Factors Affecting U.S. Commercial Space Launch Industry Competitiveness

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The U.S. commercial space launch industry is a relatively new industry, begun in earnest in late 1986 after the U.S. Government changed its launch policy as a response to the January 28, 1986 Space Shuttle *Challenger* accident. This policy change was embodied in National Security Decision Directive 254 [White House, 1986], which reinforced prior legislation [*Commercial Space Launch Act*, 1984], and an earlier Executive Branch policy directive declaring the U.S. Government's intent "to encourage, facilitate and coordinate the development of commercial expendable launch vehicle (ELV) operations by private United States enterprises," by taking NASA and the Space Shuttle out of competition with U.S. commercial launch providers for commercial and foreign spacecraft payloads [White House, 1984].

In the wake of the *Challenger* accident, the policy change marked by National Security Decision Directive 254 received strong support from a diverse collection of national policy makers, whose motivations included broadening the market for U.S. commercial launch firms to reduce launch costs for the U.S. Government, preserving U.S. industrial base capabilities for national security purposes, improving the U.S. international balance of trade, directly benefiting constituent U.S. launch vehicle manufacturers, and general promotion of free enterprise practices. It set in motion an array of implementing actions by U.S. Government agencies and spawned a series of other directives aimed at refining these policy objectives and establishing implementation guidelines for U.S. Government agencies. In the first few years following the *Challenger* accident, new policy directives dealing with space or space launch were released nearly every year. Executive Branch agencies created new offices, Congressional oversight committees conducted myriad hearings, and the domestic launch industry invested hundreds of millions of dollars in pursuit of commercial launch market opportunities.

With each successive policy directive and implementation guideline that was promulgated, additional emphasis was placed on "return[ing] the U.S. launch industry to the dominant world position it occupied in the 1960s and

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* This paper is adapted from the author's doctoral dissertation, *U.S. Commercial Launch Policy Implementation, 1986-1992*, George Washington University, January 30, 1998. The author currently serves as Director, Business Development for Lockheed Martin Special Programs, an operating element of Lockheed Martin Corporation, in Fairfax, Virginia.

BUSINESS AND ECONOMIC HISTORY, Volume Twenty-seven, no. 1, Fall 1998.

ISSN 0894-6825.

1970s" [U.S. Department of Transportation, 1996a, p. 13]. Prior to 1982, the U.S. Government conducted all launches of commercial satellites. By 1986, due to the *Challenger* accident and the absence of a U.S. commercial expendable launch vehicle alternative, the number of commercial satellites launched by the United States had fallen to zero. The policy change raised expectations in industry, within Congress, and within some U.S. Government agencies that the Government was undertaking a course of action aimed at helping U.S. launch firms to establish the capabilities necessary to compete successfully in the burgeoning international commercial launch services market.

Despite a plethora of policy statements and initiatives aimed at improving the abilities of the U.S. commercial launch industry to compete, U.S. commercial launch providers failed to secure a leadership position in the market. Eleven years after the *Challenger* accident, Europe's Arianespace still held a decisive lead. In fact, Arianespace's market share today is greater than it was prior to 1986 when NASA was competing against it, launching foreign and commercial spacecraft from the Space Shuttle. Between January 1991 and December 1996, U.S. firms were responsible for forty-one percent of total commercial launches and only thirty-four percent of total commercial payloads launched, compared with the Europeans, who captured forty-eight percent of the total commercial launches and fifty-six percent of the total commercial payloads launched [U.S. Department of Transportation, 1996a, p. 11]. Commercial launches have become an increasingly important source of revenue for their industry providers, with total annual revenues generated estimated to have grown from around $1 billion in 1991 to $1.8 billion in 1996. U.S. launch firms received only approximately thirty-five percent ($619 million) of these total revenues in 1996, with roughly fifty-three percent going to European firms ($951 million) and the remainder split in roughly equal shares between Russian and Chinese launch service providers [U.S. Department of Transportation, 1996c, p. 12].[1] While the U.S. commercial launch industry's performance has shown recent competitive improvement, it fell significantly short of the expectations for global commercial launch market dominance envisioned by both U.S. launch firm executives and U.S. Government policy makers in the first years after the policy change.

While it is clear that the United States was unable to secure a dominant share of the international commercial launch services market, it is less clear whether this is the result of some failure in policy implementation or because the policy objective was, in fact, unachievable from the start. The competitiveness of U.S. launch firms depended at least in part on the business decisions made and the strategies adopted by those firms, as well as on the business decisions made by commercial launch customers. Moreover, other factors, such as the foreign policy objectives of other governments, may have had an overriding effect on the abilities of U.S. launch firms to compete. Accordingly, there may have been no measures which the U.S. Government

[1] Revenues are approximated, based on actual price quotes and historical price averages. Amounts are in constant 1994 dollars.

could have taken that absolutely would have ensured that commercial launch customers would buy the launch services offered by U.S. commercial launch suppliers. Yet, inasmuch as U.S. launch firms have recaptured some share of the commercial launch market since 1986, there is at least a *prima facie* case to be made that the policy change has had some positive effect. This paper examines policy implementation and other factors that affected the competitiveness of U.S. commercial launch firms between 1986 and 1992.

Background

Prior to 1982, the only means into space orbit for a commercial communications satellite was aboard a U.S. expendable launch vehicle, built by a U.S. firm and launched by the U.S. Government. The U.S. Government purchased expendable launch vehicles from U.S. launch vehicle manufacturing firms and provided launch services to both commercial and foreign users, in addition to using them for Government missions. In 1983, commercial launches also became available on both the U.S. Space Shuttle, which had become operational in 1982, and an expendable launch vehicle developed and operated by a European government-backed consortium, Arianespace. With the introduction of the Space Shuttle into the U.S. Government launch fleet, U.S. expendable launch vehicles were deemed obsolete and were destined to be phased out of production. However, entrepreneurs recognized the potential advantages of privatizing or commercializing expendable launch vehicles as an adjunct to (or competitor with) the Space Shuttle and the European launch system. Early policy initiatives were promulgated that endorsed the commercialization of U.S. expendable launch vehicles and the first seeds for the industry were sown. Yet U.S. launch firms found it difficult to compete with the U.S. Government's subsidized Space Shuttle and virtually no successful inroads into the commercial market were made. In 1986, after the Space Shuttle *Challenger* accident, U.S. policy was changed and the Space Shuttle was taken out of the competition with U.S. launch firms using expendable launch vehicles for the commercial market. After this juncture, U.S. launch firms stepped up their efforts to pursue international commercial launch market opportunities, in competition with Europe's Arianespace and other potential international launch service providers.

Between 1986 and 1992, the international commercial launch industry comprised three U.S. commercial firms (General Dynamics, Martin Marietta, and McDonnell Douglas), a French company, backed in part by the European Space Agency and member country governments (Arianespace), and a foreign trade company responsible for marketing and negotiating commercial launch services for the Chinese government (the China Great Wall Industry Corporation). Other countries – in particular, Russia, Ukraine, and Japan – followed the development of the commercial launch market but did not enter into a contract for a commercial launch during this period.

The political economy of the U.S. commercial launch industry is unique, U.S. launch firms both owe their existence to and have been constrained by

their historical reliance on the U.S. Government as a developer and financier. The capabilities of U.S. launch systems initially were developed to support U.S. Government mission requirements; the space launch systems offered by U.S. firms evolved from U.S. Government intercontinental ballistic missile programs dating back to the 1950s. These capabilities were not optimized to fulfill the requirements of commercial customers to the same degree that emerging foreign competitors, such as Europe's Ariane, have been. Throughout the development of this industry, the U.S. Government controlled every aspect of U.S. launch capabilities: what tooling and infrastructure would exist, what the rates of production and launch would be, what processes and procedures would be used to build and launch them, what their technical capabilities would be and when and how these would be upgraded, and what appropriate rates of profit could be charged for their development and operation. Even as commercial market opportunities grew, the U.S. Government retained significant control over numerous factors influencing U.S. firms' ability to compete in that market.

These firms also had to overcome a U.S. Government contractors' "bias" regarding their approach to the commercial market. Prior to 1986, they had become used to a very conservative view of the relationship between risks and rewards, based on years of developing and selling launch vehicles to the U.S. Government under contracts that reimbursed their actual costs plus a fee. All of the risk was generally borne by the U.S. Government. Moreover, if the Government wanted improvements in capabilities, it generally would pay the contractors to make those improvements. The commercial market, on the other hand, is generally characterized by contracting terms under which the contractor offers a specific capability for a fixed price, which includes compensation for the risk of overrunning the bid and incorporates the expected profit. In the commercial launch market, all of the risk rests with the launch firm. Any improvements in launch system capabilities generally are developed independently by the launch firms, their costs are amortized across and recovered through subsequent contracts.

U.S. launch firms faced competition on a number of levels during the period. General Dynamics, Martin Marietta, and McDonnell Douglas regularly competed against each other for U.S. Government launch contracts, even though the products they offered had different performance capabilities. U.S. launch firms also competed against foreign competitors with different performance capabilities for commercial and foreign launch contracts. Some of the launch opportunities that U.S. launch firms were competing for were available in principle to all competitors in the international launch services market. Others, such as launch opportunities for the spacecraft of foreign governments with indigenous launch capabilities, generally were closed markets. For example, to this day, U.S. Government launch opportunities are closed to foreign competitors, while U.S. commercial satellite launches generally are open [White House, 1994, sec. 6]. U.S. launch service firms also faced a different type of competition back at home: competition for priority on the national policy making agenda, the attention of policy decisionmakers, and U.S. Government resources directed at the implementation of commercial space

launch policy, relative to the demands of other sectors of the U.S. economy. A competition of sorts also occurred between U.S. launch firms, who sought protectionist trade provisions and Government investment in research and development, and U.S. satellite manufacturing and operating firms, who sought liberalization of the launch services trade to attain lower launch prices.

Today, procurement of launch services or launch vehicles by U.S. Government agencies still makes up a substantial portion of the business base for U.S. launch firms and influences the requirements and processes used to build them. Between 1986 and 1992, commercial spacecraft launches accounted for only twenty-four percent of General Dynamics' launch business (payloads launched); thirty percent of McDonnell Douglas' launch business, and seventeen percent of Martin Marietta's launch business. On the other hand, commercial launches accounted for seventy-seven percent of Arianespace's launch business and forty-three percent of Long March's launch business [U.S. Department of Transportation, 1995, pp. 12-13]. The U.S. Government still controls almost all of the launch infrastructure (e.g., the launch pads, mission control centers, and tracking stations) as well as the terms (e.g., cost, schedule, processes, and access) under which it can be used. While some competitive factors have become liberalized as the market has developed (e.g., production rates, ownership of tooling and equipment, profit rates, and developments to enhance technical performance), the degree of U.S. Government involvement in nearly all aspects of the launch process continues to have a dominant affect on the behavior of U.S. commercial launch firms. The dependency of U.S. launch firms on the U.S. Government for launch business, as well as for infrastructure and support functions, continues to be both a blessing and a curse.

The players with possibly the greatest stake in the outcome of U.S. commercial space launch policy implementation were the U.S. manufacturers of large launch vehicles, including General Dynamics, Martin Marietta, and McDonnell Douglas. Earlier policy decisions to phase out the existing national expendable launch systems in favor of the Shuttle were putting out of business production lines that had generally been up and running for more than twenty years. While the Air Force's "assured access to space" decision to initiate a Complementary Expendable Launch Vehicle program established a new production line at Martin Marietta, the remaining expendable launch vehicle production capacity in the country was winding down as remaining Government contracts were completed. There was no commercial launch services industry in the United States at the time; launch services were marketed and provided to commercial satellite operators by the U.S. Government, using technical support from the launch vehicle contractors as needed. The new commercial space launch policy gave these firms the opportunity to establish a launch services capability, and to achieve additional revenues and earnings from existing hardware systems and capabilities that had long since been paid for by Government capital investments and contracts.

The U.S. launch vehicle industry had not been racing to enter the commercial launch services market prior to the *Challenger* accident. Many in the industry were concerned about the capriciousness of the U.S. Government's

Shuttle-only policy. Many of the companies had developed vested interests in the Shuttle-based business structure, e.g., contracts for the Shuttle External Tank, commercial investment in the Payload Assist Module D upper stage, and investments and contracts for materials processing facilities. Some were concerned about antagonizing their government customers – NASA and the Air Force – by being too aggressive and asking for too much too soon, so they opted to follow the U.S. Government's lead. NASA, on the other hand, had been marketing both foreign and commercial launch customers for the Shuttle aggressively, using its U.S. Government affiliation effectively to capture roughly fifty percent of its target international and commercial market. U.S. launch firms' executives were reluctant to invest in a market where they would have to compete with what they perceived were two government subsidized launch service providers – Ariane and the Shuttle. U.S. launch firms may also have been guilty of some "gamesmanship;" many thought the U.S. Government would ultimately come to the rescue of the industry with additional investment if industry just waited long enough.

The U.S. launch vehicle companies were all primarily U.S. Government contractors, so they thought like Government contractors – as opposed to commercial companies – that were leveraging Government programs, policies, and infrastructures in an attempt to penetrate a commercial market. As Allan McArtor, Chief Executive Officer of Federal Express and a potential commercial customer noted, "It is disturbing to me, quite frankly, that we are expecting a commercial program to be generated from heretofore aerospace contractors who, by and large, have no commercial products and rely on government programs and procurements, whether NASA or the Department of Defense. I truly hope these corporations accept the challenge...their customer is their competitor [U.S. Congress, 1986, p. 556]."

The launch industry was used to focusing on high quality technically advanced systems, low cost (required to be competitive in the commercial market) was generally an afterthought. It generally had pursued a single-customer focus, for either NASA or the Air Force, as reflected in its marketing, contracting, production, and distribution approaches. This limited its abilities to serve multiple commercial customers efficiently, a disadvantage in a market comprising twenty-five or so potential near-term customers. These companies lacked familiarity, relationships, and experience dealing with this diverse set of international commercial customers. U.S. launch companies were used to performing work on a "cost-plus" basis, in which they were reimbursed for their actual costs and paid a fee based on some percentage of their costs. This disincentivized the development of cost savings programs or a low-cost mindset amongst the workforce and management. In the same vein, these companies generally had flexible pricing contracts with their Government customers that were based on the quantities of launch vehicles they produced. The U.S. Government paid more for launch vehicles when fewer were produced than they did when more were produced. Commercial customers generally signed up to fixed-price contracts for delivery of their spacecraft to a predetermined orbit and were not concerned with production rates or other

problems internal to the launch system production companies. Finally, Government contractors were used to executing standardized contracts with their customers, filled with Government-directed clauses and caveats, as opposed to the more flexible terms and conditions possible between commercial firms.

Moreover, the Western world was besieged with an unprecedented string of launch failures between 1984 and 1987, the time period during which most companies were first beginning to seriously consider the possibility of pursuing commercial launch opportunities. In addition to the *Challenger* accident in January 1986, there were two Titan failures (in August 1985 and April 1986); two Atlas failures (in June 1984 and March 1987); a Delta failure (in May 1986); and, two Ariane failures (in September 1985 and May 1986) [Isakowitz, 1995, passim]. Aerospace companies, and their Government customers (and commercial users) were increasingly focused on returning to flight, institution of "mission success" practices, and preserving their product and launch reputations. For U.S. launch firms, these factors and Ariane's competitive lead made the commercial launch market a less attractive opportunity.

However, U.S. launch vehicle companies also had some positive attributes which assisted them in entering the commercial launch services market. The aforementioned accidents notwithstanding, they generally each had a good reputation with their U.S. Government customers for the quality and reliability of their launch vehicles. As elements of large aerospace corporations, they each had access to substantial financial resources. They also had highly competent technical personnel that knew their products, were familiar with the U.S. Government's launch ranges, and understood launch procedures, as a result of years of providing technical support to their Government customers.

Policy Implementation

The implementation of the U.S. Government's commercial space launch policy has affected the U.S. industry's abilities to compete in a variety of ways, some positive and others negative. Efforts by the Office of Commercial Space Transportation to regulate and license the commercial launch industry took an enormous amount of time to get underway; it took more than four years from the time that the initial tasking was given to the Department of Transportation (via Executive Order 12465) until its final ruling was published and another year still before the first license was issued. While these licensing and regulatory functions were required by law and sought to preserve public safety, they did little to enhance the abilities of U.S. commercial launch firms to compete. Several aspects of licensing and regulation imposed administrative burdens or modest financial burdens on commercial launch firms. The Office of Commercial Space Transportation recognized that its bureaucratic process was burdensome, however, and initiated streamlining measures to enable commercial launch firms to spend less time worrying about licensing and regulatory compliance and more time trying to win new commercial launch business.

Scheduling problems, the lack of a commercial business environment, security restrictions, and costs associated with the U.S. Government launch

infrastructure were all cited by U.S. commercial launch firms as having adversely impacted their abilities to compete [U.S. Department of Transportation, 1989, passim]. Significant energy was spent both by the U.S. Government and industry during the period under review to redress aspects of these infrastructure problems, but many could not be alleviated, either because of overall physical limitations of the existing Government facilities or the perceived high cost barriers associated with creating new infrastructure with private financing. These intractable infrastructure problems tended to adversely affect the costs, schedule, and other factors facing the U.S. launch firms in their efforts to secure commercial launch business.

The strategies used by U.S. Government agencies for procurement of commercial launch vehicles and services were largely responsible for the re-establishment of U.S. expendable launch vehicle production lines. Without the earliest Air Force procurements, specifically the Complementary Expendable Launch Vehicle, the Medium Launch Vehicle 1, and Medium Launch Vehicle 2 procurements, none of the major launch vehicle manufacturers would likely have entered the commercial launch market. Every launch vehicle or commercial launch service purchased by the U.S. Government increased the production base for commercial launch firms and offered the potential to lower the indirect costs that had to be spread against the price of launch vehicles for commercial customers. However, the Air Force structured its Medium Launch Vehicle procurements in a way that resulted in their being viewed as "lowest cost" competitions, leading competitors to believe that they must reduce the cost of their launch vehicles to be purchased by the Air Force by spreading indirect costs against projected follow-on commercial sales. While the Air Force benefited from this practice through lower launch costs, this "buy-in" by the launch firms on the Government sales raised the cost of these launch vehicles in the commercial market.

The approach taken by U.S. Government agencies towards the support of research and technology programs to improve the capabilities of commercial launch systems was a continuing source of frustration for U.S. commercial launch firms. There were numerous recommendations made by the Commercial Space Transportation Advisory Committee (COMSTAC), by Congressional authorizing committees, and by external review boards to initiate vigorous research and development and component technology research programs that would benefit the commercial launch industry. While several programs related to these objectives were begun (e.g., Advanced Launch System, National Launch System, and Spacelifter), they typically were terminated with little tangible progress to show for the effort and were not aimed from the outset at developing the capabilities needed by U.S. launch firms to compete more successfully. These premature terminations typically were the result of a lack of consensus on technology priorities, difficulties in executing joint programs between multiple agencies, low priority of the efforts within the agencies involved in light of the funding pressures they faced, or the introduction of new initiatives which were intended to supersede the existing program. NASA resisted the adoption or application for the commercial space launch industry

of the model relationship under which it and the commercial aeronautics industry had successfully developed technology that benefited commercial firms for years. Neither the Air Force nor NASA initiated relevant launch technology programs on their own; the studies and programs that were externally generated and forced on these agencies generally either were ultimately diverted to support the higher priority mission requirements of those agencies or focused on such far-term technology developments that they had little practical payoff to commercial launch firms during the period under review.

The issue of international launch trade agreements was intertwined with that of commercial satellite technology exports, as U.S. Government agency officials struggled to juggle national security and foreign policy considerations, the interests of U.S. commercial launch firms, and the interests of U.S. commercial satellite firms. Launch trade discussions with Europe, China, and the Soviet Union offered opportunities to use the issue of commercial launch trade as a tool to advance the nation's foreign policy agenda. Discussions with Europe never led to a formal agreement but did establish some basis for a discussion of what were appropriate levels of Government supports for the commercial launch industry. Commercial launch firms encouraged the U.S. Government to conclude a restrictive trade agreement with the Europeans, but a breakdown in agreement over who had the authority to negotiate on behalf of the Europeans sidelined the discussions. A decision by the U.S. Government to allow the export of satellites to China for launch clearly had an adverse impact on the competitive interests of U.S. commercial launch firms [U.S. Department of Transportation, 1988, p. 14]. However, the Memorandum of Agreement between the United States and China that implemented this decision limited the total number of commercial launches and the rate and conditions of China's market entry, partially mitigating the potential competitive damage posed by the export approval. Other decisions, such as one in which the U.S. Government would have permitted the Soviet Union to conduct commercial space launches from a new spaceport to be built in Australia, would have allowed another entrant to the commercial launch market, but under controlled terms [Congressional Research Service, 1991, pp. 72-4].

The approach taken by the U.S. Government in each of these instances involving international trade sought to balance the downside of facilitating the market entrance of new competitors with the upside of controlling the terms of market entrance. Strictly from the perspective of the U.S. commercial launch industry, continuing to restrict the export of satellites for launch by non-market economies would have been the most favorable to U.S. competitive interests. In the satisfaction of other U.S. policy and industry interests, however, the international launch trade agreements provided some protection to the commercial launch industry during which the industry could undertake measures to become more competitive.

The implementation actions discussed above portray an experience marked by mixed results. The output of the implementation did not lead to the expected outcome for the policy. This is a reflection both of the effectiveness of the policy's implementation and the limitations of the policy's design. The

policy's implementation was hampered by frequent revisions, conflicting interpretations of goals, conflicting priorities, and a lack of control over resources by organizations committed to successful implementation. Despite the promulgation of new directives dealing with some aspect of space policy nearly every year, a clear roadmap for implementing the commercial launch policy objectives was slow to evolve. An unstable policy environment and concerns over the reliability and consistency of the U.S. Government both in policy making and as a customer for commercial services had an adverse effect on the confidence of the industry. As noted by one external review committee, "commercial space policies have undergone substantial change every two years since 1982, and even newer policies are currently being promulgated. Significant additional private investments are not likely to be made in commercial space ventures until these policies become stable, and are perceived by those making investment decisions as likely to remain stable" [Advisory Committee on the Future of the U.S. Space Program, 1990, p. 43]. By the time a clear roadmap was developed, much of the competitive playing field and the strategies of U.S. commercial launch firms already had been firmly established.

Conflicting interpretations of the policy goals and conflict with other higher policy priorities ultimately had adverse effects on implementation. The policy was central to the mission of only two of the U.S. Government agencies involved, not a high priority for most, and in conflict with other high priorities for several others, creating an environment that was not conducive to effective policy implementation. The policy foundation empowered a new organization – the Department of Transportation's Office of Commercial Space Transportation – with no experience in launch issues, to identify impediments and propose remedial actions that would remove or reduce those impediments. The Office of Commercial Space Transportation identified a number of NASA and Air Force standard practices as impediments, these practices primarily included launch operations and procurement procedures which had been established to support the way things had been done in the past or the requirements of existing NASA and Air Force missions [U.S. Department of Transportation, 1985, passim]. Once identified by the Office of Commercial Space Transportation (or the commercial launch industry), remediation of these impediments generally required procedural changes – and often the expenditure of resources – by NASA and the Air Force. Even competitiveness enhancing measures, such as U.S. Government launch services procurements, research and technology programs, and infrastructure improvements, also generally required the often reluctant expenditure of resources by NASA or the Air Force. International launch trade agreements, while supported by staff from the Office of Commercial Space Transportation, were the purview of the Office of the U.S. Trade Representative and developed in close coordination with the foreign policy agenda controlled by the State Department. The primary area within the control of the Office of Commercial Space Transportation that affected the commercial launch industry was its licensing and regulatory activities. The remainder of its activities required the active support of other agencies in order for them to be implemented. Thus, the agency given the lead authority to

implement the policy did not control the resources necessary to implement the policy and had to rely on its abilities to convince these agencies to alter their behaviors, or more likely, elevate the issue to a higher interagency policy coordinating authority which could coerce these agencies to alter their behaviors.

Throughout its implementation, U.S. commercial launch policy became a tool aimed as much at accomplishing other U.S. Government policy objectives as it was at helping U.S. commercial launch firms to be better able to compete. The Department of Defense viewed and used the policy as a means of reducing the cost of maintaining an assured access to space capability, determined to restart the expendable launch vehicle production lines, the Defense Department would have ended up paying the entire bill had commercial firms not been induced to pursue possible market opportunities. The Department of Defense also traded off the interests of U.S. commercial launch firms to accomplish other national security policy objectives, such as supporting the entrance of the Soviet Union into the commercial market as a means of keeping it from exporting its ballistic missile technology and expertise to other rogue states. The State Department also purposively traded off the interests of U.S. commercial launch firms to accomplish foreign policy objectives, such as gaining leverage over the Chinese with regards to their human rights abuses or promoting a more market-based economy in the Soviet Union. The commercial launch market transitioned from one of high demand and backlog of launches to one of perceived oversupply of launch capacity in a few years. As the backlog of spacecraft payloads needing launches declined, the U.S. Government generally relaxed its interest in the competitiveness of U.S. commercial launch firms; policy makers became more likely to subjugate the interests of these firms to other policy priorities.

Other Factors

The competitiveness of U.S. commercial launch firms depended not only on the policy implementation actions of U.S. Government agencies, but also on decisions made and actions taken by U.S. commercial launch firms, international competitors and commercial customers, for reasons sometimes largely independent of U.S. commercial launch policy. These factors included: business decisions made by U.S. launch firms; purchasing decisions made by commercial satellite firms; the foreign policy priorities of other countries; and a number of other factors such as the timing of the policy, launch vehicle technical capabilities and reliability, spacecraft technology trends, and the fluctuation in the value of the U.S. dollar relative to the French franc.

Of these, the private business decisions and comparative technical capabilities of U.S. launch firms are probably of greatest significance. There was no mechanism in the policy that could ensure that firms would make the investments necessary to be successful or even to ensure that they would remain in the business. The U.S. Government could not force U.S. firms to undertake actions they determined were inconsistent with their private business interests. For example, based on lackluster internal market projections, promising

alternative investment opportunities, an early launch failure, and a conservative internal business culture, Martin Marietta chose to withdraw from the market, after signing contracts for only four commercial launches, rather than staying in the market and continuing to compete. McDonnell Douglas appeared content to serve only that niche of the market that its launch vehicles, developed for its U.S. Government launch business, could readily serve. General Dynamics invested heavily in expanding its Atlas launch vehicle capabilities, but primarily to respond to changing U.S. Government requirements. U.S. launch firms generally pursued the commercial satellite launch market as if it were a distribution of singular launch opportunities, this dispersed commercial market was viewed less favorably by some firms than the U.S. Government launch market, particularly because the Government frequently procured several launches at one time. Moreover, the expectations for commercial market success by U.S. commercial launch firms – in terms of both market size and timing and capture rates – were unrealistic and more consistent with their traditional experience with U.S. Government business than with typical commercial market performance, where substantial front-end investments and long periods of negative cash flow are more common.

Other countries interested in competing for commercial launch business each had their own policy priorities that differed from those of the United States. The motivations behind the decisions of each of these other countries to enter the commercial launch market included, *inter alia*: national prestige and independence from the United States, national security and preservation of a defense industrial base in the face of budget pressures, access to foreign currency, and high technology employment. Most of these motivations could not be diminished by the incentives and sanctions proposed by the United States. More often, the United States would appease these desires through launch trade agreements in exchange for concessions on other U.S. foreign policy or national security policy priorities. Most aspects of U.S. commercial launch policy were aimed primarily at affecting the behavior of its target groups – U.S. Government agencies charged with implementing the policy and U.S. commercial launch firms – and not the behavior of international competitors. Through some aspects of the policy's implementation, however, the U.S. Government attempted to restrict the ambitions and independent foreign policy objectives of these foreign competitors, but this was not a goal of the policy.

These other factors – individually or collectively – probably did not have any greater impact on the abilities of U.S. commercial launch firms to compete than the actions associated with the implementation of the U.S. commercial launch policy, discussed above. However, the summary of these other factors was intended to illustrate that the policy implementation alone should not have been expected to be able to ensure the expected outcome of the policy.

Conclusion

The international competitiveness of the U.S. commercial space launch industry is an important issue facing the U.S. space policy community. At

$50 million to $100 million per launch, even small changes in competitiveness can have a significant impact on jobs and revenues in the U.S. launch industry, and can contribute to a healthier national balance of trade. Florida Congressman Bill Nelson underscored the importance of the industry by stating, "The sales of one commercial launch by a U.S. company is [sic] equivalent to the import of 10,000 Toyotas" [Gipson, 1990, p. 37]. One analysis indicated that loss of four Atlas launches and one Delta launch to Europe's Ariane and China's Long March in the fourth quarter of 1994 resulted in a reduction in U.S. exports of $445 million, a loss of 31,751 direct and indirect person-years of employment, and a reduction of $281 million in Federal revenues [Greenberg and Gaelick, 1995, p. 39]. Commercial launches are expected to continue to increase over the next decade, averaging at least twenty-five launches per year for geosynchronous communications spacecraft alone, and augmented dramatically by commercial launches required for an estimated 224-242 low earth orbit communications satellites planned for launch during this period [Euroconsult, 1996]. This represents a substantial market opportunity for both U.S. launch firms and the U.S. economy.

The current competitive environment for U.S. commercial launch providers is more challenging than ever, with existing competitors, such as Europe's Arianespace, preparing to offer new capabilities to compete even more effectively. Over the last two years, Russia and China increased their share of the commercial launch market and will likely be joined by other foreign launch providers, including Japan, India, Brazil, and Israel, who may also enter the competition for available commercial launch contracts. Budget reductions by U.S. Government agencies continue to diminish future potential captive market opportunities for U.S. launch services providers, at the same time commercial customers are becoming increasingly open to considering new foreign launch service providers with lower costs. Collaboration between U.S. firms and other international launch service providers in several recently announced ventures marks a new era in the commercial space launch competition, one that portends additional dilution of market share for U.S.-manufactured launch vehicles and a blurring of traditional business and policy boundaries. Surplus ballistic missiles, made available by the successful conclusion of arms reduction negotiations between the former Soviet Union and the United States, could lead to a potential flood of additional launch vehicles and launch vehicle technologies and components onto the world market, which could further exacerbate an already harsh competitive situation.

The U.S. Government currently also faces a broad range of additional policy quandaries brought on by the significant changes that have occurred in recent years in technology, the U.S. domestic economy, and global geopolitical relations. Consistent with the National Space Transportation Policy directive released by the Clinton Administration in August 1994, the United States is embarking on a new generation of launch vehicle developments which will have significant implications for the commercial launch services market [Office of Technology Assessment, 1994]. The Air Force is in the midst of a competition to develop a new generation launch vehicle known as the Evolved

Expendable Launch Vehicle that would completely replace existing large U.S. launch vehicles within ten years and reduce launch vehicle costs by twenty-five to fifty percent [Aerospace Daily, December 23, 1996, U.S. Department of Transportation, 1996b, pp. 16-17]. Commercial and NASA launches are assumed to be an integral component of the Evolved Expendable Launch Vehicle's future mission model and are scheduled to begin in fiscal year 2002 and 2003, respectively. For its part, NASA is undertaking a high risk technology demonstration effort to develop a Reusable Launch Vehicle (RLV) that can achieve launch costs that are about one tenth of current prices [U.S. Department of Transportation, 1996b, p. 14]. While NASA is funding the majority of the technology demonstration phase of the program, known as the X-33 Program, the eventual Reusable Launch Vehicle is intended to be primarily a commercial venture, requiring an investment of $5 billion or more by industry to establish an initial operational capability. Some major U.S. Government involvement, such as the advance commitment of some number of future government launches, will likely be necessary to establish a viable program with an acceptable return on investment. At the same time, NASA managers are continuing efforts to incorporate upgrades to NASA's Space Shuttle that could extend its useful life from 2012, its currently planned retirement date, to 2030. Successful market positioning for U.S. commercial launch systems in this new environment is likely to be difficult enough without repeating the mistakes of the past.

This paper illuminates some of the lessons learned from past U.S. launch industry commercialization efforts. A better understanding of how the design and implementation of previous policies have affected the abilities of the U.S. commercial launch industry to compete could aid in the development of a useful roadmap for both the U.S. Government and commercial launch firms for achieving competitiveness in the face of these new challenges.

References

Advisory Committee on the Future of the U.S. Space Program, *Report of the Advisory Committee on the Future of the U.S. Space Program* (December 1990), 43.

Aerospace Daily, Newsletter (December 23, 1996).

Commercial Space Launch Act, Statutes at Large, 98 (October 30, 1984).

Euroconsult, *World Space Industry Survey, Ten Year Outlook* (1993 ed., Paris), Executive Summary reprinted in *Space Policy*, 9 (August 1993), 236-45.

Gipson, M., *Final Frontier* (July 8, 1990), 37.

Greenberg, J., and C. Gaelick, "When a Launch Goes to the Competition," *Aerospace America* (August 1995), 39.

Isakowitz, S.J., *International Reference Guide to Space Launch Systems* (2nd edn., American Institute of Aeronautics and Astronautics, 1995).

U.S. Congress, Committee on Science, Space and Technology, *Assured Access to Space: 1986 – Hearing before the Subcommittee on Space Science and Applications*, 99th Congress, 2nd sess. (August 13-14, 1986), 556.

U.S. Congress, Office of Technology Assessment, *The National Space Transportation Policy: Issues for Congress* (May 1995).

U.S. Department of Transportation, COMSTAC Technology & Innovation Working Group, "Commercial Spacecraft Mission Model Update," Report (May 18, 1995), App. 12-13.

U.S. Department of Transportation, Federal Aviation Administration, "Quarterly Launch Report, 2nd Quarter 1996" (April 22, 1996), 13.

———, "Quarterly Launch Report, 3rd Quarter 1996" (July 24, 1996), 16-17.

———, "Quarterly Launch Report, 4th Quarter 1996" (October 25, 1996), 12.

U.S. Department of Transportation, Office of Commercial Space Transportation, *Federal Impediments to the Development of a Private Commercial Launch Industry*, Report Submitted to Congress, (July 1985).

———, *Cleared for Launch; Annual Report to Congress: Activities Conducted under the Commercial Space Launch Act, Fiscal Year 1988* (1988), 14.

———, *Scheduling Commercial Launch Operations at National Ranges* (May 1989).

White House, Office of the Press Secretary, "National Policy on the Commercial Use of Space," Fact Sheet (July 20, 1984).

———, "United States Space Launch Strategy," Fact Sheet (December 27, 1986).

White House, Office of Science and Technology Policy, "National Space Transportation Policy," Fact Sheet (August 5, 1994), sec. 6.