surrendered to the Americans days before the Soviets marched on Peenemünde. The United States, who had just successfully tested rocket-propulsion in manned form (With the Bell XS-1), had just acquired a premier rocket scientist who just years

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[70] United States Congress House Committee on Science and Astronautics. "A Chronology of Missile and Astronautic Events."

[71] Ibid.

Corliss, *Sounding Rockets*, Section III

earlier had been temporarily arrested by the Nazis for putting too much research into the prospect of space travel.[72] Despite the push by governments for militarized rocket technology, there was no keeping rocket scientists from thinking about the alternative applications for their revolutionary new means of propulsion.

With World War II over, the United States was left in a new geopolitical position. Europe had been devastated by the massive land war, and American industrial capacity had increased enormously. The now thriving American aerospace industry had turned into a point of pride for the new world power. But importantly, they perceived a new specter on the horizon: Soviet communism. The relationship developing between the United States and the Soviet Union would have consequences reaching far beyond international politics. What started as an incidental scramble for the remnants of the Nazi rocket program turned into a new type of war. This was exacerbated by another event that occurred in 1945: the first nuclear bomb used in combat was detonated at Hiroshima.

The rivalry that developed between the two superpowers did not have its roots in a technological or industrial race, although the events in northern Germany were a harbinger for what was to come. Rather, the intense competition between the two countries was a result of a fundamental ideological difference, namely the distinction between their economic systems. Embroiled in this was the fear of many in the United States that the Soviet Union might use the aftermath of World War II in order to spread their economic ideology.

In 1947, President Harry Truman went before Congress to advocate sending aid to

[72]Congress, *Chronology*

Greece and Turkey, and in this speech he outlined a new type of threat. This threat had manifested itself in Greece, he claimed, stating that "the very existence of the Greek State" was threatened by the actions of armed men "led by Communists." The United States was the only country in a position to assist them and others who faced a similar threat. Truman thought that every country faced a similar dilemma, a choice between two "alternative ways of life." These ways of life, he explained, were either based on freedom and representation, or oppression and the will of the minority. The worldview he was describing became known as "The Truman Doctrine," and it was the position the United States entrenched themselves in during the coming decades.[73]

In the same year, an article called "The Sources of Soviet Conduct" was published in *Foreign Affairs* by an anonymous author later revealed to be George Kennan. In the article, he gave a short history of the Soviet Union, and presenting a characterization of Russia that came to inform U.S. policy. His picture of the Soviet Union and their ambitions contrasted with that of Hitler of Napoleon. Rather than being an offensive superpower, the Soviets possessed more subversive and subtle ambitions. They would rather evade defeat and slowly embed their ideology throughout the globe, creating dependent satellite states and allies.

Kennan's view of the soviets became a dominant American perspective, especially his idea of what was needed to confront them. Russia was not a rival that would engage, or could be engaged, conventionally, he thought. He wrote that

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[73] Harry Truman. "Recommendation for Assistance to Greece and Turkey." (Speech, joint session of U.S. Senate and the U.S. House of Representatives, Washington, D.C., 1947)

> the patient persistence by which it is animated, means that it can be effectively countered not by sporadic acts which represent the momentary whims of democratic opinion but only by intelligent long-range policies on the part of Russia's adversaries—policies no less steady in their purpose, and no less variegated and resourceful in the application, than those of the Soviet Union itself.[74]

Be it prescience or self-fulfilling prophecy, his ideas effectively described the future of United Sates foreign policy, and the international atmosphere that led to an entirely new era.

The policy of maintaining a rivalry with the Soviet Union and containing the expansion of Communism bled into many facets of American life and politics. It was made all the worse by the fact that both countries now possessed the ability to create nuclear weapons. Senator Joseph McCarthy, in his hunt for Communist sympathizers in the government, claimed that he had evidence of Communist infiltration into "atomic and hydrogen bomb plants."[75] Public service announcements funded by the defense department contained vivid portrayals of Communist takeovers and the steps one would need to take in case of a nuclear attack. It was on everyone's minds throughout the 1950s, as the "Cold War" became the primary concern of the United States. Then, in October of 1957, the Soviet Union launched a 200 pound satellite into orbit on a liquid-fueled rocket. They called it Sputnik I, and it shook the imaginations of Americans.

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[74]George F. Kennan (as "X"), *The Sources of Soviet Conduct*, Foreign Affairs, 1947

[75] Joseph McCarthy, "Army-McCarthy hearings," 1954, broadcast by ABS (accessed through YouTube)

Anyone in America could receive a radio signal from the satellite. The event heightened the fear and trepidation of the average American, and spurred their government into accelerated action. It was the realization of Hitler's old dream of an ICBM capable of reaching North America, but with added destructive potential. The same technology used to launch Sputnik could be used to launch a thermonuclear warhead, and the existence of Sputnik seemed to prove that the Soviet Union had a head start. With this as their impetus, both countries raced into a new era. Within the next ten years America and the Soviet Union put humans into orbit around the Earth, and only twelve years later an American boot stepped onto the surface of the Moon.

The rivalry developing between the two superpowers was fueled largely by the desire to demonstrate to the world which of the two systems described by Truman was superior. Space exploration was often justified by Congress and others as a means of generating prestige, so that any doubts about American strength would be assuaged. Alexander MacDonald puts this in the frame of economic signaling, or a "costly action or characteristic that transmits information about the signaler to observers."[76] President Eisenhower, initially dismissive of the prestige argument, became a driving force behind the early U.S. satellite program and the creation of NASA, both important pieces of the U.S. signaling effort. MacDonald argues that John F. Kennedy made the signal even more well-defined when he laid of the rational for the Apollo program: "I think the fact that the Soviet Union was ahead first in space in the fifties had a tremendous impact upon a good many people who were

[76]MacDonald, 13

attempting to make a determination as to whether they could meet their economic problems without engaging in a Marxist form of government."[77] With the containment of communism as the primary goal, and space exploration as an important signaling tool for achieving that goal, funding for NASA soared and the manned spaceflight programs were given life.

This is where most historians mark the beginnings of the "Space Age." But if Alexander MacDonald's perspective is correct, the development of rocketry and spaceflight can be seen as a revolutionary step in space expansion, but not the first step. Looking at his fully-developed picture we can properly contextualize the space race, and focus our eye on the changing role of private companies. Private interests were a part of the space race from the beginning. Goddard's early rocket research was funded in large part of university grants and donations from the likes of the Guggenheims, the Lindberghs, and the Carnegie Institute. GALCIT, which eventually became the famous Jet Propulsion Laboratory, was created at the behest of Daniel and Harry Guggenheim. With the entrance of government interest, the rules of the game changed dramatically.[78] The Mercury and Apollo programs present us with an opportunity to look at exactly how the role of private enterprise changed in the years following early rocketry and the beginning of the Cold War. To do this, we will focus on two aerospace companies, McDonnell and Douglas.

II. McDonnell, Douglas, and Manned Spaceflight

[77]Ibid., 296-297, 299
[78]Ibid., 219, 230-235, 241

Near the end of World War II, the National Advisory Committee for Aeronautics (NACA) received funding from Congress to begin investigating guided missiles and other spaceflight technology. Over the decade following 1945, they carefully stepping into the world of rocketry, developing multistage solid-fuel rockets. Following the Sputnik crisis, everything began to change for the NACA. While plans for their restructuring were being discussed, they started research for an entirely new mission: manned spaceflight.[79]

In the first couple months of 1958, NACA held meeting with their engineers and aerospace industry representatives to discuss how this new mission might be executed. Their stated purpose was to find "the quickest way to put man in space."[80] NACA engineers initially proposed a no-lift capsule or a flat-bottomed wing design. Then they entertained formal proposals from private corporations like Martin, Convair, Avco, Lockheed, Northrup, Bell, McDonnell, and others. The companies presented ideas ranging from variations on the capsule design, to a simple sphere, to more elaborate gliders or sleds.[81] This only marked the beginning of the agency's relationship with these companies. That very same year, President Eisenhower signed into law the National Aeronautics and Space Act of 1958, which not only folded NACA into the new National Aeronautics and Space Administration (NASA), but changed the fate of the organization and the companies it met with forever.[82]

During the transition, Senator Stuart Symington rightly pointed out that "the big

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[79]John M. Logsdon, ed., *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program*, (Washington, D.C.: NASA History Division, 2008), 4-7

[80]Ibid., 52

[81]Ibid., 52-71

[82] National Aeronautics and Space Act of 1958. Public Law 85-568

difference between NACA and NASA is that NASA is a contracting agency."[83] This follows the legacy established by those 1958 meetings. Later that year, the Space Task Group (STG) at the newly formed NASA put the embryonic Project Mercury into motion. They began the task of contracting companies to build the vehicles, while they were simultaneously competing with other government space programs for fund. In January of 1959, the STG was confronted with a choice between spacecraft designed by the Grumman Aircraft Engineering Corporation and the McDonnell Aircraft Corporation. Because Grumman was working on several Navy projects, the final primary contract went to McDonnell.[84]

McDonnell had a charmed existence up until this point. During World War II, the aircraft industry soared with the proliferation of wartime procurement contracts. Production of combat aircraft in the United States peaked at over 74,000 vehicles in 1944, and the industry had churned out 192,000 aircraft by the end of the war.[85] This was the industry NASA was now leaning on in order to take humans into space. McDonnell had played an important role as a parts supplier for this wartime industry—their net sales jumped from around $190,000 in 1942 to over $20,000,000 in both 1944 and 1945.[86] The actual aircraft they developed during this period were mostly advanced prototypes, including two for the Navy. According to René Francillon, aviation historian, this niche role saved them from "sharing the fate which befell most other manufacturers at the end of the Second World War: the mass

[83]Lloyd S Swenson Jr., James M Grimwood, and Charles C Alexander, *This New Ocean: A History of Project Mercury* (Washington, D.C.: NASA, 1966) 150

[84]Swenson, 134-137

[85]Mark Harrison "The Economics of World War II: An Overview" *The Economics of World War II: Six Great Powers in International Comparison* (Cambridge: Cambridge University Press, 1998)

[86]René Francillon, *McDonnell Douglas Aircraft since 1920: Volume II* (Annapolis: Naval Institute Press, 1979) , 38

cancellation of wartime contracts."[87] Afterward, the company was able to work on Navy missile contracts, which put them in position to build the first vehicle to take Americans to space.

James McDonnell Jr., founder of the company, pressed his pen to paper on February 5th, 1959, making his company prime contractor for Project Mercury. The contract included an estimated cost of $18,300,000 along with a $1,150,000 fee. While it was a small portion of their net sales at this point (sales in 1959 had ballooned to over $435,000,000), it is interesting to note that this single contract rivaled their entire sales during the peak years of WWII. In the year before they were finally selected, the design process for the Mercury capsule was internally funded, meaning that the initial money invested in the first American spacecraft was actually entirely private capital.[88]

The subsequent design process involved collaboration between a government agency and a commercial organization on an unprecedented scale. Ideas were constantly exchanged between the two entities, and a close relationship developed between the STG engineers and those in the McDonnell Advanced Design section.[89] This was partially out of necessity. The mission specifications from NASA, and the fact that the agency would own and operate the machines, meant very strict requirements constraining the entire process. The biggest problem encountered by the McDonnell team were the weight requirements necessary for launching the capsule on top of an Atlas rocket. After Wernher von Braun expressed concerns

[87]Ibid., 9
[88]Swenson, 138
[89]Ibid., 138

over McDonnell's progress in this area, the STG team kept an even closer watch over their contracted partner.[90] Following the inspection of the first full-scale mockup of the capsule, the STG decided to implement a formal contract-monitoring office.[91]

The project rapidly progressed, and as it did so complications piled up, as did costs. Within a month of receiving the contract, in a foretokening event for the space industry, McDonnell indicated that research, development, equipment costs, and especially testing would require a doubling of the original contract costs. Such an increase was flatly denied by Abe Silverstein of NASA. But it did not matter. Because of the issues involves in man-rating the capsule, modifying the design and production iterations to fit the requirements of the STG, and the extensive testing required to ensure reliability, the costs kept rising. This was accomplished through so-called "contract change proposals" (CCPs), which accumulated, inflating the size of the spacecraft contract.[92]

As time wore on, the production process was plagued by delays. Some were caused by assembly problems (such as the difficulties of working in the small interior of the capsule), some by the increasingly restrictive quality controls imposed by the STG. As a result, completion of the first capsules was delayed by months.[93] Despite NASA's original rejection of McDonnell's petition for doubling their contract, but 1960 the size of the contract had exploded to $70,000,000. Even with this massive increase, McDonnell estimated that the

[90]Logdson, 27-29
[91]Swenson, 149
[92]Ibid., 251
[93]Ibid., 249-250

contract was only 60 percent complete.[94] Over the course of the next year, with the help of the CCPs, the project moved more swiftly towards completion.

On May 5, 1962, Alan Shepard finally stepped into the seventh Mercury capsule produced by McDonnell, aptly named *Friendship 7*. His foot slipped on one of the elbow supports as he climbed aboard, demonstrating that not every detail can be accounted for, even with the most thorough analysis. Pure oxygen began to fill his lungs as he sat waiting through several launch delays. Then after four hours and fourteen minutes sitting in McDonnell's tiny spacecraft, millions of people watched the Redstone rocket carry the first American into space.[95]

A year later, modified McDonnell capsules had taken Americans to orbit on an Atlas rocket, and the original *Friendship 7* was placed next to the Wright Flyer and the *Spirit of St. Louis* in the Smithsonian Institution. During this eventful year, the capstone project in American spaceflight, Apollo, was beginning its development.[96] When *Faith 7*, the last of the Mercerury missions, dropped into the ocean carrying Gordon Cooper, it marked the 20th and last Mercury capsule McDonnell built for NASA.

In the end, the cost of the spacecraft amounted to 37 percent of the entire project's costs, or somewhere around $140,000,000—seven times the amount stipulated in the original contract.[97] Four thousand suppliers, nearly six hundred subcontractors from twenty-five

[94]Ibid., 251
[95]Grimwood, *Ocean*, 351-352
[96]Ibid., 436
[97]Ibid, 508

states were involved just in supplying parts for the capsule.[98] For private industry, it marked an unprecedented mobilization and engagement with a government agency, all for a singular purpose. It should be noted that this was not technically exploration on the part of the private companies—they simply constructed the vehicles. The exploration was done by NASA, the funding came from NASA. This was a government-directed voyage of discovery. However, the importance of private industry in making these voyages a reality should not be understated, and understanding it is essential for assessing their current and future role in the American expansion into space. Their historical role, established in Project Mercury, was taken to the next level with the Project Apollo.

Over the course of Mercury, Gemini, and Apollo, NASA used similar contracting processes to the one described for the Mercury capsule. Even while work was being done on Mercury and Gemini, the Apollo project was gearing up to take American to the Moon on the largest rocket ever built. For the former two projects, NASA had used rocket boosters based on ICBMs produced by military agencies like the Army Ballistic Missile Agency (ABMA), where Wernher von Braun was assigned. For the mission to the Moon, they required a rocket on an entirely different scale. In 1960, von Braun and his team were transferred to NASA in order to being work on such a rocket—the legendary Saturn V.[99]

The program to manufacture the Saturn launch vehicle quickly became a massive

[98]Swenson, 137

[99] Roger E. Bilstein, *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles*, (Washington D.C.: NASA, 1980) 21

undertaking for the aerospace industry. It involved coordinating public and private entities under the direction of the Marshall Space Flight Center.[100] The vehicle was planned to be a multistage rocket with several potential launch configurations depending on the required task. Its design originated at the ABMA, and guidelines for its development were established within a committee chaired be Abe Silverstein. After President Kennedy made the moon landing a priority, NASA received the resources necessary to make the ambitious launch system a reality.[101]

One of the essential pieces of the new launch system was the upper stage, common to the Saturn IB and Saturn V configurations. This upper stage was originally known as the "S-IV," and was the first major piece of the rocket to be contracted out. Like with the 1958 NACA meetings, NASA had potential contractors submit design proposals that fit within mission specifications. Eleven contractors presented designs to NASA in 1960. The final two companies in the competition were Convair and the Douglas Aircraft Company. NASA administrator T. Keith Glennan ended up choosing Douglas for several reason, including the fact that Convair still had business without the contract—their "Centaur" rocket stage was already planned for use as an upper stage in the Saturn system. In a foreshadowing remark, Glennan explained that he chose Douglas over Convair because "a monopolistic position in this field seems possible."[102]

The work that Douglas conducted on the S-IV was done in close contact with NASA

[100]Ibid., 68
[101]Ibid., 23-56
[102]Ibid., 157-159

engineering. The design on the stage went through several iterations, quickly morphing into the rocket that became the S-IVB stage of the Saturn V. The S-IVB utilized one J-2 engine, built by Rocketdyne.[103] This was, according to the Douglas engineers, the most compelling stage in the Saturn V system. It was required to be incredibly high-energy in a lightweight package, in order to perform the essential task of boosting the Apollo spacecraft from LEO into the lunar transfer orbit.[104]

The original contract signed by Douglas for the S-IV stage was small in comparison to the new contract needed to build the S-IVB. Awarded in 1962, the contract for the S-IVB amounted to $141,000,000. This meant that combined with their contract for the S-IV, Douglas was slated to receive over $200,000,000 for their work in the Saturn program.[105] As this work progressed, the nature of the contract changed. In the Mercury program and the early days of the Apollo program, contracts were made on a cost-plus-fixed fee basis (see the original Mercury capsule contract), to be modified using the CCP process. In 1966, the contract with Douglas for the S-IVB changed to a cost-plus-incentive free agreement. This meant that the amount given to Douglas would change as the cost and schedule for developing the rocket evolved. By this point the contract had increased to over $590,000,000.[106] With a cost-plus contract, the stage was made incredibly reliable and completely up to the standards of

[103]Ibid., 141, 160
[104]Ibid., 161-162
[105]Douglas to build, test stage of new rocket. 1962. Los Angeles Times (1923-Current File), Sep 02, 1962. http://login.ezproxy1.lib.asu.edu/login?url=http://search.proquest.com/docview/168189475?accountid=4485
[106]NASA makes revision in douglas pact. 1966. Los Angeles Times (1923-Current File), Jun 28, 1966. http://login.ezproxy1.lib.asu.edu/login?url=http://search.proquest.com/docview/155455820?accountid=4485

NASA, but the cost increased far beyond the original estimates.

On the 16th of July, 1969, Neil Armstrong, Buzz Aldrin, and Michael Collins began their voyage of discovery. After launch, the first stage of the Saturn V gave the astronauts a bumpy ride through the thickest part of the atmosphere, devouring its liquid fuel. With a jerk, the engines shut down, the S-IC detached, and the SII lit its engines. After nine minutes, the astronauts felt the SII shut down and detach. For a moment, they floated weightless in the command module. Then, ever-so-gently, their backs sank into their seats as the Douglas S-IVB pushed them into parking orbit with a 12-minute burn. With the engines quiet, the astronauts could take a look out the window onto Earth, as the countdown panel in front of them methodically kept them aware of when the S-IVB would restart its engines. They were pressed back into their seats once again as the Douglas stage sparked back to life, pushing them towards the Moon.[107]

III. The Post-Apollo Era

These were the halcyon days of the American space program. NASA's annual budget hit $5.2 billion at its peak in 1965. According to Roger Launius, if the organization had received the same proportion of the federal budget in 2006 as it did in 1965, it would have had access to over $77 billion.[108] The myriad contractors required to make their ambitious programs possible drew far more money than either they or NASA had ever anticipated, in

[107]Bilstein, 371
[108]Launius, 16

part due to the unanticipated complexity of the projects and the absolute importance of safety and reliability. In the period between the introduction of the cost-plus-incentive contract with Douglas and the realization of their efforts in 1969, two event occurred that hinted at the future of the space-launch industry in the post-Apollo era.

In 1966, Douglas engineers Philip Bono and T.J. Gordon proposed an audacious plan for the S-IVB. In a paper presented to the European Symposium on Space Technology in May of that year, they suggested that an S-IVB could be modified in such a way that the stage would be completely recoverable. Their proposed accomplishing this with a combination of parachutes and retrorockets that would drop the stage into the ocean.[109] In the paper, they also considered an alternative technique that would eventually allow for land-based stage recovery. This involved restarting the stage's engine to initiated braking thrust, before landing the stage on four extendable legs.[110]

The very next year, Douglas was sent on a new trajectory. It had been struggly along with the entire commercial aircraft industry, and McDonnell was keeping a keen eye on them. McDonnell's financial position was secure, as its Phantom II fighter had become an integral part of the Navy, Marine, and Air Force fleets. However, McDonnell still wanted to reduce its reliance on military contracts. In January of 1967, a merger between the two companies was approved, and Douglas was able to continue operating with the resources of the McDonnell

[109]"S-IVB Recovery Proposal," *Flight International* 26 (1966): 854

[110]Marvin Milse.. 1966. "Space junk held peril to populace." Los Angeles Times (1923-Current File), May 26, 1966. http://login.ezproxy1.lib.asu.edu/login?url=http://search.proquest.com/docview/155423842?accountid=4485

company. The new McDonnell Douglas Corporation had become an incredibly diverse company, builder of the S-IVB, as well as the Thor and Delta rocket families, not the mention the aircraft that constituted most of its business.[111]

McDonnell Douglas continued to operate for some time, but the merger that had created it was only one in a series of mergers that consolidated the aerospace industry, and especially the rocket launch capabilities within the United States. The history of the Glenn L. Martin company begins a long narrative. Early on in 1916, they merged with the Wright Company, and then almost fifty years later they merged with the American-Marietta Company in 1961.[112] Martin Marietta operated for some time, developing the Titan family of missiles that became the boosters for the Gemini Project.[113]

Meanwhile, the Convair company was refining an ICBM it was contracted to build for the Air Force in the 1940s, a rocket that was dropped and revived by the Air Force several times. This rocket, the Atlas, was eventually completed in the 50s, and was used as a booster for most of the Project Mercury launches.[114] In 1953, Convair was acquired by General Dynamics, who operated it until 1994, when Martin Marietta acquired the Space Systems portion of the company in a $209 million deal.[115] This brought the Titan family and the

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[111]Francillon, *Aircraft*, 14-16, 27

[112]"AERO CORPORATIONS MERGE." New York Times (1857-1922), Aug 08, 1916.
"MERGER OF MARTIN AND MARIETTA SET; Holders of Both Concerns Vote Approval of Plan at Special Meetings NEW STOCK TO BE LISTED Justice Agency Declines to Comment on Reports It Is Studying Deal COMPANIES HOLD ANNUAL MEETINGS" New York Time, Oct 10, 1961

[113]Barton C. Hacker and James M Grimwood, *On The Shoulders of Titans: A History of Project Gemini*,(Washington, D.C.: NASA, 1977) 41

[114] Alexander et al., *Ocean*, 21-31, passim

[115]"A Convair-Canadair Link-up" *Flight International,* April 17, 1953, 476

Atlas/Centaur family into the same company. It was expected that the merger would save nearly $450 million in launch costs for the United States.[116]

The 1990s brought the most dramatic consolidation of launch capabilities. In 1995, the Lockheed Corporation and Martin Marietta formed the Lockheed Martin Corporation in a $10 billion merger.[117] Then Boeing, which had played a crucial role in the Apollo program by manufacturing the Saturn V first stage, began to step up its game.[118] In 1996, Boeing acquired Rockwell International, the legacy of the North American Aviation company that played a key role in manufacturing both the Saturn V and the Space Shuttle.[119] With this acquisition they also received Rockwell's half share of the United Space Alliance, the joint venture with Lockheed Martin that operated the Shuttle.[120] Then, in 1997, Boeing swallowed up McDonnell Douglas in a $13.3 billion deal, giving it control over the Delta rocket family.[121]

Boeing, already the prime contractor for the International Space Station, had essentially acquired the biggest parts of the American space program left over after Lockheed's merger with Martin Marietta, and had done so in only a few years. The American space launch capabilities, at this point primarily manifested in the Delta and Atlas rocket families, as well as the Space Shuttle, were entirely under the roof of two of the largest aerospace companies. However, this was not the end of the consolidation, and was merely

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[116]"Martin Marietta closes GD deal" *Flight International,* May 11-17, 1994, 19

[117]"COMPANY NEWS; MARTIN MARIETTA-LOCKHEED MERGER IS APPROVED" New York Times, March 16, 1995

[118]Bilstein, 192

[119]Ibid., 211

[120]Graham Warwick "...and expands with Rockwell" *Flight International* August 7-13, 1996, 5

[121]Graham Warwick "Goodnight MDC" *Flight International* January 1-7, 1997, 20

the death throes for competition.

With the portion of the federal budget directed to space launches declining, and the costs of operation rising, Lockheed Martin and Boeing announced in 2005 that they were going to merge their rocket divisions. The joint venture was called the United Launch Alliance (ULA), and it marked a temporary end to any competition for rocket launches in the United States.[122] In 2006, a fledgling SpaceX (which had yet to launch a rocket), sued to prevent the creating of ULA, on the grounds that it violated anti-trust laws. The suit was dismissed, the court citing that SpaceX was not ready to compete and therefore could not demonstrate any direct injury.[123] In October of that year the FTC cleared Boeing and Lockheed Martin to create ULA, and competition for rocket launches in America officially ended.[124] The monopolistic industry NASA administrator T. Keith Glennan had tried to forestall so many years ago had come to pass.

This situation has only started to be reversed, with the maturing of SpaceX and Orbital Sciences' launch operations, and the flurry of events described at length in the introduction. With the efforts of SpaceX, not only is the nightmare of administrator Glennan ending, but the dreams of Douglas' Phil Bono are being realized. SpaceX sued the U.S. Air Force in 2014 for withdrawing satellite launches it had planned to compete out, giving them all to ULA on a sole-source contract. We do not know how the government would have ruled if the case

[122]Renae Merle "Boeing, Lockheed Join Rocket Divisions," *Washington Post*, May 3, 2005
[123]Braddock Gaskill, "SpaceX vs. Boeing and Lockheed Lawsuit Dismissed," *Nasaspaceflight.com*, February 17, 2006
[124]"FTC gives clearance to United Launch Alliance," *Spaceflight Now*, October 3, 2006

had gone through, because in 2015 the Air Force pledged to return competition to those launches in order to get SpaceX to drop the suit.[125] The company has performed numerous tests of propulsive landings on four legs. It has successfully returned four Falcon 9 boosters from suborbital trajectories to perform propulsive landing maneuvers over the ocean. Recovery of a booster could very well happen within a month of the completion of this thesis.

In addition, the contracts given to SpaceX, Orbital, and Boeing are changing the way NASA interacts with its contractors. In September of 2014, NASA chose SpaceX and Boeing as the contractors for the CCtCap program. These contracts, worth $6.8 billion, are firm fixed-price contracts, in contrast with the various cost-plus contracts used by NASA historically. Similar to the commercial cargo programs, the contractors will own and operate the transport systems themselves. NASA will, in this instance, simply be a customer, and as such will have comparatively little interaction with the internal affairs of these companies.[126] The companies, especially SpaceX, are also finding private customers interested in their launch services.

Primarily led by the communication industry, the market for space launches has increased dramatically since the 1990s. In 1996, commercial revenues in space sped past government spending, and the next year saw three times the number of commercial satellite launches.[127] With this boom in the space economy, companies involved in every part of the space industry have arisen. SpaceX and Orbital are the latest in a long line of private launch

[125]Mike Gruss "SpaceX, Air Force Settle Lawsuit over ULA Blockbuy" *Space News*, January 23, 2015

[126]"NASA Chooses American Companies to Transport U.S. Astronauts to International Space Station", http://www.nasa.gov/press/2014/september/nasa-chooses-american-companies-to-transport-us-astronauts-to-international/#.VN4upfnF98E

[127]Launius, 29

endeavors, many of which have failed. Their recent success, however has sparked competition. Immediately after the CCtCap announcement, Jeff Bezo's Blue Origin announced that it was partnering with ULA to develop a rocket engine as a replacement for the Russian engines used on the Atlas rockets.[128] Shortly after, ULA announced that it was going to develop new rockets to eventually replace the Atlas and Delta families. This "New Generation Launch System" booster will be based on the Blue Origin engine, but is not targeted to be operational until 2019. It is being accompanied by a restructuring of the company's organization.[129]

Like the slumbering HBC, the sleeping giant has been awakened, and a new climate of competition is beginning to appear. The effects of this have been felt across the globe. Directly inspired by a visit to SpaceX facilities and the threat of their lower launch costs, French lawmakers attempted to start development of their Ariane 6 rocket earlier than planned, and have started talking about attempting to accelerate innovation within France.[130]

These companies are not the only ones involved in the commercial space renaissance. Other companies taking advantage of this climate include Virgin Galactic, who are creating a space plane system for tourism. Planetary resources is investigating the possibility of mining in space. Navigation is being tackled by KinetX. NASA has contracted with Bigelow

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[128]"United Launch Alliance and Blue Origin Announce Partnership to Develop New American Rocket Engine" http://www.blueorigin.com/media/press_release/united-launch-alliance-and-blue-origin-announce-partnership-to-develop-new

[129]Tory Bruno, interview by Jason Rhian, *Spaceflight Insider*, January 26, 2015

[130]Peter B. De Selding "Citing SpaceX threat, Lawmakers In France Urge Early Ariane 6 Start" *Space News*, November 12, 2012

Aerospace to test a privately developed inflatable habitat on the International Space Station. It is schedule to launch on the eight SpaceX cargo mission.[131] The 21st century may not look like Clarke and Kubrick's fantasy just yet, but it is certainly bringing new and exciting developments to the space industry. As the development of LEO continues, these companies will be providing the infrastructure necessary to push further. SpaceX has already expressed a desire to send humans to Mars, and Planetary Resources has ambitions to send robotic probes to asteroids. Increased competition and frontier development holds the promise of opening up new opportunities for both human and robotic exploration, as part of an integrated expansionary process.

Conclusion

This brings us back to our original question. The new evolution of the American space industry has been celebrated by some, and criticized by others. Our investigation of historical episodes in exploration might shed some light on the potential of a commercially driven expansion into space. In doing this, we must be careful. In his monograph on historical analogs for space commerce, Roger Launius discusses the “use and abuse” of such analogies. The approach here is informed by the warnings and guidelines he provided.

First, let us look at the overall narrative of each country's step into the unknown. The

[131]“NASA to Test Bigelow Expandable Module on Space Station
“ http://www.nasa.gov/mission_pages/station/news/beam_feature.html

focus here is on the reasons each nation sent their initial expeditions, and the evolution of their subsequent expansion. We will attempt to establish where the similarities between these episodes exist, in order to determine how applicable the historical precedent is to our own situation. Oftentimes, in cases like this, understanding how situations differ can be equally beneficial. In our case, certain events that may be considered crucial will be of secondary importance when considering a broader perspective. After this process, we might get an indication on how to apply any lessons learned to space policy.

In each narrative of expansion, we seem to have a fairly similar arc—extremely limited private exploration precedes large government expenditure and voyages of discovery, and then a market develops largely dominated by private interest. These markets are built on the back of frontier developments that provide a base for further exploration, often motivated by the desire to expand the market. In the case of expansion into space, we seem to be just transitioning into a sustainable market based on frontier development, with further exploration on the horizon. If this is the case, it will be useful to know why governments get involved in the first place, and why the nature of expansion changes.

In the cases of Spain and the United States, you actually see a remarkably similar narrative. Both nations were involved in large wars, immediately after which they developed a rivalry with a nation that survived the war. Using technological, industrial, and ideological development forged in the crucible of the war itself, they funded voyages of discovery in a race towards certain goals of exploration. Both races were infused with ideological justifications (Christianity and democratic capitalism, respectively), but were ultimately

motivated mostly by economics and geopolitics.

Spain's economic ends are somewhat more obvious in this case—gold and trade are more tangible results of expansion. After setting up initial colonies, they let a market develop that served their mercantile goals. Britain had similar motivations, becoming involved in the same race as Spain and Portugal—to find a route to Asia. In both cases, the initial expeditions were royally funded, but subsequent settlement and exploration was largely done by private individuals and companies. This was leveraged by their governments with taxation, and despite the fact that direct involvement from the government was short-lived, they maintained a heavy regulatory presence.

The United States' economic incentives are somewhat more subtle, but no less present. The signaling value of spaceflight was clear, as we have seen from Alexander MacDonald. It meant that more countries were likely to enter into the global economic system dominated by the United States. It also provided an incredibly valuable strategy in the heated international relations of the time. In addition, it accelerated scientific development. In fact, Macdonald brings up arguments that the spaceflight engineers and scientists were able to leverage the political and economic motivations of the United States to achieve their own ends.[132] That sort of strategy seems similar to the conquistadors of Spain, who used Spain's mercantile ambitions to create little kingdoms of their own in America.

The evolving balance between private interests and state involvement seems similar in all these cases as well. Initially, it was characterized by fairly sparse private investment,

[132]MacDonald, 330-333

dominated by wealthy patrons like Prince Henry or the Guggenheims. The motivations of these patrons were very similar. Although Prince Henry stood to profit from funding his expeditions, he was motivated in large part by a desire for prestige and the fulfillment of his perceived destiny.[133] The wealthy patrons who funded observatories and early rocketry often had remarkably similar motivations—to increase their status in their community or to pursue an intrinsic interest.[134] Afterward, you have the intense but brief government involvement motivated by temporary geopolitical circumstances. This led to what could be described as a hybrid model—dominated by private capital and motivations, but with government involvement in regulation and occasional specific matters as the need arises. Recent developments in the space industry seem to be the beginnings of this third phase.

There seem to be general similarities in narrative arc—but why? The particular factors of expansion in each scenario possess similar qualities that might help to explain this. The first of these factors is double sided: risk and cost. The fact that the private activities preceding government involvement were limited and dominated by already wealthy individuals can be explained by this quality of expansion. Both trans-oceanic voyages and rocketry involved excessive costs and risks not lightly taken on by just any private individuals or organizations. When sufficiently motivated, the government is able to take on this risk themselves, usually in the form of large-scale voyages of discovery. Afterward, the role they play in private activities is largely in helping to abate risks and costs. This was the

[133]Parry, 35-36
[134]MacDonald, passim

primary reason why the Hudson's Bay Company wanted monopolistic guarantees from England, for example.

This is rooted in the fact that expansion in these cases involves long journeys though inhospitable environments. Like the many instances of rocket failure, the story of the HBC's expansion is littered with tales of failed or delayed expeditions and lost crews. The story of the *Eaglet* being sent back due to weather is a scenario all too familiar to someone who follows rocket launches. When this is the situation, maximizing the gains from each journey becomes the most important problem. This is why in the case of the Canadian fur trade, increasing cargo capacity of ships was of prime importance. In the case of spaceflight, this problem is usually tackled by trying to eliminate excess weight. The reason for this strategical discrepancy is one of the major differences when it comes to cost and risk analysis.

The difference is that getting cargo into space is simply physically more difficult than sailing across the ocean. Space-faring rockets are a new technology, involving unprecedented problems and unforeseeable difficulties. This is largely the reason why cost-plus contracts were necessary in the days of Mercury and Apollo. As seen in that chapter, making the rockets and spacecraft sufficiently capable and reliable was many times more expensive than anyone anticipated. Because of this difficulty, the particular dynamic of risk and cost management will probably differ markedly from our historical precedents. This contrast might manifest itself in the particular balance between government and private involvement over the coming years.

The gradual switch to fixed-price contracts does seem to signal that cost-plus contracts

were only necessarily temporarily as the technology was being pioneered. The recent loss of Orbital Sciences' Antares and Virgin Galactic's Spaceship Two, however, show that we still have a ways to go before the industry is fully mature, and the balance can truly shift in its direction. The dangers encountered by early ocean explorers were similar in nature and potentially even more destructive to human life, due to the amount of crew on their vessels. But the fact that they were able to carry that many people at all is evidence of the relative difficulty involved in space travel.

Another factor, related to the first, is the role of competition. In the Spanish and British experience, competition was often artificially limited. This was the result of two important facets of their expansionary process. The first is not perfectly applicable to space exploration, and that is the role of mercantilism. By creating monopolies, both countries were able to ensure that private enterprise maximized their potential profits, and therefore the potential taxes gleaned by the government. The second facet is the nature of competing in high-cost, high-risk environments. In the case of the Canadian fur trade, competition grew as the industry began to expand beyond the original frontiers. In the launch industry, competition between aerospace companies existed from the beginning. As was seen in both cases, competition can end up being intolerable for some or all of the companies involved. This can lead to mergers and acquisitions, and eventually monopoly. This is another reason why a hybrid situation usually develops. Depending on the priorities of the state, it can attempt to either limit or increase competition.

One lesson that can be learned from the historical instances here is that monopolies

have usually meant a decline in the exploration part of expansion. The HBC's long slumber on Hudson Bay is an example of this. Their exploration was mainly motivated by competition with the North West Company, and after their merger, by competition with the Americans. According to the OECD the number of successful space launches in the United States has declined by about half after the initial space market boom in the late 1990s.[135] There are certainly other factors that influence this, but an absence of launch competition as a result of consolidation might at least partially explain this. But overall, one can not say that space activity, especially with regards to human exploration, has been particularly lively during this period.

What there have been, however, are various robotic expeditions that have been remarkably successful. This is another major difference between space and historical terrestrial exploration. This type of mission was not an option for European countries expanding in the early modern era. What this means for a developing space economy and the future of exploration is not entirely clear, but it will certainly mean that previous expansionary models are not entirely adequate in analyzing our current position. One thing it might signal is NASA changing into a wholly scientific organization. Perhaps this trend will continue and NASA 's role will become similar to that of the Spanish House of Trade, or the early NACA.

Another major difference that complicates our comparison is the absence of native human populations. This is particularly applicable to the prospect of colonization and

[135]OECD(2011), "Space launch activities worldwide", in *The Space Economy at a Glance 2011*, OECD Publishing.

frontier development. Many of the difficulties encountered in colonizing North America were similar to those one comes across when considering colonization in space or on other planets. This is why Newman found a lunar colony to be an apt analogy for early HBC posts. However, the problems of colonization in space, while of a similar nature, are on an entirely different scale, and there are no local populations to help ease the transition. In Mexico and Canada, settlers were able to either exploit the Native Americans or trade with them, easing the process of expansion and the acquisition of resources. Unfortunately this came at a massive cost to the native populations. Oddly enough the absence of a major ethical issue with historical expansion makes rapid space expansion less likely.

Additionally, taking into account local populations is not actually wholly absent from space exploration. Planetary protection standards are an important part of NASA practices, ensuring that biological contamination does not occur in the course of a mission. This is done, in part, to aid in the organization's search for life on other planetary bodies.[136] This is however, a practical scientific concern and not necessarily a human rights concern. But it does take up another spot on the lift of factors that make space expansion very different from our historical precedents.

Where the analogies are the strongest seem to be in three key areas—the motivations and nature of government involvement, the roles and effects of competition and monopoly, and the role of private enterprise before and after government involvement. A narrative arc

[136]NASA Office of Planetary Protection - "Overview" http://planetaryprotection.nasa.gov/overview

involving all these factors seems to be followed, involving a complex interplay between frontier development and exploration, in the multifaceted process of expansion. Taking this into account our assessment of current space policy has to change. In considering American space exploration, Alexander MacDonald makes a critique of a certain take on space history:

> From this perspective, the Apollo Program should not be seen as the classical model of American space exploration, but rather as an anomaly. From a long-run historical perspective, this 'Apollo Anomaly' represented an exciting new paradigm for American space exploration, but ultimately a short-lived and ephemeral one. NASA and the American spaceflight community has continued to try to emulate the superficial conditions of the anomaly—with new Presidential directions and planetary destinations—in the hope that the anomalous funding, appetite for risk, and political momentum will return, but to no avail.[137]

This critique seems to be supported by the history of Spanish and British expansion into the Americas, which was dominated by private investment and initiative before and after brief periods of government sponsored voyages of discovery. The recent developments in spaceflight seem to suggest that the paradigm is shifting, just like it did in the 16th and 17th centuries.

This has many implications when considering recent space policy developments. One Critical realization is that just because the government stops directly sponsoring expansion

[137]MacDonald, 334

doesn't mean it stops being involved at all. In our historical episodes, governments leveraged private expansion for their own mercantile ends. In doing so, they helped create conditions for private investments to thrive, at least to a certain extent. The United States, with the new direction from the Obama administration, seems to be starting down a similar path. Instead of being inspired by mercantile ambitions, however, it is inspired by the knowledge that a thriving and competitive space market will be the best thing for near-space development, and eventually further efforts in space exploration.

In pursuing this sort of strategy, it is possible to take what worked from the mercantile model and eschew what may have limited it. This means creating the conditions for competition, and limiting the opportunity for monopolies to develop that cause stagnation, at least if our priorities include exploration and innovation. This seems to be exactly what NASA is doing with the commercial crew and cargo programs. The organization still has ambitions for larger projects that might take them to Mars, but at this point it is entirely possibly that a commercial company will beat them to the red planet. Pursuing these types of programs exclusively, in lieu of promoting competition and developing a market, seems like it would be a step back. However, we are still extremely early in spaceflight development, even considering how far we have come. The era of government-led voyages of discovery might not be over quite yet, but it is at the very least waning.

Right now, the new space economy seems promising. Like when New Spain's production outpaced that of Seville, it has the potential for incredible long-term growth. And like when conquistadors pressed forward into the mainland of a new continent, and HBC

explorers penetrated into the wilds of Canada, new space companies have the potential to bring about a new era of exploration. If NASA learns from historical precedent, even if it continues to perform voyages on its own, it will continue to help the new space market mature.

If we want to stretch the analogy, and speculate a little, we might consider LEO a sort of Mediterranean Sea. It is a facilitator of communications and trade between nations, and a proving ground for the technologies that will take us further. As we push beyond our comfort zone, our primary motivations will have to be more sustainable than simple geopolitical rivalry or nationalism. These are temporary and fleeting, whereas industrialism and individual ambition are ever-present. Whatever happens, if we desire to continue exploring, it will require development of our frontier. The best way of accomplishing this is to help space markets grow more robust, creating a stable launch pad for further expansion.

After the Falcon 9 first stage began its suborbital dance in preparation for the January landing attempt, the Dragon spacecraft it carried shot into orbit on the upper stage booster. The engine cut out and the booster separated, leaving Dragon to drift silently above the Earth. The spacecraft deployed its solar wings and carefully corrected its trajectory so that in a short while it would catch up with the International Space Station. Once it had arrived, the robotic Canadarm reached out and grabbed it, slowly berthing it with to station. Astronauts Reid Wiseman and Alexander Gerst then climbed in to unload the cargo Dragon had carried to them.

If Reid or Alexander had looked out of the station's cupola module at the right time, with sunshine and without clouds, the may have been able to catch sight of the upper reaches of Canada. And in between Hudson Bay and the Gulf of St. Lawrence, they would have seen a perfect ring of water sparkling in the sun, easily visible from their celestial outpost. They wouldn't be looking at a normal lake, but at the Manicouagan Crater, the largest visible impact crater on Earth. Five hundred years before, as Europeans were exploring what was to them a new world, sitting right near them was evidence of our position in the solar system, and the incredible new frontier where we would eventually expand.

Bibliography

"A Convair-Canadair Link-up" *Flight International,* April 17, 1953, 476

"AERO CORPORATIONS MERGE." New York Times (1857-1922), Aug 08, 1916.

Armstrong, Neil. Statement to the Senate, Committee on Science and Transportation. *NASA Human Space Flight Programs*, Hearing, May 12, 2010 Available at: http://www.c-span.org/video/?293473-2/future-human-space-flight-apollo-astronauts

Bilstein, Roger E., *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles*, (Washington D.C.: NASA, 1980)

Bishko, Charles Julian "The Spanish and Portuguese Reconquest, 1095-1492," in *A History of the Crusades, Volume III* ed. Harry W. Hazard (The University of Wisconsin Press)

Bruno, Tory interview by Jason Rhian, *Spaceflight Insider*, January 26, 2015

"Commercial Crew Program-The Essentials" http://www.nasa.gov/content/commercial-crew-program-the-essentials/

"COMPANY NEWS; MARTIN MARIETTA-LOCKHEED MERGER IS APPROVED" New York Times, March 16, 1995

Corliss, William. "NASA Sounding Rockets, 1958-1968: A Historical Summary." Section II

Davidson, Gordon Charles , *The North West Company*, (Berkley: University of California Press, 1918)

Davidson, Miles H. *Columbus then and now: a life reexamined*, (University of Oklahoma Press: 1997)

De Selding, Peter B. "Citing SpaceX threat, Lawmakers In France Urge Early Ariane 6 Start" *Space News*, November 12, 2012

"Douglas to build, test stage of new rocket." 1962. Los Angeles Times (1923-Current File), Sep 02, 1962. http://login.ezproxy1.lib.asu.edu/login?url=http://search.proquest.com/docview/168189475?accountid=4485

"Fact Sheet, National Space Policy" http://www.fas.org/spp/military/docops/national/nstc-8.htm

Francillon, René , *McDonnell Douglas Aircraft since 1920: Volume II* (Annapolis: Naval Institute Press, 1979)

"FTC gives clearance to United Launch Alliance," *Spaceflight Now*, October 3, 2006

Galbraith, John S., *The Hudson's Bay Company As And Imperial Factor 1821-1869,* (Berkley: University of California Press, 1957)

Gaskill, Braddock "SpaceX vs. Boeing and Lockheed Lawsuit Dismissed," *Nasaspaceflight.com*, February 17, 2006

Gibson, Charles, *Spain in America*, (New York, Harper: 1966)

Goetzmann, William H., *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West*, (Toronto: Knopf, 1966)

Greason, Jeff, interview by Eric Berger, *Houston Chronicle.* August 21, 2014

Gruss, Mike "SpaceX, Air Force Settle Lawsuit over ULA Blockbuy" *Space News*, January 23, 2015

Hacker, Barton C. and James M Grimwood, *On The Shoulders of Titans: A History of Project Gemini*,(Washington, D.C.: NASA, 1977)

Harrison, Mark "The Economics of World War II: An Overview" *The Economics of World War II: Six Great Powers in International Comparison* (Cambridge: Cambridge University Press, 1998)

Innis, Harold A., *The Fur Trade In Canda*, (Canada: University of Toronto Press, 1956)

Kennan, George F. (as "X"), *The Sources of Soviet Conduct*, Foreign Affairs, 1947

Launius, Roger D., *Historical Analogs For The Stimulation of Space Commerce*, Monographs in Aerospace History, no. 54 Washington, D.C., 2014

Logsdon, John M., ed., *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program*, (Washington, D.C.: NASA History Division, 2008)

MacDonald, Alexander, 'The Long Space Age: An Economic Perspective on the History of American Space Exploration' (University of Oxford, 2013)

"Martin Marietta closes GD deal" *Flight International*, May 11-17, 1994, 19

McCarthy, Joseph "Army-McCarthy hearings," 1954, broadcast by ABS (accessed through YouTube)

"MERGER OF MARTIN AND MARIETTA SET; Holders of Both Concerns Vote Approval of Plan at Special Meetings NEW STOCK TO BE LISTED Justice Agency Declines to Comment on Reports It Is Studying Deal COMPANIES HOLD ANNUAL MEETINGS" New York Time, Oct 10, 1961

Renae Merle "Boeing, Lockheed Join Rocket Divisions," *Washington Post*, May 3, 2005

Miles, Marvin. 1966. "Space junk held peril to populace." Los Angeles Times (1923-Current File), May 26, 1966. http://login.ezproxy1.lib.asu.edu/login?url=http://search.proquest.com/docview/155423842?accountid=4485

"NASA Awards Space Station Commercial Resupply Services Contracts" http://www.nasa.gov/home/hqnews/2008/dec/HQ_C08-069_ISS_Resupply.html

"NASA Chooses American Companies to Transport U.S. Astronauts to International Space Station", http://www.nasa.gov/press/2014/september/nasa-chooses-american-companies-to-transport-us-astronauts-to-international/#.VN4upfnF98E

"NASA makes revision in douglas pact." 1966. Los Angeles Times (1923-Current File), Jun 28, 1966. http://login.ezproxy1.lib.asu.edu/login?url=http://search.proquest.com/docview/155455820?accountid=4485

NASA Office of Planetary Protection - "Overview" http://planetaryprotection.nasa.gov/overview

"NASA to Test Bigelow Expandable Module on Space Station " http://www.nasa.gov/mission_pages/station/news/beam_feature.html

National Aeronautics and Space Act of 1958. Public Law 85-568

Newman, Peter C., *Company of Adventurers*: *Volume I*, (Canada: Penguin, 1985)

O'Callaghan, Joseph, *Reconquest and Crusade in Medieval Spain*, (University of Pennsylvania Press, 2003)

OECD(2011), "Space launch activities worldwide", in *The Space Economy at a Glance 2011*, OECD Publishing.

Parry, J.H., *The Age of Reconnaissance* (London, 1963)

"President Bush Announces New Vision for Space Exploration Program," http://history.nasa.gov/Bush%20SEP.htm

"Remarks by the President on space exploration in the 21st century" http://www.nasa.gov/news/media/trans/obama_ksc_trans.html

"S-IVB Recovery Proposal," *Flight International* 26 (1966)

Swenson, Lloyd S Jr., James M Grimwood, and Charles C Alexander, *This New Ocean: A History of Project Mercury* (Washington, D.C.: NASA, 1966) 150

"Terminations, Reductions, and Savings. Budget of the U.S. Government. Fiscal Year 2011." http://www.whitehouse.gov/sites/default/files/omb/budget/fy2011/assets/trs.pdf

Truman, Harry. "Recommendation for Assistance to Greece and Turkey." (Speech, joint session of U.S. Senate and the U.S. House of Representatives, Washington, D.C., 1947)

Warwick, Graham "...and expands with Rockwell" *Flight International* August 7-13, 1996, 5

Warwick, Graham "Goodnight MDC" *Flight International* January 1-7, 1997, 20

"United Launch Alliance and Blue Origin Announce Partnership to Develop New American Rocket Engine" http://www.blueorigin.com/media/press_release/united-launch-alliance-and-blue-origin-announce-partnership-to-develop-new

United States Congress House Committee on Science and Astronautics. "A Chronology of Missile and Astronautic Events."