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CHINA'S SPACE PROGRAM AND ITS IMPLICATIONS FOR THE UNITED STATES

by

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ABSTRACT

TITLE: China's Space Program and Its Implications for the United States

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China became a serious member of the spacefaring community in 1985 and in response, the U.S. developed agreements to limit the economic impact on U.S. space programs and to control the spread of related technology. China charges less for a space launch than a U.S. firm does and so an economic threat to the livelihood of U.S. space industries exists. The precarious U.S. launch industry is already challenged by Arianespace. The U.S. is also concerned about transferring technology to China from U.S. satellite manufacturers. The technology involved in mating satellites to boosters, measuring stress on the satellite at launch, and the development of apogee kick motors is all transferable to missile technology and may aid China in its intercontinental ballistic missile programs. Not only has China been improving its own programs, it has also sold missiles and technologies to other countries such as Iran, Iraq, Pakistan, and India. To foster the growing relationship between China and the U.S., clear policies and agreements are needed that match our national security interests with economic reality.

BIOGRAPHICAL SKETCH

Lieutenant Colonel J. Barry Patterson (M.A., Webster University) is a career communications officer who has worked in space and satellite communications systems most of his career. He has been stationed at Woomera, Australia, Scott AFB, IL, Thule Greenland, Offutt AFB, NE, the Pentagon, and Peterson AFB, CO, where he worked in space systems activities. During these tours of duty he developed operational policy for DOD satellite communications systems. He is a graduate of Air Command and Staff College, class of 1986 and a graduate of the Air War College, class of 1995.

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CHAPTER I

INTRODUCTION

China began working on rocket technology 800 years ago, but only since China began offering launch and satellite services for international customers and opened its space infrastructure to foreign visitors in 1985, has the world's eyes turned to China's space capacities.[1]

At the same time, the U.S. was finding itself in the midst of a growing problem; the loss of its position at the top of the spacefaring nations. For many years prior, the U.S. had been the undisputed leader in launching satellites and other space activities. However, the complexity of the U.S. space launch capability continued to drive the cost up and so other countries began to develop their own systems for both economic and national security reasons.

The Soviet Union also had an advanced space launch capability. The Soviets (now Russians) have always needed a robust space launch capability because their satellites were designed and built for short-duration missions. This required them to develop a capability to quickly launch satellites and until just a few years ago, they led the world in yearly space launches.

The European Space Agency (ESA) formed a consortium of European nations that had as its goal to provide the most efficient space launching capability available. ESA also wanted to be able to launch satellites free from U.S. restrictions.

Japan also started to develop its capabilities. Even less advanced countries, such as India began exploring this market.

China had been a closed country and so their capabilities were not fully known or understood. Once China decided to open up its launch capabilities to the world market, it quickly became a concern for the U.S. This capability creates two concerns for the United States and this paper will explore them. These concerns are economic- and security-based. First this paper will discuss the development of China's space capability and then analyze why this creates issues for the United States.

CHAPTER II

SPACE CAPABILITIES OF CHINA

History of Development

China began its space program by launching its first satellite on an indigenous rocket in 1970. Since that time the Chinese have made steady progress both in launch vehicle design and other areas of space technology.[2] Beginning in 1974, China launched a series of recoverable satellites. These were connected with programs involving remote sensing and microgravity research. Although the first launch was a failure, all subsequent flights were successful. This record has allowed China to claim complete success in recovering satellites from orbit.[3] China has made steady progress in advancing their expertise in space. Today they have operational communications satellites in space, a family of launchers, a modern space launch complex, and a growing list of customers.

Financial Support for China's Space Launch Infrastructure

China is driven by the need for outside financial capital to support its space program. Two policies have served as the driving forces pushing the commercialization effort. One was China's economic reform policy, begun in a call from Deng Xiaoping in March 1978 for sectors to devote their efforts to economic growth. Another was a defense industry reform policy that changed the defense-oriented industries into civilian-oriented ones. A major consequence of these two policies was that the budget for the space program was dramatically reduced. This budget was only 0.035 percent of the

Gross national Product (GNP) in 1987. Compared with the USA (0.52%), USSR (1.5%), France (0.11%), Germany (0.04%), and Japan (0.04%),it was the smallest investment among the world's spacefaring countries, which placed the Chinese space program in a disadvantageous position. To raise the necessary revenues to continue the Chinese space program, it was decided to place the Long March vehicle family and satellite service in the international market. By taking this entrepreneurial approach, the Chinese space industry successfully shifted its orientation from the defense sector to the civilian sector. It has survived by its own efforts in a changing political climate both in China and in the world. In 1991 the Chinese space industry generated 80% of its total revenue from civilian products.[4] The market will provide about $6.1 billion over the next decade, according to Paris-based Euroconsult.[5] China is doing all that it can to position itself to capture as much of that market as possible.

Communications Satellites

China has demonstrated the capability to develop, deploy, and operate and control its own communications satellites. In February 1975 the State Council of China approved the Report on Development of Chinese Satellite Communications outlined by the State Planning Commission and the National Defense Science and technology Commission and the task of developing communications satellites was incorporated into state plans.[6] Their first experimental communications satellite was launched on 29 January 1984. Since then, China has launched four additional communications satellites and today, all five are operating normally; quite a success story. There are two types, the first two satellites based on the experimental design and of limited capacity, and the last three satellites based on a more advanced design. The satellites are used primarily for television broadcasts, mostly of other countries, but also supports special services for the Chinese People's Bank, and other telephone and data circuits. The next generation satellite is planned for operation with increased capabilities and longer life span. It is designed to support the increasing demand for domestic communications and commercial and educational television.[7] The capability to successfully develop. launch, and maintain in orbit communications satellites has established China as a true spacefaring nation. It also gives China a basis for competing for foreign space launch services.

Launch Complexes

The Chinese launch complexes developed to support launches are relatively large and comprehensive. All of its sites were developed as part of a comprehensive plan to establish China's capability to support not only its own needs, but also other nations.

China operates three modern launch sites and has a fourth site under construction. Located in the Gobi desert, the Jiuquan site is equipped with two launch pads for the Long March-2 booster into orbital inclinations of 57° to 70°. Geostationary missions are launched from the Xichang site aboard Long March-3 vehicles. The third site, located at Taiyuam, provides a launching facility for sun-synchronous meteorological and earth resource missions aboard Long March-4 boosters.[8] The three different facilities provide the capability to launch to low earth orbits (LEO), geosynchronous transfer orbits (GTO), and polar orbits.[9] With these launch complexes, China has positioned itself to support any requirement for a space launch, another part of a successful commercial enterprise.

Rockets

China has developed a family of launchers that build on a basic indigenous rocket, the Long March. This basic booster first flew in 1970 and has been slowly upgraded since. Over the years, various configurations were developed as China sought to position itself in the international market. China planned to be flexible so as to meet any customer's requirement. Many of the configurations were developed to be compatible with U.S.-developed upper stages and apogee kick motors. China saw an opportunity to take advantage of other countries' failures in 1986.

The U.S.'s space program had experienced a great setback with the Challenger space shuttle explosion, a Titan-34-D had exploded, a Delta rocket had failed. In addition, an Ariane rocket had failed, so the two premier space launching countries' capabilities were suspect. This opened up a market the Chinese felt they were prepared to fill.[10] Their Long March rockets were versatile and available.

There are now three versions of the Long March, the Long March 2, 3, and 4. The Long March-2 has a version capable of carrying and interfacing with U.S. upper stages such as the PAM-A, PAM-D2, AMS, SCOTS, and HPPM. There are also variations of each Long March rocket. Any of the rockets can be fitted with a variable number of strap-on rockets to further the boost capability of the first stage. This gives the Chinese rockets the capability to deliver approximately ten tons to low earth orbit or up to eight tons to geosynchronous transfer orbit, capabilities that exceed those of the comparable European Ariane 4.[11,12] The Chinese also have plans for developing a much larger vehicle than those currently available, one capable of placing 25 tons into low earth orbit. This would be approximately in the same class as the Russian Proton booster.[13]

China has positioned itself as a leader in space. It has developed its own space complexes, a command and control structure, a family of boosters, and operational communications and recoverable earth sensing satellites. Thus, China has demonstrated the capability to support space launches and is now aggressively marketing that capability. The next section will discuss other nations' capabilities to provide space launches in this highly competitive field.

CHAPTER III

INTERNATIONAL LAUNCH MARKET

The international market for space launches is continuing to grow and this will result in a $95-115 billion global market for satellites, ground stations, and launch services through 2004, according to an assessment of world space markets by the Paris-based Euroconsult organization. Projections of the spacecraft development portion of the market have increased by 6.5 percent in the past 18 months. The international development of communications satellites through 2004 will generate a market totaling $14.4-17.4 billion. The booster and launch services market should total $14.5 billion to orbit 217 communications spacecraft, 33 of them military. Another 14 spacecraft for meteorology should be launched, generating another $900 million in launch service business. Finally, a market totaling $65-83 billion is developing for communications satellite ground stations and receivers around the world. On an annual basis, sales and exports for U.S., European, and Japanese markets in all space sectors is now about $35 billion per year, the report said.[14] With this type of market, what kind of space launch capabilities exist to support the demand? Besides China, there are three countries and one agency with a viable space launch capability.

U.S. Space Launch Capability

The U.S. has the largest number of different launch systems, so if it experiences a failure, this does not totally ground the U.S. capability.

The Pegasus is the smallest and cheapest booster available right now. It is designed to be air-launched, originally from a B-52, but now from a L-1011 airliner and can boost a 2000 pound payload into low earth orbit (LEO) for about $12 million.[15] Orbital Science Corporation also has a stretched version of the Pegasus, but the only launch of it to date failed.

Other companies, such as Lockheed, have similar launchers in the planning stage. Lockheed's Lockheed Launch Vehicle (LLV-1) is expected to put 3000 pounds into LEO for about $12-14 million.[16]

One step up from that is the Delta II. A booster with the best track record, it had 36 launches in a row before experiencing a failure and that was only a delay, not a catastrophic explosion. It has the capacity to boost 11000 pounds into LEO or 4000 pounds into high earth orbit (HEO) at a cost of $45-50 million.

The next family of boosters is the Atlas II, which can boost up to 18000 pounds to LEO or 7700 pounds into HEO. The cost per launch is $60-70 million.

The next type of proven booster is the Titan II, based on old Titan intercontinental ballistic missiles. This rocket, in various configurations can put 18,500 pounds into LEO or 7700 pounds into HEO, and costs $40-45 million.

Finally, the heavy lifter of the U.S. fleet, the Titan IV, can boost 39,000 pounds into LEO and 10,000 pounds into HEO, but costs $170-220 million per launch and typically takes a minimum of six months to prepare for launch.[17] A more typical scenario involves a launch preparation time of twelve to eighteen months, and often experiences delays after the entire launcher and payload reach the pad.

The system designed to be the workhorse of the U.S., the Space Transportation System (STS), more commonly known as the Shuttle, is really the heavy lifter of the fleet, but because it is manned and so complex, its costs are really prohibitive. Since the Challenger explosion in 1986, payload restrictions have been imposed, but it is capable of lifting 57,700 pounds to LEO and 13,000 pounds to HEO.[18] Unfortunately, a launch costs between $500 to $750 million, depending on how the costs are calculated.[19]

European Space Agency Space Launch Capability

The European Space Agency (ESA), a consortium of France, Germany, and Italy, was created with the basic idea to be a viable, economically efficient launch business. The entire space launch complex was built to be a profit-making venture. Over the years ESA has successfully launched many satellites and now ranks first in terms of number of commercial launches each year. They have recently demonstrated the capability to launch a rocket about every twenty-one days.[20] In 1994, they had a backlog of 37 satellites, representing a combined order value of about $2.9 billion.[21]

The workhorse of ESA is the Ariane 4 and various versions have flown, with the most current version being the 44L. This rocket is capable of placing 10,200 pounds into HEO and a typical launch costs $55-65 million.

ESA is looking to the future and has the next version, the Ariane 5 in testing. This rocket is designed to place up to 39,600 pounds in LEO or 15,200 pounds into geosynchronous transfer orbit. Ariane 5 was originally designed to be cheaper than Ariane 4 and it will be, if calculated on a cost-per-pound to orbit. However, it is designed for a heavier class of satellites and operational costs have mounted. Ariane managers now believe a launch will cost around $130 million, still less than the cost of a comparable U.S. rocket, the Titan IV.[22] The Ariane 5 continues to be tested and the first commercial launch is now scheduled for October 1996.[23]

Russia's Space Launch Capabilities

Russia has a stable of proven space launch vehicles and it faces more of a business challenge in getting into the commercial business then it does a technical one. "The launch vehicles at their disposal are probably the most attractive element for any kind of unified program," says Nick Johnson, an analyst with Kaman Sciences. "Depending upon what kind of spacecraft you have and what kind of orbit you want, they've got a launch vehicle well suited to the mission.[24]

In spite of their stable of workhorse rockets, they are currently focusing on the Proton, a proven design, that can put 44,100 pounds in LEO and 12,100 pounds into HEO.[25] There are restrictions associated with using Russia's Services. The U.S. has similar concerns with both Russia and China and so has negotiated an agreement with Russia concerning their entry into the commercial market. Under the terms of the agreement signed in 1993, between 1993 and 2000 Russia can only perform eight launches of satellites into geosynchronous orbits. The price Russia can charge must be not more than 7.5 percent of a U.S. launch, or about $45 million.[26] Russia is allowed to bid for LEO launches and the restrictions are similar in pricing arrangements, but no firm numbers are called for. In spite of these restrictions, Russia will provide additional competition for space launch business.

Japan's Space Launch Capability

Japan started its venture into space by exploiting U.S. technology, and has used this technology to complete 24 successful launches. Japan wanted to be free of U.S. restrictions and so developed its own rocket, the H-2. It is designed to be comparable with and compete with, the Ariane 44L booster. Unfortunately, today, the H-2 currently costs around $120 million, almost twice that of Ariane 4.[27]

The H-2 has been tested and has a capability to launch 20,000 pounds into LEO or 8,000 pounds into HEO.[28] Unfortunately, the H-2 is also one of the most complex rockets ever developed and has suffered two failures recently. It has been unable to satisfactorily explain the reason for the catastrophic failures and thus is not a strong contender for business currently. To successfully compete, it will have to solve its technological problems, demonstrate a better reliability rate, and cut its launch costs.

This completes the review of the major players in the space launch field. Other countries, such as India, Brazil, and Israel, have some space launch capabilities, but they are only currently launching their own satellites and have not entered the commercial market.[29]

CHAPTER IV

IMPACT OF CHINA'S CAPABILITIES

Domestic Impact

The space capabilities developed by China have provided internal benefits, especially in the area of communications. China's communication and broadcasting services are backward, especially for long-range communications, in which not only is the quantity of telephone channels small, but the communications quality is also poor, and is severely limiting development of the Chinese economy.

However, since 1984, China has established a number of earth stations for satellite communications, operating through China's own satellites. This has resulted in a significant improvement in communications, especially long-range communications and is overcoming the communications difficulties of remote districts. Use of the operational satellites is already resulting in rapid development of telecommunications, television, and radio broadcasting in China, skipping the traditional development stage. Setting up a quality radio and television broadcasting system to cover 80 percent of China using traditional systems would have cost $370 million, but using the existing communications satellites will cost only $185 million and will provide 100 percent coverage.

Educational television is now providing 30 hours of programming per day and reaching over 500 educational centers and 46,000 other display points, representing a coverage rate of over 83 percent.[30] Communications satellites are now being used to transmit financial data for the Bank of China, reducing the time it takes for money to be transferred from one institution to another. This reduction means that $4.6 billion is available for six extra days instead of being tied up in transfers, greatly increasing the working capital and enhancing the availability of funds.[31]

Thus, China has benefited from its space program in several ways. First, the space program created many jobs, building the space launch complexes, doing research and development on the space system components, building various missiles and guidance systems, as well as the satellites that are flown on them, and operating and maintaining the space complexes and control stations for the operational satellites. The marketing of this capability has brought income into China to finance all this. Additionally, as discussed above, China's space capabilities resulted in improved communications throughout China, and promises more improvements in the future.

Economic Impact On U.S. and International Launch Market

As the Chinese have gained experience and success in the space business, they have begun pushing for more involvement. In September, 1994, Chinese officials approached U.S. space station managers about joining the international space station program, but were told that this could not even be discussed informally because such negotiations have to be handled through the State Department. "They were very interested and they were persistent," Wilbur Trafton, NASA's associate administrator for space station, said.[32]

Apparently discussions continued because later reports indicate that NASA was informed to expect increased space cooperation between the two countries in the near future. The cooperation could involve a major Chinese contribution to the space station, said one congressional staffer. "The Chinese want to provide more than launch services for the program and they are eager to find a reason for manned space flight efforts," the staffer said.[33] The Chinese see this as a way to enhance their stature as a spacefaring nation. They also see the opportunity to gain expertise and technology upgrades to benefit their own space systems. Finally, there is always the commercial aspect of the space station and this is a major motivation for the Chinese.

China has also agreed to launch satellites not covered by Sino-U.S. agreements. China Great Wall Industry Corporation of Beijing is under contract to launch 12 satellites in 1996 for Iridium, a proposed constellation of 66 communications satellites in low earth orbit (LEO). Led by Motorola Inc. of Schaumberg, IL, Iridium is one of a number of proposed constellations that would contain several communications satellites in orbits only hundreds of miles above the earth, or LEO. Satellites in LEO were not covered by the previous agreements, but are included in the new agreement just recently signed and discussed later in this paper.[34] There are still issues to be worked because the Long March rocket is not known for its precision in launches, but apparently Motorola felt this could be worked out.

From the above discussion, it is clear that China has become a player in the space launch business, although not yet a major one. China definitely has desires to increase its share of the space launch business and continues to update its technology and capabilities, but why should this cause the U.S. any concern? This Chinese venture definitely creates two issues for the U.S.; one is economic and the other is security.

Economic Concerns

The U.S. space industry employs thousands of personnel and is a multibillion dollar industry. Other countries, but most notably the European Space Agency (ESA), with its successful Ariane rocket, has taken business once only the U.S. would have. Now, China threatens to draw other customers from the U.S., further impacting the capability of the U.S. to maintain its position in that industry. As a result, the U.S. signed an agreement with the Chinese in January, 1989 that limited the Chinese to launching only nine geosynchronous satellites through 1994, and stipulated that prices offered to international customers would be on a par with comparable services offered by U.S. firms and other agencies.[35]

However, the pricing has generated an international controversy because China has offered launch services for around $30-55 million. This is 30-75% of the price of ESA's Ariane, 50% of Atlas, 25% of Titan, and 70% of Delta. China's pricing has been criticized as being subsidized by the government and leading to dumping. The Chinese argue their price policy is the result of low-cost Chinese labor, low-cost Chinese-made materials needed for manufacturing launchers, depreciation of the Chinese Yuan (unit of currency), the need to offer a favorable price for the introduction of a new product, the long period of depreciation of launch facilities, the high reliability of launchers, and a comparable price associated with launch capability.[36]

Although China only captured four percent of the world's market in 1990, while Ariane had 63% and the U.S. had 33%, China continues to market its capabilities hard, leading to some concern among U.S. launchers about their financial future.[37] The U.S. wants to secure as large a share of the $15.4 billion market for itself, but has a hard time competing with the prices China is advertising. China's Long March expendable launch program has become a significant competitor for telecommunications satellite launches. As a result of China's low prices, Hughes recently reserved ten launch slots using the Long March through the end of the decade.[38] It is ironic that China is a major threat to European and U.S. launch providers because it is offering lower prices and good service - the essence of capitalism.[39]

There have been cases which caused the U.S. to complain and enter discussions concerning perceived violations of the 1989 agreement. There were accusations that the Chinese broke the agreement in February, 1990 when they signed a deal with the Saudi Arabians to launch a satellite for $25 million, which was roughly half what U.S. and European companies charge.[40] On July 21, 1994, China successfully launched a satellite from the Xichang space center. This was only China's sixth foreign-satellite launch, but its success continues to bring more prospective business.

In October, 1994, the U.S. began renegotiating the agreement that will expire in 1995. In preparation for this, Don Eiss, deputy assistant U.S. Trade Representative for industry and labor, told the U.S. Transportation Department's Commercial Space Transportation Advisory Committee on 19 October, 1994 that China's compliance with the pricing provision of the current agreement has been a "source of more than some dissatisfaction and frustration on the part of both the U.S. government and certain elements of the U.S. launch industry." In an interview, Hua Liu, third secretary in the science and technology section at the Chinese embassy in Washington, defended the prices, saying labor and material costs are different in China. He also noted that the Long March rocket is a relatively new series of vehicles and said some of the prices are promotional. He expressed confidence that the two sides would narrow any gap between their positions in follow-on discussions.[41] Apparently he was correct, as the U.S. and China signed an agreement in October, 1994 that will allow the U.S. to sell some of their satellite technology to China, although this is not the renewal or extension of the extensive space launch agreement set to expire in 1995.[42] As a result, China pledged to adhere to a "global ban on exports" that goes beyond requirements set forth in the Missile Technology Control Regime, according to U.S. State Department officials. In response, the U.S. lifted export sanctions imposed since August, 1993. Although China previously promised to follow the international missile accord and then broke its pledge, Secretary of State Warren Christopher called the latest agreement "a very important step forward."[43]

In January, 1995, the U.S. and China finally signed the bilateral space launch agreement than replaces the one covering the period 1989-1994. Under these terms, China made major gains compared to the previous agreement.

Under the old agreement, China could only launch nine satellites during the five year period. Under the new agreement, China is allowed to launch 15 geostationary satellites through 2001 and this number can rise, if international demand rises. The 15-satellite limit can rise if the number of satellites going to geostationary orbit equals or exceeds 20 annually or if western countries are unable to meet the demand for launches. If the average annual number of commercial launches is 20 or more over the next three years, two satellites can be added to China's limit. If the average exceeds 20 over the next four years, five satellites can be added, for a total maximum number of 20 launches by China. Therefore, China may be allowed to launch over twice the number of satellites under the new agreement it was authorized under the old one.

China is also required to price its launches within 15 percent of what western countries charge. The agreement requires special consultation if China violates the pricing agreement, but did not provide specific courses of action. The apparent failure of the U.S. to take any action when China failed to adhere to the price restraints under the old agreement was a source of frustration and is discussed elsewhere in this paper.

Finally, this new agreement covers the launch of low earth orbit satellites, which was not covered by the previous agreement. Here, no percentage figure was stated, just that Chinese launches be priced on a par with comparable Western services. Nor does the accord place specific numbers on China's launches. However, the agreement states that combined Chinese-Russian participation in these launches can be no greater than 50 percent of the total.[44] This provides a lot of latitude because the Iridium project alone plans to launch 66 satellites and other low-earth systems are planned similar to Iridium. Globalstar will have 48 satellites in LEO and another system will use twelve. The Iridium project itself is one program that is involved with the U.S.'s security concerns, as will be discussed below.

Security Concerns With Technology Transfer

Although China has developed a robust space system, they do not have as sophisticated systems as the U.S. China has not developed the systems that allow precise orbit insertion, nor do their rockets have capabilities to control the rates of burn. Finally, China has not refined the capability to measure and control levels of stress placed on satellites. Controlling these forces would allow more sophisticated satellites to be placed in orbit. Because satellites provided by U.S. companies do possess these types of technology, the U.S. was concerned with the potential transfer of technology that might accompany China launching any U.S.-made satellites. The U.S. concern is divided into two areas, although they are somewhat intertwined; the first concerns advances China might make to its own civilian launch systems. The second is the applications these advances could have to military systems that China might not only use, but also export to rogue nation-states such as Iraq, Iran, and North Korea.

Launching a satellite is a very technically complicated activity. China has not independently developed all of its competence in this area. China's technology transfer process has taken on added urgency and a new form with the current windfall of Russian scientists and engineers now working in large numbers for various Chinese interests. By standing on the shoulders of Russia, the United States, Japan, and others, China hopes to more quickly overcome what remains a huge technology lag.[45] To counter just this type of transfer, the U.S. has restricted the types of satellites that can be launched by China and placed restrictions on how even those satellites must be safeguarded. The U.S. is concerned that China might make technology advances that would allow them to compete more strongly in the space market, further impacting the U.S. space launch business. Of more a national security concern is the impact pirated U.S. technology might have on China's military rockets.

Under U.S. law, the administration must restrict any activity that threatens the non-proliferation guidelines of the Missile Technology Control Regime (MTCR).[46] Therefore, negotiations were conducted to determine what China could expect in marketing her space launch capabilities to U.S. companies. As a result, restrictions were placed to limit the number of U.S. satellites China could launch, as well as the type of satellites.

One area of concern is the technology associated with the launching of the Iridium satellites, discussed earlier, and the application this could have to multiple independently targeted re-entry vehicle (MIRV) warheads. Several of these satellites will be launched simultaneously on one rocket and must be dispensed accurately in different orbits. Western satellite vendors will need to support Chinese development of this capability to ensure the correct placement of the satellites. This technology is directly relevant to the development of MIRV'ed missile systems.[47] It is considered a direct application from accurate satellite placement to accurate MIRV launching.

Another area of concern is the development of the apogee kick motor, designed to boost a satellite from geosynchronous transfer orbit (usually an elliptical orbit about 600 miles high) up to geosynchronous orbit (about 22,300 miles high). Since the Chinese kick motor has no flexible nozzle to direct or correct the vector of the rocket's existing gases, its solid rocket propellant must be configured with great care to have exactly the right grain structure and be shaped to produce exactly the right amount of thrust for exactly the right amount of time. It is hardly surprising that the Western firms associated with these Chinese-launched satellites want to validate or certify the propellant and witness Chinese test firings of the kick motor. Yet such certification will not only help China make satellite upper stages for civilian customers, it will also help China make much more reliable, efficient military solid-rocket motors than the first generation systems it currently has.[48]

Finally, all U.S. satellites to be sold to China are likely to come with integration analysis to make sure that Chinese launcher systems are suitable and properly mated with each satellite. This analysis is critical to assure that a given space launcher performs (for example, ignites, separates its individual stages, and cuts off its motors or engines) without shaking or shattering its sensitive payload. This load analysis helps assure the successful launch of civilian satellites. But it can also be used for military launches. Transferring this knowledge would directly assist China to develop advanced, highly accurate MIRVs for its long-range ballistic missiles.[49]

As can be seen, China could certainly make advances in its military systems. If this was not enough to concern the U.S., China has sold their present missile systems and missile technology to several nation-states aligned against U.S. national interests. These states include Iraq, Iran, and North Korea, so the U.S. feels justified in the concerns it has as well as the restrictions it imposes on China.

CHAPTER V

CONCLUSIONS

The U.S. clearly has well-founded concerns with the directions China's ambitious space program has taken and has established agreements to deal with those concerns. So what course of action should the U.S. now pursue? The U.S. has two compelling reasons to continue to work with China. First, China will be a contender for space launch business whether the U.S. likes it or not. Second, the U.S. wants to be involved in the economic activities taking place in China. The economy of China is continuing to grow and the U.S. hopes to foster trade agreements with China to take advantage of that growth. Therefore, the U.S. should look to work with China in two areas: compliance with the pricing policy and compliance with the transfer of technology restrictions.

The previous agreement with China concerning space launch pricing was not enforced and the new agreement does not appear to have specific points of enforcement other than to call for consultations if pricing violations occur. The previous agreement accomplished little. U.S. officials either were unwilling or unable to prove allegations that China priced its launches in violation of the agreement. Even if true, it has been unclear what action would or could have be taken. The Chinese conducted only four of the permitted nine launches permitted under that agreement.[50] The new agreement must be verifiable and have clear, enforceable terms. The arrogant way China has flaunted the pricing limitation clearly indicates this. The new agreement does specify that China's launches must be priced within 15 percent of Western launches for geostationary satellites, but only carries the requirement for low earth orbit satellites to be "on a par with Western prices". This caused trouble with the last agreement because no one could agree on what "on a par" really meant. "On a par" is not defined in the new agreement and this leads to wide disagreement over what is included in the total price and how we compare total cost, as can be seen from the discussions when previous launches were discussed. Finally, there should be a clear penalty if China violates the terms of the agreement and the U.S. must be willing to impose it. If, for instance, China underprices a satellite launch in violation of the agreement, it would be restricted from selling its services to any future U.S. customer and other existing contracts would also be canceled.

In the matter of technology transfer, several recommendations are in order. First, a review should be undertaken to ensure we are not transferring knowledge that will be useful in a military related area. We are fairly careful about the hardware technology, but have been less concerned with the knowledge base given, as an example is the load analysis previously discussed. The U.S. must be very careful about what items it finally chooses to transfer to China. The most sensitive missile-related hardware embedded in U.S. satellites, such as kick motors and guidance and control systems should be transferred only if they cannot be separated, removed, or duplicated from the satellites themselves.[51]

Finally, not only should the U.S. be concerned about technology transfer, it must be concerned about the conversion of that technology to military applications. In any future missile non-proliferation talks, the U.S. should focus not only on the spread of Chinese missile technology to other countries, but on the missile modernization in which China is engaged. There are reports that China is engaged in developing a new mobile solid rocket ICBM with high accuracy nuclear warheads. As described above, much of the technology involved in commercial satellite launches is directly transferable to this effort. The U.S. must be careful not to contribute to this effort and should discourage all other countries from doing the same.

If these recommendations are followed, the U.S. and China can certainly continue to share the space launch business. This can further the developing friendly relations we are cultivating with China. By establishing clear and enforceable limits to the transfers we are willing to undertake, we will not only establish a solid groundwork for mutual understanding, we will earn their, perhaps grudging, respect for being willing to stick to our principles, instead of waffling on each decision. Finally, through opening dialogues with the Chinese, we can draw them out of their inward focus and bring them into a partnership with the rest of the world's space community. This can only enhance diplomatic relations and give us more inroads to broad areas of mutual interest.

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