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THE RISE OF ASIA'S DEMOCRATIC SPACE POWERS:

HOW JAPAN AND INDIA BECAME THE NEXT SPACE POWERS IN THE
TWENTY-FIRST CENTURY.

by

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ABSTRACT

Since the end of World War II the world has seen several nations expand into the space age. Also after the Second World War, the Cold War began and many nations found themselves allying themselves with either the hegemony of the West or the Communists. Space was no exception in this dilemma, as weaker nations began to develop their own indigenous space programs and had technological diffusion from one of the hegemonies. Japan and India are two democracies that both sought support for their indigenous space programs from the west, particularly from the U.S.

These two nations emerged from poverty and a broken infrastructure during the 1950s and have grown over the last sixty years into two of the most advanced space-faring nations in the world. These two nations have overcome several external and internal factors ranging from Communist expansion to bureaucratic strife. Japan and India have been and remain the two leading democratic nations in Asia that have risen to the rank of space power.

DEDICATION

To my grandfather George Kunze.

Thank you for all that you did in my life, you will always be an inspiration.

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CHAPTER 1: INTRODUCTION

The space programs of Japan and India are two of Asia's strongest and most advanced, leading the continent into the next age of space. While they have had competition from other Asian nations such as China and North Korea, Japan and India are unique because they have advanced into space-faring nations while upholding their democratic values. Sometimes it can be more difficult for a democratic nation to answer to the demands of a space program than a tyrannical or autocratic government can. In a democracy a government must answer to the rights and will of the people while also meeting the demands of the elected leadership. Another challenge a democracy may face is term limits and election periods. Space programs require long periods of planning, budgeting, and design, and for some projects, development can take years or even decades. A democracy needs to be able to be consistent in its space program, which can be difficult when there are changes of regime power during election times. Japan and India not only had to persevere through internal challenges such as these, but they were also surrounded by a growing communist bloc, which created several external pressures. The Communist expansion and the two nation's ties to the west and the demands of democratic society created major struggles for the space agencies of Japan and India. Despite the challenges, these two nations have overcome every obstacle that came before them and have created two of the most advanced space programs of the twenty-first century.

The twentieth century brought forth a new era for mankind, the space age. After the fall of Nazi Germany in 1945, the U.S. military found a cache of German rockets at the V-2 facility of Mittelwerk, Germany (McDougall 1985, 44). U.S soldiers scoured the grounds of the

Mittelwerk weapons plant collecting substantial data from the German rocket program. The U.S. took plans, rocket parts, and even acquired scientists, such as Wernher Von Braun, who were willing to surrender to the U.S. Following close behind, the Soviet Union discovered Peenemunde and collected as much data and scientists as it could as well. Several leftover scientists were either captured by or surrendered to the Soviet Army and were taken back to the Soviet Union to help develop the Soviet rocket program (McDougall 1985, 45). The U.S. did receive more benefits from the German rocket program than the Soviets did, however, without acquiring this support the Soviets would have lagged behind in rocket development (Siddiqi 2000, 83).

Both nations foresaw the benefits of starting a rocket program and both relied on German technology as a stepping stone for their own rocket and space programs. The discoveries at Peenemunde and Mittelwerk facilitated what would become the Cold War's race for space. The secrets found at these facilities only helped to worsen the fears of nuclear war and destabilization within the international community because the technologies that were created for a space program had the potential to be used by the military for intercontinental ballistic missiles and spy satellites. For the first time a nation's heartland could be penetrated at the push of a button. These two superpowers began a race for space that lasted for decades, and along the way they helped to inspire and spread space technologies to their allies and other states.

After the Second World War nations around the globe suffered from poverty, damaged economic infrastructures and political turmoil. The global situation at this time seems like an unlikely breeding ground for developing or war ravaged nations to begin rising to the status of

space powers. Space programs, no matter the country involved, are expensive and require the commitment of vast amounts of resources. They require a certain level of technology, political backing, and funding that most countries are not willing or able to commit to.

During the Cold War the world watched as the Soviet Union made impressive strides in achieving space superiority with *Sputnik I* and a lunar probe during the 1950s. The Soviet Union was plagued by poverty and deplorable social and political conditions and yet was still able to manufacture and launch large rockets and satellites rather quickly. How can a nation that has a starving population justify a space program that could take billions of capital out of potential social programs? Space programs seem to be justifiable only when the population is well nourished and healthy, and not during periods of poverty. The Soviet Union was controlled by a Communist regime that made all of the political and economic decisions rather than an elected body like a democratic parliament or legislature. The government was a centralized technocracy and did not have an electorate to answer to (McDougal 1985, 444). The Soviet Union could thus spend vast amounts of capital on a space program with little overt internal political strife amongst the populace. For the Soviet Union, being a space power was initially a matter of prestige and "proof" of superiority over the West's capitalist system.

In a government that has no democratically elected body, certain projects are easier to develop and maintain. If a certain program is unpopular, the government doesn't have voters to answer to, they won't be voted out of office next term if they fail to comply with the citizen's will. Despotic states like China and the Soviet Union can easily move funding around to sponsor whatever programs they see fit. Though the Soviet Union may have made it to space first, they

did so at a very high social cost. They neglected their populace in exchange for advanced technologies and global prestige. Almost every move the Communist states made were based on international standing, power, and competition with the west and usually at the expense rather than the benefit of their people.

Democratic states also have an issue when it comes to technological failures. The autocratic governments of Nazi Germany and the Soviet Union suffered several failures during their launch trials. However, the people of those countries were not aware of all of the malfunctions, rather only their successes, because of censored media. Nations that have a closed system often censor state failures from their people and the international community in order to make themselves appear to be more prestigious and developed. Democracies typically have some form of freedom of speech or press and so cannot hide a failed launch from the population. In the democratic state of Japan, the media was often critical of failed launches like the Japanese *Lambda* rocket series.

It is apparent that democracies are already at a slight disadvantage when it comes to running a space program, but for some states it is even more challenging because of external factors. During the Cold War the landmass of Asia was primarily controlled by the communist bloc. The Soviet Union, China, Vietnam, North Korea, and others fell to Communist control, many of which were tyrannical or genocidal. During this time Asian democracies found it difficult to remain independent from this growing Communist sphere of influence. Despite these challenges, Japan and India were able to remain democracies throughout the Cold War and were even able to begin their own indigenous space programs.

Since the 1950s India and Japan have been the leading democratic space powers in Asia. Japan has been bound to some restraints due to treaties drafted after their aggressions during World War II came to an end. During Japan's time as a spacefaring nation, it has remained under the influence of the U.S. until fairly recently. While Japan was free to make its own political decisions, it was often times held to certain obligations and restraints because they chose to use U.S. parts and engineers in order to develop their space program faster. Though this partnership was generally met with some reluctance, the fact remains that Japan more than likely could not have progressed as quickly as it has if it had not remained in a partnership with the U.S. While in this alliance they also fell under the protection of the western hegemonic state during the Cold War, which was important for the small island nation, because large Communist nations neighbored it. Japan has refused to arm itself with nuclear weapons and so has had to rely on the U.S. for a strategic advantage as well (Mochizuki 2007, 742).

India has remained a free democratic state since its liberation in 1947 (Freedman 2003, 444). The Indian government has led a space program that has been almost entirely indigenous, and unlike the Japanese, it was not beholden to one particular super power. India shares borders with the People's Republic of China and was near the Soviet Union, putting it in close proximity to Communist territory. Being Democratic and near the Communist sphere of influence, India felt the need to evenly balance itself between the two competing hegemonies and thus received benefits and parts from both the U.S. and the Soviet Union. India remained neutral for most of the Cold War, so as not to upset the balance of power. India has also remained within a close space partnership with its ally, Japan.

Japan and India have changed the way the world views a space-faring nation, as these two nations are quickly becoming the next space powers of the twenty-first century. It has been difficult for both countries to establish this status. They have had to address a multitude of internal and external issues that at times seemed as though they would bring the space programs to a halt. The question is how and why these democratic nation-states were able to rise out of poverty and political unrest to become the world's next space powers in the twenty-first century. These states have rivaled and at times even surpassed the technologies of the U.S. and Russia and yet sixty years ago they were severely behind technologically.

Much has changed since the Cold War's beginnings when the U.S. and the Soviet Union were the only two space powers. The alliances of the Cold War and the exchange of space technology with foreign states helped to start the space race in Asia. The politics of the Cold War allowed for India and Japan to take advantage of existing space and rocket technologies plus begin their own indigenous space programs, becoming the democratic space pioneers of Asia. These nations both share a lot in common including a long history with the original space powers, the U.S. and the U.S.S.R. Japan and India also started their programs around the same time during the early 1950s. The technology used to develop their rockets and satellites has also been used for both civil and military purposes in Japan and India. India had arisen from colonial exploitation, a broken government and a destitute population. Japan was trying to rebuild itself, its economy, and its government after its defeat in World War II and was also under U.S. occupation until 1952. Despite these challenges India and Japan were able to consciously formulate and operate an effective space program.

Space programs are expensive and often criticized as being an unnecessary use of funds, especially for a society that is impoverished. Japan and India each created justifications as to why and how a space program would be beneficial and each was able to draw enough support for their program to become two of the next space powers of the twenty-first century. It was difficult politically convincing the starving populations of India and the war torn peoples of Japan that the government was going to spend large amounts of capital on a space program. This technology was new and periodically its benefits were greatly questioned as being worth the financial burden. Space programs are very costly and some of these projects appear to be borderline sci-fi to the common man, much less a farmer in the rural communities of India or a fisherman in Japan. The governments of India and Japan instituted policies and doctrines that established successful space programs that have been beneficial for everyone from the rural agriculturalist to the urban banker. Japan and India represent two of the most successful and competitive space-faring nations since the original powers the U.S.S.R. and the United States.

CHAPTER 2: HISTORICAL CONTEXT

The struggle for space and missile superiority between the U.S. and the U.S.S.R. did not end at their borders, for the Cold War brought surrounding nation-states under the influence of these hegemonies. Nations around the world began to fall under the influence of the U.S. or the Soviet Union and it became a standoff between the democracies of the west and the communist tyrannical states. The buildup of these alliances simplified technological and militaristic diffusion from the sponsoring state and into the satellite state. During this time it was a competition between the U.S. and U.S.S.R. to really see whose ideology was the strongest and most effective.

Space would be no exception for this international rivalry, as both nations attempted to achieve a far superior advancement in technology over the other. For example, the Soviet Union launched the first satellites *Sputnik I* and *Sputnik II* in 1957, and launched the first probe to impact the moon (McDougal 1985, 61). The United States responded with their first satellite in 1958, *Explorer*, which was also the first satellite to have a scientific purpose (retrieving astrophysical data) (McDougal 1985, 168). These advancements were significant to international politics, because each super power was trying to pull as many smaller nation-states under their influence as possible, attempting to sway the balance of power to their side. In order to convince a potential ally that it was the dominant power, the U.S. and the Soviet Union had to out compete each other politically, socially and economically.

During the early stages of the space race, space and rocket technology was controlled by the military in both nations, so having influence over allies could allow the two super powers to

place missile bases within the ally's borders, giving them more of a strategic advantage. With these international missile placements came the first instance of missile technological diffusion into the hands of a foreign authority. The U.S. scattered missile sites across Europe including Turkey, a NATO member. The Soviet Union placed facilities across Asia, Eastern Europe and Cuba.

The U.S. supported the construction of more domestic and international military installations in order to significantly threaten the Soviet Union into deterrence with the guarantee of a U.S. counter-strike with complete annihilation of Soviet territory. The Soviet Union responded by scattering missile sites across their allied states as well, creating an equally dangerous scenario for the U.S. and its allies. The placement of such bases not only allowed for the exchange of technology and intelligence between the hegemonic nation and the ally, but it also upset the balance of power in the world because each player in the Cold War needed to ensure that they had enough missiles to deter a first strike from the enemy. Any added or lost allies meant a change in the international balance of power. With this fluctuating balance of power came new theories of nuclear deterrence such as the doctrine of Mutually Assured Destruction. India and Japan were both absorbed into the politics of the Cold War, trying to balance between their freedom and alliances.

India is a rising space power in Asia, and was heavily influenced by politics of both the Soviet Union and the U.S. India contains a vast territory, with rural and isolated regions throughout the land. Nearly eighty-percent of the population lives in rural villages, which is one reason the space agency would cater to them first (Harvey et al. 2010, 148) The majority of the

people are poor, and the early government equally impoverished. The modern peoples of India have lived through economic hardships, colonialism, and several open conflicts since their independence. In what appeared to be a broken and dilapidated nation-state in the 1950s, one would not assume to find one of the most advanced space programs in the world beginning to develop. India's drive for spacefaring capabilities was not influenced by technological diffusion from one of the hegemonies alone. India's program was truly inspired by the need to provide mass communications to the scattered rural farmers, to the laborers in the fields, and to the villagers where good hygiene was not an established cultural practice. There was a sense of national pride after the end of the colonial period and the government wanted to modernize the country and heal the broken economy. Indian officials felt that by bringing the nation together through mass communication that they could educate the masses and better their quality of life. They hoped that education would cause a rise in industry and agricultural production across the country.

There was also a militaristic agenda for a missile and space program in India. India had a history of border tensions with Pakistan, and throughout its history since its independence in 1947 there have been several wars and conflicts between the two nations (Baker et al. 2001, 258). Pakistan began developing its own nuclear missile program in the 1960s so India felt they should establish a missile program as well in order to protect its borders and deter a first nuclear strike attack from Pakistan (Freedman 2003, 445). The military would not only inherit missile technology from the space program, but it would also use satellites to make it easier to communicate with dispersed troops in the field, and the Indian military could also observe enemy troop movements and installations using satellites equipped with optics.

The father of India's program, Vikram Sarabhai, was an educated Indian physicist, who envisioned an India that would be brought up from post-colonial economic failure, into a modern world that could compete with the western super powers (Harvey et al. 2010, 142). He was very driven by nationalism and technological supremacy, which can be seen in his quote, "If we are to play a meaningful role nationally, and in the comity of nations, we must be second to none in the application of advanced technologies to the real problems of man and society" (Moorthi 2004, 263). However, it is difficult to achieve economic success when a nation has such a distressed populace like India's. Sarabhai felt that India's first step to achieving economic gain would be to unify the citizens of India through mass communications and education. Sarabhai's program called for multiple satellites in orbit that could relay TV and radio programs across India, from the urban townsman to the rural villagers. On these mass media outlets there would be programs that would be played for entertainment value; however, the main focus was always educational programs that were broadcasted specifically for the rural communities, in an effort to instruct them on proper farming and hygienic care (Harvey et al. 2010, 148). These TV and radio programs were played across India in a hope that the rural communities would listen and begin executing the practices that the programs taught them. It is evident that this program was a vast success as farm production increased significantly as did the quality of life and health in India during this time period.

An impoverished nation such as India had a difficult task explaining to the people the reasoning behind spending vast amounts of money on the space program. This is a country that had people starving to death since independence, and yet the government was willing to contribute millions to a domestic space program. The government of India struggled to convince

the people that the program would be beneficial in the long run. The idea of mass communications through satellites seemed to be the best option India had at the time when it came to unifying and aiding the populace. Sarabhai and Prime Minister Nehru's administration believed that mass communication would spread education to the rural communities and that it would help to reduce the poverty in the nation. Therefore the new government of India voted in favor of funding the space program. The government found that a space-based system of mass communication would cost approximately 577 million as opposed to a ground-based system, which was estimated to cost about 1.8 trillion rupees (Harvey et al. 2010, 148). Though the costs seemed frivolous to some in India's parliament, the decision to start a space program was one of the most cost-effective decisions for improving the overall health and quality of life for the people of India.

Though it was an expensive program, it could have had an even higher price tag had it not been for the radical nationalism seen in India after the fall of British colonialism. India didn't want to have to rely on foreigners for launches or satellite construction. They wanted to hold on to their independence, not to get absorbed into the influence of the Soviet Union or the United States, and to keep their program indigenous. They had to rely on foreign assistance from time to time, but for the most part they were able to stay neutral throughout the Cold War. This belief in an indigenous program meant India could develop its launchers and satellites domestically without having to pay more for a foreign nation to do it for them. This significantly cut the cost and saved the program billions of rupees over the last sixty years. Once the Indian government had decided to follow through on a space program, the next step was how and where to begin. India didn't have captured Nazi scientists or documents for assistance like the U.S. It

was clear that they would have to seek support from the countries that already had preexisting knowledge of space technology.

The Indian space program began in the town of Thumba, a rural area with a sparse population (Harvey et al. 2010, 145). It is at Thumba that Sarabhai launched the first Indian sounding rockets, the earliest stage of the Indian space program in 1963. The sounding rockets helped the Indian scientists understand atmospheric and weather conditions, but this was just the beginning for what India's space program would become. Sarabhai's views on the subject were generally accepted because of his influence in the Nehru government of India. He was almost followed with a cult of personality, as he became the single voice of India's space program. He also believed in the fervor of Indian nationalism and that the space program in India should be built by Indians for Indians. Sarabhai was a firm believer in building India into a competitive nation and believed that to achieve success in space India must be fully developed in its industries. He once stated that "We cannot have 20th century space research with 19th century industry of antiquated systems of management and organization" and that "we have to rise from an in-built culture" (Harvey et al. 2010, 152). These quotes truly demonstrate the drive Sarabhai had for the program and the passion he had for his country and fellow Indians.

The call for a domestically-built Indian space and missile program fed into Indian nationalism and pride. Though it took longer for them to achieve their space goals because they were not relying solely on the U.S.S.R. or the U.S. for support, they were also able to remain independent and neutral in the Cold War politics. It was difficult for India to remain neutral as it was within the sphere of influence of the Soviet Union. During the era of the Cold War, India

was a democratic nation-state on a continent that was falling nation by nation to the doctrine of Communism. China was the only Communist state that bordered India, however, the growing communist influence in the region and in India's own parliament posed a threat to India's democracy. It was of the upmost importance for India to stay away from the pull of Communism in Asia because the majority of citizens didn't want to fall under the rule or influence of another state. Being a democratic state, it would seem likely that India would naturally gravitate toward allying itself with the U.S and the west. However, the U.S. had been opposed to India's space and missile programs, fearing it would be transformed into a military tool and used against Pakistan in a future border conflict. This tension with the U.S. pushed India away from the U.S.'s influence as well, especially in the 1990s when the U.S. imposed sanctions on India because India was trying to purchase cryogenic engines from Russia (Moltz 2008, 236).

In 1974 India became a nuclear power, which meant that they were part of an elite group of nations and therefore a viable ally for either side of the Cold War. With India having a nuclear and missile program being developed alongside its space program after the 1970s, it had to be even more cautious with how close it got to either the Soviet Union or the United States . If India would have allied itself with one of the super powers, it may have caused a disturbance in the balance of international nuclear powers. India did gain some technological support from both the Soviet Union and the United States, but for the most part they remained neutral, not swaying entirely to one side or the other. The Indians really attempted to have an entirely indigenous program built by Indian workers and designed by Indian scientists, but on many projects they still had to rely on foreign assistance. It became a delicate balance working with the U.S., Europe, and the Soviet Union as they did not want to upset the delicate balance in the

Cold War by being perceived as one-sided. This program was a sign of Indian pride and nationalism and Sarabhai was not about to let it fall under the influence of Communist or Western powers.

The island nation of Japan is another rising Asian space power that has also built a domestic space and rocket program. In some ways Japan and India's space programs are quiet alike. Many Japanese scientists including Hideo Itokawa, a Japanese aerospace engineer who became a national symbol similar to India's Sarabhai, worked alongside Indian aerospace engineers (Harvey et al. 2010, 5). Itokawa never quite carried the authority or weight Sarabhai did, but he still became the father of the Japanese space program and helped create a predominately indigenous space program as well. Like India, Japan was also faced with a damaged infrastructure and both programs began around the same time.

Japan was also different in some ways from India though, especially when it came to what drove their space program. Japan's initial reasoning was more economic and scientific. Japan acquired some German missile secrets, because they were in an alliance with Nazi Germany during World War II. However, one of the primary submarines carrying rocket parts and documents was lost to the sea, taking many of the Nazi secrets to the bottom. Only a few plans and data sheets made it back to Japan, which would delay its jet engine development near the end of the war (Harvey et al. 2010, 1). Japan was defeated by the American forces and forced to sign a treaty on the battleship *USS Missouri*, officially ending the war with Japan in 1945. After the treaty was signed, Japan's military was disbanded into a small defensive force. All offensive weapons were destroyed or confiscated, leaving Japan without a standing army,

navy or air corps. Unlike India, Japan did not have the opportunity to spend millions of yen on military expenditures until after 1952 and even then was reluctant to invest heavily in anything more than a defense force, which left more money for civil space funding and scientific research (Burleson 2005, 165). This also meant that its space program would not be dominated by a military agenda. Without the military influence in their space program they would also feel less international pressure from states fearing an aggressive build up in Japan, which is one criticism India often suffered from with the development of its space and rocket program. Though Japan did not have a militarized space program that could be perceived as a threat, the U.S. still wanted to be involved with Japan's program and to monitor Japan's advancement so as to control a potential competition in the space market. The U.S. tried to monopolize the space market and crush any competition by systematically offering parts at cheaper rates. The U.S. parts and technology were usually better and could always be offered at a cheaper cost than it would for the buying nation to develop them indigenously. The U.S. also put economic and diplomatic pressure on Japan in order to get the nation to buy space technologies from the U.S., allowing the United States to instill influence on the program while also keeping a watchful eye on it (Harvey et al. 2010, 24).

Japan is very close geographically to China and the Soviet Union, which meant that they were within close proximity of the expanding Communist territory in Asia, and also within close range of Chinese nuclear missiles after 1962. Despite the differences between the U.S. and Japan, Japan looked to the United States for defensive support, as Japan was initially left with a weak defensive force and renounced any interest in obtaining nuclear weapons of their own (Freedman 2003, 445). Japan became an ally of the U.S. during the Cold War because they

needed U.S. technology and military support in order to deter any aggressive actions from the Communist mainland.

Japan, like India, had wanted to remain neutral and create a domestic program from Japanese parts and labor. However, with the balance of power in East Asia being very much out of favor with their democratic and capitalistic nation-state, the Japanese reluctantly allied themselves under the hegemony of the U.S., which had been their occupying power after World War II. The Communist threat is one reason why they were so willing to cooperate with U.S. intervention in their program.

During the Cold War the U.S. dictated some portions of the Japanese space program and shared limited amounts of technology with the island nation. During the entire course of this alliance Japanese nationalism would push the government to make the space program more indigenous. It was seen as a dishonor in Japan to rely on a foreign nation for help in a field that is so crucial to not only the advancement of the technology and economic markets in Japan, but for the overall national pride and fervor of the people. Over time Japan freed itself more and more from the control of the U.S. and developed many of its own rockets, boosters, and satellites with very little foreign assistance and in some cases even entirely independent. After their defeat in World War II it was important for the Japanese people to feel that they had created this program indigenously because they were essentially trying to gain a sense of national prestige and soft power in the region by having a program few possess.

Having a domestic space program has also opened up a lot of new economic markets for Japan. Since the country is no longer under the guise of another state's control, it can now

launch foreign satellites or even manufacture satellites for foreign customers. Japan has also expanded professional careers in the aerospace field that previously were not present in Japan. Japan had a damaged infrastructure after the Second World War and the space program helped to rebuild part of the industrial sector of Japan. The growth in Japan's commercial and government space programs has created new opportunities for people educated in sciences and engineering in Japan and forspin-off industries. This has helped to reinvigorate the career pool and has created a stronger economy in Japan. During the Second World War, Imperial Japan funneled capital into aeronautical research for military aircraft, and Itokawa was a part of this assembly. However, after the war many companies like Mitsubishi were shut down until after 1952 and some were destroyed by the bombing campaigns. By creating a new civilian sector for aerospace engineering Japan was able to help put these educated sciences back to work and over time increase the overall market with more careers in the space program and spin-off industries. The nation was restrained in its military spending and arms manufacturing and therefore had more capital to use on the civilian sector of space development and scientific research. They could also focus more on space missions that were geared toward scientific education so they could gain a deeper understanding of astrophysics.

These two nations are the contenders for the Asian space race in the twenty-first century. While several nations across the Middle East and Asia have some sort of a space or rocket program, aside from China, none are as developed as the programs seen in Japan and India. Many countries in twentieth century Asia were second-world developing nations or war ravaged, or emerging out of the era of colonialism as the French and British began to lose control of their empires after World War II. Japan and India did not seem to be in any position to take on the

immense amounts of spending space programs required, especially while many people in their borders were without food or shelter.

When India received its independence from Britain in 1947 it suffered from terrible poverty but was at least left with the foundations for a well organized western style democracy. Japan, had just lost World War II in 1945, was under treaty with the U.S., lacked a military, and had a broken infrastructure with catastrophic internal damage from the war. It did not seem likely at the start of the Cold War that these countries would become the leaders in the Asian space race. The question that must be answered is why these two nations would use valuable resources on space programs when they were experiencing political, social, and economic turmoil. The answers to this are as diverse as the nations themselves, ranging from technological diffusion, national security, economic gain, and international prestige.

For Japan, the race for space was more of an economical factor. They couldn't establish an army or a navy until after 1952 and even after the San Francisco Peace Treaty was signed in 1952 they were not interested in developing anything more than a defensive police force, which therefore left more capital to be extended to other civilian projects including the space program. The space program helped to launch Japan into the twenty-first century, spread information through mass communication, and also opened up new economic markets in Japan. Japan has also focused more on scientific and aerospace research for civilian purposes earlier than most spacefaring states because it didn't have a military agenda in its space program. Research is not mutually exclusive between the civilian and military sectors and research for either side can be beneficial, however, Japan chose to use more resources for space exploration and research than

on military related hardware for its program. This also opened another market for Japan as nations were interested in gaining access to the meteorological, astronomical, and geographical data the Japanese satellites were relaying.

India had motives in both security and economic interests for space. An Indian space program came out of the idea that spreading educational propaganda across the rural countryside might help to teach the villagers proper farming and hygiene. This would in theory increase the overall quality of life for people in India. The goal behind the program seemed plausible; however, the execution seemed like science fiction for India in the 1950s. Sarabhai's influence persuaded most Indian officials to believe that spreading mass communication would help the economy. There was a clear threat unfolding in Asia, as Pakistan and India headed off into a micro hot war of their own. India's military wanted a space program not only for large rockets to carry nuclear weapons, but also for satellite communication, to help keep troops connected across vast portions of India and for observation satellites. It is apparent that there are various reasons behind the evolution of space programs in these nations. The democratic nations of Japan and India have redefined the international politics of space and are raising new questions that will need to be addressed by the global community in the near future. These two states are quickly becoming the space powers of tomorrow.

CHAPTER 3: INDIA

In 1947 India officially proclaimed its independence from the colonial powers of England. With a functioning constitution by 1950 and an established parliamentary government, India was ready to take a hold of its own destiny. The British Empire had held India as a colonial trading post since the early eighteenth century. From the 1700s till 1947 the English spread their influence and military control across India. The English East India Tea Company had a vast amount of power over the domestic and economic policies of India and tightened laws and restricted the freedoms of the indigenous peoples (Hirose 1994, 32). However, the English would not be the first foreign nation to control the Indians. The Moghul Empire had ruled India from the early sixteenth century until the mid-eighteenth century when the Moghuls were defeated and replaced by the British in 1857 (Islam 2011, 205). For centuries the people of India were under the control and influence of a foreign authority, which is why India had such vehement sentiments of nationalism after they gained independence in 1947 (Hirose 1994, 30)

It is India's subjugated history that will be one of the factors leading to the decisions made about the development of its space program. The people of India were finally proud to be Indian in the twentieth century, as it was the first time in any citizen's life-time that they were free to make their own political decisions. However, this new found nationalism came with a terrible reality; the English had controlled much of the wealth and resources in India, leaving a broken infrastructure. The people of India had mainly been the laborers for the British companies in India, and now that industry had all but left. Though poverty was widespread, the English did help to politically organize the country, leaving it with a more stable political system

with democratic values (Hirose 1994, 29). The new government's first task was to reorganize the economy and to get people back to work. However, this was difficult since the geography of India makes even the simplest government mandate a challenge.

India is a country with a large border that encompasses a large and diverse population. The people of India are not centralized in cities across the country with suburban areas in between but instead spread out in rural communities. India has a wide diversity of geographical features, ranging from the Kedar Mountains, the Thar Desert, an extensive coastline, and muddy swamps scattered intermittently across the territory (Basrur 2009, 17). It is as though every feature from the world has formed somewhere onto India's modern landscape. A relentless climate also brings on hardships for the citizens, with monsoons, flooding, snow, and sand storms. This diverse topography has made civilization a challenge in some parts of India even in the modern era. Though there are large developed cities scattered across India, such as New Delhi and Mumbai, a large percentage of the population of India is isolated in farming villages across the terrain. The new government of India found it challenging to communicate with these rural peoples, making it difficult to motivate the citizens toward a better economy or democracy. It is hard to represent a population in India's parliament if the government cannot effectively communicate with these villages. Mahatma Gandhi had believed that the best way to unify India was to politically penetrate these rural masses, to get involved with the local peoples and to understand and solve their socioeconomic needs (Hirose 1994, 36).

Poverty and under production were two driving forces for India's decision to establish its own space program. India needed to advance technologically in order to develop into a thriving

competitive world economy. The Indian people had a well educated man who had a passion to build India into a world power and bring it out of its impoverished state. He was Vikram Sarabhai, the father of India's space program and an Indian physicist who had a particular interest in aerospace technology and astrophysics (Harvey et al. 2010, 142). He was also a key political figure in modernizing India's general economy and a radical activist who fervently requested Indian scientists abroad in foreign nations to return home to help India progress domestically. Sarabhai had been active in physics research and went to the tropics to study cosmic rays in these zones. After his research, Sarabhai decided that India should build a cosmic ray institute indigenously so that more scientists can research these activities. He began what he called the Physical Research Laboratory (PRL) in 1947, a small cosmic ray operation that was first operated in his home and personally funded. Prime Minister Nehru showed his support for the program by conducting the formal opening of the PRL at its new permanent headquarters in the city of Ahmedabad in 1954 (Harvey et al. 2010, 143). His facility was very successful in its research findings and in 1954 Nehru also agreed to fund at least three more cosmic stations in India to help Sarabhai collect more data on cosmic rays.

India's entrance into the spacefaring world came in 1953 with the announcement of the International Geophysical Year (IGY) to be held in Belgium in 1957 (Harvey et al. 2010, 143). This was an international conference on science, and one of the first such exchanges between the west and the Soviet Union after Stalin's death. Sarabhai was chosen to represent India at the conference and to discuss India's space interests to the global community. The IGY would be India's first participation in an international space project and the first time India would publicly demonstrate its interests to become a spacefaring state. Three years later the Soviet Union

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launched *Sputnik I* in 1957, which was a design the U.S.S.R. had since IGY that quickly changed the realm of space forever. The small man-made satellite inspired Sarabhai to bring this type of technology to India because he felt there would be a lot of potential in developing and advancing such a device. He felt that these developments could be used to help rebuild India's broken infrastructure over time.

India's first prime minister, Jawaharlal Nehru had a deep commitment to democracy and made the economy one of the greatest concerns early on in his administration (Basrur 2009, 11). His political thinking was much aligned with Sarabhai's in that they both felt technology was a key to solving the Indian economic downturn. During a speech known as "Tryst with Destiny", Nehru demonstrated that he was in full support of having a modern industrial India that was independent of foreign assistance (Basrur 2009, 83). The space program was fully supported by his administration and by the preceding Gandhi prime ministers. The ideologies of Nehru and Sarabhai can both be found in the initial stages of the Indian space program, as both are trying to bring modern technology into India that will help end the poverty.

In 1961 Sarabhai made a proposal to the Indian government explaining that he may have found a solution to many of India's troubles. It is in this proposition to the Indian government that Sarabhai first lays out his plans to use satellite technology to relay educational videos and radio shows to rural populations throughout India. He felt that a space program could provide the mass communication India needed in order to be successful and competitive in its domestic and international markets (Doyle 1994, 116). The new government was very supportive of starting a space program and established the National Committee for Space Research

(INCOSPAR) under the Indian Energy Commission. The government and Sarabhai believed that linking the citizens together through mass communication would help to end many of the social obstacles the new government was faced with, such as low farm profits and lack of hygiene and health care in many of the rural communities.

Sarabhai and the Rise of India

Vikram Sarabhai gained a lot of prestige and national recognition from his control and development of the space program and almost governed INCOSPAR alone. In India one can clearly see a similar trend, as Sarabhai became a national icon, formatting the future development of India's space policy according to his will. The citizens and the government were eager to follow his call to action because here was a native Indian trying to better his community and people. He was an Indian nationalist who wanted an Indian-owned and operated space industry that could bring in better professional jobs and to help rebuild the dilapidated infrastructure.

The area of Thumba on the southern coast was chosen as the launch site for India's then primitive rocket program. It was an isolated community owned by several local Catholic missionaries. Sarabhai had to convince the group to relinquish some of the land for the facility and when he announced that the program would benefit the impoverished rural communities of India, the Catholic group willingly agreed to allow the team to use the land. This was an almost inaccessible and rugged terrain that was greatly under developed. It was isolated enough from settlements that the rockets would not interfere with communities or daily life in India. INCOSPAR was also concerned with launch accidents and so this remote location cut back on

the fears of having a faulty incident occur over a local village. Accidents lead to negative media coverage and the developing space agency could not afford to gain any of that. It needed to win over the administration in its early years so it could legitimize itself and secure more funding. India's democracy was still young at this time and INCOSPAR needed to have a favorable stance with the political administration so the government would allocate more funding to them in the future. However, there were some drawbacks to this site initially because the location was so isolated and the agency could not afford expensive moving equipment. Consequently, the early rockets were brought to the site on foot and by bicycles and then assembled on location (Harvey et al. 2010, 145).

The early stages of the rocket program consisted only of basic sounding rockets that could test atmospheric conditions. After several successful launches, Sarabhai decided that India should try to be a part of the international launching community and wished to transform Thumba into a multi-national launch facility. Through help from the United Nations (UN), Thumba became a testing site for the U.S., Soviet Union, and France. Sarabhai wanted an indigenous program, but he also understood the benefits of having more developed spacefaring nations involved. He hoped that there would be some technological diffusion between these partner states. The three states chosen represent how India tried to remain fair and balanced between the West and the Communists. They were not willing to succumb to a particular hegemonic state due partially to their new sense of independence and so tried to remain as neutral as possible between the two competing ideologies during the Cold War. The U.S. space agency, the National Aeronautics and Space Administration (NASA), contributed to telemetry for ground personnel, France provided Centaure rockets, and the Soviet Union gave India

computers and a helicopter for observations (Harvey et al. 2010, 146). This balancing of aid

received from both the Communists and the West shows India's strive to remain neutral and fair

between the two doctrines.

Sarabhai really wanted a completely indigenous space program, however, the lack of

technology and resources made this an unattainable goal at the time. Therefore, the use of

foreign equipment and personnel in an international cooperative effort helped India to gain

access to foreign engineering without being perceived as an inferior nation begging for

assistance. Although foreign nations can be beneficial, they can also put India's public image

and security at risk because India did not want to fall back into its days of colonialism or look

like an inferior state. It did not want to become a satellite state for either the West or the

Communists, so each decision made had to be even handed between the super powers, so as not

to cause a disturbance in the international balance of power. By staying a distance from both

countries and by creating an international front at Thumba, India was able to achieve support

without losing much prestige or independence.

From 1963 to 1968 sixty-five rockets were fired from Thumba, including American

Nikes, French Centaure, and Soviet M-100s (Harvey et al. 2010, 146). Over the course of this

time India had reengineered the Centaure rockets that had been given to them by the French into

their own designs. The new rockets could achieve a height of 360 km, receiving valuable

atmospheric data from various altitudes. This project allowed India to hone its skills in sounding

rocketry, gain access to foreign and domestic weather information, and it also gave India an

opportunity to improve upon the rockets that were given to them. They were able to not only

manipulate the shape of the rocket but they also improved the solid-fuel engines on the Centaures, making them easier to fuel and handle in the remote hills of Thumba. The success of the sounding rocket project made Sarabhai feel as though it was time to move toward fulfilling his goal of having an education system based on space-based mass communications.

Before funding a project of such financial magnitude, the Indian government wanted to see a test conducted in some rural populations. Sarabhai had to request assistance from a foreign power in order to help give the government of India its proof of the benefits of a space program. This time India went directly to NASA and the United States for support with this effort. The entire educational program came to be known as Satellite Instructional Television Experiment (SITE) and the program's first phase would be with the use of a U.S. satellite (Gopalaswamy 2008, 66). The U.S. satellite chosen was ATS-F (Applications Technology Satellite-F) and it would be moved over India by NASA so Indian villages could receive its broadcasts. Before the U.S. began readjusting the satellite for India, India had to build several ground stations in the rural villages so they could receive the programs. The ground sets were primarily built from local parts and scrap with some components coming from Japan (Harvey et. al 2010, 155). This helped to not only cut costs but to also make it easier for citizens to repair them locally so they could stay connected to the broadcasts.

The SITE program's mission of educating the rural communities carries the ideology of Prime Minister Nehru, however, it also met the demands of the new political regime in India. Prime Minister Indira Gandhi had been trying to homogenize the population and centralize politics since her election in 1966 (Hirose 1994, 62). One way she planned to do this was to

make Hindi the dominant language and to spread it throughout India. Having a nationally

recognized language helps to unify the population and what better way to spread this than

through mass communication via satellites. Prime Minister Indira Gandhi created slogans such

as *garibi hatao* (remove poverty) that were relayed through public communications to try and

unify the population around her Congress Party as well (Hirose 1994, 57). The prime minister

may have been in favor of Sarabhai's plan for satellites not only because it would benefit the

population, but because it could also transmit political messages in Hindi to the rural

communities to help strengthen her party and political agenda. According to one Congress Party

member, "the strength of the Congress Party derives from a psychological blackmail which

projects through the mass media that the Prime Minister is the only person who can run the

country and, that therefore the Congress is the only party which can deliver the goods" (Hirose

1994, 97). The people of the lower castes in India were vulnerable to political slogans and so

would have easily been manipulated to side with the Congress Party if they were being fed this

information in the rural communities through the mass media (Hirose 1994, 98). The previous

quote illustrates that Indian leadership must have been in favor of the space program because not

only was it fulfilling Nehru's promises but it became an outlet for political dominance.

Nationalism really becomes apparent in the space program during SITE in the 1960s, as

Sarabhai calls for Indian engineers abroad to help construct the ground stations and their

equipment. The minister of communications decided that America's RCA Company should

come into India and build the ground stations instead. Sarabhai demonstrated his national

prestige and political weight when he telephoned Prime Minister Indira Gandhi and had the

previous minister's contract overruled. Sarabhai was India's space program, and his drive was

synonymous with India's progress in this field. The ground stations created new jobs around the country and also gave the people pride in an Indian program. The only foreign parts in the ground station project were some receivers supplied by Japan, an ally of India.

Once ATS-F was in orbit and the ground stations were constructed, the next phase of SITE began, which was the broadcasting of educational programs. Every week there were twenty-minute long broadcasts sent via ATS-F to the rural communities' receivers. The local villages usually had one TV at a village community center or government complex. Farmers and laborers would come and watch specials about crops, pesticides, pastoralism, and other agricultural education that would help the villagers improve their farming capabilities (Harvey et. al. 2010, 155). Anthropologists then studied and compared two groups of villagers, those who received the broadcasting and those who were continuing on with pre-satellite agricultural methods. The results were staggering, as Sarabhai and his team witnessed an increase in farming success in the villages exposed to mass media communication especially among women (Pal 1980, 71). Those without television contact had remained stagnant in their farming methods and levels of productivity. The government felt that these results were evidence enough to put their full support behind the SITE project and begin moving toward a more developed indigenous space program.

By 1969, INCOSPAR could no longer support the Indian space agency, as it had outgrown the institution. A separate agency, the Indian Space Research Organization (ISRO), was created after the success of the SITE program to fulfill the nation's progressing space needs (Burleson 2005, 136). From 1951 to 1991 life expectancy almost doubled from 32 to 60 years of

age. There is also a decrease in infant mortality rates per 1000 live births that drops from 183 in 1951 to 90 in 1991 (Thakur 1995, 315). The results are staggering and the increase in India's quality of life can be directly linked to space programs and projects like SITE, whose only function was to provide a better life for the citizens of India. These statistics helped to prove that SITE and similar programs over time have helped to improve the lives of India's citizens, especially in the rural communities.

On December 30, 1971, during a conference for Indian revitalization and the planning of SITE's next step, Vikram Sarabhai passed away in his sleep at the age of 52. India's national hero, a symbol of progressivism, revitalization, and nationalism died suddenly, alone, and without warning. Sarabhai never lived to see his project fulfilled or to see all of the effects of SITE's overwhelming success in India over time. There was no heir to the space empire Sarabhai had created; no one in the agency had his drive. India's politics on space would change as there was no longer a strong man, a national icon guiding the progression with public authority. Though nationalism would still play a role in the development of their predominately indigenous program, there would no longer be a centralized figure of power guiding the program in this direction.

The Post-Sarabhai Era

After Sarabhai's death, ISRO went back to the United States for support with furthering Sarabhai's SITE and Television for Development. In 1974 NASA launched ATS-6, the second satellite for SITE's development since the experimental program began with ATS-F (Harvey et al. 2010, 155). It was stationed in geosynchronous orbit over India by NASA and it relayed

television programs to the various villages, three hours a day, mixing agricultural and health programs. The programs were then followed up by thirty minute children's science programs. Though Sarabhai was deceased, his influence was still overwhelmingly present in the beginning stages of SITE. His earlier writings indicate, while he wanted a fully indigenous program, that he believed India would have to rely partly on foreign assistance for the early stages of the program because India lacked a geosynchronous launcher and therefore couldn't follow through with the program alone. He felt that they would at least have to rely on foreign powers to launch and build satellites for India and then in the second stage of his plans, foreigners would launch Indian manufactured satellites for them. The final stage, Sarabhai hoped, would be to move India towards indigenously launched and manufactured satellites, ending their reliance on foreign assistance.

The benefits received from the SITE project demonstrated how important a space program was for India's economy and thus helped to justify the high costs of the program. It became apparent that the system could be used for civilian purposes other than just television and radio program broadcasting. Satellites could also be used to track storms and provide early alerts to citizens of potential natural disasters such as flooding or rain storms. Satellites also gave citizens improved maps for navigating hazardous areas and helped India's industries find the right areas to mine for valuable resources. By the 1970s, India had plans to build its own domestic satellite, a small satellite with simple scientific instruments on board. India felt that they could have a satellite manufactured indigenously long before they had a homemade launcher, so ISRO began funding a domestic satellite program. They postponed a launcher

program due to the costs and felt that they could continue to rely on foreign launchers for the time being.

In 1972, Satish Dhawan, an Indian aerospace engineer, was appointed to the position of chairmen in the ISRO by the Indian Prime Minister Indira Gandhi (Harvey et al. 2010, 159). During the later 1960s, India's scientists started to lean more toward the side of the Soviet Union, abandoning their original doctrine of neutrality. They became engulfed in the hegemony of the Soviet empire and found technological trade and diffusion to be simpler than with the Europeans or the United States. Dhawan had been able to draft an agreement between the Soviet Union and India during his first year at ISRO. In the resolution, Soviet tracking and sounding ships were allowed to use Indian harbors and in exchange the Soviet Union would launch Indian manufactured satellites. In 1975 the first indigenously manufactured Indian satellite, *Aryabhata*, was launched out of Kapustin Yar, the Russian launch facility (Correll 2006, Vol 4).

It was a simple satellite, whose primary scientific purpose was to study different kinds of stellar activity such as solar flares and radioactive particles interacting with the Earth's ionosphere. India's second satellite, *Bhaskhara*, was launched four years later and was meant to be a back-up and later replacement for *Aryabhata*. *Bhaskhara* was also a scientific satellite capable of interpreting sun and stellar activity; however, it came with some other features that *Aryabhata* lacked. *Bhaskhara* was equipped with a camera for taking pictures of Earth, a radiometer to study ocean behaviors, and a data relay antenna to experiment with data communication (Burleson 2005, 139). These experiments were very valuable to India, as the research done could help the population gain a better understanding of weather patterns and

geography. These programs also had a strong political message for the world that India was beginning to leave its mark on space. With these first domestically manufactured satellites came the confidence of a whole new generation of space opportunities for India.

Aryabhata was not the only Soviet program that India was involved in. In 1978 the Soviet Union made an agreement with Prime Minister Indira Gandhi to begin training the first Indian cosmonaut. The man picked for the endeavor was Squadron Leader of the Indian Air Force Rakesh Sharma. He began training in 1978, complete with learning Russian, and Soyuz mechanics. In 1984 Sharma was lifted out of orbit on Soyuz T-11 carrying an Indian flag and several ethnic foods to share with his fellow cosmonauts (Harvey et. al. 2010, 234). This was the first time an Indian was in space and it demonstrates the close bond India had with its Soviet neighbors.

The space program for India in the 1970s had retained its original intention of being used to better the people's quality of life, to improve the agricultural capabilities of the farmers, and to study meteorology and topography. An improved economy was the major driving force for India's space program, though nationalism was still a priority it had toned down a bit in ISRO since Sarabhai's passing. There was no longer this key icon guiding nationalism in the program, but instead a large entity, ISRO, led more by a think tank of engineers than a single leader. Dhawan's ideas were impressive and got India to its next step in space with an indigenous satellite, however, he would never carry the prowess or respect Sarabhai had.

By the mid 1970s, India had a fully indigenous satellite engineering program and ISRO felt that it was time to begin a more developed Indian launcher program. India was still hopeful

it could free itself of the foreign influence and support from its various space allies, but they couldn't achieve this until they had an indigenous launcher. Though India still planned to coordinate missions and exchange technological and scientific data with foreign powers, India wanted to manufacture its own launchers to fulfill its mission of being an independent space power. Sarabhai's plea for the return of Indian scientists from abroad was also finally answered during the 1970s, as Indian nationals living in foreign nations began returning home to help develop the launcher program. Many young educated Indians with a background in math, physics, and engineering had left India for places like the U.S., U.S.S.R., and France to find higher paying and more stable careers that were not present in India before the 1960s. During the early years of the space program in India, the job market was scarce and its future was still highly unpredictable, which made a lot of educated people not want to take part in the program. The successes of India's satellites and a growth in ISRO to over ten thousand jobs in the aerospace field convinced a lot of these displaced nationals to come back home because more funding was being pumped into the program and thus more opportunity in their fields. The Indian economy was growing, educated Indians were returning home, and the space program was bringing in more jobs in various fields to support a growing middle class in India (Harvey et al. 2010, 164). The space program has not only helped the field of aerospace engineering, but also mass media, agriculture, mechanics, and various other technological fields because there has been several "spin off" inventions from the space program to help such industries advance and grow. The development of a launcher would bring with it even more careers and more employment security for the space professionals in India. It also meant that the Indian

government could begin saving significant amounts of rupees by using its own domestic launchers and could also charge foreign nations for payload space on board Indian launchers.

The first rocket developed by India to carry satellite payloads was known as the Satellite Launch Vehicle (SLV) and it had its first successful launch in 1979. It was a small solid fueled rocket that was reminiscent in design and function of the American Scout rocket (Harvey et al. 2010, 165). The SLV was designed primarily to carry small satellites and payloads into low earth orbits (LEO) for India. The project again solved two issues for India, it not only increased the overall job market in the country but it also carried a strong message to the international community. It meant that a "third-world" or developing nation that was escaping poverty could arise as a space power, which redefined what it meant to be an authority in the space community in the twentieth century. The economic success and the increase in international prestige for the space program also meant an increase flow of capital from the Indian government. This influx of capital helped to create projects like the PSLV, however, it also allowed ISRO to create a new launch facility. Larger rockets like the PSLV require a more developed facility with a larger footprint. Thumba was no longer adequate enough for the larger launchers India was planning to develop. The site chosen for the new facility was the island of Sriharikota, which was very similar in its geography to Cape Canaveral with a marshy environment on the eastern coast overlooking water. It was a somewhat isolated island on the east coast that was closer to the equator than Thumba, which allowed for more efficient launches into equatorial orbit. Rockets should be launched in an eastward direction into the Earth's counter clockwise rotation and as close to the Earth's Equator as possible allowing for the greatest efficiency in breaking orbit.

Sriharikota was also surrounded by water, so if a rocket was launched and it had a fatal malfunction it would plummet into the ocean rather than over a village on the mainland.

SLV was almost entirely Indian manufactured, with an estimated eighty-five percent of its parts were developed in India (Harvey et al. 2010, 164). It had been in the works since 1973, several years before the launch of *Aryabhata* out of Kapustin Yar had even occurred. After six years of development it was launched in 1979, but had a malfunction resulting in harsh media coverage from Indian news agencies and from newscasters abroad. In a democracy such failures can be catastrophic for public relations because the citizens see millions of rupees going up in smoke. In an autocratic regime such mistakes can be covered up more effectively by the government. For democratic India the space agency could only accept its public backlash and try to impress its citizens and government during the next launch. The researchers followed through in 1980 with SLV's first successful launch with an Indian satellite on board, as it carried the 36.75 kg *Rohini* satellite into orbit. The ability to manufacture an indigenous satellite and a domestic launcher and then place that satellite into orbit with the launcher made India a spacefaring nation. However, India still had more development before it would become fully independent as it still couldn't reach geosynchronous orbit (GEO). The *Rohini* launch gave India the foundation it really needed to fulfill its space program's independence and another step toward manufacturing a geosynchronous launcher. Geosynchronous orbit is coveted by space programs because a satellite in this orbit allows for greater stability and communication between the satellite and the Earth ground station below. The satellite stays in the same orbital position, creating a direct link between it and the Earth station.

India's next drive toward a large launcher came with the design of a system known as IRS or Indian Remote Sensing, which is primarily a civilian based system (Mistry 2001, 1036). It is a collection of satellites that takes hundreds of high resolution photographs of India's topography (Burleson 2005, 139). As of 2004 India was recorded as having six IRS satellites in orbit tracking various sources (Moorthi 2004, 264). There was a lot of promise in this field as it could provide a great deal of civil data to the rural populations, including weather tracking, mapping, and hydrology. IRS would also provide crucial oceanographic, geological, and other resource information that would allow Indian industries to determine where the best regions were to set up facilities or where valuable resources may be harvested most effectively so they could increase profits and productivity (Baker et al. 2001, 151).

Sarabhai felt that in order for ISRO, SITE, and future programs to be completely successful, the industries supporting India should be better developed first and that they should be allowed access to the information space research offered. He once wrote that India could not have twenty-first century space technology while relying on a culture that had nineteenth century industrial technology, meaning India needed a stronger infrastructure before they could make significant strides in space. In order to place such a system in orbit, India would need a rocket larger than the SLV. Sarabhai had planned for India to one day have such a system to aid in geographic research and the 1980s would make tangible the ideas Sarabhai had twenty years previous. It was believed that these satellites would help researchers, businesses, and industries gain more knowledge of the land so that they could successfully utilize and extract natural resources more effectively. Using IRS photos and technology could also help determine where

the best places to farm were and what land was the most arable and economically valuable for increased productivity in farming.

Military Potential

The systems thus far have been manufactured for the betterment of society and the economy. However, it was during the 1970s that India's quickly began advancing development in its space program along with escalating tensions on the India-Pakistan border, which began to raise concerns among officials in both the West and the Soviet Union. In 1965 and 1971 India and Pakistan went to war, both of which were caused by Pakistani aggression and border claims (Thakur 1995, 201). India felt an existential threat from its neighbors and felt that perhaps a nuclear program could be the answer to their problems, after all Pakistan had a nuclear program that had been in development since 1972. India's government felt threatened and therefore funneled more money into its defense buildup. India's officials looked to the space program for help with their endeavor to create a first strike or deterrent nuclear force. Though the SLV rocket was developed to carry satellites in orbit, the rocket could be reengineered into an intermediate range ballistic missiles to carry nuclear payloads (Mistry 2001, 1023). In the last two decades India has felt a significant increase in external pressure as Muslim insurgents from Pakistan and the Middle East continue to infiltrate India. Pakistan has also begun experimenting with checker-board politics, making an alliance with India's bordering neighbor, China (Thomas 1996 53).

The high resolution optic cameras onboard the IRS satellites, while originally designed for civilian purposes could also be used for military surveillance of enemy troop movements and

foreign military installations. The mass communications satellites could also be used for military operations by providing fast and efficient messaging between troops and high command. Satellites and rockets could serve a dual purpose for India, by both increasing the quality of life for the citizens, while also ensuring their national security (Mistry 2001, 1028). However, the use of space for military activities crosses a line regarding the ethical use of space. Most nations have come to an agreement that weapons should not be allowed in space, however, there is still the issue of whether space-based rockets or satellites should even be used in association with military operations. India has received a significant amount of international criticism for its nuclear program, which has resulted in a backlash against parts of India's space program as well, since the ISRO was responsible for rocket development.

Despite the apparent militarization of some of India's space agency, it doesn't appear as though India is looking to weaponize or arm space in any way. Most nations, regardless of political ideology have been in an universal agreement that space should be kept civil and peaceful, especially after China's ASAT (anti-satellite weapon) launch in 2007 (Moltz 2008, 298). Since 1967 the Outer Space Treaty has had a clause that states that space should be kept peaceful and according to Dr. Moorthi of the ISRO, to arm space with weapon systems would be detrimental to international society and commerce (Moorthi 2004, 267). It seems that Dr. Moorthi is suggesting that while India has used space for surveillance purposes, it does not intend on arming satellites or space in any way.

New Directions

India had hoped to continue its civilian space program and begin what is known as INSAT. INSAT (Indian National Satellite System), was originally proposed in 1976, and was to be an extended and more complete form of the SITE program. INSAT was designed to be a system of satellites working in unison to transmit mass communications and mapping. Its purpose was to provide not only geographic, geological, and agricultural information, but to also relay early warning messages to citizens throughout India of potential weather dangers. The European Space Agency (ESA) had developed its own commercial launcher to compete with foreign markets for space launches. The ESA was offering free launches for the first few customers, so India quickly put together a satellite program known as APPLE (Ariane Passenger Payload Experiment) and launched it on board the ESA's new launcher, the Ariane 2. APPLE was an experimental satellite that was designed to test out some of the implications and engineering that would be used for the INSAT program. APPLE and INSAT required a geosynchronous launcher and since India was still years away from such a rocket, it accepted the ESA's offer (Harvey et al. 2010, 185). Though the project was put together quickly (in less than three years), a lot of precious information was gathered from this project. From APPLE the Indians learned how to stabilize a satellite and operate a satellite in the geosynchronous orbit.

India's satellite program was developing at a faster rate than their launcher program. They had launchers that could reach LEO or Pakistan, but they didn't have the capabilities to sustain a satellite in the much coveted GEO orbit. India was desperate to put INSAT into orbit and felt that it would greatly benefit the nation and the Congress Party overall. With nationalism being put aside once again, INSAT was launched on an American Delta rocket from Cape

Canaveral and manufactured with help from NASA. The government pushed the leaders of ISRO to go to the Americans because they felt INSAT could not wait, that such a program should be instituted as soon as possible because of its social and economic benefits. Again, these satellites could be used to spread the Congress Party's message to the people of India. This was a form of political power for them and Prime Minister Gandhi because it allowed them to directly influence and interact with the citizens of India while continuing to display this idea that they were the only party that could deliver these goods. Though the program was designed to save lives with early warnings and help boost the economy, it was not an immediate need like the government made it out to be. Had they been more patient, they could have developed the satellite indigenously, saved capital, and developed a greater sense of international prestige. However, the politicians wanted the project in orbit quickly so India could have a better established network of communication satellites to aid their agendas. The government therefore pushed for American assistance to quicken the development of the INSAT project. The first satellite, INSAT-1, was launched by NASA in 1982, and NASA was also contracted to launch the next seven in the INSAT series (Moltz 2011, 118). The system had a series of satellites launched by the U.S. into geosynchronous orbit and together they relayed valuable material back to Earth. Everything from media broadcasts to photographs of Earth's geography were sent back home from INSAT.

INSAT was a success and was followed up by INSAT-2, which was primarily developed in India by Indian technicians. Like INSAT-1 it was still launched by a foreign party, but this time by Europe's Arianespace. INSAT-2 was developed to further the original program and conducted many of the same operations as INSAT-1 had done. INSAT-1 and 2 together

provided more than 700 television and 200 radio stations to the Indian citizens by the year 2000.

This system was able to transmit broadcasts to over ninety percent of the Indian population, rural

and urban alike (Harvey et al. 2010, 194). From the 1990s to the mid-2000s India developed

more INSATs for the program, creating a large network of satellites in orbit.

  The INSAT project created more jobs in the space program, further assisted in early

weather tracking, agricultural production, and provided mass media to the rural populations.

However, as beneficial as it was, it still was not being conducted fully under Indian control.

American and European launchers were still transporting Indian satellites into orbit for them,

even into the early 2000s. This resulted in higher costs for ISRO and a cut in Indian

international prestige because they still were not fully independent in their launch capabilities.

This was a problem for nationalists who wanted the soft power of being an independent

geosynchronous launcher state. For ISRO the staff and engineers this international reliance

created a separate issue as well. INSAT relied on a series of interconnecting satellites, if one

was disabled or lost orbit, a replacement would be needed rather quickly. To constantly rely on

foreign assistance meant that they would be at the mercy of foreign launch programs and would

also have to succumb to their higher price tag as well. India's next step was to manufacture the

long anticipated geosynchronous launcher so that they could replace damaged INSATs and

become fully independent in launch capabilities. This would greatly indigenize the space

program for the nationalists and it would also create a new economic market in the global

economy by allowing India to charge foreign nations a fee for payload space on board Indian

rockets. A geosynchronous launcher would also give India a stronger element of soft power and

prestige in the international community because it meant India had a technology and a capability the majority of nations in the world do not posses.

Reaching GEO

The goal of India has always been to have a space program free from foreign control and influence with their own manufactured satellites onboard Indian-operated and launched rockets. From the Scout-inspired SLV came the next rocket, a much larger version known as Augmented SLV (ASLV) in the 1980s. It was an intermediate rocket with larger boosters than the SLV, capable of putting a heavier payload (40kg) into an orbit of 150-300 km of LEO (Harvey et. al. 2010, 198). It was a highly flawed project early on and was met with several failed missions. The ASLV was short lived and ISRO soon scrapped the project and moved towards a new design because they needed to put heavier payloads at a higher orbit. Indian engineers created the Polar Satellite Launch Vehicle (PSLV), which was much larger and had more powerful engines than the previous ASLV (Burleson 2005, 141). The PSLV put India in line with the "big launchers" like Japan, China, U.S., U.S.S.R., and ESA. The engine on board the PSLV was the third largest solid fuel engine in the world, second only to the American space shuttles and Titan rockets (Harvey et al. 2010, 202). This launcher gave India the ability to launch larger payloads into orbit, but they still could not quite reach GEO. PSLV launches may not have been able to achieve the desired orbit, but it did greatly help to expand parts of the IRS program and it placed several new satellites into orbit to help with general weather and earth observation.

India has made one final transition in its rocket phase and that was the move from PSLV to the Geostationary Satellite Launch Vehicle (GSLV) (Burleson 2005, 136). The original

rockets of India in the twentieth century were modeled after French Centaur rockets and

American Scouts while their satellites were transported into the heavens onboard American

Titans and European Arianes. Indian satellites of the twenty-first century are transported on

Indian engineered GSLVs. It was a forty-year-old plan originally drafted by Sarabhai in the

1960s and it finally came to fruition in 2004 as the GSLV program had its first successful launch

carrying an educational satellite (EDUSAT) into space (Harvey et al. 2010, 227).

Most of the GSLV was manufactured by Indian engineers, however, in 1991 Russia (the

Soviet Union had just collapsed) and India came to an agreement that Russia would sell a KVD-

1 cryogenic engine to India to be used on the new GSLV launcher (Moltz 2008, 237). The U.S.

pressed for sanctions to be imposed on India and Russia on the grounds that the transaction

violated international trade of missile technology (Correll 2006, Vol. 4). America brought

evidence to the U.N. demonstrating how several "peaceful" engineers in India's space program

were also working on the nuclear missile project, trying to demonize the Indian space program,

making it appear as though ISRO was a militarized institution with a secret agenda for war.

Though the U.S. claim was partially true that ISRO had worked with the military, such military-

space relationships were apparent in all major space programs including NASA. At one point

the strain became so tight between Russia, India, and the U.S. that Russia backed out of the

transaction and requested a large sum of reimbursement to be given to Russia from the U.S. to

make up for lost profits from the exchange. The Moscow-New Delhi engine transaction was

eventually followed through with after President Clinton took office in 1993 and the aggressive

tensions began to relax (Von Bencke 1997, 153). India was still asked by the U.S. to publicly

agree to only use the cryogenic engine technology for peaceful and ethical space purposes. After

over ten years of engineering and criticism the GSLV was complete with a Russian cryogenic engine and made its first successful launch in 2004 (Harvey et al. 2010, 225).

The new launcher has brought a lot of potential projects to India, including manned missions, a planned lunar mission, and new economic markets. The GSLV puts India into a very elite group as most nations do not have a launcher, much less one that is capable of reaching geosynchronous orbit. They can now launch their own large satellites into orbit and can also freely launch payloads for foreign countries that are not able to do so themselves. Nations including Germany, Belgium, Italy, Israel, Canada, and Japan have used payload space on board Indian GSLV rockets (Harvey et al .2010, 252). Recently in 2010, Obama also changed ISRO's status in bilateral trade making it possible for the U.S. to conduct more trade and missions with India without requiring a special license (Moltz 2011, 133). This will hopefully smooth over past relations and stimulate more development and cooperation between these two space powers. The GSLV also still remains the most up-to-date launcher India has in its fleet and as of 2012 they are still working to improve the boosters to carry even larger payloads safely into geosynchronous orbit.

Television for Development

India's space program began with the dream and drive of one man, Vikram Sarabhai. A revolutionist in India, Sarabhai saw space as a way to easily communicate with the masses of India and to provide beneficial educational broadcasts to people who had previously been isolated from mass media outlets. He believed that if India focused on those in the rural communities, that their increase in agricultural production and overall quality of life would

increase and help to invigorate the lethargic and desperate Indian economy. For centuries India was under foreign occupation, but the 1940s brought liberation and independence for the first time in any living Indian's life. For the people, having an indigenous space program was more than prestigious; it was a way of showing the international community Indian pride.

Achieving the status of being a spacefaring nation was challenging, but the ISRO and Sarabhai never gave up on India. Conquering space was primarily for economic reasons in India, as it not only gave educated Indians lucrative and stable careers, but it also helped to expand and improve other industries such as agriculture, geology, and meteorology. Not only could village people learn how to keep themselves clean and grow more plentiful crops, but they could also watch dangerous weather patterns developing and prepare people earlier before disaster strikes, saving countless lives. Despite the military diffusion of some space technology in India, the positive aspect of this civilian program has far outweighed any negative consequences of their aerospace advancements thus far. As proof of India's peaceful agenda, the world has yet to see a micro nuclear war between India and Pakistan, however, millions have been educated, the economy is on the rise, and the life expectancy in India has almost doubled since the first launch of the SITE satellites. India has greatly benefitted socially and economically since the development of their space program (Doyle 1994, 110).

India's space program is still evolving, especially in the economic sector. They are not only taking their own payloads into geosynchronous orbit, but also those of foreign nations willing to pay a fee to India in order to get their satellites into orbit. The Indian space market is moving farther away from governmental control as well, as more private companies are looking

to commercialize the industry (Correll 2006). Several spin-offs have come from ISRO projects, and companies around India want to expand on these inventions and turn them into profitable international and domestic markets. Private businesses are also interested in space tourism and think tanks in the Indian government and the ISRO are looking to get involved with this field as well. They are also working on developing their own cryogenic engine and abandoning the old Soviet-inspired model attached to the modern GSLV, which would make it an entirely Indian developed missile. The GSLV in the twenty-first century has allowed India to begin planning manned missions including a possible manned lunar landing within the next two decades.

Talks of a manned mission began in 2003 when China launched their first *yuhangyuan* (astronaut) in orbit (Harvey et. al. 2010, 238). The GSLV was the rocket picked and it has been redesigned to have a cabin in it upper nose cone. For aid with this mission India has sought support from the Russians, and a joint group was created between Indian and Russian scientists to analyze this mission in 2008. India went through several tests including dropping cabins from helicopters. The Russia-India group settled on a design that was reminiscent of the Soyuz capsule and has created an astronaut training center. As of 2010 Russia and India have grown apart and India is redesigning the capsule (Harvey et. al. 2010, 239). The human spaceflight program has had some financial setbacks, but India recently contributed two billion dollars to the program to develop a program that will have a Russian trained Indian cosmonaut fly on board a Soyuz in 2013, and a GSLV launched mission in 2015 (Moltz 2011, 133). There is also a lunar probe mission that has been scheduled for 2013 as well and a potential manned lunar mission by 2020 (Moltz 2011, 133).

India has been very successful as a space power in the modern era, even though it was slow in its original progression. It seems that it is still in accordance with its original function to help the impoverished areas of India. In 2008, Indian space official, Rajeev Lochan, stated that "The security of this infrastructure, its renewal, and expansion as needed, and the uninterrupted and assured continuity of its operational services form the core of India's concerns and space security." (Moltz 2011, 125). Meaning, the main drive for India's space program is still to aid the populace and their quality of life, however, it this is not the only concern as another official, Bharath Gopalalswamy, points out "India no longer views space as only enhancing the living conditions of its citizens but also as a measure of global prestige." (Moltz 2011, 126).

In order to fully appreciate the Indian program one must keep in mind that the nation had just come out of colonialism as a very impoverished nation and yet within twenty years India had a functioning space program with several indigenous programs. They also did not have the privilege of raiding Mittelwerk or Peenemunde with the Americans or the Soviet troops in 1945 and thus were forced to go out and seek assistance from those nations that had been there, who had the secrets, and who were willing to cooperate politically. India was not only concerned with getting the technology but rather from whom they could get it. It was a fine balance between western and Soviet technological diffusion. India had wanted to remain independent after 1947 and was not looking to get tied up in the Cold War politics or become a puppet state for either hegemonic state. India generally made sure that it maintained friendly relations with both sides throughout its entire space program's existence and that they were fair and evenly balanced in accepting international assistance.

During the beginning of their space program, the citizens of India found it difficult to understand why their nation would spend billions of rupees on futuristic technology that seemed so out touch, so alien to India's masses. Through programs such as SITE and INSAT, the Indian government has shown the people how beneficial the space investment was for not only the economy but also for the entire population's well being. India has proven itself to be one of the most powerful spacefaring nations on the Asian continent and it all started with the Indian government and its citizens' decision to follow Sarabhai's model. The economic reimbursement, the engineering breakthroughs, and the social benefits space has given to India can only begin to predict the potentials that the future will bring. The results cannot even begin to be quantified; the human condition in India has been well served by the space program.

CHAPTER 4: JAPAN

In 1937 the army of Japan captured Peking, China, a momentous task for a small island nation with sparse natural resources (Beasley1987, 203). Japan was able to conquer much of China, the Philippines, and many other islands throughout the South Pacific during World War II. They became a feared people as they tortured, raped, and pillaged the Asian continent. By 1940 Japan had joined the Tripartite Pact and became an official member of the Axis Powers, along with Germany and Italy (Beasley 1987, 221). This new alliance gave the three powers mutual protection from the allied forces, particularly the Soviet Union, and also allowed for more open technological diffusion. This would allow Japan to later gain access to the secrets of the German juggernaut, like its advanced jet engines, synthetic fuels, and V-2 schematics. The Japanese had hoped that this treaty would give them the advantage they needed to overcome their enemies in Asia, but more importantly their greatest threat from the Western Hemisphere as well, the United States. Japan had gained access to vast amounts of natural resources across the South Pacific as their troops conquered it, but felt that the United States and its Pacific Fleet was a threat to Japanese expansionism.

Japan took advantage of its new pact and sent submarines on secret missions to Germany to retrieve V-2 rocket and jet engine parts and plans (Harvey et al. 2010, 1). Towards the end of the war, Japan was faced with a relentless American bombing campaign. Tokyo was set ablaze by incendiary bombs and soon many other cities suffered the same fate. Japan needed a plane that was capable of reaching the American B-29s more effectively at their higher altitudes and speed. In 1944 Japan brought back rocket and engine blueprints and components from Germany,

and began constructing the first Japanese jet fighters. However, Japan could not successfully mass produce the jet fighters in time and soon the war was over in 1945 (Harvey et al. 2010, 2). On August 15, 1945, Japan officially surrendered to the United States on the deck of the U.S. battleship *Missouri*. The Japanese industrial infrastructure was in ruins and the military was reduced to a small defense force. Nearly five million demobilized Japanese troops were displaced throughout the South Pacific and the U.S. military under General Douglas Macarthur was the supreme authority in occupied Japan (Mcnelly 1963, 29). Japan's aggressive actions had cost the country its freedom, as the United States began to impose strict sanctions through the peace treaty. One of the most crucial points in the treaty relating to space policy was the reduction and suspension of the Japanese armed forces, which also meant a restriction on rocket programs (Moltz 2011, 47).

Japan began anew as a democracy, demilitarized, and with an unstable economy in its early postwar years. Its infrastructure was severely damaged by the bombing campaigns, and many once thriving communities were now piles of rubble. The new government was met with diverse challenges after the Second World War, and space travel was not a feasible venture in 1945 Japan. Unlike India, Japan is not large with isolated agricultural communities, though in some cases the terrain can be unpredictable and dangerous. Japan was not to the point that satellite technology was deemed a need for Japan to be successful as it was in India. Japan began to rebuild itself after the war and became a nation strongly devoted to civil technological advancement, especially since it did not have to fund a standing military any more.

The possibility of Japan becoming a spacefaring nation came from one man's ambitions, Hideo Itokawa. Itokawa was a Japanese scientist who was trained in a diversity of fields, yet took a special interest in aerospace engineering and physics. During the war he designed planes and rockets for the Japanese military. While with the military, Itokawa had access to the latest jet and rocket technology from Germany and was really drawn to its capabilities. However, his career as a war engineer came to an end with the Japanese surrender in 1945, and he then sought employment at the University of Tokyo (Harvey et al. 2010, 4). During the late 1940s and early 1950s, Itokawa watched as the U.S. and the U.S.S.R. developed and launched their rockets and he was really impressed with the technology. Despite restrictions on rocket launches, Itokawa started a small organization of former war engineers known as the Avionics and Supersonic Aerodynamics Research Group (AVSA), which focused on bringing rocket technology to Japan (Harvey et al. 2010, 5). Though Japan did not need a rocket program at the moment, it did need a prestigious program that would open up new markets in the economy and also bring national recognition. Japan in the early post war era needed economy boosters, and Itokawa believed space technology could bring in beneficial jobs and benefits that could help raise the struggling economy and create an improved international image for Japan.

Japan: The Early Years and IGY

In 1953 the International Geophysical Year (IGY) was officially announced, and nations all over the world came together to contribute to this international scientific undertaking. The IGY was a scientific mission held in 1957 that focused on Earth sciences such as gamma rays, meteorology, and gravitational pull (Harvey et al. 2010, 5). Itokawa felt that this would be the most opportune time to announce Japan's goal of becoming a spacefaring nation because it

would allow Japan to gain a greater amount of recognition from the international scientific community. The government at first was strongly opposed to Itokawa and AVSA, however, one inspirational Parliament official read through an article on the economic potentials of being a spacefaring nation and helped to sway the government in favor of funding AVSA and its IGY missions (Harvey et. al. 2010, 7). AVSA had been experimenting with basic sounding rockets, but for the IGY, Japan needed larger and more developed rockets. Itokawa and his group crafted the *Kappa-6* sounding rocket, which carried different meteorological instruments on board that were used to study the Earth's atmosphere and weather patterns (Harvey et al. 2010, 7). Japan didn't have much space technology during the 1950s and certainly did not have the means to break orbit. The Japanese contributions to the IGY were insignificant, however, their determination and drive to become a space player was well noted among the major space powers, the U.S. and the U.S.S.R.

The Japanese government was very much impressed by the work of Itokawa and AVSA during the IGY and chose to increase funding for the program, a sign of an increase in government acceptance for the space program and *Kappa* (Moltz 2011, 48). During the 1950s the sounding rockets became larger and more advanced, with each design being able to carry a larger payload to a greater altitude. Not only were the rockets becoming more sophisticated with multi-stage components, they were also gaining a lot of local publicity, so much so that Tokyo University changed their name to the Institute of Space and Aeronautical Science (ISAS) (Berner 2005, 3). ISAS became the forerunner for Japanese space and rocket missions, as the institution began to manufacture and launch larger and more advanced rockets. The ISAS rockets had won over the Japanese government and in 1961 the government purchased land and constructed a

launch facility at Uchinoura, an isolated fishing community (Burleson 2005, 162). Along with

the site at Uchinoura, Japan also commissioned the construction of radar and tracking facilities

throughout the country (Harvey et al. 2010, 11). The government of Japan felt that rocket

technology may be a beneficial investment because it would bring more commercial and civil

opportunities to their nation.

At Uchinoura ISAS encountered one of its largest problems, one that would be in power

for most of the Japanese space program. Fishermen in the area would not allow the ISAS to

launch rockets during certain seasons because it would endanger their profits. Rocket launches

were scare away fish and disturb the fishermen's livelihood. Being a democratic state that need

to respect and uphold the rights of its citizens, ISAS was forced to reach an agreement with these

local fisherman. The fisherman set the launch cycle periods, anytime frame out of the one given

to ISAS was unacceptable. This is one reason why Japan would later seek aid from the U.S.

ISAS had to launch during certain times and those times conflicted with the fishermen's

schedules. ISAS was sometimes forced by its own citizens to seek foreign support for its

launches. The fisherman held this power until fairly recently when the Japanese government

began to give ISAS more power over its launch dates.

Japan's sounding rockets continued to develop slowly during the 1950s and early 1960s.

Each class of rocket in Japan was designated with a Greek letter, such as *Kappa, Lambda,* and

Mu. After the *Kappa* series rocket, Japan had developed the *Lambda* rocket by 1965 (Harvey et

al. 2010, 15). *Lambda* was a slightly larger sounding rocket, but it had several launch setbacks

and was broadcast as a failure by the Japanese and global media. Some officials in Japan began

to lose favor with ISAS during these setbacks and threatened to cut back space funding if conditions did not improve.

The failures of *Lambda* during the 1960s shows how a democratic government can react against a bureaucratic agency like ISAS. Between high costs and negative public media coverage, ISAS was putting itself in danger of losing support or even funding from the government. The Japanese parliament the Diet carries the law and budget making power in the government and for a bill that adjusts the budget to be accepted, it must be supported by at least 50 members in its lower house, the House of Representatives and at least 20 from the upper house, the House of Councilors (Masuyama 2004, 261). When considering there are several hundred representatives in the Japanese Diet, this is a very small number of individuals who could take action against ISAS. Despite the unpopular coverage and the launch failures, it appears the Japanese were still in support of the space programs growth since the Diet didn't cut funding to ISAS during the 1960s.

The Japanese space program remained almost completely indigenous since its origins, aside from the few designs they had received from the Nazis. Itokawa took great pride in keeping the program a Japanese manufactured and led program, but the failures of the *Lambda* project put a lot of doubt in the minds of ISAS as to whether the program could be developed in a timely manner without foreign assistance. Japan was faced with a very similar crisis that their Indian allies had, poverty and a weak infrastructure after the war. India had fought its way out of colonialism in the 1940s, while Japan had fallen under U.S. occupation in 1945. Japan's government was under the control of the United States after the war and parliamentary bills

could not even be passed without the consent from U.S. officials until after 1952 (Miyoshi 1998, 84). The occupation of Japan is one of the many reasons as to why Japan would be in an alliance with the U.S. even into the modern era (Moltz 2011, 43). By 1952 the San Francisco Peace Treaty had given Japan its independence, but it was left with rebuilding its industrial infrastructure and no drive to rearm an offensive force. With the failures of *Lambda* in the 1960s and the Communist victory in China in 1949, the Japanese were in need of a strong defensive ally and one that could provide assistance to the Japanese space program. After 1946 Japan was operated by a western style democracy and chose to ally itself with the U.S. for security and support during the Cold War.

A Growing U.S. Dominance

The U.S. wanted to make sure the Japanese space program did not become competitive with NASA and therefore put more pressure on the Japanese government during the 1950s to allow the U.S. to invest in the Japanese space program. If the U.S. could operate within the Japanese space agency and sell contracts to it, then the U.S. could set restrictions on ISAS and control the terms of Japan's activity in the space market. The Japanese government continued to reject the advances from the U.S. during the 1950s through the mid-1960s. However, by the later 1960s the program's slow pace caused discourse amongst ISAS officials that were either in favor or against U.S. intervention. Itokawa left the program in 1967 during this split because he felt that he lost his ability to hold the program together and so went off to do research on oil storage facilities (Harvey et al. 2010, 15). Itokawa, much like Sarabhai, was always the central guiding figure in the Japanese space program, as he had almost single-handedly led its early development. Itokawa, while a national identity, was never able to fully become the icon

Sarabhai was and so he quietly faded from the scene as new Japanese space enthusiasts arrived to steer the space program into its next stage.

This next phase was the development of the *Mu* series rockets, a larger more sophisticated rocket than the *Lambda*. The *Mu* series was important because it was developed to carry satellites, which is the first time Japan breaks away from sounding rockets with basic atmospheric instruments on board. During the 1960s several *Mu* rockets were designed and launched, but it is the *Mu-4S* that made the most memorable strides. In 1970 it launched *Oshumi*, a Japanese test satellite, and in 1971 it also launched *Tansei* and *Shinsei*, two scientific satellites (Harvey et al. 2010, 18). However, with these successes came several failures, costing Japan millions of yen.

ISAS did have one advantage in the government during its failures or setbacks. It did not have to deal with a change in party power from 1948 till 1989 in the Diet (Masuyama 2004, 251). During this nearly 40 year span of time the Liberal Democratic Party (LDP) held power in the Diet and so ISAS was able to remain fairly consistent in its endeavors because it had continued support from the LDP. While democratic space powers generally have to struggle with frequent legislative and executive changes, ISAS did not have to deal with these inconsistencies. The longevity of the LDP meant a higher level of security for funding for ISAS space projects. This does not mean that ISAS had a free ticket with the Japanese Diet. ISAS still had to be successful and progressive because the LDP could just as easily turn against ISAS. The Japanese leadership was in favor of the space program as the ruling LDP remained committed to the cause.

In the late 1960s the Japanese government had grown weary of the multitude of failures that occurred during the ISAS launches. Everything from satellite loss to rocket failures occurred all too often according to the government. Japan decided in 1969, after Itokawa's influence in ISAS began to subside, to accept licenses from the United States (Harvey et al. 2010, 22). The U.S. had put a lot of pressure on Japan to accept U.S. licensing, which started in 1965. President Johnson sent several diplomats including Vice President Humphrey and James Webb (the second administrator of NASA) to Japan to get the Japanese to agree to a diplomatic agreement that would return Japan's occupied territory of Okinawa in exchange for space licenses (Berner 2005, 2). ISAS's increasing failure rate was discussed during meetings between U.S. and Japanese officials and used as leverage by the U.S. to encourage the Japanese to accept U.S. support. The U.S. argued that these failures could be limited by simply using American equipment. Though it had wanted its program to remain indigenous, the national fervor within the space program had subsided significantly since Itokawa resigned in 1967 (Harvey et al. 2010, 15).

The Japanese, since World War II, were very good at working in partnership with industry leaders and then launching a similar enterprise of their own in the future, which is another reason why they were so willing to relinquish some of their drive for a purely Japanese space program for the moment (Kay 1995, 141). The U.S. offered several deals to Japan that would return to the Japanese the island of Okinawa and other lost territory from the war in exchange for allowing the U.S. to offer licensing on space products. In 1969 Japan finally succumbed to U.S. diplomatic pressures and accepted the American offer of licenses to Japanese companies like Mitsubishi for the development of space products (Berner 2005, 2). Just two

years after this deal was reached Japan had two very successful launches with the *Tansei* and *Shinsei* satellites. The U.S. had promised cheaper and more reliable parts from the new partnership and the successes of these two satellites in 1971 demonstrate a follow through on the U.S. promise.

The Japanese program had been historically indigenous, but times were changing in the 1960s and the Japanese could no longer ignore the advantages of a partnership with a stronger space faring nation like the U.S. Despite the fact that their program was technologically behind when compared to the U.S. or ESA, there was a growing threat coming from the Communist mainland that Japan needed defense from. By 1961 North Korea was aligned with China's Communist Party and had also made diplomatic relations with the Soviet Union. By the late1960s North Korea had basic rockets and nuclear reactors, given to them through technological diffusion from the Soviet Union (Habib, O'Neil 2009, 378). North Korea had the capability to strike Japan with a conventional rocket and was now trying to create a nuclear weapon, which greatly worried the Japanese people and upset stability in the region. Though it was not a substantial threat in the 1960s because the Koreans were just beginning to develop nuclear capabilities, it was the future that concerned the Japanese the most because they feared that North Korea's rockets and nuclear program would advance to the point that Japan would become a viable threat. There was evidence at the time that the North Koreans were trying to produce intermediate range ballistic missiles (IRBM) to threaten the west and its allies, including Japan (Doyle 1994, 49). Later in 1998, North Korea launched its *Taepodong* missile over Japan, an act seen as threatening by the Japanese government (Moltz 2008, 248). Japan in the 1960s was very vulnerable because it was still pulling its economy out of the devastation of World War

II and the Communist forces on the mainland poised an ever greater threat. Russia, China, North Korea, Vietnam, and others had fallen or were falling to the Communist forces by the 1960s and 70s. Japan, like India, was almost alone on the continent as a democracy. However unlike India, Japan sided only with the west and chose to grasp that realm of influence.

Stranded in a sea of red, Japan needed an ally and so this only helped to further solidify Japan's relations with the U.S., as Japan officially accepted the licensing agreement with some reluctance. Feeling the international pressure from the growing Communist influence, Japan suspended its indigenous fervor and soon received support from the United States. The space alliance was more than just Japan gaining U.S. technical assistance and parts; it was a matter of national protection and survival as well because the alliance meant Japan know was fully under the U.S. sphere of influence during the Cold War. Though it was seen as a setback by many in ISAS to rely on foreign assistance, the small island nation may never have achieved its goals so quickly had it not been for this alliance. Like the Indians, Japan found that their goals could not be achieved without foreign support and their national security was in danger without an open alliance with at least one of the powers of the Cold War.

The Creation of NASDA

In the late 1960s the dependence on the U.S. was not the only drastic change to the Japanese space program. In 1969 the Japanese government established NASDA, a new space program that would focus on larger boosters, guidance systems, and other projects dealing with improving launch vehicles, satellites, and programs that would increase the quality of Japanese life (Burleson 2005, 162). ISAS was now given the main responsibility of focusing on scientific

analysis and experimental missions. In 1969 NASDA and ISAS were given almost equal

portions of the federal budget, however, as time progressed NASDA took on more of the funds

and ISAS slowly faded into the background (Harvey et al. 2010, 22). Japan's new policy for the

1970s would focus on achieving larger rockets to reach higher orbits with less dependence on

western technology from the United States and Europe. Japan still wanted an edge in Asia and

for now the best way to achieve this would be to acquire components from NASA and the ESA

so Japan could produce more powerful rockets, however, the new direction of their space policy

would come with U.S. restraints that Japan would not want to be bound by for long.

ISAS had its last major rocket series development starting in 1966 with the *Mu* class

rocket series. It was a larger and more sophisticated rocket that replaced the *Lambda* and *Kappa*

series. It went through several stages of development until Japan manufactured the *Mu-4s*, a

rocket that was fairly comparable in size and performance to the American *Scout* rocket and

included a great deal of parts and engineering from the U.S. (Harvey et al. 2010, 19). The *Mu-4s*

allowed Japan in 1971 to finally reach a significant satellite orbit. The first satellites launched by

the *Mu-4s* were scientific satellites (*Tansei* and *Shinsei*) that were sent up to study radiation belts,

plasma waves, particle rays and other stellar phenomenon (Harvey et al. 2010, 18).

The *Mu-4s* was soon replaced with the *Mu-3c*, which was developed to push deeper into

space and set up a higher orbit. The successful launches of the *Mu-3c* were dwarfed by the

creation of Japan's new space agency NASDA during the early 1970s (Harvey et al. 2010, 22).

ISAS's two successful rockets were now complete but were soon to be replaced by the designs

drafted by the new heavily-funded institution of NASDA whose primary goal was refocused to

reach geosynchronous orbit. ISAS's role in Japanese space politics became less significant with each passing year. NASDA was now the focus of the Japanese space fleet as it pushed to develop a rocket that would end dependency on U.S. components, launches, and support.

NASDA's first undertaking was to locate a new launch facility for itself, which it did in Tanegashima, another small fishing village much like ISAS' Uchinoura (Harvey et al. 2010, 23). The region was the most ideal for NASDA's needs and was once considered by Itokawa to be a possible launch site for ISAS when he was still in power. Once a site was chosen and the facility was constructed, NASDA built several new tracking stations around Japan and began its first stages of improved rocket design. This site also ran into the issue of scheduling launches around fishing cycles. NASDA could only launch during certain times of the year, which again forced them to rely on foreign assistance for launching some satellites.

Achieving geosynchronous orbit is very important for a space program because it means it can place a satellite in a continuous 24-hour orbit, which means the satellite stays in one fixed spot making it easier to communicate with its ground station. Once a nation can sustain a satellite in a GEO orbit, it can now open new economic markets by selling payload space on board Japanese launchers to foreign nations who would like a satellite placed in GEO orbit, but do not have the capacity to do so themselves. The Soviet Union and United States had reached this orbit by the 1960s and sent satellites up for foreign states in exchange for a service charge or some other form of barter. It was clear in the later 1960s and early 1970s that China and India both were advancing towards their own GEO launcher as well. Japan wanted to take advantage of this market before India and China could, but this would not be possible while under the

license agreements of the United States (Berner 2005, 2). NASDA was now the main focus in Japan's government because Japan needed to cut ties with the United States and end Japan's reliance so they could take advantage of the space market. Japan could not sell licenses, contracts, or even launch some payloads because most of their program was connected to the United States. The U.S. was very systematic in the way it suppressed the Japanese space program, by always offering up cheaper and more dependable parts to ISAS and NASDA. NASA had the technology Japan needed and the U.S. was willing to sell Japan the parts it needed so as to prevent Japan from building the components themselves and thus from becoming a competition. The U.S. had hoped that it could restrain any Japanese competition by restricting the terms of the licenses.

Itokawa had warned Japan against relying on a foreign nation for assistance with space technology, especially one as powerful and influential as the United States. However, the small nation found it necessary, although with much disinclination, to align itself with the democratic U.S. during the Cold War. Japan gained a significant amount of technological data from this allegiance and was able to develop better rockets, more powerful boosters, and guidance systems. These luxuries came at a cost for Japan though, as they were often unable to work on some space instruments, components or even launch certain satellites on Japanese launchers or land because of top secret restrictions imposed by NASA (Harvey et al. 2010). The Japanese were often left out in the dark on many of their own programs during the 1960s and early 1970s because the U.S. did not want Japanese engineers to gain access to top secret U.S. data. The Japanese believed that NASDA would eventually put an end to U.S. control with its more developed rockets and so the government poured more funding into this institution (Harvey et al.

2010, 22). NASDA wasted no time in developing its first rocket and by the mid-1970s it

unveiled the first of many successful rockets that would be added to the Japanese space fleet.

Japan's Satellites

NASDA's rocket program had the dream of breaking with U.S. influence; however, in

the early stages they still greatly relied on America for technological diffusion and international

support. The first rocket produced by NASDA was the N-1, which was very similar in

dimensions and performance to the American Thor rocket (Harvey et al. 2010, 25). The N-1 was

developed in the early 1970s and was put to the test when it launched the ETS-1 satellite in 1975

(Berner 2005, 4). ETS-1 was a Japanese satellite program that focused on preliminary

communications. The ETS project was the first satellite launched indigenously by Japan to reach

geosynchronous orbit, making Japan the third country in the world to reach such an orbit by the

1970s (Harvey et al. 2010, 24). NASDA was already proving to be quite successful, more so

than its contender ISAS, which had failed to place a satellite into the 24-hour orbit. Achieving

24-hour orbit was seen as a great success in Japan, but Japan more than likely could not have

reached this orbit in such a condensed amount of time had it not been for U.S. intervention

(Harvey et al. 2010, 25).

The N-1 offered a new direction for Japan's space program now that 24 hour orbit was

possible. The previous satellite missions had almost consistently been small scientific satellites

that focused on astrophysical data. Japan realized with this new rocket that better

communications, television and other services were possible and that they could offer a great

deal of potential economically. In1978 Japan began to experiment with larger communication

satellites starting with *Yuri 1,* which was launched on board an American Delta. While N-1 was a very successful launcher, it was not powerful enough to launch larger and more sophisticated payloads like *Yuri 1* so the Japanese still had to rely on the U.S. for this launch. *Yuri 1* was the first of four *Yuris* that would be launched over the course of almost twenty years (Harvey et al. 2010, 27). Overtime the *Yuris* became more complex, and each *Yuri* was more domestically built than the previous, with *Yuri 4* being almost completely developed by Japanese engineers (Harvey et al. 2010, 27). Japan still could not quite launch the heavier satellites needed for mass communications so they continued to rely on foreign launchers to do so, but for now Japan was making small strides into this field. Japan was slowly investing more funds into the communication satellite (comsat) market during the 1970s because it really wanted the mass communication outlets NASA so long had enjoyed (McDougall 1985, 429). By continuing to launch with the assistance of the U.S., Japan could still reap the benefits of having better communications while also beginning experimentation with and perfecting indigenous comsats for when the time would come that they would be an independent space faring nation.

Another major program coming out around the N-1 rocket's period was the *Sakura* satellites, which were television and telephone related satellites. The purpose of the *Sakura* project, which like *Yuri* was followed up by a series of *Sakuras*, was to increase the amount of television stations and telephone band frequencies available in Japan (Harvey et al. 2010, 27). Several other programs similar to *Yuri* and *Sakura*, such as *JCSat* and *Superbird*, were also being conducted at this time. It the 1970s there is a shift beginning in Japan, from having astroscience as the primary focus for missions to a more commercial or socially beneficial drive for space projects in Japan. Japan could now better communicate within its borders and with the

international community, but more importantly, communication and television satellites helped to expand the commercialization of space and thus open up new economic markets in Japan. Like India, Japan enjoyed the economic increase it gained from opening up this new market in space. It created new media outlets, professional jobs, and brought in foreign investors who were interested in getting involved with the Japanese market. Mass communications is one example of how a democracy can also bring its citizens together in favor of a space program. It is beneficial for a space program in a democracy if the people feel as though they have something to gain from a space program.

Communications and television broadcasting dominated Japanese satellite policy from the 1970s to the 1980s; however, it was not the only experimentation and development going on in the field of satellites. Japan had also realized the potential of having weather tracking satellites. Japan is an island nation that is haunted by the threat of typhoons, tsunamis, and a myriad other catastrophes that can create a death toll of biblical proportions. In order to provide early warning weather detection to the people, NASDA and ISAS began to experiment with weather tracking satellites in the late 1970s. These satellites have also greatly helped Japan to record and access geophysical data that has been helpful in weather resource tracking as well (Doyle 1994, 40). It began with the Geostationary Meteorological Satellite (GMS) in 1977, which was developed by NASDA, but again was launched out of Florida on board a U.S. Delta (Harvey et al. 2010, 29). Like the *Yuri* and *Sakura* satellites, the GMS had a series of satellites in orbit that replaced, improved, or worked with fellow GMS. By 1995 five GMS satellites had been placed in orbit and they had helped Japan to photograph, track, and detect developing

storms and disasters, which provided early warning detection to the citizens of Japan and helped to save countless lives.

NASDA continued to make impressive advances in its space program and by 1981 they had even dropped the N-I program in favor of the N-II, a larger rocket that carried even larger satellites into the geostationary orbit (Berner 2005, 5). However, despite these rocket advances and satellite advances Japan was still unable to free itself from U.S. dominance and contracts. The N-II seemed to be a significant step in the right direction for Japan, but still history shows us that Japan was still launching *Yuris*, *Sakuras*, GMS, and other satellites on board foreign rockets. The N-II was able to launch a couple of *Sakuras* and ETS satellites, but again the majority of launches are done outside of Japan. One of the major reasons behind this has been the continued overwhelming dominance of U.S. intrusion into the Japanese space program. Japan was still not able to participate in some of the satellite launches because they involved classified U.S. engineering. On these projects Japan could only reap the benefits of having such satellites in orbit without gaining firsthand knowledge of its engineering like they had hoped or even the prestige of launching it into orbit indigenously.

While the U.S. did have a significant influence on Japanese affairs after the Second World War, Japan was also placing a lot of domestic restrictions on itself as well. The other reason for Japan having to launch satellites out of Cape Canaveral was because of the control the fishing communities still had over ISAS and NASDA launches. The fisherman of Uchinoura and Tanegashima forced the space agency continued even into the late 1970s to negotiate launch times that worked around the fishing season. The government had to respect the rights of the

fisherman because Japan was a democracy with individual rights and liberties. In an autocratic state the government would not have had to respect the rights of the fishing communities and could have proceeded with the national agenda. This is an issue spacefaring democracies can encounter when the rights of the people clash with the will of the state, a compromise must be drafted. In some cases, launches had to be done by a foreign party like NASA or the ESA because they couldn't launch out of Uchinoura or Tanegashima due to the fishing communities restrictions. Some projects had to meet a launch deadline which forced ISAS and NASDA to go abroad for launch assistance. Fishing is a major industry in Japan and so launches must be conducted during low periods in the fishing season so as to not scare away profits. The fishing community can be blamed for why some of the Japanese launches were done out of the country. Certain launch windows had to be met and so Cape Canaveral became a viable launch site for some projects. This shows that the U.S. restrictions were not the only contributing factor for foreign assistance, but an internal problem Japan would have to address in the future if it were to continue to be a space power.

Japan's Modern Rockets

NASDA and ISAS still planned to establish Japan as an independent space faring nation but it first had to develop an indigenous rocket that could make payloads comparable to Delta, and of course it needed to figure out a more flexible schedule with the fisherman. NASDA and ISAS took the next step towards achieving this goal, which would be once again a larger and better rocket. In 1986 NASDA and ISAS, for the first time since their split, cooperatively worked on a new larger rocket known as the H-I project. The engineers of these two institutions settled on a cryogenic upper stage with an engine powered by hydrogen (Harvey et al. 2010, 31).

The H-1 rocket almost doubled the payload capacity of the N-II, and more importantly the development contract was awarded to Mitsubishi meaning this rocket, would be almost completely developed by a Japanese company (Berner 2005, 7). Together, NASDA and ISAS had made the most significant stride in Japanese aerospace technology since Japan subjected its program to U.S. influence in the 1960s. The H-I was one of the most significant and successful advances in Japanese rocketry. It seemed to really carry the promise of finally relinquishing American dependence in the future, especially since most of it was made in Japan including the guidance systems, which previously had been manufactured by a third party like ESA (Burleson 2005, 187). The N-I and N-II were successful and should not be undermined, but the H-I had a carrying capacity that made Japan more internationally competitive, even more so than India at the time as India would not have a successful cryogenic launch like the H-I until 2004 (Harvey et al. 2010, 31). This was significant because this put Japan ahead of India in rocket engine development.

The H-I was just the beginning of larger and more improved rockets in Japan during the 1980s, many of which have continued to be used even into the modern decade. Japan had also continued to develop more improved *Mu* rockets, which allowed them to expand their experimentation programs in space. One such experiment was developed to study solar activity, which was conducted by two satellites known as *Yohkuh* and *Hindoe* or Solar A and Solar B. *Yohkuh*, launched in 1991, and *Hindoe*, launched in 2006, expanded our knowledge of the Sun and set a milestone in Japanese experimentation (Harvey et al. 2010, 43). Solar A and B, both launched on board the new *Mu3S-II* used x-ray telescopes (with both Japanese and U.S. components), spectrometers, and other instruments to penetrate the Sun and study its

compositions. Two more successful *Mu3S-II* launches were conducted in 1985 when Japan

launched *Sakigake* and *Suisei* into Japan's first deep space mission.

In 1986 Halley's Comet passed Earth and many spacefaring nations across the globe

were ready to send probes to the comet to study its properties, Japan was one of them. Using the

Mu3s-II, *Sakigake* and *Suisei* worked in unison to record different aspects of the comet,

everything from solar wind effects to photographs of the comet up close (Harvey et al. 2010, 39).

The *Mu3s-II* had another successful scientific mission approved in 1987 and this was Japan's

first lunar impact mission. The *Mu3s-II* rocket launched a probe known as *Hiten*, which after

many complications made a lunar impact in 1993 making Japan the third nation to impact the

moon, after the Soviet Union and the United States (Harvey et al. 2010, 45). The launching of

this probe proved once more that Japan was an advanced spacefaring nation that still had a future

in space travel.

The last of the *Mu* series rockets was started in 1989 and was grounded by 2006 with its

last successful launch in February of that year. Built by ISAS and the U.S., the *Mu-5* was the

final *Mu* rocket and was designed to double the lifting power from the *Mu-3* (Harvey et al. 2010,

50). It was a very successful rocket and led several high profile launches like the *Hayabusa,*

Suzaki, and *Akai* projects. This was one of Japan's most successful rockets as it could place

large payloads into geosynchronous orbit, send probes deeper into the solar system, and was in

active service for a decade. The *Mu*'s advanced boosters allowed the *Hayabusa* satellite to

reach, land on and explore the asteroid, *Itokawa* and it took the Japanese satellite *Kaguya* into

lunar orbit. *Kaguya* was a very significant satellite because it was the first Asian satellite to reach

the moon on October 4th, 2007. The competition was close as China reached lunar orbit one month later with *Chang e*, and India launched its own lunar satellite, *Chandraya*n, a year later (Harvey et. al. 2010, 64). Though it was an impressive rocket it still did not fully lift Japan's reliance on the U.S. for its launches.

NASDA's Fulfillment and the 1990s

Japan's last rocket development came in the 1990s with NASDA's promise of an indigenous rocket finally being fulfilled with the H-II rocket series. It was almost entirely domestically built and for the first time Japan could provide launches to foreign nations without violating licensing agreements with a foreign power (Harvey et al. 2010, 68). This was a very important feat for Japan because it had been trying to open up this lucrative market since Itokawa was still employed with ISAS in the 1960s. For the first time in its history Japan could now launch satellites and other projects into Low Earth and Geostationary Orbit for nations that didn't have spacefaring capabilities. Another important feature was that it used a cryogenic engine, like the H-I, that was indigenously built, unlike their counterparts the Indians who relied on a Soviet design that sparked international debate (Harvey et al. 2010, 225). This rocket engine was believed to be more advanced than anything the U.S., India, or the Europeans had at the time and in fact some of these countries purchased fuel tanks and parts from Japan (Harvey et al. 2010, 70-71).

This success was short lived as the Soviet Union, U.S., and Europe soon caught up to Japan, and then surpassed them in technological advances. The Japanese rocket became almost obsolete because the technology became outdated and the price of a launch for foreign powers

still remained high, almost twice the cost of a Delta launch, which is one reason why they have yet to send up a foreign payload (Harvey et al. 2010, 74). NASDA continued to work on the H-II model and created the H-IIA in the late 1990s, however, almost 20% of it was U.S.-made this time (Berner 2005, 9). They had finally achieved spacefaring independence, but couldn't keep up with the technology, falling back into the arms of their original supplier, the U.S. The H-IIA was augmented once again and fashioned into the H-IIB which was essentially the same design, but it had a larger engine cluster at the base that gave it more lift than the H-IIA (Harvey et al. 2010, 79). Again, with the H-IIB Japan was still relying on the U.S. for some parts, but it was less than the H-IIA required (Berner 2005, 7). Currently Japan's space agency still utilizes the H-II series as its most advanced and primary launcher, with the most recent launch of the H-II in February of 2011.

The H-II series, though it has had some minor setbacks and technical difficulties on the launch pad, has been a very successful launcher. It finally gave Japan a strong sense of independence but more importantly it gave Japan the ability to compete internationally in launch markets. Today, Japan is one of the strongest space powers in the world and competes with larger more powerful countries like Russia, China, and the U.S. Japan struggled to achieve these victories during the last half century, but the international prestige and the resources gained from all these successful launches have been immeasurable.

During the late 1980s the U.S. began work on its *Spacelab* missions and during the next fifteen years they would launch twenty-two different missions related to this project, some of which included Japanese equipment and astronauts. The first Japanese astronauts chosen for the

mission were launched aboard the U.S. shuttle for their *Spacelab J* mission in 1992 (Harvey et al. 2010, 108). NASDA would have preferred this mission to be the first time a Japanese citizen went into space, however, this mission ended up being the second occurrence. The Tokyo Broadcasting Station, celebrating its forty years of service to Japan, celebrated its anniversary by sending a journalist into space. The journalist flew to *Mir*, a Soviet space station, in 1989, a sign of the changing political climate (Harvey et al. 2010, 103). This was the first time in Japan's post-war era that it allowed spacefaring ties to be conducted with the Soviet Union. While this was not the epitome of stability during the Cold War, it does show a decline in tensions between the westernized Japanese government and the Communist mainland.

Japan: 2000 and Beyond

In 1984 Ronald Reagan announced the construction of a new space station known as *Freedom*. The Reagan, Bush sr., and Clinton administration's made major budget cuts in the that drastically restricted funding for the space station *Freedom* making it difficult for the U.S. to operate a station alone (Harvey et al. 2010, 114). Between the years 1984 and 1992 *Freedom* had run out of funds. *Freedom* turned out to be the groundwork for what would become the International Space Station (Harvey et. al. 2010, 114). Russia also was experiencing difficulties in funding its Mir 2 project and so the Russians and the Americans jointly created a space station program which was renamed the International Space Station or ISS (Moltz 2008, 237). The ISS was constructed of several different labs sponsored by different nations, including Japan, who contributed the *Kibo* lab (Burleson 2005, 185). Japan now had a stable operating capsule on the ISS but unlike the Russians and the Americans they were not able to resupply *Kibo* effectively without foreign assistance. While they have had a space shuttle named *HOPE* in design for

decades, the shuttle designs have not been developed into a functioning program due to budget cuts. For now *Hope* has been replaced by a simpler mechanism known as the Hope Transfer Vehicle or HTV (Burleson 2005, 189). The HTV is shaped like a large cylinder and is launched aboard the H-IIB and then released once in an orbit that would link HTV with the ISS. After its mission was complete the HTV is released from the ISS and it burns up in the Earth's atmosphere (Harvey et al. 2010, 116). The purpose of the HTV was to launch supplies to the astronauts at Kibo once a year, however, the U.S. and Russia made it clear that their space craft and technicians would still be the primary caretakers for the ISS (Lambright 2003, 143).

Japan was also going through internal changes with its space agencies ISAS and NASDA. In 2003 Japan decided that it would merge ISAS and NASDA into a single entity known as JAXA. This agency was first led by the head of NASDA and has since brought scholars from both agencies together in a more cost-effective organization. Since 2003 JAXA has been responsible for Japan's space policy (Harvey et al. 2010 131).

By 2008 *Kibo* was fully functional, the HTV project was a success and Japan's close ties with the U.S. gave Japanese astronauts the opportunity to travel between the Earth and their *Kibo* lab. The U.S. space shuttle still continued to fly Japanese astronauts to the ISS until the Shuttle was cancelled because Japan has been unable to successfully engineer a shuttle or spaceplane of its own. While Japan has greatly benefited from the U.S. shuttle launches, since the 1980s Japan has wanted an indigenous shuttle. Over the last three decades Japan has struggled with several designs, but each came with its own set of flaws. The plans for *HOPE* and the smaller shuttle project known as *HOPE-X* have both remained very unsuccessful, with *HOPE* being abandoned

due to budget cuts and the smaller *HOPE-X* was cut due to test failures (Harvey et al. 2010, 124).

Japan has drafted several different spaceplane designs like the *HIMES* (Highly Maneuverable

Experimental Space Vehicle), but all have remained unsuccessful as well.

Despite the lack of a shuttle it seems that the Japanese population is very much in support

of continuing space exploration, especially in the realm of space tourism. In 1993 over 3,000

people in Japan were surveyed about their position on space tourism and the majority of which

were in agreement with such a program (Jenkins and Launius 2006, 263). The Japanese also

created what they call the *Kankoh-maru,* or "tourism ship," which aired on Japanese TV in 1997

as the first advertised space tourism vehicle in the world (Jenkins and Launius 2006, 263)

However, like the Japanese Shuttle programs the tourism industry has suffered from a poor

economy and technological problems.

Japan's Space Program in 2012 remains almost stagnant because of budget cuts (Berner

2005, 20). They have been unsuccessful in developing an effective shuttle of their own and have

made several cut backs within the last few years because of the struggling global economy. This

economic downturn has been increasing in Japan since the mid 1990s and has caused several

issues with properly funding space projects for the coming future (Freedman 2003, 411). Japan

must increase its space development if it is to remain a space power, as India has already made

claims that it may launch its own astronauts into orbit by 2014, a feat Japan has no clear date set

for (Harvey et al. 2010, 140). While Japanese astronauts have gone into space on board NASA's

shuttle, it has not had an astronaut launched into orbit by a Japanese vehicle. Japan's closest

space ally, the U.S., has created some challenges that Japan was not ready for as well. There is

competition unfolding between China, India, and Japan in the realm of space technology, as demonstrated by the probe race to the moon. It is important that Japan begin plans for a Japanese launched astronaut in order to compete with China and India. This is a demonstration of soft power and international prestige and so it is vital to Japan's international space image to remain competitive with China and India.   The U.S. has cancelled the space shuttle program and has yet to develop a successful replacement because NASA is also faced with budget cuts. Japan has had to turn to the Russians for help in getting to the ISS like its American allies. Japan will need to reevaluate its position in space and its shuttle program in the coming years if it is to remain a spacepower in the world.

CHAPTER 5: CONCLUSION

Being a democracy and operating a massive multi-billion dollar space program can be very difficult at times. Every year budgets are drafted by the legislative branch and every year those budgets fluctuate, sometimes in favor of and sometimes against the space program, which can lead to challenges in project planning. The space programs of democracies have to answer to the governing body and that government must answer to the people who have the power to vote. In a democracy the power is in the hands of the voters and if they don't approve of certain policies, the legislatures in support of such policies may not be reelected come next election period. It can also be very difficult to plan certain launches or projects around a fluctuating and unknown budget and administration change. In a democracy the government succumbs to its citizen's individual rights as was seen with the comprise between NASDA, ISAS, and the fishing communities. There is also typically some form of free speech in a democratic state that can be used by the media to negatively portray the space program, like it did with the *Lambda* rocket program in Japan and the ASLV in India.

Japan and India were two democracies that are very similar to most western governments and did not want to fall under Communist control. They were surrounded by the ever expanding Communist Bloc for most of their space program's development. The Soviet Union had emerged after the Bolshevik Revolution in 1917, China had fallen after the Second World War, and other nations such as North Korea, Vietnam, Laos, and Cambodia began to fall to Communism during the latter half of the 20th century. It is truly remarkable that India and Japan

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Japan and India were two democracies that are very similar to most western governments and did not want to fall under Communist control. They were surrounded by the ever expanding Communist Bloc for most of their space program's development. The Soviet Union had emerged after the Bolshevik Revolution in 1917, China had fallen after the Second World War, and other nations such as North Korea, Vietnam, Laos, and Cambodia began to fall to Communism during the latter half of the 20th century. It is truly remarkable that India and Japan

were able to grow and expand into westernized systems while being completely surrounded by a growing communist influence.

India did receive some technologies from the Soviets to help them in their space endeavors, and they never fully succumbed to Communist ideologies like China or Vietnam did. India had a greater sense of international independence than Japan did because they were not under occupation or influence as Japan was with the U.S. India had just recently gained its independence in 1947 and was struggling to pull itself out of poverty and political corruption. It became a very successful state and was even able to develop one of the most sophisticated space programs in the world. India went from having citizens starving in the streets of Dubai to broadcasting, via satellites, agricultural shows to rural villages to improve production and quality of life. The results of such technological breakthroughs helped to create an incredible increase in food supplies that occurred within the span of less than twenty years.

India has had the foundations and the potential to become a world super power for some time. Having a well established space program has only helped to legitimize this claim and gain a greater sense of soft power. Since the development of its larger launchers, India is now able to compete in the international payload launch market and it has allowed India to launch a diversity of satellites on their own. India has been able to put commercial, communication, and military satellites into orbit without foreign aid, allowing India to gain an advantage over its neighbors militarily, socially, and economically. They have increased their farming capabilities, their national security, and communications all through satellite and big launcher technology.

As a democracy, it was difficult for India to begin its space program because it had a large rural population that it had difficulty uniting. People were starving and the country had a collapsed infrastructure after the end of British colonialism in 1947, but it was left with the foundations for a well established democracy to serve the people. How can a country invest large amounts of money on a space program when it cannot even feed its citizens became the question India's democratic government had to answer. How could they tell people that India was going to space rather than India was going to create social welfare programs? The answer came from Sarabhai, the father of India's space program and a capitalist who wanted to use space as a means of increasing the Indian economic market and the livelihood of its citizens. It also came from the drive of Nehu and Gandhi family to improve India's conditions and the Congress Party's political agenda.

As a democracy they had to follow certain democratic values, unlike the Soviets or the Chinese. The Indian government wanted to ensure that the people would benefit from the space program and that they would remain in support of it for some time to come. The applications of projects like SITE, INSAT and other mass communication programs allowed the Congress Party to reach out to the population. The space program was favored and utilized by the Congress Party and Prime Ministers Nehru, Indira Gandhi and her son Rajiv Gandhi. Nehru saw the space program as being an aid to the people, to help solve some of India's socioeconomic issues. For Indira and Rajiv Gandhi and the Congress Party, mass media was seen as an outlet for them to further spread their agenda of unifying India, spreading Hindi as the national language, and by creating a "catch-all" base as their electorate. Rajiv Gandhi was also active in economic reform during the mid 1980s and really pushed for international and domestic technology transfers

(Thomas 1996, 136). The space program would also fit into his administration as it would open

several new markets for technological trade. The space program benefited everyone from the

rural farmers to wealthy land owners in India. These benefits, whether the people understood

them as being related to space or not, also helped Prime Minister Indira and Rajiv Gandhi gain a

larger support base during elections. Mass media was one way the political elite in India could

maintain their control and authority in the Indian government.

The space program created economic and social improvements in hygiene, health,

agriculture, optics and other systems because it utilized satellites for civilian purposes. Some of

the satellites also aided in spying, however, they were generally used to benefit the citizens of

India, either through mass communications or through early weather warnings. With an increase

in agricultural productivity, increasing health and stability in the rural communities and a

growing element of international prestige, the Indian citizens have come to greatly favor the

space cause. The people of India over time began to fully understand what a space program

could do for them as well.

ISRO has been very successful at keeping the Indian government on its side. Local and

national governments have supported the Indian space agency in its endeavor to help strengthen

India's infrastructure, even during times of major setbacks. Local towns really wanted to bring

space agency facilities to their region because they wanted the economic growth and prestige it

would bring to their community. Throughout the entirety of the space age in India, ISRO has

been in full support of and has been able to sell its ideas to the people and government of India.

It has helped to bring India from its impoverished beginnings in 1947, to a space power in the

modern era. Today India is one of the fastest growing economies in the world and the space

program has aided significantly to this growth and development, thus answering its Nehru's

promise to build a better India (Moorthi 2004, 265).

This democracy has been able to keep a stabilized space program even when elections

bring about a change in the administration. Space projects take years and sometimes decades to

develop an on-going product. It is difficult to make such plans or guides when the next

president, prime minister, or legislative body could bring an end to that program. However,

India has been able to persevere through the challenges of being a space power and a democracy.

It has answered to the needs of the people while keeping the government in unison on its projects

and development. Throughout the Indian space agency's life span it has continued to receive

support from the government. So far a change in administrative power has not caused a fatal

blow to ISRO, aside from some budget cuts due to the state of the current global economy.

India's space program should become a model for other developing democracies to

examine and adopt, because it really brought a great deal of prestige to India while it also helped

to rebuild India's infrastructure. The space program made it easier for the citizens of rural

communities to stay connected with the rest of India and also allowed the government to

broadcast messages regarding improved hygiene and agriculture to the televisions of these rural

communities as well. The program has also opened new foreign payload launch markets, which

has helped to fund their space program and to bring in a great deal of international prestige and

soft power for India. Along with these social benefits came a great deal of national security

interests as well. Advanced optics have allowed India to use spy satellites to examine its hostile

neighbors and with this same technology it has also helped to warn Indians of natural disasters. The Indian space program has been an exceptionally well operated and established system that has been well worth the investment. The democratic government was correct in choosing to utilize its scarce resources to establish ISAS and NASDA and all of the programs they put into production.

Japan has also been exceptionally successful in their program as well. While India sought space for economic and social reasons, Japan originally set out to explore space for scientific research and international prestige. After World War II, Japan was closely controlled and monitored by the U.S. due to treaty restrictions. The Japanese were held to a treaty after World War II and could not operate, fund, or develop a standing military, which also included rockets, until after 1952. Through Itokawa's determination, Japan was able to rise up out of the broken post-war infrastructure and begin its own age of space. Over time and through lots of negotiations with U.S. officials the San Francisco Peace Treaty loosened the restraints after 1952, and Japan was finally able to move further in its endeavors. Japan always remained under the auspices of the U.S. though because of its reliance on foreign assistance with many satellite launches (Miyoshi 1998, 2004).

Japan, much like India, has had a democratic system since its independence, which was very close in date to India's (India-1947, Japan-1952). However, unlike India, Japan was always monitored by the U.S. up until the H-IIB which has greatly reduced U.S. dependency in Japan. For the most part this alliance was met with some reluctance within Japan, but it is believed that Japan would not have made such swift progress in its space projects alone. Much of the physical

engineering and parts of rockets, especially in early models, came from the U.S. and U.S. contractors. The U.S. could always offer cheaper and more reliable parts than a Japanese indigenous program could offer. It was very practical for Japan in its early stage to rely on the U.S. for those parts and services. There was also the domestic issue of the fishing communities, who controlled when launches could be conducted. This was a comprise NASDA and ISAS had to accept if they were to continue operations on the coast. Overtime the fisherman would lose their authority, but during the early stages of the space program they controlled what season and time frame the rockets could be launched which pushed NASDA and ISAS to launch certain payloads on foreign launchers.

Despite the fisherman and a lack of advanced booster technology early on, there were other external forces that were pushing Japan deeper into the arms of the U.S. Japan didn't have much of a choice in deciding on the U.S. as a partner in space because Japan also needed a strong defensive ally. Japan wanted to have a strong ally during the Cold War and so allied itself with the hegemony of the U.S. Japan was surrounded by large powerful communist nations throughout the entirety of the Cold War. China, the Soviet Union, North Korea, Vietnam, Cambodia, and many others were falling into the hands of the Communists at a very fast rate. Some of these nations even had a rocket program that was perceived as an existential threat to Japan. Japan, wanting to remain free and democratic was not prepared to turn to the Soviets or the Chinese for aerospace support and risk being absorbed into the Communist hegemony. Instead they sought support from the west.

Not only did the government of Japan have to answer to the citizens of Japan, they also had to answer to the United States. Though the partnership was not outright favored by the Japanese, they couldn't have been as successful alone. The partnership also made them a legitimate member of the United State's sphere of influence, which added a certain level of national security and military protection for Japan during Cold War. The Japanese often struggled with this partnership as they were often limited in their engineering possibilities. In many cases Japan couldn't even perform launches domestically because many Japanese satellites were composed of sensitive U.S. parts and there were continued restrictions imposed on ISAS and NASDA by the fishing communities. In some cases the U.S. wouldn't even allow Japanese engineers to cooperate on some projects due to the top secret nature of some parts and rockets.

Aside from the difficulties between them and the U.S., Japan also had to contend with an unstable economy early on. Japan's program was quite successful, but for a while it seemed that they were never going to achieve the dreams of Itokawa, especially his goal of completely indigenous launchers. However, as history shows us the Japanese persevered through their struggles and brought forth one of the most advanced space programs in the world. They have their own fleet of satellites, geosynchronous launchers, and international partnerships with the Europeans, Russia, the U.S. and its neighbor and long time space ally, India.

Japan had myriad factors acting against its space program, its first was U.S. foreign policy. Japan had to settle treaty disputes with the U.S. to allow for a space program to develop. Japan, being a democracy, had to work through its legislature and executive branch in order to free itself from the terms of the treaty with the U.S. Once they had been given the right to

develop rockets and satellites in their partnership with the U.S., they could now advance into bigger and better rockets and satellites. Japan had wanted to increase its prestige and to become a thriving technological partner in the international community.

Itokawa showed the citizens that satellites could offer a profound amount of potential to Japan if they grasped this new technology. Itokawa had big plans for the space agency; however, he would not stay in it long enough to see Japan's greatest accomplishments. The development of ISAS and NASDA only increased their space potential, as these two agencies fought to develop better projects in order to receive more funding. The government of Japan allocated more funding to NASDA over the years as ISAS slowly collapsed into a smaller and smaller program. NASDA was given the goal of creating a GEO launcher that could end the U.S. reliance. This was a major driving force for the Japanese citizens who wanted an indigenous program that they could be proud of. An indigenous program would also mean more high-paying careers during their post-war economy.

The leaders of these two space programs play into the development of the "great man theory." In this theory a centralized leader becomes the guiding or mainstream figure. In this case they became the personified version of the Indian and Japanese space programs. The names Itokawa and Sarabhai were synonymous with the space programs in India and Japan. They alone were the foundations for the early developments of their nation's space programs. In the United States Von Braun held this position as the guiding figure for rocket development and for the Soviet Union it was Sergey Korolev. These two men helped lead the United States and the Soviet Union into becoming space powers just as Sarabhai and Itokawa did for Japan and India.

This great man theory may explain why space programs amongst the space powers today have suffered major budget cuts over the last couple decades.

While space technology has continued to advance and make progress in the modern era, space programs don't seem to carry the same prestige or importance domestically as they did in the 1960s and 1970s. They still provide a stronger since of soft power, as they can do something most nations may never have, however, it seems that their popularity has decreased amongst the home front. This could be partially contributed to the nature of Cold War politics and the rise of détente in the 1970s resulting in a decrease in global tensions, however, the lack of a strong man makes for an excellent case as well. However, it doesn't seem to be a coincidence that foreign influence and dependence becomes a stronger factor in the space programs of Japan and India after Itokawa leaves the program in 1967 and Sarabhai passes away in 1971. Perhaps what space programs need to be more successful is a figurehead, someone that can speak up for the program and be recognized by the population and government that they serve.

Japan and India have changed the way the world looks at space. These two nations came from broken infrastructures, impoverished and unstable communities and yet became two of the most advanced space faring nations in the world. These nations have answered the original question in several different ways. The space programs of India and Japan were important for political, economic, and social gain. They have also aided in increasing national security, international prestige, and soft power. Japan arose from the ravishes of war and a damaged industrial infrastructure and India began its program after centuries of colonial rule and an impoverished populace. Full of domestic and international turmoil during the stages of their

space program, India and Japan showed the world that a state did not have to be a super power to

conquer space.

REFERENCES

Baker, John C., Kevin M. O'Connell, and Ray A. Williamson. *Commercial Observation Satellites: at the Leading Edge of Global Transparency*. Santa Monica, CA: RAND, 2001.

Basrur, Rajesh. *Challenges to Democracy in India*. New York: Oxford University Press, 2003.

Beasley, W.G. *Japanese Imperialism 1894-1945*. Oxford: Clarendon Press, 1987.

Berner, Steven. *Japan's Space Program. A Fork in the Road?* Santa Monica, CA:RAND, 2005.

Burleson, Daphne. *Space Programs outside the United States: All Exploration and Research Efforts, Country by Country*. Jefferson, NC: McFarland, 2005.

Correll, Randall. "U.S.-India Space Partnership: The Jewel in the Crown." *Astropolitics: The International Journal of Space Politics and Policy* 4.2 (2006): 159-77.

Doyle, Stephen E. *Civil Space Systems: Implications for International Security*. Aldershot, England:Dartmouth, 1994.

Freedman, Lawrence. *The Evolution of Nuclear Strategy*. New York: Palgrave, Macmillan, 2003.

Gopalaswamy, Bharath and Harsh Pant. "India's emerging Profile in Space*". The RUSI Journal*. Vol. 53, Issue 5 (2008): 66-71

Habib, Ben, and Andrew O'neil. " Korea's Emergence as a Nuclear Weapons State and the

    End of the Disarmament Paradigm." *Global Change, Peace, and Security*. Vol. 21, Issue

    3 (2009): 377-387.

Harvey, Brian, Henk Smid, and Théo Pirard. *Emerging Space Powers: the New Space Programs*

    of Asia, the Middle East and South America. Berlin: Springer, 2010.

Hirose, Takao. *Two Asian Democracies*. New Dehli:Konark Publishers PVT LTD, 1994.

Islam, Arshad. "The Backlash in Delhi: British Treatment of the Mughal Royal Family

    following the Indian "Sepoy Mutiny" of 1857.*" Journal of Muslim Minority Affairs*.

    Vol. 31, Issue 2. (2011): 197-215.

Jenkins, Dennis, and Roger Launius. "Is It Finally Time for Space Tourism." *Astropolitics*.

    Vol. 4, Issue 3. (2006): 253-280.

Kay, W. D. *Can Democracies Fly in Space?* Westport: Praeger Publishers, 1995.

Lambright, Henry. *Space Policy in the Twenty-First Century*. Baltimore MD: Johns Hopkins UP,

    2003.

Masuyama, Mikitaka. "Japan: The Prime Minister and the Japanese Diet." *The Journal of*

    Legislative Studies. Vol. 10, Issue 2-3 (2004): 250-262.

McDougall, Walter. *The Heavens and the Earth*. Baltimore and London: The Johns Hopkins

    Press, 1985.

McNelly, Theodore. Contemporary Government of Japan. Boston: Houghton Mifflin

    Company, 1963.

Mistry, Dinshaw. "The Geostrategic Implications of India's Space Program." *Asian Survey*.

Vol. 41, Issue 6. (2001): 1023-1043.

Miyoshi, Akira. "The Diet in Japan". *The Journal of Legislative Studies*. Vol. 4, Issue 4.

(1998): 83-102.

Mochizuki, Mike. "Japan's Shifting Strategy Toward the Rise of China." *Journal of Strategic*

Studies. Vol. 30, Issue 4-5. (2007): 739-776.

Moltz, James. *The Politics of Space Security*. Stanford. Stanford University, 2008.

Moltz, James. *Asia's Space Race*. New York: Columbia University Press, 2011.

Moorthi, D. "What 'Space Security' Means to an Emerging Space Power." *Astropolitics*.

Vol. 2, Issue 2. (2004): 261-269.

Pal, Yash. *Space and Development*. Oxford: Pergamon Press, 1980.

Siddiqi, Asif. *Sputnik and the Soviet Space Challenge.* Gainesville: University Press of

Florida, 2000.

Thakur, Ramesh. *The Government and Politics of India*. New York: St. Martin's Press, 1995.

Thomas, Raju. *Democracy, Security, and Development in India*. New York: St. Martin's Press,

1996.

Von Bencke, Matthew J. *The Politics of Space*. Boulder, CO: Westview, 1997.