National Aspirations, Imagined Futures, and Space Exploration: the Origin and Development of Korean Space Program 1958-2013

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National Aspirations, Imagined Futures, and Space Exploration:

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LIST OF ABBREVIATIONS

ADD - Agency for Defense Development

COMS - Communication, Ocean and Meteorological Satellite

CIA - Central Intelligence Agency

COSPAR - Committee on Space Research

DSTRI - the Defense Science and Technology Research Institute

DMZ - Demilitarized Zone

ERC - Engineering Research Center

ESA - European Space Agency

ETRI - Electronics and Telecommunications Research Institute

FMS - Foreign Military Credit Sales

FROG - Free Rocket Over Ground

HVAR - High-Velocity Aircraft Rocket

ICBM - Intercontinental Ballistic Missile

IGY - International Geophysical Year

IIT - Inha Institute of Technology

INS - Inertial Navigation System

ISS - International Space Station

ISSA - Institute of Space Science & Astronomy

KAERI - Korea Atomic Energy Research Institute

KAI - Korea Aerospace Industries

KAIST- Korea Advanced Institute of Science and Technology

KAP - the first Korean Astronaut Program

KARI - Korea Aerospace Research Institute

KAS - Korean Astronautical Society

KCIA - Korean Central Intelligence Agency

KDI - Korea Development Institute

KHTT - Know-How Tansfer and Training

KIST - Korean Institute of Science and Technology

KM – Kick Motor

KMAG - Military Advisory Group to the Republic of Korea

KNSC - Korea National Space Committee

KOMPsat - Korean Multi-purpose Satellite

KOSEF - Korea Science and Engineering Foundation

KRISS - Korea Research Institute of Standards and Science

KSLV - Korean Space Launch Vehicle

KSR – Korean Sounding Rocket

KSSSS - Korean Student Space Science Society

KT - Korea Telecom

MAAG - Military Assistance Advisory Group

MAP - Military Assistance Program

MCIE - Ministry of Commerce, Industry, and Energy

MD - McDonnell Douglas

KIMM - Korea Institute of Machinery & Material

MCTR - Missile Technology Control Regime

MEST - Ministry of Education, Science, and Technology

MND - Ministry of National Defense

MOC - Ministry of Communication

MOST - Ministry of Science and Technology

MPT - Ministry of Posts and Telecommunications

NAO - National Astronomical Observatory

NASA – National Aeronautics and Space Administration

NDSRI - National Defense Scientific Research Institute

NH – Nike Hercules

KAI - Korean Aerospace Industries Ltd

KITsat - Korea Institute of Technology Satellite

NSC - National Security Council

ROK – Republic of Korea

RSA - Russian Space Agency

SaTReC - Satellite Technology Research Center

SNPE - Societe Nationale des Poudres et Explosifs

SSRA - Space Science Research Association

SSTL - Surrey Satellite Technology Ltd.

STPRC - Science and Technology Promotion Review Council

TSA - Technology Safeguards Agreement

URM - Universal Rocket Module

WEC - Weapons Exploitation Committee

YAC - Young Astronaut Council

YAK - Young Astronauts Korea

SUMMARY

The goal of my dissertation is to describe the history of the South Korean1 space program and to use it to offer some insights on reframing space history from a global point of view. South Korea is a new player among the space faring nations. While some of the necessary infrastructure was put in place in the 30 years after the launch of Sputnik, the country only really made a commitment space in the 1990s, developing rapidly to become a significant presence today. The launch of KITsat-1 (*Uribyul*-1, the first Korean satellite) in 1992 marks its first major achievement, after which it built up its technological capabilities in the space sector in a relatively short period. South Korea now has twelve satellites and operates several space projects, and successfully developed its first space launch vehicle, KSLV-1, also known as *Naro*, in 2013. Although KSLV-1 is derived from the first stage of the Russian Angara rocket, combined with a solid-fueled second stage built by South Korea, its successful launch was the crucial step for the development of the country's civilian space program. South Korea aims to develop the first wholly Korean-made launch rocket, KSLV-2 by 2020, which will additionally be used to launch a moon orbiter later that year.

Korea's recent aspiration to space exploration can be seen as part of global narrative in which the conquest of space is not dominated by a few superpowers. Our understanding of the past half-century of space development is, however, still firmly rooted in the framework of the old Cold-War-centered approach to space history. Until recently, only large and powerful nations have been able to mobilize the resources necessary for access to space, so the early years of space exploration produced a simple narrative: a fierce space competition between the Soviet

Union and the U. S., with a few countries following behind in a struggle to increase their presence in space. Yet emerging powers' stories of space development were barely noticed in comparison with the abundant literature on the space history of the super-powers and the increasing literature on middle-range space powers. In order to situate the South Korean space program in this evolving global context, this dissertation attempts to answer the following critical questions: What is the origin of Korean space development? Why is South Korea a late-comer in space, and why is it becoming more active today? How have its motivations and rationales evolved in defining relationships with other countries including the U.S., Russia, France, China, Japan, and even North Korea? Why does it continue to emphasize the need for "Korean" technology in space? In essence, what is Korean about the Korean space program?

I seek answers to these questions by examining the relationship between a "space program" and "the construction of national identity" in a political, social, and transnational context. Through historical analysis, I will show that South Korea's space program has been primarily driven by nationalistic rationales implicit in the argument that space development served "modernization," "self-defense,", "economic security", and "national prestige." By tracing the multiple links between technological prowess and national imagination, I connect these four rationales using to periodization; 1950s~1960s, 1970~1984, 1985~1997, and 1998~2013. A close examination of the history of the development of space exploration in South Korea offers a fertile ground for exploring the question how the rationales of space development have evolved as the Korean state worked on nation-building in a global context.

CHAPTER 1: Introduction

The goal of my dissertation is to describe the history of the South Korean[1] space program and to use it to offer some insights on reframing space history from a global point of view. South Korea is a new player among the space faring nations. While some of the necessary infrastructure was put in place in the 30 years after the launch of Sputnik, the country only really made a commitment space in the 1990s, developing rapidly to become a significant presence today. The launch of KITsat-1 (*Uribyul*-1, the first Korean satellite) in 1992 marks its first major achievement, after which it built up its technological capabilities in the space sector in a relatively short period. South Korea now has twelve satellites and operates several space projects, and successfully developed its first space launch vehicle, KSLV-1, also known as *Naro*, in 2013. Although KSLV-1 is derived from the first stage of the Russian Angara rocket, combined with a solid-fueled second stage built by South Korea, its successful launch was the crucial step for the development of the country's civilian space program. South Korea aims to develop the first wholly Korean-made launch rocket, KSLV-2 by 2020, which will additionally be used to launch a moon orbiter later that year.

Korea's recent aspiration to space exploration can be seen as part of global narrative in which the conquest of space is not dominated by a few superpowers. Although rivalry between the United States and the Soviet Union framed the early historiography of space exploration, going into space always engaged more nations. By the mid-1960s, other

[1] Republic of Korea (ROK), South Korea and Korea will be used interchangeably throughout the thesis.

countries had already begun to develop the capability to send satellites into orbit using their own launch vehicles. In 1965, France became the third nation to achieve access to space with an indigenously built launcher, later sharing technologies with other European countries to develop the Ariane launcher family.[2] Japan and China launched their first satellites in 1970, followed by India in 1980, and Israel in 1988. Furthermore, since the end of the Cold War, a growing number of states and corporations have begun to seek their own place in space exploration. Looking back over the space age, Brian Harvey et al. divide the "space powers" into three categories: the original space "super-powers" such as the U. S. and Russia/Soviet Union; a larger group of "middle-range space powers" who launched their satellites between 1960 and 1980 such as France, Japan, China, and India; and the new "emerging powers" that followed thereafter, such as Israel, Brazil, North Korea, Iran and South Korea.[3]

Our understanding of the past half-century of space development is, however, still firmly rooted in the framework of the old Cold-War-centered approach to space history. Until recently, only large and powerful nations have been able to mobilize the resources necessary for access to space, so the early years of space exploration produced a simple narrative: a fierce space competition between the Soviet Union and the U. S., with a few countries

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[2] France provided a spaceport for ESA (European Space Agency) space launchers in French Guyana, transferring between 1975 and 1980 its capability to ESA as a founding member. ESA signatories at the time of first launch were Sweden, Switzerland, Germany, Denmark, Italy, United Kingdom, Belgium, Netherlands, Spain, France and Ireland. These countries became shareholders in the commercial company Arianespace dealing with production, operation, and marketing except Ireland and United Kingdom. For a detailed history of European space program see John Krige, *Fifty Years of European Cooperation in Space: Building on its Past, ESA Shapes the Future* (Beauchesne, 2014).

[3] Israel became the eighth nation to have space launch capability in 1988, followed by Iran in 2009, North Korea in 2012. Brazil has yet to launch a satellite into orbit independently and its space program suffered three satellite launch failures in the early 2000s. Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America* (London; Chichester: Springer; Praxis, 2009), p. 543.

following behind in a struggle to increase their presence in space. Yet emerging powers' stories of space development were barely noticed in comparison with the abundant literature on the space history of the super-powers and the increasing literature on middle-range space powers. For this reason, space historian Asif Siddiqi suggests that "other national space programs will require us to approach space history with new lenses as more and more new narratives join the old cold-war-centered approach to space history."[4]

In order to situate the South Korean space program in this evolving global context, this dissertation attempts to answer the following critical questions: What is the origin of Korean space development? Why is South Korea a late-comer in space, and why is it becoming more active today? How have its motivations and rationales evolved in defining relationships with other countries including the U.S., Russia, France, China, Japan, and even North Korea? Why does it continue to emphasize the need for "Korean" technology in space? In essence, what is Korean about the Korean space program?

I seek answers to these questions by examining the relationship between a "space program" and "the construction of national identity" in a political, social, and transnational context. Through historical analysis, I will show that South Korea's space program has been primarily driven by nationalistic rationales implicit in the argument that space development served "modernization", "self-defense", "economic security", and "national prestige." By tracing the multiple links between technological prowess and national imagination, I connect these four rationales using to periodization; 1950s~1960s, 1970~1984, 1985~1997, and 1998~2013. A close examination of the history of the development of space exploration in

[4] Asif Siddiqi, "Competing Technologies, National(ist) Narratives, and Universal Claims: Toward a Global History of Space Exploration," *Technology and Culture* 51, no. 2 (2010): 425–443.

South Korea offers a fertile ground for exploring the question how the rationales of space development have evolved as the Korean state worked on nation-building in a global context.

Historiographical Context

Compared to China, India, and Japan which have received the bulk of recent attention for their space programs in Asia's space race,[5] there has been very little research on the origin of the Korean space program and its development; there is still no comprehensive monograph. However, since the mid-2000s, several scholars have begun paying attention to the emergence of South Korea as a new player which has been remarkably dynamic over the past decade. Many scholars have attempted to explain its dynamics mainly through economic perspectives. For example, Lee Joosung and Chung Seungmi argue that Korea's space development has been focused on "technology catch-up," where the growth of industrial competitiveness is an important rationale.[6] Kim Jongbum shows that the Korean space program has been directed under the "banner of pragmatism," through an analysis of presidential speeches from 1993 to 2005.[7] Similarly, Hwang Chin Young argues that the space industry is a symbolic industry through which South Korea can prove its national

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[5] For a detailed history of Asian countries' space programs see Brian Harvey, *China's Space Program - From Conception to Manned Spaceflight* (Springer, 2004); Yasushi Sato, "A contested Gift of Power: American Assistance to Japan's Space Launch Vehicle Technology, 1965-1975," *Historia Scientarum* 11, no. 2 (November, 2001); Gopal Raj, *Reach for the Star: The Evolution of India's Rocket Programme* (New Delhi: Viking, 2000); Ashok Maharaj, *Space for Development: US –India Space Relations, 1955 – 1976* (Doctoral Diss., Georgia Institute of Technology, 2011).

[6] Joosung J. Lee and Seungmi Chung, "Space Policy for Late Comer Countries: A Case Study of South Korea," *Space Policy* 27, no. 4 (November, 2011): 227–233.

[7] Jong Bum Kim, "Rationales of Korean Space Development," *Technology Trend of Aerospace Industry* 4, no. 2 (2006): 3–9. (in Korean)

technological capability as well as its national power.[8] Following Hwang's argument, Juan Felipe Lopez-Aymes defines the "emblematic character" of the Korean space industry as "economic nationalism" - the interaction of economic process and national identity that includes a political use of that identity for developmental purposes.[9]

Other scholars focus on the evolution of South Korea's capability in space as it relates to its national security. Daniel Pinkston argues that South Korea has developed rocket technology for military and civilian applications dominantly in response to the actions of North Korea.[10] Kim Kyung-Min also argues that the notion of a space program still sounds "exotic and adventurous" to South Koreans; it merely wishes to build its own capability to gather information aimed at identifying the existence of any security threats across the border.[11] Stressing the influence of a U.S. ban on developing long-range missiles, James Mortz argues that Korea's swift progress is due to "the desire to be recognized as an independent, modern, and technologically advanced society."[12]

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[8] Chin Young Hwang, "Space Activities in Korea—History, Current Programs and Future Plans," *Space Policy* 22, no. 3 (August 2006): 194–199.

[9] Juan Felipe Lopez-Aymes, "Automobile, Information and Communication Technology and Space Industries as Icons of South Korean Economic Nationalism," *Pacific Focus* 25, no. 2 (July 26, 2010): 289–312.

[10] Daniel Pinkston, "North and South Korean Space Development: Prospects for Cooperation and Conflict," *Astropolitics: The International Journal of Space Politics and Policy* 4, no. 2 (August 1, 2006): 207–227.

[11] Kyung-Min Kim, "South Korean Capabilities for Space Security," in John Logsdon and James Moltz (eds.), *Collective Security in Space: Asian Perspectives* (George Washington University; the Space Policy Institute, 2008): 67–74.

[12] James Moltz, *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks*, (Columbia University Press, 2011), p. 138.

Previous research on South Korean space development has certain limitations. First, most of the previous studies are descriptive reports of the current conditions of Korea's space development and a catalogue of events since the 1990s (with the exception of a few which start in the 1970s), rather than providing the full story since the 1950s within the framework of relevant social, political, and economic contexts. Thus, these studies and reports are largely disconnected, failing to provide a comprehensive and historical overview of South Korean space development. Second, they are dominated by the political and diplomatic context in which political leaders have constructed a "master narrative" of the history of space exploration and made major decisions regarding national space policy. So they did not include much of the public discourse describing space exploration which rhetorically and symbolically communicates persistent ideas about space exploration.[13] These histories instead serve as "a filter for the public understanding of spaceflight and consequently contribute to the public enthusiasm for space exploration and national space policy." Third, the most critical and common problem is that by heavily focusing on the national narratives of professional engineering identities, they pay scant attention to the connected histories of developed space-faring countries and their international collaborations in a global context. Indeed, the Korean space program has been at the intersection of multiple flows of knowledge from a variety of sources across borders in complicated diplomatic and political contexts.

[13] This point was made by Glen Asner, "Space History from the Bottom Up: Using Social History to Interpret the Societal Impact of Spaceflight," in Steven J. Dick and Roger D. Launius (eds.), *Societal Impact of Spaceflight* (Washington, DC: NASA, 2007): 387–406.

A Transnational Perspective on the Korean Program

With these limitations of the existing literature in mind, I here reframe the history of South Korean space development by focusing on the complex relationship between "nation-building" and "space development" within a changing global context. Throughout the 20th century, and with particular emphasis after WWII, governments came to see science and technology as levers of industrial development, economic growth and military strength. As instruments of modernization they promised both to improve the lives of citizens in both developed and developing countries, and to project the power of the nation-state abroad.[14] For example, in her book, *the Radiance of France: Nuclear Power and National Identity after World War II*, Gabrielle Hecht shows that France's nuclear program after World War II offered "technological prowess" as a solution to restore its glorious past after WWII, epitomizing the link between French radiance and technological achievement.[15] "Technologists," including engineers as well as top administrators of industrial state enterprises, justified the investment in a large-scale technological system by placing it in direct historical lineage with past national achievements: nuclear reactors were the modern heirs of the Eiffel Tower, twentieth-century symbol of technological progress. Suzanne Moon's research on Indonesian industrialization is another good example.[16] She explores the connections between technology and the postcolonial project of national identity formation in

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[14] Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress*, (New York: Oxford University Press, 1990).

[15] Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity After World War II*, (Cambridge, M.A.: The MIT Press, 2009).

[16] Suzanne Moon, "Justice, Geography, and Steel: Technology and National Identity in Indonesian Industrialization," *Osiris 24* (2009): 253-277.

Indonesia in the early period of industrialization, from 1950-75. The process of defining a national identity for Indonesia was particularly challenging due to its geographic and social fragmentation; it is an archipelago consisting of more than 13,000 islands where there are hundreds of different languages and sizable minorities who are Hindu, Buddhist, Christian, and animist. In this context, political elites worked assiduously to use a variety of technologies to unite the people around a cohesive national project: technologies such as newspapers, the radio, television, the airplane, and satellites were enlisted to overcome both cultural difference and physical distance. To unite the people of the islands, create patriotic loyalty to the new state, and to define Indonesia's place in the world geographically and politically, technology and national identity were made to play mutually reinforcing roles in the narratives.

Space programs are perceived as an important sign of technological prowess in the construction of a national identity, because only nations and alliances of states have had the resources to develop reliable and effective space transportation systems.[17] The history of the past 50-years of spaceflight shows that the connection between nation-building and space development has endured both in reality and in perception. The American and Russian space programs have reinforced the notion that space exploration is a powerful vehicle for expressing a nation's broader aspirations. The emerging powers, including China and Japan, have also strengthened the link between nationalism and competence in space activities recently. South Korea is not an exception. In an interview with the BBC in November 2007, the president of KARI, Paik Hong-Yul, insisted that "our space program is about courage and

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[17] Asif Siddiqi, "Spaceflight in the National Imagination," in Steven J. Dick (ed.), *Remembering The Space Age: Proceedings of the 50th Anniversary Conference* (Washington, DC: NASA, 2008): 17-35.

dreams. This is above money; it's about developing as a nation and that's why we do it."[18] Nevertheless, all nations do not share the same rationale for space exploration. Rather, each defines its space accomplishments according to its own cultural and social values, rooted in the framework of the national imagination.

I draw attention to the concept of "imagination," which plays a significant role via artificial mediators in the making of the collective consciousness whether it crosses the borders of a nation-state or not. The concept of "imagination" has been used frequently by historians for explaining how the "nation" is constructed as a mental image of affinity within its citizens' minds. Benedict Anderson defined a nation as "an imagined community…[that is] both inherently limited and sovereign."[19] Indeed, the advent of print technology in more wealthy nations allowed people to "imagine" large linked communities that had previously enjoyed no special form of togetherness. In the eighteenth century, newspapers and novels created a vernacular readership whose limits often helped to "define the nation". These forms provided the technical means of 'representing' the kind of imagined community that is a nation. Meanwhile, Arjun Appadurai has argued that the contemporary world has manipulated the imagination via the media and made it public, thereby emphasizing the role of the imagination as an essential component of the new global order.[20]

The role of the imagination in national space exploration has tended to center around the projects of the two main space superpowers, the United States and the Soviet Union. For

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[18] "South Korea Buys into Space Dream," BBC News (November 12, 2007).

[19] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, Rev. ed. (London; New York: Verso, 2006).

[20] Arjun Appadurai, *Modernity Al Large : Cultural Dimensions of Globalization* (Minneapolis; London: University of Minnesota Press, 1996).

example, in his book, *Space and the American Imagination*, Howard McCurdy offered largely cultural explanations for the changing American attitudes toward space exploration in the twentieth century and the subsequent changes in public policies. He defines the imagination as "mental images of events or processes that are not actually present," and the mental images produced by the imagination may also be called "vision". McCurdy argues that the vision of the space program has provided a strong boost promoting the American space programs since the early 1940s, borrowing U.S. historian Walter McDougall's expression, "Once these forces [a rich economy, the appropriate technology, and imagination] started pushing in the same direction, a large government-supported space program was automatic."[21] According to him, the vision of space as "the New World" and "the final frontier" inspired the "American" space program since the early 1940s. In their attempts to justify the modern space program, advocates worked hard to sustain the image of discovery fostered by previous explorers, such as Lewis and Clark pressing across the uncharted continent, Admirals Peary and Byrd's exploration of the icy waters of the poles, and Lindberg's non-stop, solo, trans-Atlantic flight[22]. Indeed, the preexisting American cultural ideals of the endless frontier, of the heroic explorer, and of progress through technology made selling the space program to policy makers and the general public much easier.

Similarly, in his recent book entitled *The Red Rockets' Glare: Spaceflight and the Soviet Imagination 1857-1957*, Asif Siddiqi attempts to reframe the birth of the Soviet space program by linking the ideology for building a communist nation to engineering. The Russian

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[21] Howard McCurdy, *Space and the American Imagination* (Washington: Smithsonian Inst Press, 1999), p. 34.

[22] Ibid. p. 143.

imagination of the cosmos in the late nineteenth century intersected with the practical realities of rocket engineering, in other words "technological utopianism." According to him, the network of space activists, including science fiction writers and philosophers, in the 1920s through the 1950s promoted a technological utopian view of space exploration. Before the Revolution of 1917, for example, Russian utopian philosophers, such as Lev Trotskii, incorporated both Marxist notions and twentieth-century modernist ideals of science and technology[23]. Their dream of space flight represented "liberation from Earth" and "fantasy beyond reality," which could represent total liberation from social injustice and imperfections in the past through a combination of technology.[24] In this way imagined futures influenced the thinking of Soviet citizens, creating the notion that space exploration was both inevitable and necessary.

McCurdy and Siddiqi's works are crucial not simply because they show how national imagination has had a significant role in moving a space program forward, but because they provide major insights into the nature of the relationship between nation-building and space exploration. The imagineries that facilitated nations' space programs have not been one-dimensional; rather they were heterogeneous as well as historically contextual. For example, McCurdy points out that even though the imagination of the 'final frontier' boosted American space projects and seems to reflect the American spirit, the notion of "frontier opportunity" was also criticized as simplistic by many Americans. African Americans and Indians did not view the New World as a land of opportunity and invention, and frontier women did not

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[23] Asif Siddiqi, *The Red Rockets' Glare : Spaceflight and the Soviet Imagination, 1857-1957* (Cambridge UK; New York: Cambridge University Press, 2010), p. 76.

[24] Ibid, p. 78.

enjoy the same freedoms as frontier men. Indeed, one of the most important images in the post-Apollo era was that space travel would become routine and available to ordinary citizens, rather than that space exploration would exemplify national prowess. Siddiqi also points out that the major Russian imagination, “technological utopianism,” showed that the Soviet Union’s space program was not the outcome of forces that were consistent with the aims and ideologies of the state. Rather, it was only possible under the fantasy and fascination with twentieth-century modernist ideals of science and technology, which were significantly influenced by “foreign factors”.

Articles claiming to offer a transnational perspective on history have proliferated for the past two decades. However, discussions on the pros and cons of this concept are still ongoing in some fields, and the opportunity for historians of technology to engage with a transnational perspective has emerged only recently. Chris Bayly’s AHR (American Historical Review) group suggests that transnational history is “an approach to history that focuses on a whole range of connections that transcend politically bounded territories and connect various parts of the world to one another. Networks, institutions, ideas, and processes constitute these connections, and though rulers, empires, and states are important in structuring them, they transcend politically bounded territories.”[25] Notice, they use the term “politically bounded territories” instead of national borders. Essential to the notion of the transnational history is to “transcend and de-isolate” the nation-state as a unit of analysis.

[25] Chris Bayly et al., “AHR Conversation: on Transnational History,” *American Historical Review* 111: 5 (2006): 1441-1464, p. 1446.

Meanwhile, Erik van der Vleuten's recent study gives three guidelines for a transnational history of technology.[26] First, transnational history often refers to the study of cross-border flows. This focuses on the circulation of flows of people, ideas and objects across national boundaries, with the structures that support these flows and with the different scales across which structures and flows operate. Second, "transnational" is frequently employed to refer to the study of the historical role of international nongovernmental organizations such as IBM, Unilever, international trade unions, and in science and technology history, transnational networks of scientists and technologists. Third, transnational history is often taken to mean "de-centering the nation-state from its position as the principal organizing category for scholarly inquiry." A major difficulty in this view is that de-centering the nation-state would lead to abandoning the national as a category of analysis altogether. However, the true meaning of the guideline is to place the nation-state in its proper historical context. The nation-state remains "a key analytical category that should be contextualized, not abandoned."[27]

In this dissertation, I use van der Vleuten's three guidelines for a transnational history of technology to explain how a transnational study of the Korean space program is possible. I attempt to rupture the South Korean national frame and to situate scientific and technological practices in a transnational framework by tracing their technological trajectory back to 1958 when the rocket team established in the National Defense Scientific Research Institute (NDSRI) launched its first modern rocket. By tracking the history of Korean space

[26] Erik van der Vleuten, "Towards a Transnational History of Technology: Meanings, Promises, and Pitfalls." *Technology and Culture* 49: 4 (2008): 974-994.

[27] Ibid. p. 984.

development from its first step towards an autonomous rocket technology before the 1970s (a period dominated by ballistic missile development for national security), to the first Korean space launch vehicle (Naro) project in 2000s - which aspired to attain an indigenous capability for space development enabling South Korea to join the top 10 countries in the space industry - I will show how its political dynamics are closely intertwined with the global environment in which Korean space policy has evolved over time. The alignment entails complex and social interactions that served to encode collective imaginations of the good society. A transnational study of the Korean program will not only overcome the limitations of a national history of the Korean space program, but also contribute to re-framing the history of space exploration to reflect a global context.

A key argument of this dissertation is that the path of nation-building which enables a country's space program is deeply connected to constructing the collective imaginary of a desired social order, which entails complex international interactions in a constantly changing global context. This dissertation will also take up Siddiqi's challenge that a significant step toward reframing the history of space exploration to reflect a global context must include an examination of the space-faring histories of non-superpowers. Considering these points, I suggest a transnational study of the Korean space program provides a fertile ground to better define the way in which the relationship between nation-building and space exploration has affected our discipline's approach to the history of spaceflight. There is a link between national imagination and space exploration which connects the narrow perspective of national identity to a larger, global vision. Therefore, the center of this analysis of the Korean space program is located in the Korean national imagination for space exploration – which itself is deeply embedded in a transnational context.

Dissertation Chapters

The argument is developed in four central chapters based on a periodization of the dominant rationales driving space development. These rationales were a “rocket for modernity” (1950s~1969), “self-defense” (1970~1984), “economic security” (1985~1997), and “national prestige” (1998~2013).

In the first chapter, I take a closer look at the early history of South Korea’s first step towards a space presence in 1950s and 1960s. During this period, the country had made an effort to redefine its national identity to secure national pride through science and technology, while struggling to deal with humiliation over past failures such as Korea’s colonization and then war and division. The launch of Sputnik in 1957 directly affected the space aspirations of the people in one of the world’s poorest countries at that time. It provided not only motivation for political leaders to develop guided weapons for national security but also inspiration for ordinary people to emerge from backwardness to embrace the excitement of cutting-edge technology. A rocket development team was established in the National Defense Scientific Research Institute (NDSRI) in 1956; it launched its first modern rocket successfully in 1958. Also as public interest in space science increased, several amateur rocket clubs and scholarly associations fostered a boom in space science by promoting the idea that “we can do it.” These measures were blunted by Park Chung Hee, who seized power through a military coup in 1961. He dismissed NDSRI in order to secure the U.S.’s approval and continued assistance as required by President John F. Kennedy’s changing foreign policy toward South Korea; the U.S. would provide for consumable military items rather than investing in up-to-date equipment. Consequently, national missile development was put on hold, and the public's high nationalistic aspirations did not become a massive social movement or drive national space policy for a decade.

The security situation around South Korea before and after 1970 dramatically changed Park's view on Korea's military capability. His perception of a waning of the U.S. commitment to defend South Korea at a time of heightened vulnerability to North Korean political and military offensives led Park to seek ways of becoming more independent of the American military. In the mid-1970s, the Park Chung Hee government often conflicted with the Carter administration, because Park wanted to develop nuclear weapons and guided missiles, in anticipation of Carter's withdrawal of US forces from South Korea. Seeking to stabilize the always tense Korean peninsula, the United States put pressure on the Koreans to end their work. In 1975, the South Koreans agreed to American demands, ended their nuclear weapon program and signed the nuclear Non-Proliferation Treaty. Park continued to develop guided missiles in the name of "self-defense." Despite pressure from the U.S. for fear of proliferation, engineers from the Agency for Defense Development (ADD) successfully developed the surface-to-surface missile NHK-1, also known as *Paekkom* (White Bear), in 1978. Although South Korea had to sign the bilateral agreement, known as the 'Missile Guideline,' which allowed only for the development of missiles with the shorter range of 180km in exchange for technological assistance from U.S. in 1979, the country established a strong infrastructure for future space programs. The second chapter traces how and why South Korea succeeded in developing the NHK-1 missile but suspended efforts in developing nuclear weapons in the 1970s. It will focus on U.S. policy toward South Korea and Korean efforts to diversify its sources of supplies of technology and materials and to acquire its own defense plants and production capabilities for the missile. It will also discuss Korea's acquisition of the most advanced weapons available in the international market.

The third chapter deals with the period from 1985 to 1997 when South Korea began to outline an economic rationale for moving the country into the field of space technology, based on technological advances through the defense industry in the 1970s. The Korean economy—which had once been characterized by an emphasis on low-cost labor and assembly-type operations in the 1970s—was now in the midst of a significant transformation reflecting a new commitment to skill and knowledge-intensive industries. Also, due to the increasing international technology protectionism of the 1980s, South Koreans perceived the failure to escape from underdevelopment and to catch up with the advanced industrial nations as one of the most serious risks facing their country. In this atmosphere, South Koreans began to view space as a realm with frontier technologies that they must master to join the ranks of the advanced countries. The Ministry of Science and Technology (MOST) initiated a 15-year space development plan in 1985. Its long-term objectives were to acquire the independent technological capabilities for space development, and to join the top 10 countries in the global space industrial market by launching a domestically-configured communication satellite with the help of overseas expertise by 2001. With the first Korean research institute to specialize in space development, the Institute of Space Science & Astronomy (ISSA), established in 1986, the Aerospace Industry Development and Promotion Act, which included the first significant funding for space projects, was enacted in 1987. Subsequently, the Korea Aerospace Research Institute (KARI), Korea Advanced Institute of Science and Technology (KAIST), and Korea Telecommunication (KT) emerged as new actors in the civilian space program. Initially relying on the import of technology from foreign countries, they soon aspired to attaining an autonomous and indigenous launch capability for space development. In 1996, South Korea announced its first Basic Plan on Mid-to-Long-Term National Space Development, of which the main objective was to launch the first Korean space launch vehicle, KSLV-1 (also known as *Naro*) with a satellite developed independently at a local launch site in 2010 and to join the top 10 countries in the space industry.

National security concerns soon intervened to renew South Korea's emphasis on the development of space capabilities. The so-called "*Taepodong* Shock" viz., North Korea's attempt to launch a *Taepodong-1* space vehicle with a satellite in 1998, directly affected the direction and independent development of KSLV-1. The South Korean government brought its independent launch of KSLV-1 forward by five years, from 2010 to 2005, and demanded that the U.S. revise the 1979 missile guideline to allow South Korea entry into the international Missile Technology Control Regime (MCTR). This political drive led South Korea to turn to international cooperation with Russia rather than overcome technical difficulties in developing an indigenous liquid-fueled rocket for KSLV-1. The final chapter aims to offer an historical overview of the emergence of South Korea as a new space-faring nation by launching KSLV-1 in 2013, focusing on how the KSLV-1 project has evolved in the complicated contexts of national motivations and international politics. Even though South Korea changed the plan to purchase technologies from Russia for KSLV-1, its nationalistic vision for space, represented by the slogan "Launching our own satellite with our own rocket from our own country," has persisted throughout the period. KARI conducted landmark projects for the exposure of space development to the public, including an initiative to restore *Singijeon*, a 15th-century South Korean rocket system, and embarking on the first Korean Astronaut Program. After all, the KSLV-1 project was about "developing a nation" so that South Korea could prove its national technological capability as well as its national power.

A Note on Archives

To tell the full story of Korea's rocket/space program, I relied on a variety of sources collected in South Korea during my one-year stay in 2014 and occasional visits. My sources are mostly from archives in the form of official documents. The National Archives of Korea and The Presidential Archive of Korea located at *Seongnam* provided not only government documents, correspondence and briefs between agencies, and official letters by key personnel, but also some background material about political leaders' crucial decisions on space policy through all the periods that I covered in this project. The National Assembly Library of the Republic of Korea, the Archive of Seoul National University in Seoul, and the Archive of Inha University in Incheon were consulted to trace the efforts of Korean scientists and engineers in the early years of Korean rocket program during 1950s and 1960s. The Satellite Technology Research Center (SaTReC) in KAIST and the Korea Aerospace Research Institute (KARI), the main actors in the civilian space program since 1990s, have not established formal archival facilities to date. Although the scattered documents have not been well-organized yet, I have consulted with Library of KARI and Library of SaTReC to collect relevant materials. To fill the gaps, I consulted with a few scientists, engineers and government officials who were involved in the space projects, and conducted interviews with key actors who were concerned with the projects. Thankfully, they shared their personal collections and much useful source material. To offer some preliminary thoughts on the nationalistic idea that characterizes the public rhetoric surrounding the Korean space program, I examined the discourse generated by governmental agencies, journalists, and public commentators etc. Newspapers, magazines and personal memoirs were also useful for this purpose.

Apart from these Korean sources, documents have been also collected in the United States. To understand the diplomatic and political relationship between the U.S. and South Korea and its influence on the Korean rocket program during the 1960s and 1070s, I used declassified State Department documents from the National Archives, the CIA, the Ford Presidential Library, and the Woodrow Wilson International Center for Scholars. Their digitized archival collections were extremely helpful, saving time and money in my search for valuable primary source materials. I also benefited from three volumes on the topic of Korea between 1964-1976 in FRUS (Foreign Relations of the United States) published by the U.S. Department of State, CIA documents in "South Korea: Nuclear Developments and Strategic Decisionmaking," issued in June 1978 and released in 2005, and the "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives" which deals with the plans by the Korean National Intelligence Service to manipulate American institutions to the advantage of South Korean government policies in the 1970s.[28]

[28] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," October 31, 1978 (Washington D.C.: U.S. Government Publishing Office, 1978), p. 173.

CHAPTER 2

Early History – The Sputnik Shock and Korea's Rocket Fever

1958-1969

South Korea's first attempt to establish a presence in space can be traced back to ballistic missile development that began in the late 1950s. The first challenge faced by the South Korean government was to establish the building blocks for the country's scientific-technological base for developing ballistic missiles. The nation's political leader, Rhee Syngman, set up the team that developed the missile in the National Defense Scientific Research Institute (NDSRI) in 1956. Its first modern rocket was launched in 1958. However, NDSRI was disbanded in the political turmoil of the 1960 April Revolution that was followed by a military coup in 1961. In the political and technological setting of Korean missile development, security was the dominant aspect of relations between the U.S. and South Korea. This chapter deals with the U.S.' perception of South Korea in the geopolitical context of the sixties, and describes its influence on the Korean rocket program.

During this period, South Korea also made an effort to redefine its national identity and to boost its national pride, while struggling with humiliation over past failures such as Korea's colonization followed by war and division.[29] The historical episodes of the developed countries' space exploration in the Cold War represented by Sputnik in 1957 and

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[29] Gilbert Rozman, "Comparisons of National Identities in East Asia," *Harvard Asia Pacific Review* 11, no. 1 (May 6, 2010): 3-6.

Apollo's landing on the Moon in 1969 influenced the Korean people, in relation to "aspirations for a Western modernity." In this chapter, I also illustrate social responses to some amateur rocketeers' efforts to launch their self-made rudimentary rockets, and the role played by civilian organizations in promoting space science after Sputnik.

Rockets, Satellites, and Modernity

South Korea was one of the poorest countries in the world at the end of World War II. The Japanese colonial period left the country with very few industries in the modern sense and no technical personnel pool,[30] and little progress had been made in the economy by 1950. The Korean War (1950-1953) devastated even this weak foundation; the nation's gross national product (GNP) in 1953 was $67 per capita.[31] Although the Korean government made some efforts for science and technology as part of post-war reconstruction, space science and technology related to sounding rockets and satellites was a luxury. South Korea had neither the time, the personnel, nor the funds to purse S&T initiatives in this period. It did not even participate in the global geophysical activities with 67 other countries during the International Geophysical Year (IGY, July 1957-December 1958) for lack of funding.[32]

[30] Before the liberation, South Korea had only around 400 scientists and engineers with academic degree all over the country. Kim Keunbae and Song Sungsoo, "Incomplete Reconstruction of Science and Technology," in the National History Compilation Committee (ed.), *Modern Science and Technology and the Change of Life* (Seoul: Doosan-Donga, 2005): 90-106, p. 90. (in Korean)

[31] Jong Won Lee, "The Impact of the Korean War on the Korean Economy," *International Journal of Korean Studies* 5, 1 (Spring/Summer 2001): 97-118.

[32] Jung Changhee, "On International Geophysical Year," *Dong-a Daily* (March 24, 1961). (in Korean); Werner Buedeler, "The International Geophysical Year" (UNESCO, 1957)

The domestic newspapers at the time published articles deploring the pauperism of the scientific community and the political apathy to the news on space development in advanced nations. A newspaper criticized the politicians' disinterestedness in IGY; "it is an unusual physical phenomena where the politicians are busy observing only the weather of *Gyeongmudae* (the presidential house) rather than perplexing problems like cosmic rays, solar spots, or the Earth core's heat." [33] According to a scientist's reminiscence, South Korean Foreign Ministry officials were upset only after seeing an illustration of the Earth decked with the flags of all the nations that had participated in the IGY in *Life* Magazine.[34] It included a North Korean flag but not the South Korean one.[35] North Korea played its role in the IGY community when it built the first astronomical observatory installed on a telescope made in Germany on *Mt. Daesung* near *Pyongyang* in March 1957.[36]

When the Soviet Union successfully launched Sputnik I on October 4, 1957 during the IGY, the satellite caught the world's attention as a technical achievement; South Korea was naturally one of them. While the Sputnik marked the start of the space age and the U.S.-U.S.S.R space race, the dominant image of space science and technology for Korean people was that it represented the aspiration to Western modernity and democracy. *The Kyounghang Daily* on October 8, 1957 delivered its top news story about the Soviet Union's successful launch of Sputnik I, and urged in the editorial that "we have to reflect on our parsimony on

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[33] "Excursus," *Kyunghyang Daily* (July 13, 1957). (in Korean)

[34] Kwon Youngdae, "A Troubled Participation in the International Conference," *Kyunghyang Daily* (October 10, 1973). (in Korean)

[35] "The New Portrait of Our Planet," *Life* 49, no. 19 (November 7, 1960), p. 74.

[36] "Red Koreans Join IGY," *Missiles and Rockets* 3, no. 1 (January 1958): 60; Marcel Nicolet, "The International Geophysical Year 1957/58," *World Meteorological Organization (WMO) Bulletin* 31 (1982): 222-231.

rebuilding science and technology for overcoming the economic backwardness without sparing efforts for securing and maintaining power."[37]

The cartoons in newspapers used the image of an artificial satellite as an illustration of Western modernity to lampoon the social and political backwardness of the country in those days. A cartoon in *Dong-a Daily* on December 21, 1957 shows a man who presses a button to launch a rocket and another man who operates a strange box with many hands. Its caption states, "Victory of the National Security Law: Foreign countries have artificial satellites, while Korea has the '*Keosuki*' (rubber-stamp machine)."[38] This cartoon was a biting satire on the political corruption with which the ruling Liberal Party rushed through a revised bill for the National Security Law. As protests mounted in South Korea against President Rhee's dictatorial regime in the mid-1950s, government leaders denounced the protesters for weakening South Korea's national security and forcibly put down the protests. They further restricted freedom of speech in 1958 by amending the National Security Law to provide death sentences or long prison terms for such crimes.[39] By comparing space rockets and satellite with a strange looking machine, the cartoon was meant to criticize the ruling party's political corruption. The rocket and satellites in the cartoon thus symbolized the democracy that Korea had not fully achieved.

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[37] "Editorial," *Kyunghyang Daily* (October 8, 1958). (in Korean)

[38] "Conquer of the National Security Law: Foreign countries have artificial satellites, while Korea has the 'Keosuki'" *Dong-a Daily* (December 21, 1958). (in Korean)

[39] Norman Levin and Yong-Sup Han, *Sunshine in Korea: The South Korean Debate over Policies toward North Korea*, (Rand Center for Asia Pacific Policy, 2002), p. 15.

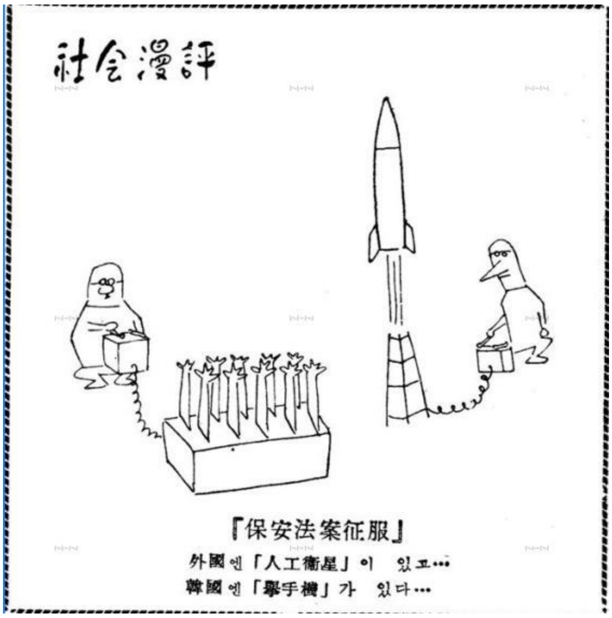

Figure 1: “Victory of the National Security Law: Foreign countries have artificial satellites, while Korea has the ‘Keosuki’” (Left); “Scientific Competition: The U.S. has artificial satellites, yet we have a ‘talking tree’” (Right). (Source: *Dong-a Daily*)

Another cartoon in *Donga Daily* on 17 January 1959 uses a U.S. satellite as a symbol of Western modernity. The cartoon, which states “Scientific Competition: The U.S. has artificial satellites, yet we have a ‘talking tree,’” depicts a tall western man with a round-shaped satellite and a short man wearing a shirt printed R.O.K with a tree that has a human face.[40] The talking tree stands for a cult leader, Park Taesun, who linked himself to the return of Christ as one of the two witnesses of olive trees in the Bible. Although the Olive Tree movement, named by the followers, was the largest and fastest growing of the new, syncretic Korean religions after the Korean War[41], Park was accused of injuring and defrauding his

[40] “Scientific Competition: The U.S. has artificial satellites, yet we have a ‘talking tree,’” *Dong-a Daily*, (January 17, 1959). (in Korean)

[41] James Huntley Grayson, *Korea: A Religious History* (London: Routledge Curzon, 2002), p. 208.

followers, and he was sentenced to two and a half years in jail in 1959. By comparing the U.S.'s satellite and the 'talking tree' under the name of 'scientific competition,' the cartoon deplores the reality of Korean society that could not go forward as a modern society while it was captured by a religious cult.

The Korean Amateur Rocketeers

The fascination and astonishment with the launch of Sputnik did not only remind people of the social and political backwardness of the country. The "beep-beep" sound that emanated from a simple transmitter aboard the Soviet satellite inspired amateur rocketeers around the world, and rocket fever in South Korea rapidly increased after the Sputnik. The stories of some amateur rocketeers and the social reaction to their achievements illustrate the notion of exploring space, which links to the idea of a nation's prowess in science and technology.

Among the amateur rocketeers who appeared since Sputnik, nineteen-year-old Kim Kiyong's story is noticeable.[42] Fascinated by the news about Sputnik, Kim dedicated his whole high school education to rocketry. After graduating from high school, he spent an entire university tuition fee to develop his own rocket. Despite becoming the laughingstock of the people in his village, Kim launched a self-built rocket successfully on March 16, 1958. The rocket was 107cm in height, 20cm in diameter and 65kg in weight, and reportedly rose 2km, during a 12-second burn time. On June 12, 1958, President Rhee invited Kim to the

[42] "Launching Korean Rockets," *Dong-a Daily* (August 27, 1958). (in Korean)

Blue House to talk about its military implications. Encouraged by the first successful launch, he now attempted to launch the rocket publicly on August 23, 1958, but it ended in failure when it exploded at an altitude of 5m.

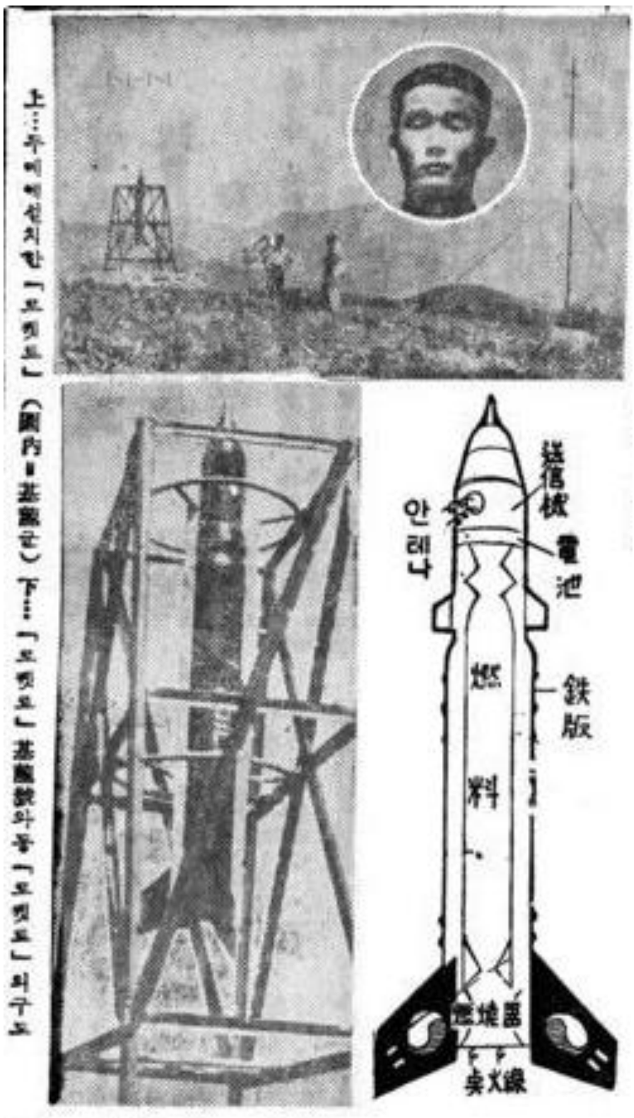

Figure 2: An Amateur Rocketeer, Cho Joongsuk and his rocket. (Source: Dong-a Daily)

Another twenty-five-year-old amateur rocketeer, Cho Joongsuk, was a poor shoe-repair man's son.[43] He abandoned going to high school due to the economic hardship, and worked for a steel plant and body shop for years. Meanwhile, he became interested in rocketry after the news about Sputnik, and taught himself how to make a rocket. Finally, he succeeded in launching a four stage rocket, 37.5 cm in height, 2.25 kg in weight on August 20, 1958. According to the village folks who gathered to watch the rocket launch, the rocket soared up into the air with a tremendous explosive sound so high that they could not see the multiple-stage rockets disengage with the naked eye. Moon Wonsuk, Lieutenant colonel in the Department of Development of the Army Military Headquarters, visited Cho to see if the rocket could be useful for military purposes.[44]

Even though the two rockets were rudimentary and without a strictly scientific base, the social response to the first Korean modern rockets was very enthusiastic. All those involved said that they taught themselves rocket science for several months motivated by Sputnik, and the newspapers assessed the two amateur rocketeers' achievement as "the triumph of Korean science," and saw in it hope for the "restoration of scientific creativity as in the past," (that was represented by several scientific instruments such as *Chukuki*, the world's first rain gauge of *Choseon* dynasty in 16th century).[45] One newspaper article, entitled "The Spirit of Korean Youth is Still Alive," covered their stories with news that Lee

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43 "Increasing Rocket Fever," *Kyunghyang Daily* (August 13, 1958). (in Korean)

44 Ibid

45 "Launching Korean Rockets," *Dong-a Daily* (August 27, 1958). (in Korean)

Changhoon had won the gold medal in a marathon in the Third Asian Games on May 29, 1958.[46] The marathon had been a competition of national pride to Koreans ever since Sohn Ki-Jeong won the gold medal in the marathon at the 1936 Berlin Olympics as a member of the Japanese delegation and removed the Japanese flag from his running tunic at the medal ceremony. Dealing with the two stories together, the newspapers devoted long columns to the events and used the occasion to boost the pride and praise the superiority of the Korean people.

The popular enthusiasm for rockets stimulated nationalism enabling an amateur rocketeer to raise funds for research abroad — by fabricating documents! *Dong-a Daily*, a daily newspaper on June 11, 1961 tells the story of a twenty-year-old amateur rocket enthusiast Oh Sukeun, in an article entitled "A Korean Young Scientist to the World."[47] He had taught himself to design a five-stage rocket over two years and launched a self-made two-stage rocket which was 2.1m in height, 32.5cm in diameter, and 225kg in weight. He sent 3000 pages of papers and blue prints, the result of his research, to Wernher Von Braun, who had develop the V-2 missile in Germany in WWII and became the first director of NASA's new Marshall Space Flight Center. According to the newspaper article, Oh received an invitation letter to a Missile School in NASA with the highest commendation for his new discoveries in rocket science from Von Braun.

The newspapers scrambled to report Oh's story praising him as "a pride of Korean science" and for proof that while "our country was well known for geniuses for a long time,

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[46] "The Spirit of Korean Youth Is Still Alive," *Kyunghyang Daily* (May 31, 1958). (In Korean)

[47] "A Korean Young Scientist to the World Stage," *Kyunghyang Daily* (November 1, 1961). (in Korean)

we have still a good number of the nameless geniuses." [48] However, three months later, it was discovered by the Bureau of Public Information that Oh had faked all the documents, including the invitation letter and Von Braun's signature and pictures on it, though he raised 2 million *Hwan* (roughly 1 million dollars today) by donations from corporate sponsors.[49] Although his story turned out to be a hoax, it indicates that the popular interest in space science was very high, and effective enough to perpetrate a swindle by misusing Dr. von Braun's name.

The Societies for Space Science

As public interest in space science increased, some amateur rocket clubs and scholarly associations, such as the Korean Astronautical Society (KAS) and the Korean Student Space Science Society (KSSSS), were established in 1958 and 1959 respectively.[50] The president of the KAS was Jung Nakeun, of the National Defense Scientific Research Institute (NDSRI), and the vice president was Kim Heechul, a professor at Seoul National University. The association, which was constituted of elites such as professors and researchers as well as ordinary people such as carpenters, teachers and students, evolved into a big organization with four-hundred members in about one year. They managed to keep rocket research, experiments, and public lectures going with their own funds. The KAS also published the first edition of *the Journal of the Korean Astronautical Society* in October 1958. Its role and

[48] "Going to U.S. by Dr. von Braun's Invitation," *Kyunghyang Daily* (October 30, 1961). (in Korean)

[49] "Proved to be a Fake," *Kyunghyang Daily* (November 1, 1961) (in Korean)

[50] *Korean History of Aerospace Science and Technology*, (The Korean Society for Aeronautical & Space Sciences, 1987), p. 101. (in Korean)

objectives can be seen in the preface of the second number of the Journal published in May 1960. It attempted to boost the public interest in space science by promoting the idea that "we can do it," as seen in the preface of the second volume of the journal:

> The developed countries have been achieving progress in space science thanks to their governments' massive support, yet it seems to be very hard for us to catch up with their research level immediately. Nevertheless, we have to go forward step by step with the hope to be among them in the future by looking into fundamental and comprehensive issues of space science.[51]

The KSSSS grew into a big organization with one–hundred members, most of whom were university students in the Seoul area by 1960. Under the advice of Prof. Wi Sangkyu and Prof. Han Mansub of Seoul National University, they published a monthly magazine, *the Bulletin of the Space Science Association*, and held public lectures, symposiums, and exhibitions on space science to live up to public expectations. The KSSSS also encouraged the members to join research and development activities according to their interests and specialties under the seven departments; metallography, chemistry, propulsion, electric devices, ballistics, hydrodynamics, and astronomy. Informed by the research activity, they pursued a scheme to develop and launch a two-stage rocket named 4s-7. The symposium for

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[51] Kim Heechul, "Preface," *Journal of Korean Astornautical Society*, Vo.2, no. 1 (May 1960): p. 1. (in Korean)

making their research public was greeted with a packed house of experts such as professors of universities in Seoul as well as rocket enthusiasts.[52]

The success of various public activities prompted the KAS and the KSSSS to hold a national rocket competition for university students in 1960. However, they had only one application for the competition from the rocket team at the Inha Institute of Technology (IIT), which had already finished manufacturing and testing several rockets. Thus, the KAS and the KSSSS decided to hold a public demonstration launching the IIT rocket team's rockets instead of delaying the competition to recruit more participants. On November 19, 1960, the launching site of IIT's rockets in Incheon was packed with thousands of spectators including Seo Minho, the vice chairman of the House of Representatives, and Lee Hongjong, the director of NDSRI. Under the guidance of Prof. Son Myoungwhan of the ordnance engineering department of the IIT, the rocket team made two single-stage rockets; IITO-1A (2.2m in length, 12.5cm in diameter, and 120kg in weight) and IITO-2A (1.7m in length, 12.5cm in diameter, and 70kg in weight).[53] Both rockets used JPN (Jet Propellant Navy) for solid propulsion — a colloidal double-based propellant used in U.S. rockets during World War II. The IITO-2A, a flight test model without payload, failed when the rocket exploded in the air. Happily the IITO-1A which had a parachute recovery system for a communication device inside of a nose cone succeeded in the planned flight. However, its recovery of the communication device ended in failure since the parachute did not separate from the body of the rocket.

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[52] "The KSSSS's Symposium for 4S-7 Rocket," *Dong-a Daily* (April 23, 1961). (in Korean)

[53] "Successful Launch of a Domestic Rocket," *Dong-a Daily* (November 20, 1960). (in Korean)

"If possible, we have to do it at all costs, even by selling land"

While public interest was concentrated on the modernity of space science with which they had to catch up someday, the political leaders were interested in rockets for the modernization of the military in the geopolitical context of the bipolar Cold War. In the late 1950s, after the Korean War, the protection of the Korean nation against communism was at the core of the state's priority for national development. In his anti-communist rhetoric Rhee Syngman, the first president of South Korea, constantly requested U.S. military and material support to defeat North Korea and reunify Korea.

The Armistice Agreement of the Korean War of July 7, 1953 was signed in anticipation of guaranteeing a peaceful resolution to the Korean issue, through discussions about "withdrawing all foreign forces from Korea and a peaceful resolution to the Korean issue."[54] However, Rhee Syngman was very critical of the U.S. withdrawal following the agreement, being anxious about the asymmetry in warfighting ability between the South and North. Rhee claimed that the U.S. had complied with the provisions of the ceasefire agreement, while the North Koreans had modernized conventional weapons and equipped the military with missiles and atomic weapons. He was worried that the situation in Korea would be "another Pearl Harbor."[55]

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[54] "Armistice Agreement for the Restoration of the South Korean State," Korean War Armistice Agreement, July 27, 1953; Treaties and Other International Agreements Series #2782; General Records of the United States Government; Record Group 11; NARA, http://www.archives.gov/historical-docs/todays-doc/index.html?dod-date=727, (accessed on May 1, 2013).

[55] "A Significant Korea Crisis," *Dong-a Daily* (May 24, 1957) (in Korean)

Based on his conviction that South Korea's military was "a relic of World War II,"[56] Rhee asked for U.S. atomic weapons and guided missiles to offset the North's military might. "Our intention is," he said to the media after the U.S. Army Chief of Staff, General Maxwell D Taylor's visit to Seoul on April 1, 1957, "not to acquire any special weapons, but to ensure safety in the overall military capability as much as possible to prevent Communists from making aggression. Guided missiles are one of the ways to achieve security." Finally, on January 17, 1958, *Honest John* rockets and 280mm artillery pieces were deployed by the U.S. on Korean soil on condition that two divisions of the Korean armed forces were removed.[57] On January 22, 1958, Rhee sent a telegram to express his appreciation to a Democratic Congressman, Daniel J. Plaid, who urged a provision of modern arms for South Korea, at the House of Representatives Appropriations Committee Hearings.[58]

President Rhee's interest in the autonomous development of the rocket is thought to have started at this time. Jung Nakun, the director of the National Defense Scientific Research Institute (NDSRI), put a plan into practice. He is the very person who created a rocket boom in both military and civilian domains in the late 1950s. Born in 1918 in South Korea, Jung moved to Japan to major in mechanical engineering at Kumamoto University and electric engineering at Tokyo University, and worked as a technical officer in Japanese Military Forces at the end of World War II. After decolonization in 1945, he returned to his home country to be the manager of the second arsenal of Korean army. And he became the

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[56] "Need to Modernize the Armed Forces," *Kyunghyang Daily* (April 2, 1957). (in Korean)

[57] Cha Sang-chol, *50 Years of the Korea-U.S. Alliance,* (Soul: Saenggakui Namu, 2004), 18. (in Korean)

[58] "Urgent Need of Guided Missiles," *Dong-a Daily* (January 22, 1958). (in Korean)

director of the Defense Science and Technology Research Institute (DSTRI), which was newly established in Seoul for promotion of Korea's military capabilities on June 15, 1950.[59]

At this time there were few research institutes of science and technology in South Korea, so that expectations were high for the DSTRI, which retained most of the highly-educated domestic manpower in the field. However, on June 25, 1950, only ten days after the institute was established, the Korean War broke out. The DSTRI could not conduct research properly because it had to take refuge frequently during the war. Only when they returned to Seoul at the end of the war in September 1953, could they start their jobs in earnest. Finally, on July 14, 1954, DSTRI incorporated the army arsenal and was reborn as a national institute, NDSRI by a presidential decree.[60] NDSRI recruited 120 highly-educated people holding a university degree in science or engineering from 1955 to 1959; it emerged as the best science and technology institute in reality as well as in name despite the poor domestic environment.

Although the mission of NDSRI was to report the results of investigations, research, and tests regarding defense issues to the army, the assignments from military demand were rarely required because the urgently-needed arms and ammunitions were procured via U.S. military assistance.[61] The selection of research topics was relatively free; they covered the

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[59] Park Taekkyu, "Interview with an Elder Scientist: Jung Nakun," *Science and Technology: Korean Federation of Science and Technology Societies Monthly* 27, No. 10 (October 1994): 81-83. (in Korean)

[60] Kim Kisuk, "History of Korean Ordnance Technology (1/3)," *Defense and Technology: Korea Defense Industry Association Monthly*, sno. 131 (January 1990): 66-75. (in Korean)

[61] Kayunhoi (ed.), *National Defense Scientific Research Institute* (Kayunhoi, 2003). This private booklet written by Kwayunhoi, a reunion of researchers who had worked for NDSRI, is almost the only material remained to have comprehensive substance about it.

research range from conventional weapons, military food and clothing to nuclear and rocket studies. Most research products were confidential. They also began issuing *the Bulletin of the Scientific Research Institute* that reported on their successful researches from 1956.[62]

NDSRI's concerted efforts in the development of the rocket began with establishing a rocket development team in November 1956. At this time, the institution consisted of three research groups and nine sub-laboratories, a mechanics workshop and a military food workshop, and the administration office. The director Jung appointed Lee Seungwon who doubled as the manager of the research group 1 and as a professor at Seoul National University, as the general manager for rocket development, and allocated responsibility according to research purposes; Group 1 to rocket design and manufacture, Group 2 to multistage rocket separation, Group 3 to a guidance system, and a newly established Lab 13, also called the powder lab, to rocket fuel and safety management. He also recruited Prof. Seo Jaejin and Prof. Han Mansub of Seoul National University as part-time employees for rocket engine development and vehicle design.[63] They were almost the only persons in South Korea who held degrees in aerospace engineering from a developed country, so their research experience was a great addition to NDSRI's rocket team. For example, Prof. Han held a master's degree from University of Minnesota[64], where he studied rockets and satellites with

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[62] NDSRI issued seven volumes of *the Bulletin of Scientific Research Institute,* which remain part of them in the Library of Seoul National University and in National Museum of Korean Contemporary History located in Seoul.

[63] Park Taekkyu, "Interview with an Elder Scientist: Jung Nakun."

[64] In September 1954 the Seoul National University while still suffering from the destruction of the Korean War agreed to receive educational and technical support from the University of Minnesota. Prof. Seo and Prof. Han were funded by the Minnesota Project. For the description of the background of the Minnesota Project see U.S. International Cooperation Administration, *Report on Survey of*

Prof. Rudolf Hermann who had participated in developing the V-2 rocket with Wernher Von Braun in Germany during the WWII.[65]

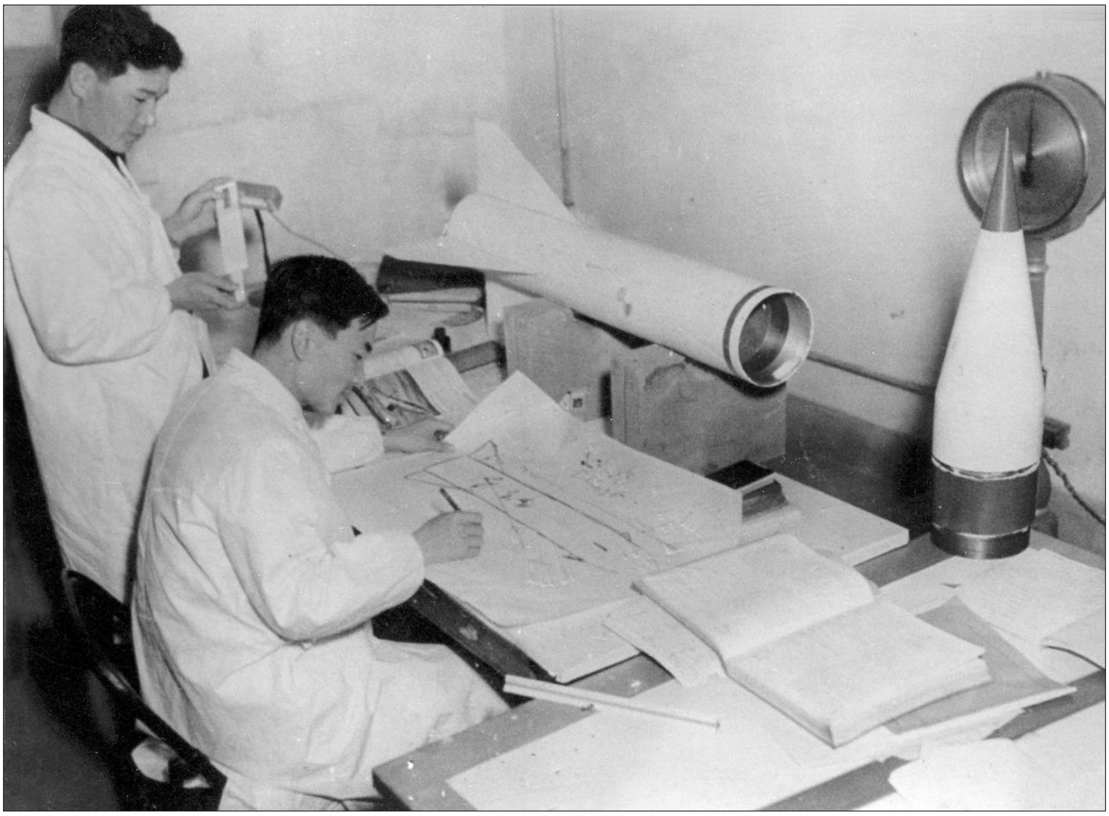

Figure 3: Designing a Rocket in NDSRI (Source: Hong Jaehank private collection)

National Higher Education in the Republic of Korea: Supplementary Memorandum of Explanation, (University of Minnesota, 1960).

65 Email interview with Han Mansub by Author (April 19, 2013).

They designed a two-stage rocket and a three-stage rocket not to meet any specific range requirement, nor to launch a particular payload for scientific research. Instead, they wanted to see its performance with available resources. The rocket team realized that it was almost impossible to manufacture rocket propellant by themselves, so they decided to utilize an integral solid propellant used by the 5-inch HVAR (high-velocity aircraft rocket) retired from the Korean Air Force.[66] At this time, the Korean Air Force had trouble disposing of the old HVARs transferred from U.S. Air Force after the Korean War. With the permission of the U.S. Air Force, the Korean Air Force transferred 2,000 HVARs to the NDSRI. The rocket team rearranged two or three of the rocket propellants to form a tube inside the single-stage rocket they designed and manufactured.[67]

When Sputnik was launched in October 1957, the rocket team had advanced to the step of manufacturing a two-stage rocket and a three-stage rocket after several successful tests of the single-stage rocket. They were highly motivated by the news about Sputnik; however repeated failures in the separation of multistage rockets left them completely dejected. Prof. Seo attempted to apply the separation method that he had learned when he was in Minnesota University; the first stage rocket would be disengaged by the air friction as its propulsion power was exhausted. However, this method was proved to be unsuccessful by repeated failures, so they changed approach and adopted Lab 13's proposal. It would separate the first-stage using the explosive power of the powder, which Lab 13 produced by mixing

[66] Han Mansub, "Memoirs: A Story of the First Korean Rocket," *KSAS Magazine: The Korean Society for Aeronautical & Space Sciences Monthly* 1, no. 2 (2007): 12–23. (in Korean)

[67] Lee Keunbae, "Memoirs: A Behind Story about Launching the Rocket," in Kayunhoi (ed.), *National Defense Scientific Research Institute* (Kayunhoi, 2003), p. 139. (In Korean)

various kinds of oxidizers and metal powders like antimony.[68] They succeeded in several tests for the new method, after which their rocket project gathered steam. Group 2 developed a telemetry device to receive a flight signal and a guidance system to direct the rocket trajectory by controlling four delta fins.

Finally, on October 10, 1958, they successfully launched the first experimental rockets in a test firing near Inchon, some twenty miles west of Seoul. The launch was conducted behind closed doors, and six of seven rocket launches reportedly succeeded.[69] A weekly U.S. rocket magazine, *Missile and Rocket* on March 9, 1959, introduced NDSRI's first rocket test as an example of the "interest that rocketry and space technology has given rise to, with considerable activity in many other nations of the world."[70] On July 27, 1959, the NDSRI rocket team also made a public display of five rockets in Incheon. President Rhee, as well as Carter B. Magruder UN commander, and Defense Minister Kim Jeongryum attended with more than 20,000 citizens in Incheon.[71] The rocket team successfully launched three single-stage rockets, *005-ho, 006-ho*, and *007-ho* followed by a two-stage and three-stage rocket. The two-stage rocket named *67-ho* (4.65m in length, 22.9cm in radius) flew over 26km, rising to a maximum altitude of 9.5km, and the three-stage rocket named *556-ho* (3.17m in length, 16.7cm in radius) flew over 81km, rising to a maximum altitude of 4.2km. Reportedly, stage-separation of multistage rockets presented a grand sight as it could be seen by the naked eye, and made a deep impression on the government officials and citizens.

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68 Ibid.

69 "Domestic Rocket Success," *Dong-a Daily* (October 12, 1958). (in Korean)

70 William Miller, "World Rapidly Adding More Missile Ranges," *Missiles and Rockets* (March 9, 1958): 14–16.

71 "The First Korean 3-stage Rocket Launched," *Dong-a Daily* (July 28, 1959). (in Korean)

Encouraged by the successful rocket launch, President Rhee praised the rocket team adding that "if possible, we have to do it at all costs, even by selling land."[72]

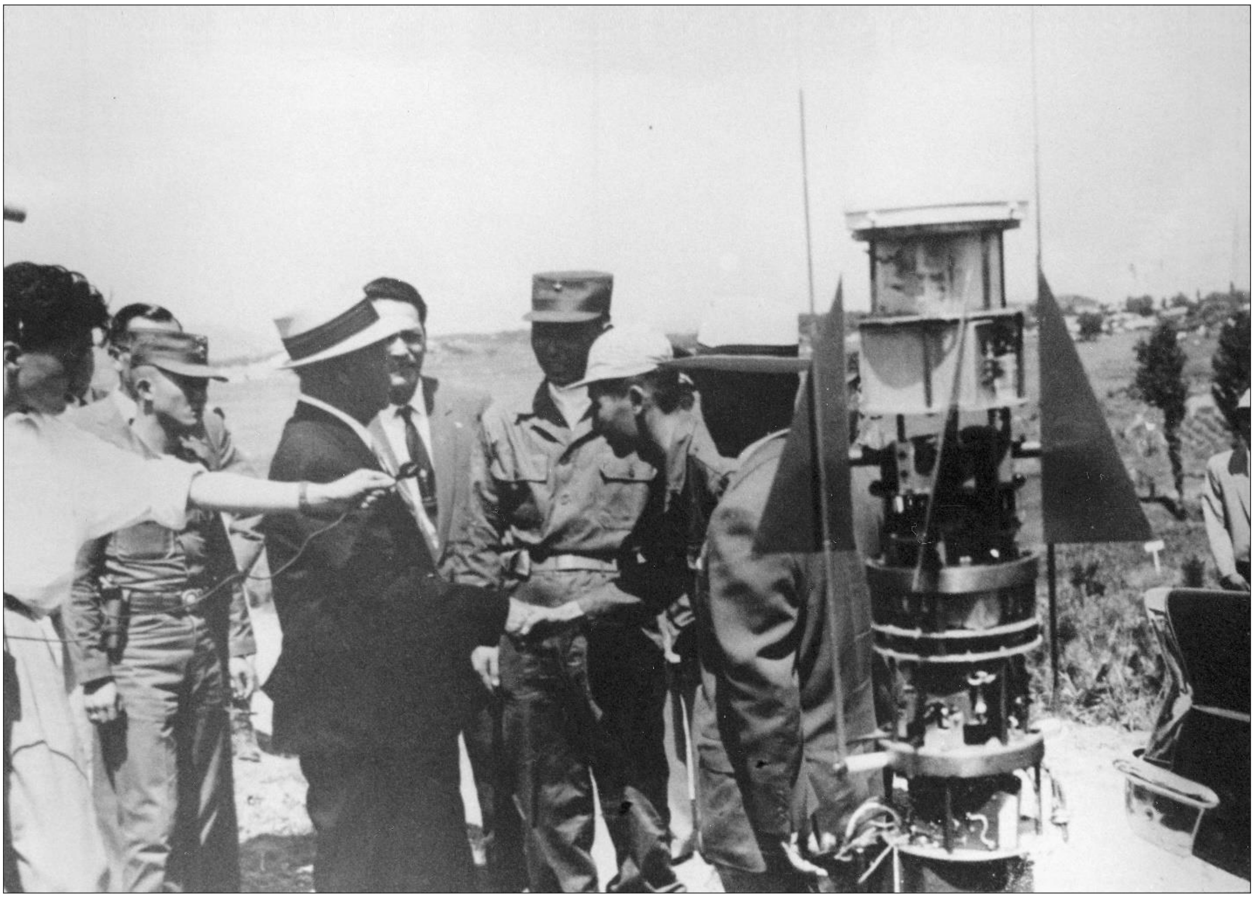

Figure 4: the President Rhee Syngman and the Guidance System of the *67-h*o two-stage Rocket (Source: National Archive of Korea)

[72] Han, "A Memoirs: A Story of the First Korean Rocket," p. 16; Jun Changduk, "Memoirs: Thought on NDSRI," in Kayunhoi (ed.), *National Defense Scientific Research Institute,* (Kayunhoi 2003): 137-138. (in Korean)

Table 1: Data of Rockets Launched by NDSRI in 1959 (Source: Photograph Album from Hong Jaehak private collection)

Missile Designation		005	006	007	067	566
Performance	Range	4.7km	7.5km	8.2km	26km	81km
	Altitude	2.2km	3.3km	3.6km	9.5km	42km
	Velocity	?	1,200km/h	1,310km/h	1,820km/h	3,620km/h
	Stability	Aerodynamic Stabilizing Fin				
Frame	Length	0.78m	1.75m	3.01m	4.65m	3.71m
	Diameter	5.6cm	16.7cm	16.7cm	22.9cm	16.7cm
	Span	?	49.1cm	76.7cm	160.6cm	76.7cm
	Weight	?	78kg	139.9kg	213kg	141kg
	Material	Steel			Steel, Duraluminum	
	Stage	1			2	3
Power Plant	Propellant	Solid				
	Thrust	?	1,770kg	3,540kg	1,770kg/ 3540kg	435kg/ 1,770kg/ 1,770kg
Guidance		Unguided			Guided	Unguided
Payload	Payload			Signal Transmitter	Altimeter Accelerometer Receiver Telemetering	Signal Transmitter
	Weight	?	13kg	26kg	14kg	1.2kg

After the public display, NDSRI set up a new research project to develop a guided rocket using domestically produced propellant. The government's support for the rocket team of NDSRI seemed to increase as the procurement of material and equipment went ahead without delay.[73] In the late 1959, they began research on a liquid-propellant rocket and presented their paper in the second International Symposium of Rocket and Aeronautics held in Tokyo, Japan in May 1960.[74]

NDSRI and the Diplomatic Relation with the U.S

The rocket fever in South Korea in the late 1950s, began to decrease rapidly with the political turmoil of the April Revolution in 1960, a popular uprising to overthrow President Rhee's autocratic state, followed by a military-led coup d'état in May 1961. Having been in office since 1948, President Rhee struggled to prolong his stay in power despite increasing domestic discontent with limited economic and social development and pervasive political corruption. Rhee had pushed through several constitutional amendments which made the presidency a life-long position and he became increasingly repressive as he amended the National Security Law to tighten government control over all levels of administration including the local units. On April 19, 1960, protests by students and citizens against the irregularities of the election on March 15, 1960 burst out in city of *Masan* and spread nationwide. Subsequent protests in the Seoul streets finally led Rhee to step down from power on April 26, which is called the April Revolution. As South Korea adopted a parliamentary system to remove power from the office of the president, the prime minister,

[73] Kim Chungu, "Memory of Rocket Research," in Kayunhoi ed., *National Defense Scientific Research Institute* 2003: 162. (in Korean)

[74] Fumio Tamaki et al. (eds.), *Rockets and Astronautics: Proceedings of the Second International Symposium held in Tokyo*, (International Symposium on Rockets and Astronautics, 1960).

Chang Myon, and his cabinet was sworn into office on August 23, 1960. However, the new government's efforts to implement effective reforms did not last long. Major General Park Chung Hee, who was then the Director General of Korea Army Operations, formed the Military Revolutionary Committee, and led a military coup on May 16, 1961.[75]

It was hardly possible for NDSRI to perform its mission properly in such political turmoil. The director of NDSRI, Jung Nakeun left and Brigadier General Lee Hongjong was appointed as his successor. After the resignation of President Rhee, all the research at NDSRI made slow progress without his ongoing support. When Park Chung Hee seized power rumors spread that NDSRI might be closed down having lost its reliable supporter.[76] To cope with the rumors, Lee Hongjong tried every possible means to promulgate and justify the existence of NDSRI; he distributed information booklets and launched a monthly popular journal, *Science and Technology*, to deliver the latest trends in science and technology in June 1961.

Notwithstanding many efforts to save the institution, the Minister of National Defense of the military government, Song Yochan, announced his plan to close down the NDSRI "in order to achieve budget reductions" on June 29, 1961.[77] Finally the institution which had been founded by presidential order was abolished by Cabinet order No. 47 of July 10, 1961. The abolition of the institution meant getting rid of everything that the institution had accomplished to date including administrative documents, manpower, and even research

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75 For a detailed process of the April Revolution and Park's coup, see Edward Mason, *The Economic and Social Modernization of the Republic of Korea* (Cambridge: Harvard University Asia Center, 1980)

76 Kayunhoi (ed.), *National Defense Scientific Research Institute* 2003, p. 35. (in Korean)

77 "Dismiss NDSRI to Simplify Organization," *Dong-a Daily* (June 29, 1961). (in Korean)

products. The direct reason why Park's government dismissed NDSRI remains unclear, because the abolition of the institution could not be fully justified simply on financial grounds. According to Han Mansub's reminiscence, there was a rumor that Jung Nakeun, the director of NDSRI, incurred the wrath of Song Yochan, the Army chief of Staff at that time, by making frequent visits to the President without Song's permission. Song then used his influence to close the NDSRI.[78] However, the rumor could not be corroborated; a more important reason seems to be related to the diplomatic relations between Park's government and the United States.

The primary purpose of Park's revolt was to "replace the corrupt and incapable Chang Myon government" which was sworn into office after the April Revolution. The principles of Military Revolutionary Council set forth were the following: [79]

1. The new regime would take a strong anti-Communist position in the operation of the country.
2. The new government would create stronger ties with the free world and the United States and would adhere to the peace-keeping efforts of the United Nations.
3. Steps would be taken to eliminate corruption and to establish new moral standards throughout the country.
4. Efforts would be made to eliminate starvation in the country and to create a new, self-reliant, national economy.

[78] Email interview with Han Mansub by author (April 19, 2013).

[79] Park Chung Hee, "What Has Made the Military Revolution Successful," *Koreana Quarterly*, Vol. III, No. 1, (1961): 18-19.

5. The people’s goals of Korean unification would be pursued by the regime under the banner of Korean nationalism.
6. The revolutionary government would be turned over to duly elected representatives of the people as soon as the tasks set forth above were accomplished.

Park’s national development program focused on reconstruction and the creation of an industrial base, in an environment characterized by external political threats from the North, as well as repression of dissent at home. He saw economic development and national security as inseparably linked, yet building a strong military required a strong industrial economy first. The South Korean economy was too small, too poor and too vulnerable to security threats to attract foreign capital, while the North had already surpassed its southern rival. Increasing anxiety even more, the North-South gap continued to widen throughout the 1960s, with Kim Il Sung’s successful completion of the Three-year Recovery Plan (1954-1956) and the first Five-Year Plan (1957-1961). To catch up with the North, in both economic and military capabilities, the Park government reorganized the state apparatus and began a series of five-year national economic plans in 1962 to jumpstart the economy.[80] Park visited Washington from 14 to 17 November, 1961 to enhance his prestige at home and assure continued large-scale American aid for the national economic plan.

[80] Joo-Hong Kim, “The Armed Forces,” in Byoung-kook Kim and Ezra Vogel (eds.), *The Park Chung Hee Era : The Transformation of South Korea* (Cambridge, Mass.; London: Harvard University Press, 2011): 168-199, p. 171.

At the beginning of the Kennedy administration, the U.S. made noteworthy changes in its foreign policy toward South Korea.[81] American interest in Korea's economic condition had been based on a belief that a stable, militarily strong, and pro-American government in Korea was essential to U.S. strategic interests. This change was characterized by the replacement of military-support grants with economic-development loans. The key points of the new proposals were to reduce military grants, to reduce the size of the South Korean army, and to increase economic development aid.[82] For military assistance, the U.S. sought to maintain Korea's reliance on the U.S. for armaments and for a major part of the Korean defense budget. Military assistance was provided primarily through the military assistance program (MAP), administered by the Department of Defense.

The MAP program consisted of grants which Korea could use to obtain military equipment and supplies services from the U.S. The Korean Government used MAP dollars to purchase "operations and maintenance" items, rather than investing in up-to-date equipment.[83] For example, in late 1965 Park invited Paul Benke of Colt Industries to suggest that the Korean Government would purchase a certain number of rifles from Colt if Colt, in return, would help build a rifle plant in Korea. However, Benke replied that Colt would be willing to sell the rifles but would not build the plant because Colt could supply the rifles

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[81] Park Tae-Gyun, "Change in U.S. Policy toward South Korea in the Early 1960s," *Korean Studies* 23, (1999): 94-120.

[82] "Presidential Task Force on Korea-Report to the National Security Council," (June 5, 1961): Papers of John F. Kennedy Presidential Papers, President's Office Files, Countries, Korea: Security, 1961-1963, John F. Kennedy Presidential Library and Museum, http://www.jfklibrary.org/Asset-Viewer/Archives/JFKPOF-121-004.aspx (accessed on October 18, 2015)

[83] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," October 31, 1978 (Washington D.C.: U.S. Government Publishing Office, 1978), p. 173.

from its own facilities in Hartford, Conn. Benke explained to the subcommittee that Colt's position had been supported by the Departments of State and of Defense.[84]

Supposedly, this policy also applied to NASA's international cooperation programs during the early 1960s. NASA was meant "to be an arm of American diplomacy." Since the Space Act of 1958, NASA played a major role in kick-starting and orienting incipient space programs in many friendly countries through the UN Committee on Space Research (COSPAR).[85] For example, NASA negotiated Memoranda of Understanding and initiated cooperative sounding rocket programs with 13 foreign countries. The foreign country supplied the launch crew and launch services, the site, and the experiment, and NASA supplied the rocket, knowhow, some instrumentation and so on.[86] Some of the countries just wanted to "do something in space" without sufficient background and preparation, such as India, New Zealand, and Pakistan. However, South Korea was never considered for cooperation, even though it had demonstrated its capability and interest in developing a rocket.

In this diplomatic context with the U.S., one can see that the political leaders of the military government could fear that NDSRI, which had done research on up-to-date weapons like guided rockets, would provide the U.S. government with a pretext for early suspension of military assistance to Korea. Also, the U.S. was concerned that the South Korean

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84 Ibid, p. 78.

85 John Krige, "NASA, Space Science, and Western Europe," in John Krige, Angelina Long and Ashok Maharaj, *NASA in the World: Fifty Years of International Collaboration in Space* (Palgrave Macmillan, 2013): 24-49.

86 William R. Corliss, *NASA Sounding Rockets, 1958-1968: A Historical Summary* (Washington D.C.; NASA SP-4401, 1971), Chapter 7.

Government would use an expanded military production capability to attack North Korea. Moreover, NDSRI was established and operated without consulting the Military Advisory Group to the Republic of Korea (KMAG), a United States military unit which had helped train and provide logistic support for the South Korea Army since the Korean War.[87] Thus, the Park government, which clearly wanted and needed the U.S.'s approval for the military government as well as its assistance, did not have a rationale to run an institute for research of up-to-date weapons such as NDSRI. They were determined to comply with the U.S. policy that would provide for consumable military items but not to build up basic levels of armaments or Korean defense industries.

Meanwhile, the economic development plan designed and carried out in 1962 was carried out successfully, with focused state investment and industrial discipline, and with the U.S. providing security and training to the South Korean military and police forces. In the early 1960s, economic assistance programs provided much of the support-96 percent for the Korean defense budget, 64 percent in 1966, and about 14 percent in 1971. When the First Five-Year Plan was completed in 1966, many goals had been exceeded. The annual GNP growth rate, which had been projected at 7.1 percent, was actually over 8 percent. Annual per capita income had risen from $96 to $131.[88]

The Rocket Team at the Inha Institute of Technology

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[87] Regarding KMAG's activities, see Robert Sawyer, *Military Advisors in Korea: KMAG in Peace and War* (Washington, D.C.: Center of Military History U.S Army, 1988).

[88] "Investigation of Korean-American Relations," p. 177.

The national rocket development project that had been pursued by NDSRI since the mid-1950s stopped with the abolition of the institute in 1961. Civilian interest and efforts in rocket development were seriously influenced by the abolition of NDSRI. The KAS and KSSS, which had led the popular rocket boom with NDSRI's huge support, canceled all the planned events including public lectures, symposiums, journals and magazines, and rocket development and demonstrations. These organizations finally fizzled out by 1962. Although newspapers and magazines carried news stories about space development focused on the space race between the U.S. and the Soviet Union, they no longer covered stories about amateur rocketeers through 1960s. It was the Inha Institute of Technology (IIT) that maintained its interest in rockets for the 1960s in South Korea.

IIT was almost the only civilian organization that had made an effort to develop rockets and launch them since the late 1950s. IIT had more interest in rockets than any other university probably because the founder of the institute was President Rhee. Since decolonization in 1945, the Ministry of Education had proceeded with relatively consistent educational policies for science and technology. In 1952, in the midst of the Korean War, Rhee proposed the foundation of an educational institute that would provide expertise and hope to a lagging industrial sector. The driving force behind the proposal was the will and determination of a group of Koreans who had immigrated to Hawaii in 1902.[89] Financial resources for the foundation came from a government subsidy ($1 million), the proceeds of the sale of the Korea Christian Institute, an organization founded and managed by Rhee for the purpose of educating the children of the original emigrants, and donations from Korean

[89] Regarding the first Korean immigrants to Hawaii, see Wayne Patterson, *The Korean Frontier in America: Immigration to Hawaii, 1896-1910* (University of Hawaii Press, 1988).

emigrants in Hawaii ($150,000). In April 1954, built in Incheon where the first immigrant had left, the Inha Institute of Technology took its name from the first two letters of 'Incheon' and 'Hawaii.'[90]

IIT started with six departments including mechanical, marine, electric, chemical, metallurgical, and mineral engineering, and four years later, in 1958, it established two new departments, nuclear and ordnance engineering. The decision was made by President Rhee[91] to reflect the increasing international interests in atomic energy and rockets in the late 1950s.[92] In "a statement of opinion on establishment of departments," Baek Sunyub, the Army Chief of Staff at that time, mentioned "Now that the achievements of modern science let us see artificial satellites orbiting, IIT's establishment of the nuclear and ordnance departments is an epoch-making event [that will help us] emerge from backwardness and contribute to national security and social development."[93]

Although the IIT's rocket team was a students' sub-organization of the ordnance department, they were supported and encouraged technically and financially by the university authorities as well as by the army. After the rocket team launched its first rockets, IITO-1A

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90 Rhee Syngman, "Commemorative Speech," in *40 Years of Inha:1954-1994* (Incheon: Inha University Press, 1994) (in Korean)

91 "… [the two departments] were established in obedience to President Rhee's instruction to focus on the nuclear and ordnance science…" *Inha Hankbo* (Feburary 2, 1958), Inha University Library (in Korean)

92 As a result of President Eisenhower's "Atoms for Peace" program, the United Nations in August 1955 conducted the first International Conference on Peaceful Uses of Atomic Energy in Geneva, Switzerland. With the participation in the conference as a momentum, Korean Atomic Energy Research Institute (KAERI) was established in 1959 as one of governmental bodies under the Ministry of Nuclear Energy. See *50 Years of KAERI: 1959-2009,* (KAERI, 2009).

93 *40 Years of Inha:1954-1994* (Incheon: Inha University Press, 1994), p. 113. (in Korean)

and IITO-2A, successfully on November 19, 1960, IIT was expected to become the center of civilian rocket development in South Korea. However, it could not escape the political turmoil of the April Revolution in 1960, because the founder was no less a person than President Rhee. Furthermore IIT did not have an independent foundation to finance it, although it had been established as a private institution; the members of the board of directors were mostly government officials appointed by President Rhee. A conflict between professors and a student council committee over the institute president's Choi Syngman's ability to remain in office crippled the smooth functioning of the institute.[94] It was not until the military coup in May 1961 that the conflict was settled by an administrative order for the resignation of the president and several professors.

The military government tightened controls on the whole society on the pretext of political reform. It abolished twelve out of thirty private universities in all parts of the country and merged similar departments in a university.[95] IIT was ordered to cancel two departments, ordnance and nuclear engineering, for reasons that remain obscure, by the Decree on Standards for the Redevelopment of Universities and Colleges on September 9, 1961.[96] As the ordnance engineering department closed, the rocket team, a sub-organization of it, seemed to be disbanded. IITO-B, their follow-up project of IITO-1A and 2A for producing a

94 Ibid, pp. 136-138.

95 "Act on Special Cases Concerning Education," (September 2, 1961), National Archive of Korea (BA0084271). (in Korean)

96 *40 Years of Inha:1954-1994*, pp. 145-149. (in Korean)

rocket using a self-developed asphalt propellant, was soon dropped in this troubled situation.[97]

All the same, the student members reorganized the team as a sub-organization of the student council committee and renamed it the Space Science Research Association (SSRA) in late 1961. Even though they could not expect any financial and technical support from the school authorities or the army anymore, SSRA launched an ambitious project to develop a three-stage rocket carrying an experimental rat and a camera for ground observation at their own expense after several fund-raising efforts.[98] They designed a new type of rocket using the self-developed asphalt propellant, and produced and launched several 40cm-long single stage rockets, IITRA-1 and 2, to test the stability of the new propellant and the flight vehicle by 1964. The first two-stage test rocket, IITA-3R, was launched on November 24, 1964 to test the parachute recovery of the second-stage carrying no payload.[99] However, due to a malfunction of the electric ignition system, the second stage rocket engine fired first even before the first stage rocket had fired. The second stage rocket was recovered by the parachute which opened at only a few tens of meters high.[100] Despite the strange record of "Failure in the stage rocket ignition, but success in the separation and recovery of the second

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[97] Choi Sanghyuk,"Rocket Launch and Plan," *Inha Gongdae Shinmun* (December 7, 1964) (in Korean)

[98] "SSRA, Shed Light on Development of Rocket Propellant," *Inha Gongdae Shinmun*, (November 16, 1962). (in Korean)

[99] "Soul of Inha Soared up to the Sky, IITA-3R Successful Launch," *Inha Gongdae Shinmun*, (November 2, 1964). (In Korean)

[100] "Interview: Park Kwangwoo, the Leader of SSRA," *Inha Gongdae Shinmun* (December 2, 1964). (in Korean)

stage rocket" in the first test, a week later the test was a complete success as the second stage rocket soared up to an altitude of 18km.[101]

Figure 5: IITA-7CR 3-stage Rocket Launched by IIT in 1964 (Source: Library of Inha University)

[101] "Editorial: A Significance of Rocket Launch," *Inha Gongdae Shinmun* (December 2, 1964).(in Korean)

Table 2: Rockets Produced by SSRA of IIT (Source: *Inha Gongdae Shinmun*)

Date	Rocket	Stage	Length (m)	Diameter (cm)	Weight (kg)	Velocity (m/s)	Altitude (km)	Purpose	Result
60.11.19	IITO-1A	1	2.2	12.5	54.0	300	?	Recovery of Telemetry Device	Destruction of Fins
60.11.19	IITO-2A	1	1.7	12.5	31.0	450	?	Flight Test	Disintegration in Midair
62.9.27	IITRA-1	1	0.4	4.4	0.5	200	1.2	Propellant Test	Break away of Nozzle
62.10.2	IITRA-2	1	0.4	5.0	0.8	220	1.4	Propellant Test	Steady Flight
64.6.10	IITA-1	1	0.3	4.4	0.7	180	1.4	Propellant Test	Steady Flight
64.7.20	IITA-2	1	0.4	5.0	1.0	220	1.8	Flight Test	Destruction of Fins
64.10.17	IITA-3	1	1.8	7.5	11.6	500	20	Flight Test	Steady Flight
64.11.24	IITA-3R	2	1.5	7.5	12.7	610	0.01	Separation & Recovery of 2nd Stage	1st Stage Ignition Fail
64.12.1	IITA-3R	2	1.5	7.5	12.7	610	18	Separation & Recovery of 2nd Stage	Steady Flight and Recovery
64.12.19	IITA-7CR	3	2.8	17.5	67.5	830	50	Recovery of a Camera	Steady Flight,, Recovery Fail

Choi Sanghyuk, the leader of SSRA at that time, and who became a researcher at NASA Langley Center later, appealed to the government for financial support through a newspaper column arguing that they had a technical capability to develop a guided weapon in five years, and even a sounding rocket, as well as a space launch vehicle to put a small satellite into low-orbit of the Earth by 1976.[102] Finally, on December 19, 1964, SSRA made a public display of a three stage rocket, IITA-7CR, at *Songdo* near *Incheon* as part of the celebrations for the 10th anniversary of the IIT. IITA-7CR (2.8m in length, 17.5 cm in diameter, and 67.5 kg in weight) was loaded with a camera in its nosecone to take about 30 photos of the Korean peninsula as it descended slowly by parachute from an altitude of 50km. In the presence of hundreds of students and citizens as well as VIPs of the school authorities, the rocket was successfully launched. The flight was smooth, but at touchdown the camera was blown far from the predicted target area due to unexpected strong winds in the upper atmosphere. The camera was not recovered.[103]

Although the launching display was enough to show off its technical capability and attract public attention, it was not easy to find a strong supporter. In 1965, the school authorities discussed the promotion of SSRA to a research institute directly responsible to the government, but this soon fizzled out. All their efforts to make SSRA a "Korean rocket development project"[104] were ignored by external supporters including the government, and they could not make progress in further research. In 1968, the SSRA was on the lookout for an opportunity to enter rocketry again and attempted to produce a new model of a rocket with a small amount of money that they gained from the school with some difficulty. This venture soon collapsed. The SSRA was disbanded after several test launches of small rockets in late

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102 Choi Sanghyuk, "Rocket Launch and Plan," *Inha Gongdae Shinmun* (December 7, 1964). (in Korean)

103 "10th Celebrations and Successful 3-stage Rocket," *Inha Gongdae Shinmun* (December 23, 1964). (in Korean)

104 Kim Hyuk, "On Developing a Rocket: Urgent Financial Problem," *Inha Gongdae Shinmun* (April 25, 1968). (in Korean)

1968 due to lack of funding. And “their dream to make IIT like Tokyo University,”[105] where Dr. Hideo Itokawa started his research on a pencil rocket in 1955 and became the father of Japanese space development, finally collapsed.[106]

Space exploration in Korea had to remain an unfulfilled alternative to the ‘aspiration’ to Western modernity in the late 1960s. A survey conducted by a newspaper when Neil Armstrong landed on the moon in 1969 showed people’s delight as well as their feeling of alienation.[107] Most newspapers articles were filled with a full description of the process of two astronauts landing on the moon and commentaries on humanity’s greatest achievement, but an article entitled “Our Aspirations are too great. Overwhelmed by reality, but we also someday…” expressed various ordinary people’s first impressions on the scene of humanity’s first moon landing. For example, Kim Sooyoung, a taxi driver in Seoul, said “I hope that I can drive a car developed and manufactured by our engineers in Seoul as soon as possible,” and Yang Jaehee, a housewife, replied to the questionnaire that “It sounds just like a chimerical story of a far-away land, as I am in a reality in which the water supply was cut off last night.” Also, the damage from a recent storm flood in the country was severe enough to highlight to the people the wide disparity in science and technology between rich and poor

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105 Ibid.

106 Regarding the Japanese efforts to space presence during 1960s, see Yasushi Sato, “A contested Gift of Power: American Assistance to Japan’s Space Launch Vehicle Technology, 1965-1975,” *Historia Scientarum* 11, no. 2 (November 2001); Ashok Maharaj, “An Oveview of NASA-Japan Relations from Pencil Rockets to the International Space Station,” in John Krige, Angelina Long and Ashok Maharaj, *NASA in the World: Fifty Years of International Collaboration in Space* (Palgrave Macmillan, 2013): 24-49..

107 “Our Aspirations are Too Far… Overwhelmed by Reality, but We Also Someday…,” *Kyunghyang Daily (*July 21, 1969). (in Korean)

countries. “We have to get a move on with modernization,” said Kang Wonho, a police officer, “as we are concerned about things like flood damage even in the space era.”

Conclusion

The Sputnik shock of 1957 directly affected the space aspirations of the people in one of the poorest counties at the time, South Korea. It provided not only motivation for political leaders to develop guided weapons for national security but also inspiration for ordinary people to emerge from backwardness by being made aware of up-to-date technology. The rocket development team was established in the NDSRI under the President Rhee’s strong support in 1956, and the team launched its first modern rocket successfully in 1958. As public interest in space science increased, some amateur rocket clubs and scholarly associations, such as the KAS and the KSSSS, encouraged a boom of interest in space science by promoting the idea that “we can do it.”

However, the revolution changed everything. NDSRI entered a crisis after Rhee’s resignation by the April Revolution in 1960, and Park Chung Hee, who seized power through a military coup in 1961, dismissed NDSRI in order to secure the U.S.’s approval and continued assistance by resonating with Kennedy’s changed foreign policy toward South Korea which would provide for consumable military items rather than investing in up-to-date equipment. After NDSRI was shut down, no further work on national missile development took place for a decade in South Korea. Also, despite of some amateur rocket men’s enthusiasm for rockets and the public’s high nationalistic interest in their projects, their aspirations did not provide substantive fruition for a massive social movement or lead to a national space policy. The KAS and KSSS which had led the popular rocket boom under NDSRI's huge support fizzled out, and the Inha University rocket team which managed to keep their rocket research was also disbanded due to lack of funding after producing several rockets by late 1960s.

Yet, in the late 1960s, a chain of events that created the impression that the United States was weak-kneed in dealing with South Korea's security made Park doubt the reliability of U.S. military support to South Korea. These concerns for South Korea's security caused Park to initiate a surface-to-surface missile program and to establish the Agency for Defense Development (ADD) to pursue modernization programs for South Korea's armed forces. In the next chapter, I will describe how the ADD successfully developed the surface-to-surface missile, NHK-1, also known as *Paekkom*, in 1978 which consequently established Korea's industrial and technical base for space development in the 1980s.

CHAPTER 3

A Korean Rocket for Self-reliance 1970-1984

Many researchers of the Korean space program take the early 1990s as its starting point when South Korea launched its first national satellite Wooribyul-1.[108] However, the decade of the 1970s is critical to the understanding of the early history of the space program. It is then that South Korea established a strong infrastructure for future space programs by successfully developing the first surface-to-surface guided missile. The South Korean defense industry was accorded a "unique importance as symbol of modernization," and it exerted a "dominating influence in setting overall scientific and technical priorities."[109]

In the late 1960s Park Chung Hee, president of South Korea, came to doubt the reliability of U.S. military support to South Korea. These concerns for the security of South Korea caused Park to initiate nuclear weapons and surface-to-surface missile programs and to establish the Agency for Defense Development (ADD) in 1970 to modernize the armed forces. The pursuit of nuclear weapons was suspended in the mid-1970s, though the ADD successfully developed the surface-to-surface guided missile, K-1 (*Paekkom* or *Baekkom*; white bear), a modification of the U. S.-produced Nike Hercules missile in 1978. However, in

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[108] Brian Harvey, Emerging Space Powers the New Space Programs of Asia, the Middle East and South America (London; Chichester: Springer; Praxis, 2009); Chin Young Hwang, "Space Activities in Korea—History, Current Programs and Future Plans." Space Policy 22, no. 3 (August 2006): 194–199; KARI, 2006 White Paper of Space Development (MOST, 2007) (in Korean)

[109] Janne Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (the Brookings Institution, 1991), p. 17

1979 South Korea had to sign a Memorandum of Understanding with the U.S. to limit the missile range to 180km as a precondition of purchasing U.S. missile technology. Meanwhile, Chun Doohwan, who seized power through a military coup in 1980 after Park's death, curbed the missile programs by downsizing the ADD. These series of events weakened South Korea's capability to produce ballistic missiles without outside assistance.

A major issue in the development of Korea's capability to support its defense in 1970s was Korean-American diplomatic relations. Overall, the U.S. approached the matter with caution, opposing the development of advanced defense weapons such as nuclear weapons and guided missiles. The Korean government, by contrast, was strongly committed to the rapid expansion of defense production independent of and sometimes in conflict with U.S. interests and policy. Through the efforts to develop a guided missile in the 1970s, South Korea created the infrastructure and trained skilled workers in the ways of modern industrial production, and subsequently used them as a means of promoting a space program, including the Korean Sounding Rocket (KSR) and the Korean Space Launch Vehicle (KSLV) Program from the 1990s onwards.

This chapter traces how and why South Korea succeeded in developing the missile while it suspended efforts in developing nuclear weapons in the 1970s. The focus will be on U.S. policy towards Korean "self-reliance" and Korean efforts to diversify its sources of supply and to acquire its own defense plants and production capabilities for the missile.

Increasing Threats from the North and the Nixon Doctrine

During the early 1960s, the U.S. discouraged the growth of a full range of Korean defense industries, urging production of consumable military items rather than up-to-date military hardware. Park Chung Hee, who had seized power in 1961, wanted to secure the U.S.'s approval and continued assistance by cooperating with the U.S.'s policy toward South Korea. (Chapter 1) However, in the late 1960s, the Park administration was determined to pursue military self-sufficiency, in some instance assessing its own needs independently of the U.S.

Park's drive to reduce military dependence on the U. S. was a combination of historical trends and events.[110] The most potent reason for the change of Park's view on Korea's military capability was the so called "the second Korean War" i.e. the increasing threat from North Korea in the late 1960s.[111] In 1966, North Korea determined that a peaceful reunification of the Korean peninsula could not be attained without active guerrilla action in South Korea. Kim Il Sung announced the abandonment of the policy of seeking to unify Korea by peaceful means and the adoption of a new, more militant policy toward South Korea.[112] The peak of North Korea's hostility was reached on January 21, 1968, when a group of 31 North Korean commandos attempted a daring raid on the Blue House in Seoul to

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110 Peter Hayes, Chung-in Moon, and Scott Bruce, "Park Chung Hee, the US-ROK Strategic Relationship, and the Bomb," *The Asia-Pacific Journal: Japan Focus* 9:44, No. 6. (October 31, 2011). http://japanfocus.org/-scott-bruce/3630 (last accessed on October 18, 2015).

111 Daniel Bolger, *Scenes from an Unfinished War: Low-Intensity Conflict in Korea, 1966-1969*, Leavenworth Papers #19 (Combat Studies Institute, 1991). Available online at: http://usacac.army.mil/cac2/cgsc/carl/resources/csi/Bolger/bolger.asp (last accessed on October 18, 2015); Also see Mitchell Lerner, "'Mostly Propaganda in Nature': Kim Il Sung, the Juche Ideology, and the Second Korean War," *North Korea International Documentation Project Working Paper #3* (Washington D.C.: Woodrow Wilson International Center for Scholars, December 2010)

112 Andrew Scobell and John M. Sanford, *North Korea's Military Threat: Pyongyang's Conventional Forces, Weapons of Mass Destruction, and Ballistic Missiles*, Strategic Studies Institute Monograph (Carlisle, PA: U.S. Army War, 2007), p. 31.

assassinate Park. The team was divided into six groups, each having a specific mission within the Blue House. Although none of them reached the Blue House, they managed to cross the 38th parallel, infiltrate the city, and approach within a kilometer of the destination. In the ensuing gunfight and subsequent search for the commandos, all but three commandos were killed, along with 2 American and 26 ROK soldiers. Two of the three North Koreans escaped and the other one was captured and interrogated. The captured commando, Kim Shin Jo, said at a press conference that the objective of the mission had been "to get the head of Park and kill important subordinates."[113] It was the first raid on Seoul since the Korean War. The raid came as a great shock to the Korean Government and people and seriously affected confidence in their security and anti-infiltration capability. The Korean Government wanted to respond with force, and President Park told U. S. Ambassador William Porter that "Korean Forces could be in Pyongyang in 2 days' time" at a meeting immediately after the raid.[114]

However, two days later, on January 23 in 1968, before the U.S. had time to decide exactly how to respond to the Blue House raid, the intelligence ship U.S.S. Pueblo and its crew were captured by North Korea. The U.S.S. Pueblo was one of America's electronic intelligence ships with a nine-hundred-ton hull equipped with highly sophisticated instruments to collect electromagnetic intelligence information along the east coast of North Korea. North Korea claimed that the ship had intruded into its territorial waters, and they towed it into Wonsan port along with its crew of 82 men. President Park felt that resolute action was required to insure stability of South Korea in the face of these provocations. He

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[113] "North Korea Says Kim Was to Assassinate Park," *The New York Times* (January 23, 1969).

[114] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," October 31, 1978 (Washington D.C.: U.S. Government Publishing Office, 1978), p. 55.

urged the U.S. to retaliate with preemptive air strikes against the North. However, the Johnson administration responded by seeking to de-escalate the crisis. The objective of U.S. policy was "to prevent further escalation of tension, to de-escalate if possible, and to ensure the ROK troops do not violate Armistice Agreement."[115]

At the beginning of the incident, Johnson tried to threaten North Korea. The U.S. released the vessel and crew by alerting about 1,500 air force and navy reserves and dispatching the nuclear-powered aircraft carrier, Enterprise, to the East Sea. However, he finally decided to rely on a campaign of diplomacy, including using whatever influence the Soviet Union would bring to bear on North Korea. The U.S. negotiated directly with North Korea at *Panmunjom*, and eventually succeeded in their goals.[116] Korean political leaders were already highly indignant that the Pueblo incident quickly overshadowed the Blue House raid and that the U.S. government was more concerned about the Pueblo incident than the raid. The U.S.' negotiations with North Korea were viewed by the Korean Government as tending to isolate South Korea further in its international relations.

Until late in 1968, North Korea's activities had continued unabated and so did South Korea's disappointment in the U.S. government. On the night of October 30, 1968, 120 men of Unit 124 landed on the coast between *Ulchin* - *Samcheok* in *Gangwon* province and moved inland on a 30-day mission to create guerilla bases in the *Taebaek* Mountains. It took several

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[115] "Telegram from the Commanding General" (November 10, 1966), Foreign Relations of the United States (FRUS) 1964-1968 Volume XXIX, Part 1, Korea, Document 99, Office of the Historian, Bureau of Public Affairs, United States Department of State. Available online https://history.state.gov/historicaldocuments/frus1964-68v29p1/d99#fn1 (accessed on October 18, 2015)

[116] Robert R. Simmons, *The Pueblo, EC-121, and Mayaguez Incidents: Some Continuities and Changes*, (Washington: University of Maryland Press, 1978), pp. 2-20.

weeks for U.S. and South Korea forces to capture or kill the infiltrators; 110 North Koreans had been killed and 7 captured, for the loss of 40 regular army, police and militia and 23 civilians. Nevertheless, there was no further U.S. response to the North.

Despite the change of the U.S. Government in 1969, to the South Koreans, the U.S. seemed to fail to respond forcefully to Communist aggression in Korea. Early in the Nixon administration, there was another incident between the U.S. and North Korea. On April 14, 1969, a naval intelligence plane, an EC-121 operating out of Japan, was shot down by North Korea over the East Sea (Sea of Japan), and the 31 members of the crew were killed.[117] The mission of the EC-121 was reported as being routine and was conducted far from North Korean territorial waters, leading the National Security Council (NSC) to seriously consider retaliation. However, President Nixon chose to avoid the risk of opening a second front and antagonizing the Soviet Union and China.

By May 1969, the level of intensity of the conflict had been reduced substantially, yet Park's anxiety over security was increased due to Nixon's new foreign policy.[118] At an informal press conference on Guam in July 1969, Nixon stated that "the United States would assist in the defense and developments of allies and friends," but would not "undertake all the defense of the free nations of the world."[119] This so-called 'Nixon doctrine' sought to

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[117] Ibid.

[118] Seunggi Paik, *US-Korean Security Relations since 1945*, (Seoul Press, 1998); Also see Lyong Choi, The Foreign Policy of Park Chunghee: 1968-1979, Ph.D. Dissertation (The London School of Economics and Political Science, 2012).

[119] "U.S. Foreign Policy for the 1970s: A New Strategy for Peace," (February 18, 1970) Foreign Relations of the United States (FRUS) 1969-1976 Volume I, Foundations of Foreign Policy, 1969-1972, Document 60, Office of the Historian, Bureau of Public Affairs, United States Department of State. Available online: https://history.state.gov/historicaldocuments/frus1969-76v01/d60 (last accessed on October 18, 2015)

rebalance U.S. policy by subordinating other concerns to the waging of the Vietnam War, establishing a new policy to reduce the commitment of ground troops in Asia, and reevaluating relations with the People's Republic of China. The new policy contained three main propositions:[120]

1. The United States would honor its treaty commitments.
2. The United States would provide a shield if a nuclear power threatened the freedom of certain nations.
3. In cases of other types of aggression, the United States would furnish military and economic assistance when requested and appropriate, but nations directly threatened should assume primary responsibility for their own defense.

The decision was related directly to efforts to disengage from Vietnam "without appearing to retreat" as the U.S. had to be able to say that the Nixon doctrine applied to all of Asia. The doctrine was applied to Middle Eastern regions as well as Asian countries such as the Philippines, Thailand, Vietnam, and others which might be threatened by Communist aggression. South Korean leaders were confident that their contribution in Vietnam and the historical ties with the U.S. would serve to exempt their country from the new policy. However, Nixon was to make South Korea the principal example of implementation of the

[120] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 59.

Nixon doctrine. He was to apply the Nixon doctrine in South Korea by withdrawing 20,000 troops.[121]

Korea's Response to the Nixon Doctrine

President Park aggressively opposed the American drawdown, insisting that the U.S. reduction should be small, and that any military realignment should be accompanied by a sharp rise in U.S. military assistance to South Korea. The troop reduction was a significant issue which might weaken him at the 1971 election. In response to Park's reaction, Nixon invited Park to San Francisco for a state visit, August 21-23, 1969. At the meeting with Nixon, Park argued; [122]

> Kim [Il-sung] will provoke a war if he believes that this American policy toward the ROK is going to change or has changed. Kim's objective in making various provocations is to have American troops stationed in the ROK withdraw as they have done in South Vietnam, alienate the ROK from the U.S. and have the U.S. not intervene when anything happens in Korea. The strengthening of ROK defense would check these provocations of Kim and have him give up the idea of invading the South by force. A way to achieve this objective is to strengthen the equipment and combat capability of the ROK forces rather than to strengthen U.S. forces in South Korea, to the extent that the ROK can single-handedly resist North Korean invasion, since the U.S. has various commitments all over the world.

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[121] Ibid, p. 62.

[122] "Memorandum of Conversation: Talks between President Nixon and President Pak," August 21, 1969, FRUS, 1969-1976, Volume XIX, Part 1, Korea, 1969-1972, Document 35. Office of the Historian, Bureau of Public Affairs, United States Department of State. Available online: https://history.state.gov/historicaldocuments/frus1969-76v19p1/d35 (last accessed on October 18, 2015)

To reassure him that the U.S. would not turn its back on Korea and would be responsive to its security needs, President Nixon decided to provide funding for a 5-year plan to modernize the ROK armed Forces in March 1970 pursuant to recommendations by the NSC. The administration would submit a proposal Congress for the modernization program including military assistance at a level of $200 million per year. This comprised either a MAP grant of $200 million per year or its equivalent in MAP funds at a lower level supplemented by equipment and other supplies in excess of U.S. needs between fiscal years 1971 and 1975.[123]

The U.S. Government expected Park to understand the terms of troop reduction and were reasonably pleased with the assurance of the 5-year military modernization package. However the Korean leader was still dissatisfied. While U.S. had decided that troop reduction and ROK armed Forces modernization should be initiated simultaneously, Park insisted that the military modernization should be prior to troop reduction. Indeed, there was no guarantee that the Congress would actually vote the funds needed to implement the modernization program in time, considering the program as being different from the normal annual security appropriation. On April 9, 1970, Senator Joseph Tydings criticized the Nixon administration for failing to apply the Nixon doctrine quickly to Korea arguing that "South Korea possesses the military manpower and resources to handle any invasion threat North Korea could pose in the foreseeable future."[124] The advocates in the Congress argued further that the South

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[123] This decision was officially designated by "U.S. Programs in Korea," National Security Decision Memorandum 48 (Washington D.C.,: National Security Council, March 20, 1970) Available online: http://fas.org/irp/offdocs/nsdm-nixon/nsdm-48.pdf (last accessed on October 18, 2015)

[124] Senator Tydings, Remarks on "Implementing the Guam Doctrine: The Case for Withdrawing U.S. Troops from Korea," Congressional Record, (April 9, 1970), pp. S5514-S5517 quoted by

Korean economy was strong enough to protect itself without any ground troop support from the U.S.

When vice President Spiro Agnew went to Seoul for direct talks with Park on August 26, 1970, he kept emphasizing that although the President made foreign policy, it was the role of Congress to decide on appropriations. At the meeting, planned to last about an hour, but that went on for almost 6 hours without breaks, Agnew told Park that "all American troops would be withdrawn from South Korea when that country's armed forces were fully modernized perhaps in five years or more."[125] Agnew emphasized that Nixon would be unable to guarantee the modernization program because "Congress holds the purse-strings and that no money can be allocated without its support or acquiescence."[126] On August 29, 1970, immediately after Agnew's visit, Korean newspapers reported that the Pentagon had announced that the U.S. had already reduced the 63,000 person-ceiling by 10,000.

Korean concern peaked after Agnew's visit. While the Nixon administration considered the military modernization program essential for the military self-sufficiency of South Korea, Congress viewed the program as part of the annual security assistance legislation. An additional problem for Korea was that they believed that the program would be predicated on grant assistance, but the Congress changed the nature of military assistance to all countries from direct grants to direct sales of military equipment, with credit

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"Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 64.

[125] *New York Times* (August 27, 1970).

[126] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 67.

arrangements to be provided through Foreign Military Credit Sales (FMS) as necessary.[127] The modernization plan was presented to Congress in the fall of 1970 as a $150 million supplemental appropriation to the Security Assistance Act of that year. In December, the Congress approved a large loan for the construction of an M-16 rifle factory in Korea as the first step in the modernization program.

Military Assistance to Korea

On February 6 1971, the U.S. and South Korea reached the agreements and announced the matter of U.S. troop withdrawal and the modernization plan for the South Korean Armed Forces.[128] The U.S. agreed to provide a package of $1.5 billion in military aid to South Korea over a five-year period. On 10 March, 1971 the 7th Infantry Division began to withdraw from South Korea. The 2nd Infantry Division gave back its 18.5 miles of Demilitarized Zone (DMZ) to the South Korean Army and took responsibility for the 7th Infantry's positions between Seoul and the DMZ. The South Korean Army defended the entire 155 mile DMZ for the first time. In return, Nixon enhanced the U.S. Air Force in South

[127] The terms of credit provide that "the borrower shall pay the U.S. Government's cost of borrowing, with a one-time charge of one quarter of one percent. The repayment period shall not exceed the useful life of the item; the repayment period is typically 4 to 8 years, but may not exceed 12 years. Payments are mad semi-annually." U.S. Department of Defense, *Military Assistance and Sales Manual,* 5105. 38-M. (Washington: Government Printing Office, 1 August 1978) p. E-5. Available online: http://www.samm.dsca.mil/sites/default/files/1978%20MASM/1978-08-01%20-%20MASM.pdf (last accessed on October 18, 2015)

[128] House Committee on International Relations, *Human Rights in Korea and the Philippines: Implications for U.S. Policy: Hearings* (Washington, DC: U.S. Government Printing Office, 1975), p. 41; From 1971 to 1978, the U.S. supported Korean production of high-speed coastal patrol and interdiction craft, model 500 helicopters, conversion of M-48 tanks, M-60 machineguns, and the M-16. "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 78.

Korea with an additional F-4 squadron from Japan. On March 27, 1971, the reduction of 20,000 troops was completed.[129]

Park's fear, however, grew over the next few years as he perceived the assistance level to be diminishing. The military assistance decreased from $291 million in 1971 to $149 million in 1973. (Table 3) However, as South Korea began to purchase military equipment under FMS programs in 1971, the U.S. began to reduce its grant in aid for operations and maintenance. Increasing military sales replaced the military aid program, and became the new trend in U.S. policy. The change from a military assistance program to military sales to South Korea was rapid and a large amount of arms were delivered to South Korea under FMS.

Congressional opposition to dictatorial government in South Korea also increased Park's insecurity. The Nixon administration initiated a dramatic transformation in the policy of containment and isolation of China; Henry Kissinger, Nixon's assistant for national security affairs, secretly visited Peking. Nixon himself visited China in February 1972. South and North Korea expressed a willingness to have direct talks with each other, in response to the change in the international situation. After the first meeting between two Koreas in July 1972, Park announced that South Korea needed a new constitution in order to strengthen its negotiating position. On October 17, 1972, he restructured the Government and imposed the *Yushin* Constitution, which virtually guaranteed him lifetime Presidency and restricted the civil rights of Korean citizens.

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[129] Myung Ryul Bae, *Security Assistance to South Korea: Assessment of Political, Military, and Economic Issues from 1947 to 1989*, Master thesis (Air University Air Force Institute of Technology, June 1998), p. 42.

Table 3: Security Assistance for Fiscal Years 1971-1977 to the ROK (Source: "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 70

SECURITY ASSISTANCE FOR FISCAL YEARS 1971–77 TO THE REPUBLIC OF KOREA

[In millions of dollars]

	Military assistance program—grant assistance		Foreign military sales—sales on credit terms		Excess defense articles—grants of equipment	
	Requested [1]	Actual [1]	Requested	Actual	Requested	Actual
iscal year:						
1971	290.8	291.2	10.0	15.0	....	137.7
1972	239.4	155.5	15.0	17.0	40.0	227.8
1973	215.7	149.6	25.0	24.2	33.6	29.7
1974	263.7	94.1	25.0	56.7	43.0	17.7
1975	161.5	82.6	52.0	59.0	20.8	3.1
1976	76.7	62.4	126.0	126.0	25.0	.2
Transition quarter [2]	1.9	1.5	1.5	134.1	....	....
1977	11.0	2.6	275.0	152.4	....	....

[1] As requested by the administration; actual amounts provided to the ROK.
[2] In fiscal year 1976, the end of the fiscal year was changed from June 30 to Sept. 30. The second set of figures refers to the ransition quarter running from July 1, 1977, to Sept. 30, 1977.
Source: Library of Congress.

When President Ford started his term of office after Nixon's resignation in 1974, the Congress became actively concerned about U.S. involvement in the international arms trade and U.S. arms transfer. Congress passed the Foreign Assistance Act of 1974, which linked the human rights issue to military assistance levels. This led to "the most serious cut in the Korean modernization program because of Park's worsening record on human rights."[130] As a result, the Congress did not fulfill the administration's modernization commitment until 1977, two years after the scheduled completion date. In response to Congressional legislation,

[130] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 70.

the Park government attempted to persuade the U.S. government and Congress not to withdraw U.S. troops and at least to provide South Korea with a massive military assistance and security commitment through intensive lobbying, cash campaign contributions, cash pay-offs, and trips to South Korea. This developed into a big political issue between the two countries, popularly known as "Koreagate."[131]

Military Modernization for Self-Reliance

Although the U.S. in this instance pledged compensatory assistance to modernize ROK forces after troop withdrawal in the early 1970s, Park's security concerns and discontent on the budget cut made by Congress led him to strengthen Korea's own defense capabilities. In the early 1970s, South Korea had only one division of unguided, Honest John missiles, and planned to build a factory in *Yangsan*, South *Gyeongsang* Province, for manufacturing the M-16 rifle with the support of the U.S. Realizing the weakness of South Korea's defense capability, Park began to emphasize the principle of "self-defense" and then "self-reliance" with an eye to reducing dependence on what, he thought, was an unreliable superpower ally.[132] In 1970, President Park claimed in his New Year's addresses that; "During the 1970s, we should actively seek to achieve reunification of our country by peaceful or non-peaceful means, and secure a potent defense-power superior to the North so

[131] For a survey of the Koreagate see Chae-Jin Lee, *A Troubled Peace: U.S. Policy and the Two Koreas*, (Johns Hopkins University Press, 2006), pp.95-102.

[132] Sung Gul Hong, "The Search for Deterrence: Park's Nuclear Option," in Byoung-kook Kim and Ezra Vogel (eds.), *The Park Chung Hee Era: The Transformation of South Korea* (Cambridge, Mass.; London: Harvard University Press, 2011): 483-512, p. 487.

that we can defeat their sudden attacks instantly with our strength alone. This is the spirit of self-reliance, I always speak about."[133]

Park had already emphasized "self-reliance" as a key political slogan for economic modernization in the early 1960s. However, the slogan, for now, was promoted as a national slogan in the name of defense. This led Park down two main paths: the modernization of Korea's conventional arms inventory and the preliminary consideration of nuclear weapons and guided missile options. Planning for force modernization began in 1970 when he ordered a unilateral review of the earlier plan and an accelerated timetable for defense industry expansion. He hoped that this revised force improvement plan, to be completed in 1980, would enable South Korea to meet an attack with only logistic and air support from the U.S. Later Park's resolution to continue the expansion of defense budgets and aggressive procurement policies led to three government decrees in the mid-1970s; a 1973 Law on the Defense Industry, a 1974 Force Improvement Plan for the buildup of Korea's armed forces (the First *Yulgok* Project), and the 1975 Defense Tax Law that was designed to finance the development of the defense industry.[134]

Before he declared to launch a full scale development of heavy and chemical industry to support the weapons development program in January 1973, the Korean Government established two defense agencies to mobilize all scientific resources in the military, industry

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[133] Park Chung Hee, "New Year's Address" (January 1, 1970), Presidential Archive of Korea. (in Korean) http://15cwd.pa.go.kr/korean/data/expresident/pjh/speech13.html (last accessed on October 18, 2015)

[134] Hee-Jung Moon, "The Diamond Approach to the Competitiveness of Korea's Defense Industry: From the Park, Chung Hee to Lee, Myung Bak Era," *Journal of International Business and Economy* 11(2) (2010): 69-111, p.77.

and academia for weapons development in 1970; The Agency for Defense Development (ADD) and the Weapons Exploitation Committee (WEC). The ADD was established on August 6, 1970 to conduct military research and the development of weapons, weapons systems, equipment, and material for the Korean military and assistance in the development of technology in the area of defense industries. The WEC was established on August 16 as an ad hoc governmental committee designed for the covert development of modern weapons to bolster South Korea's defenses. Oh Won Chul, Second Secretary for Economic Affairs, and other high ranking Blue House officials were among the participants.[135]

The Efforts for Nuclear Weapons

Meanwhile, Park began to consider the nuclear and missile option as a deterrent as well as a political tool. Although the U.S. continued to deploy 600-700 tactical nuclear weapons in South Korea,[136] Park feared that these tactical nuclear weapons might be removed with the troop withdrawal. In the early 1970s, he started pursuing a nuclear weapons capability and the development of medium range surface-to-surface missiles. According to a memoir of Kim Kwangmo, a chief secretary for Oh Won Chol, a newly appointed member of the Blue House senior staff in charge of developing defense-related heavy and chemical industries, Park used to say to Oh: "The security of South Korea is decreasing due to the troop withdrawal. I am feeling that we are so easily swayed by the U.S. They hold us so

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[135] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 79.

[136] Peter Hayes, "The Republic of Korea and the Nuclear Issue," in Andrew Mack (ed.), *Asian Flashpoint: Security and the Korean Peninsula* (Canberra, Australia: Allen & Unwin, 1993), p.52.

cheap. Is there anything that can make a weak nation talk big?"[137] He wanted to acquire the technology and capability to possess nuclear weapons just like Japan and European countries, rather than the completed nuclear weapons.[138]

Park and his high-ranking staff believed that developing nuclear weapons seemed feasible, because their country already began its nuclear research in 1954 with the help of the 'Atoms for Peace' movement promoted by the U.S. South Korea formally initiated nuclear activities when it became a member of the International Atomic Energy Agency in 1957.[139] The Atomic Energy Law was passed in 1958, and the Office of Atomic Energy was established by the government in 1959. The first nuclear reactor, TRIGA-Mark II provided by U.S. firms General Atomics and General Dynamics started its operation in March 1962.[140] This reactor could not be used for peaceful scientific research and creating radioisotopes for medical and agricultural purposes. During the 1960s, South Korea made continuous progress in nuclear energy, and access to this technology raised hopes for the future acquisition of civilian nuclear power.

From late 1960s, nuclear energy was believed to be the most promising means to reduce its heavy dependence on imported energy sources, especially oil, which accounted for

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[137] Special Report Team of Joongang Daily, *SIlrock Park Jung Hee*, (Seoul: Joong-ang M&B, 1998), pp. 260-261. (in Korean)

[138] Oh Won-chol, "Bloody Fight between Park and Carter," *Shindonga* (November 1994), p. 426. (in Korean)

[139] John DiMoia, "Atoms for Sale? Cold War Institution-Building and the South Korean Atomic Energy Project, 1945–1965," *Technology and Culture* 51:3 (July 2010): 589-618.

[140] On 30 December 1995, the TRIGA-Mark II was shut down, and in 1997 KAERI began a four-stage project for decommissioning. "Nuclear Reactors are Retired /Decided to Preserve 'TRIGA Mark II,' and to Dismantle 'Mark III'," *Dong-a Daily* (January 10, 1995).

about 60% of Korea's energy consumption. Energy demand was likely to continue to grow about 10% annually in line with Korea's rapid economic growth, resulting in some modest reduction in its relative dependence on imported energy supplies. This led South Korea to initiate one of the developing world's most ambitious nuclear energy plans.[141] In 1968, the government conducted the feasibility study for its first commercial nuclear power plant, *Kori-1*.[142] Fifteen nuclear power plants were to be constructed by 1991, providing 44% of the country's electricity-generating capacity.

The scope of South Korea's nuclear ambitions, however, soon changed to encompass the acquisition of nuclear weapons. Park's nuclear advisers in the WEC decided to proceed with the development of nuclear weapons.[143] They were aware that it was a major issue to acquire a reprocessing plant to manufacture plutonium from irradiated uranium fuel, which could be produced in a civilian power plant. Although most of South Korea's civil nuclear power program was based on American equipment and technology, the U.S. would put pressure on the Koreans to end their nuclear work for seeking to stabilize the always tense Korean peninsula. Thus, South Korea steered clear of the U.S. in seeking reprocessing equipment and technology. From 1972, it led the Korea Atomic Energy Research Institute (KAERI) to put top priority on the acquisition of a reprocessing capability and directed the

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141 Buhm Soon Park, "Technonationalism, Technology Gaps, and the Nuclear Bureaucracy in Korea, 1955-1973," in eds. Youngsoo Bae and Buhm Soon Park (eds.), Bridging the Technology Gap: Historical Perspectives on Modern Asia (Seoul: Seoul National University Press, 2013): 153-197.

142 South Korea broke ground in 1971 for a 500-megawatt electric nuclear power plant Kori-1, and finally opened it up in July 1978. 40 Years *of KAERI*, (KAERI, 1990). (in Korean)

143 "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 80

ADD to acquire the technology for nuclear weapons and missile design.[144] It began negotiations to purchase a NRX-type heavy-water research reactor from Canada, a small reprocessing facility from France, and a research lab for mixed-oxide nuclear fuel fabrication from Belgium.[145] These facilities were an integral part of the institute's long-term plan for nuclear power development, as well as a necessary component of a covert program within the military to develop a nuclear weapons capability.

U.S. Pressure on the Korean Nuclear Program

India's nuclear test in 1974 alerted the world to the dangers of the spread of nuclear weapons. Moreover India, in a first for a developing nonaligned country, had diverted plutonium for its nuclear test from materials generated by an NRX-type reactor. Canada suspended its negotiations for the sale of a similar research reactor to South Korea. The U.S. Government began to intensify its scrutiny of South Korea. U.S. intelligence officials judged that some steps to develop nuclear weapons technology had been taken which appeared designed to pave the way for a nuclear weapons program in the early 1970s. According to a CIA report[146], in 1974 and 1975 a much expanded, dedicated nuclear weapons program took

[144] Sung Gul Hong, "The Search for Deterrence: Park's Nuclear Option," p. 487.

[145] Memorandum for Kissinger from Smyser, "Development of U.S. Policy Toward South Korean Development of Nuclear Weapons" (February 28, 1975), Box 9, National Security Affairs. History and Public Policy Program Woodrow Wilson International Center for Scholars. Available online: http://digitalarchive.wilsoncenter.org/document/114617 (last accessed on October 18, 2015).

[146] The most important of the CIA documents about the relationship between nuclear weapon and guided missile program of South Korea in 1970s is US Central Intelligence Agency (CIA) National Foreign Assessment Center, "South Korea: Nuclear Developments and Strategic Decisionmaking," issued in June 1978, declassified in October 2005. Available online: www.foia.cia.gov/docs/DOC_0001254259/DOC_0001254259.pdf (last accessed on October 18,

shape, combining missile design work with nuclear and chemical warhead research in a project designate "890."[147] The project was undertaken to acquire a missile that could threaten Pyongyang, while long-term nuclear fuel cycle technology was sought to keep the bomb option open. The report noted that "the nuclear weapons design team took clear shape in mid-1975, when it was divided into three substantive subgroups working on warhead structure, high explosives fabrication, and computer codes."

In February 1975, the National Security Council of the U.S. agreed with the U.S. embassy in Seoul that "the ROK has entered the initial stage of nuclear weapons development,"[148] and Ambassador Richard Sneider began taking the U.S.'s objections to reprocessing directly to South Korean officials;

> If Korea begins to build a reprocessing plant, it will be widely assumed that it is seriously working on a nuclear weapons program. This perception would be potentially destabilizing in all of Northeast Asia. North Korea would certainly press its allies for a similar capability, and both China and the Soviet Union would see potential nuclear threats to their own territory. Perhaps most important such a development might possibly tip the balance on proliferation in Japan. Consequently, the Korean case would seem to warrant special bilateral action with the ROK, in addition to the controls we are contemplating in the international regulatory mechanisms.[149]

2015); As an analysis of this document, Peter Hayes and Chung-in Moon, "Park Chung Hee, the CIA, and the Bomb," NAPS Net Special Reports (September 23, 2011).

[147] CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 6.

[148] "Development of US Policy toward South Korean Development of Nuclear Weapons" (February 28, 1975) US National Security Council Memorandum. Available online: http://digitalarchive.wilsoncenter.org/document/114627 (last accessed on October 15, 2015)

[149] Draft US Department of State Cable on Approach to South Korea on French Reprocessing Plant, (July 11, 1975) Gerald R. Ford Presidential Library, National Security Adviser Presidential Country Files for East Asia and the Pacific, Box 9, Korea (9). Obtained by Charles Kraus. Available online: http://digitalarchive.wilsoncenter.org/document/114623 (last accessed on October 18, 2015)

The fall of Vietnam in 1975 and the late North Korean President Kim Il Sung's visit to Beijing in the same year had an extremely destabilizing effect on Korea's security environment. In an interview with the *Washington Post* in June 1975, Park stated that if the U.S. were to withdraw its nuclear umbrella, South Korea would develop its own nuclear weapons.[150]

However, under pressure from the U.S. and Canada, which used the leverage of pending power reactor sales and credit approvals to bolster their case, KAERI dropped its plans for purchasing both the reprocessing and mixed-oxide research facilities. In January 1976, at a Senate Government Operations meeting, Myron B. Kratzer, director of the State Department's Bureau of Oceans and International Environment and Scientific Affairs, disclosed that "South Korea has canceled plans to purchase a French plutonium reprocessing plant that could be used in the manufacture of nuclear weapons, … The cancellation reportedly followed heavy U.S. pressure." This was said under questioning by members of a Senate Government Operations subcommittee about U.S. pressures on the Koreans.[151]

Currently KAERI oversees Korea's bilateral cooperation with the U.S. in the peaceful uses of atomic energy, generally open to foreign scrutiny by keeping it out of sensitive fuel cycle work. In 1975, the Korean government agreed to American demands and ended its program and signed the nuclear Non-Proliferation Treaty in April.[152] Finally, in late December 1976, Park ordered the immediate suspension of all activities related to Project 890

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[150] *Washington Post*, (June 27, 1975), A32.

[151] "Seoul Cancels A-Plant Deal: Sought French Plutonium Facility," *Washington Associated Press (AP)* (January 30, 1976).

[152] Peter Hayes, *Pacific Powerkeg: American Nuclear Dilemmas in Korea* (Lexington: Macmillan, 1991).

following cabinet officials who convinced him that the weapons program was a major irritant in relations with the U.S. Some believe that Park continued a clandestine program that only ended with his assassination in 1979,[153] but this is not confirmed. Consequently, the U.S. actively cooperated in the expanding Korean nuclear power program and agreed to sell U.S. commercial power reactors**.**

Park suspended the effort for nuclear weapons after strong U.S. diplomatic intervention, but that was not the only reason. Notably, the Cabinet discussion regarding nuclear weapons had begun as early as 1970, before Park's decision to initiate a weapons program in late 1974. The delay of the decision making implies that the Korean research institutes had undertaken development projects beyond their competency and means. The CIA pointed out that his decision "was strongly conditioned by the poor performance of the ADD. … and by the lack of any immediate need for nuclear weapons development,"[154] describing that the policy planning for the nuclear weapons program "was erratic, even haphazard."[155] According to Oh Won Chul, Park had not decided actually to produce a South Korean bomb, but that he was determined to acquire the technology and capability to do so, because "Park wished to have the [nuclear] card to deal with other governments."[156] Testimonies of some nuclear scientists and officials who were involved in the project also support this view. According to them, the economic planning board was not very supportive

[153] See "South Korea Special Weapons," provided by Globalsecurity.org http://www.globalsecurity.org/wmd/world/rok/index.html (last accessed on October 18, 2015)

[154] CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 7.

[155] Ibid., p. 11.

[156] Don Oberdorfer, *The Two Koreas: A Contemporary History* (Basic Books, 2001), p. 55.

when questioned about the enormous budget plan. For this reason, some scientists have cast doubt on the extent of President Park's commitment to nuclear weapons.[157]

Park's Path to Missile Development

South Korea came to face outright pressure from the U.S to stop its nuclear weapons program. Regarding a missile system, however, the U.S. apparently provided its technology to South Korea, though with some strict restrictions. It is not clear if the aim of South Korea's missile development was specifically related to the use of nuclear warheads with the delivery system. Although the guided missile NHK-1 South Korea developed in 1978 could be used as a delivery system for nuclear weapons,[158] U.S. intelligence judged that Park preferred conventional, tactical missions for surface-to-surface missiles.[159] Park tended to view North Korea's Soviet-supplied FROGs (free rocket over ground) and 130-mm artillery as a potent weapon of terror, and was obsessed with acquiring a means of threatening Pyongyang to the same degree that the North could threaten the South. North Korea had a weapons system which reached Seoul, whereas the South's rockets and artillery could not travel the 160km to Pyongyang. For political reasons alone, the South's Government was obsessed with acquiring a means of threatening Pyongyang to the degree that the North could threaten the South.

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[157] Seung-Young Kim, "Security, Nationalism and the Pursuit of Nuclear Weapons and Missiles: The South Korean Case, 1970-82," *Diplomacy & Statecraft* 12(4), (December 2001): 53-80.

[158] The NHK-1 or Paekkom, developed in 1978, is assessed to have a capability to carry nuclear warheads. Janne Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (Sashington: Brooklings Institution, 1991), p. 50.

[159] CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 4.

Park's first order for a surface-to-surface guided missile was made almost simultaneously with the decision to pursue nuclear weapons. On December 26, 1971 he personally wrote down a list of specific characteristics he wanted to see in the missile program and handed the memo to Oh Won Chol, then a newly appointed member of the Blue House senior staff. He was at the center of Park's missile initiative. Oh summoned Ku Sang-Hoe to the Blue House, later to be known as the father of South Korean missile development, to hand him the memo. This memo called for the development of an independent missile system, with the goal of producing surface-to-surface ballistic missiles, with a range of 200km initially, but being progressively increased in later stages.[160]

The missile development started with a feasibility study group by a group of scientists and engineers including Park Kwiyoung and Dr. Ku Sang-hoe from the ADD, Dr. Lee Kyoungseo from the Korean Institute of Science and Technology (KIST), Dr. Hong Jaehak from Korean Air Force Academy, and several officials from the Korean Central Intelligence Agency (KCIA) on May 1, 1972.[161] They assembled in a secret apartment, on the side of the *Han* River in Seoul, under the disguised name of "The Promotional Plan for the Aerospace Industry." It developed the plan for acquiring guided missiles, calling for the successful

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[160] Oh Won Chul, "Chun Doo-hwan and the U.S. Intervention in the Development of Ballistic Missiles," *Sindonga* (January 1996): 388–409. (in Korean)

[161] Interview with Dr. Hong Jaehak by author (July 3, 2014); Dr. Hong, a professor of Korean Air Force Academy then, was one of the members for the feasibility study group. He moved to ADD for development of NHK-1 in 1972, and became the president of KARI in 1991.

testing of mid-range surface-to-surface missiles by the end of 1974 and long-range missiles by the end of 1976.[162]

The task, however, was almost "to create something out of nothing" for them. In fact, no one among them had developed a guided missile previously.[163] After studying catalogues and textbooks from abroad, mainly Japan and the U.S., for several months,[164] they got an unexpected message. The U.S. MAAG (Military Assistance Advisory Group) invited Ku Sang-Hoe to tour the missile-related facilities in the U.S. from May 16, 1972 for two months. The MAAG had been working with the South Korea to develop depot-level maintenance capabilities for the HAWK and Nike-Hercules missile system.

They wanted a local maintenance facility to be operated under contract "to save money over the life-cycle of these missiles given lower labor costs, reduced transportation costs, and utilization of local repair parts."[165] During the visit, Ku made every effort to gather information related to guided missile development. And when he visited the U.S. Army Missile Research Center, located in Huntsville, Alabama, for two weeks, he got over 800 pages of documents about equipment, facilities, budget, and organization for developing

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162 Ku Sang-hoe, "A Retrospective of Dr. Ku Snag-hoe: A Living Witness of Korean Missile Development," *Sindonga* (February 1999). (in Korean)

163 Interview with Dr. Hong Jaehak in Seoul by author (July 3, 2014)

164 Major texts were varied from research documents about the pencil rocket of Tokyo University to the U.S. Army's AMCP (Army Materiel Command Publication) data package. Interview with Dr. An Dongman by author (November 13, 2014) Dr. An was an assistance researcher of the rocket design team for NHK-1 project. He became the president of ADD in 2005.

165 Senate Committee on Foreign Relation, *U.S. troop withdrawal from the Republic of Korea: an Update, 1979 : a Report to the Committee on Foreign Relations, United States Senate by Senator John Glenn* , 96th Congress, 1st session (Washington D.C.,: U.S. Government Print Office, 1979), p. 53. In Collection of University of Florida Government Document Pamphlets; https://archive.org/details/ustroopwithdrawa00unit (last accessed on October 18, 2015)

a guided missile, provided by Mac Daniel, the director of the center. Through the feasibility study based on this kind of document gathered abroad, they were barely able to build the Basic Plan for Developing Ballistic Missiles on September 15, 1972. [166]

Remodeling Nike-Hercules

In May 1974, ADD selected the Nike-Hercules (NH) for reverse engineering to develop a missile design. The NH was an outdated missile system which was developed in the 1950s and deployed in South Korea by the U.S. in January 1961. Since it was designed for surface-to-air missile use, it had a lot of shortcomings and inefficiencies for surface-to-surface use. Nevertheless the rocket team was confident that they could convert the NH to be fit for the surface-to-surface mode by introducing new propellant material, semiconductors, a computerized guidance system and a new warhead on it. [167] ADD's rocket team intended to upgrade the NH to a new model with a maximum range of 180km with a 500kg payload so that it could reach Pyongyang and two of North Korea's major ports, Nampo and Wonsan far behind the DMZ.[168]

ADD chose McDonnell Douglas (MD), manufacturer of the Nike-Hercules (NH) missiles, as its preferred licensor. At that time MD was suffering financial difficulties in the

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[166] Ku Sang-hoe, "A Retrospective of Dr. Ku Snag-hoe: A Living Witness of Korean Missile Development"

[167] Interview with Hong Jaehak by author (July 3, 2014)

[168] CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 4.

mid-1970s, and was eager to sell missile design technologies.[169] Although MD requested $30 million for technology transfer, ADD could not afford to pay this from its budget. The ADD proposed a joint research project just for increasing the range of NH missiles from 180km to 240km, which would progress in three stages; a feasibility study for the first stage, design research for the second stage, and development for the third stage. ADD made a contract with MD to pay $1.8 million for the first stage. Under the agreement, ten ADD researchers were sent to MD in Los Angeles for six months, where they learned the relevant technology under strict security.[170] As Dr. Lee Kyoungsuh recalls it, "coming back to the hotel, we sometimes hid technical documents in our underwear to copy them all through the night, and brought them back next morning."[171] On completion of the six-month-long feasibility study, the ADD acquired basic design technologies for the missiles. However, only after achieving the capability to design missiles, did ADD cease the joint project with MD.[172]

By early 1975 the State Department concluded "Linkage of nuclear weapons development to an advanced missile capability would have the most serious strategic implications given the ROK's geographic location." Yet, since South Korea officially abandoned its nuclear weapons program by signing the nuclear Non-Proliferation Treaty in

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169 "Memorandum for Lieutenant General Brent Scowcraft:,Sale of Rocket Propulsion Technology to South Korea" (February 4, 1975) National Security Council from Department of State, Gerald R. Ford Presidential Library, National Security Adviser Presidential Country Files for East Asia and the Pacific, Box 9, Korea (3). Available online at History and Public Policy Program Woodrow Wilson International Center for Scholars Digital Archive, http://digitalarchive.wilsoncenter.org/document/114634 (last accessed on October 18, 2015)

170 Oh Won Chul, "Chun Doo-hwan and the U.S. Intervention in the Development of Ballistic Missiles," pp. 397–400.

171 Lee Eunyoung, "A Retrospective of Three Staffs for ADD Weapon Development," *Sindonga* (December 2006): 276–287. (in Korean)

172 Interview with Hong Jaehak (July 3, 2014)

April 1975, the U.S. began to allow technology transfer, even limited, for Korea's missile program. There are two main reasons for this. First, the U.S. underestimated South Korea's broad effort to acquire a surface-to-surface missile capability beyond the NH. Apparently, the U.S. policy was to discourage the ROK from acquiring an effective and independent surface-to-surface guided missile capability. But the NSC judged that "A propulsion manufacturing capability is a necessary but non-critical component compared to the sophisticated warhead and guidance technology which would have to be developed by the ROK to make an effective missile of the kind visualized by State."[173] It determined that South Korea lacked the capability to design and produce an improved missile control and guidance system and warhead. NSC also believed that "NH is not an effective medium range surface-to-surface weapon because the guidance and warhead were not developed for that kind of use."

Second, the U.S. believed that South Korea would be able to acquire similar technologies from other states if the U.S. did not allow such sales and transfer. Rather, by limited transfer of technology, they "would gain leverage or a better opportunity to monitor ROK rocket development."[174] For example, another major element in ADD's effort was to acquire propellant technology. ADD contacted a company producing the propellant for NH, because U.S. companies were legally required to secure the State Department's prior approval for the sale of propellant technologies. Its initial answer was 'no.' [175] Thus ADD

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[173] "Memorandum from Morton I. Abramowitz to Richard Smyser: Lockheed Sale to South Korea," (March 5, 1975), National Security Council, Gerald R. Ford Presidential Library and Museum, East Asia and Pacific Country Files, compiled 1974 – 1977, (PZA0002772) Available online at History and Public Policy Program Woodrow Wilson International Center for Scholars Digital Archive, http://digitalarchive.wilsoncenter.org/document/114634 (last accessed on October 18, 2015)

[174] Ibid.

[175] Interview with Hong Jaehak (July 3, 2014)

concentrated its resources on missile development, and actively sought to purchase the necessary propellant and guiding technologies, parts and components on the international market.[176] The ADD initially chose to contact a French company, Societe Nationale des Poudres et Explosifs (SNPE), for the purchase of technology, equipment, parts and components. However, SNPE required $20-30 million for that. In the middle of the negotiations with SNPE, the ADD swiftly contacted Lockheed for the purchase of some of the equipment at the plant, getting the news of Lockheed's plan to close down its propellant plant in California due to financial difficulties. The ADD made a contract with Lockheed to buy its California propellant factory at the price of $2.6 million - but without the manufacturing technology – in December 1975.[177] The manufacturing technology was excluded from the deal because when the State Department approved the Lockheed case it refused to provide further "significant" technology. NSC judged that its turning down the Lockheed manufacturing technology sale would be "an essential signal to the ROK regarding our future intentions."[178] Nevertheless, the ADD completed a separate deal with SNPE to acquire the manufacturing technology at a cost of $3 million.[179]

Overall, there were two faces to Korean Government defense policy; a public and official stance in support of U.S. policy, and a private, covert strategy of pursuing its own goals. The U.S. appeared to follow an "ambiguous policy with respect to the Korean policy

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176 Oh Won Chul, "Chun Doo-hwan and the U.S. Intervention in the Development of Ballistic Missiles," pp. 388–409.

177 Sung Gul Hong, "The Search for Deterrence: Park's Nuclear Option," p. 495.

178 "Memorandum from Morton I. Abramowitz to Richard Smyser: Lockheed Sale to South Korea"

179 Sung Gul Hong, "The Search for Deterrence: Park's Nuclear Option," p. 496; Sang-hoe Ku, "A Retrospective of Dr. Ku Snag-hoe, a Living Witness of Korean Missile Development"

for missile development."[180] Consequently, the continuing discrepancy between the two countries' perceptions of the military needs of South Korea created another opportunity to develop South Korea's capability for missile development. South Korea's behavior illustrates the difficulty of controlling technological developments in a country for once it "can purchase manufacturing technology, efforts to restrict its access to weapons or critical components become less effective and may only delay rather than terminate programs that the local government values."[181]

Successful Launch of *Paekkom*

After the construction of the Daejon Machine Tool Center and the relocation of the Lockheed propellant factory to Daejon, the missile development program quickly gained momentum. By 1975, the Daejon Machine Tool Center had grown into an autonomous center for research of guided rockets, with 500 scientists and engineers on its start.[182] ADD's missile researchers were divided among the six directorates of the agency's Daejon Center. The Directorate One handled with propulsion work; Two handled aeroballistics research; and Three, electronics and guidance and control development. Also, there was a group responsible for testing and evaluation of the missile flight test at *Anhung* in *Chungchung*

[180] "Investigation of Korean-American Relations: Report of the Subcommittee on International Organizations of the Committee on International Relations U.S. House of Representatives," p. 87.

[181] Janne Nolan, *Trappings of Power*, p. 51

[182] Interview with An Dongman (November 13, 2014)

province on the west coast of South Korea.[183] They developed an NH guided missile system following a four-step strategy, which replaced individual components they developed in NH rockets and tested them.[184] The first step was to test the domestic guidance and control system, by assembling it on an NH rocket; secondly it was the propulsion engine, third the rocket fuselage, and the final stage was for the rocket attaching all the components they had developed.

As of May 1976 the initial design of the improved missile was near completion. Only its control surfaces and a portion of the hydraulic system would be replicas of the Nike Hercules, but the rocket motors, airframe, control system, and onboard guidance system would be dramatically upgraded or entirely redesigned.[185] Using French assistance for both propellant and production technology, ADD succeeded in casting a reduced-scale motor. Static tests on these motors confirmed in mid-1976 Korea's ability to cast a carboxyl terminated polybutadiene-type propellant.[186] ADD also modified a command guidance system of the Nike Hercules to extend its range and accuracy.[187] Also it improved the onboard guidance system by making extensive use of solid-state electronics rather than the vacuum tube technology of the standard Nike Hercules. The ADD had not produced a

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183 CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 8.

184 Lee Eunyoung, "A Retrospective of Three Staffs for ADD Weapon Development"

185 Interview with Hong Jaehak (July 3, 2014)

186 CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 9.

187 Interview with An Dongman (November 13, 2014)

prototype missile by December 1976, when Park suspended Project 890, of which the missile program was part.

Initially the ADD planned to finish developing the missile in late 1980, but with the inauguration of the Carter administration, ADD adjusted the target date to October 1978. During his presidential campaign in 1976, Carter promised to withdraw all American ground troops and nuclear weapons from South Korea, though on March 9, 1977, the Carter administration announced the delay of its withdrawal plan until 1982. Beginning its first flight tests in April 29, 1978, the ADD scored a success rate of 50% in eight flights by September 16.[188] Finally, the ADD successfully tested the surface-to-surface missile, named NHK-1 (also known as Paekkom-1 and Baekgom-1, which means white bear in Korean), on the west coast of the Korean Peninsula, on September 26, 1978. About a week later, on October 1 it was demonstrated in the 30th national military day parade.[189]

The ADD's missile work focused on modifying the U. S. produced Nike Hercules surface-to-air missile as a surface-to-surface weapon with 150km range. However, of the original Nike Hercules, only the control surfaces and part of the hydraulic system remained. The CIA was able to obtain detailed technical parameters for the ADD's research: "Although the performance of the missile will not differ significantly from that of the standard Nike Hercules, the ADD prototype is to include a new rocket motor using French propellant and motor technology, a modified missile airframe, and an improved, all solid-state command

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188 Lee Eunyoung, "A Retrospective of Three Staffs for ADD Weapon Development"

189 "Domestic Guided Missile Firstly Shown to Citizen at National Military Day Parade," *Kyunghyang Daily* (October 2, 1978)

guidance package."[190] However, to secure U.S. guidance technology and equipment, which were required to complete the development of guided missiles, South Korea had to sign the bilateral agreement, known as the Missile Guideline with the U.S. that placed highly restrictive conditions on its ballistic missile development capabilities. Under the terms of the agreement, South Korea is prohibited from developing missiles with a range greater than 180km and above the maximum warhead weight of 500kg.[191]

After the first successful test flight of the NHK-1, the Defense Ministry announced that South Korea now ranked as the seventh nation that could produce its own missiles. Every news media used this as the lead story and allocated the first page to the story. This was out of all proportion to reality. The NHK-1 was described as the first "indigenous Korean" missile which was developed by Korean engineers' dedicated efforts despite the pressure from the U.S. in fear of proliferation. *Daehan* (Korea) News, the government's promotional film, reported that "The whole process of the rocket development was implemented by our scientists and engineers," and "if the guided missiles produced by our hands are to deployed to the front and the coast, our lands, sea, and sky will be secured as a home of peace and prosperity."[192]

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[190] CIA, "South Korea: Nuclear Developments and Strategic Decisionmaking," p. 9-10.

[191] The original document of the Missile Guideline between two countries has not been disclosed to the public yet. However, it is known that the guidelines were first agreed with the U.S. in July 1979, when the commander of U.S. Forces Korea, John Wickham, sent a letter to then defense minister, Roh Jae-hyun asking that the South's missiles should not exceed 180 km in range and carry payloads of less than 500 kg, which Roh accepted. "Editorial," *Chosun Daily* (July 17, 2012).

[192] *Danhan News* (7 October, 1978)


The Kyunghyang Daily News
1978년9월27일(수요일) ③ 【일간】
京鄕新聞
國產유도탄發射성공
國防硏究陣「韓國型」凱歌 中·長距離 地對地 성능誇示
세계 7번째 開發國…곧 量
多聯裝·對戰車 로키트도 試
朴대통령參觀 "技術陣우수"
揷橋川 농업개발 現場시찰
오는손님 따뜻하게
가는손님 인상깊게
국제관광공사

Figure 6: "Successful Launch of Indigenous Guided Missile" Source: *Kyounghyang Daily*

Chun Doohwan, Downsizing the ADD

After the successful development of the first Korean missile, ADD initiated plans for a more sophisticated missile equipped with an inertial navigation system (INS) as well as ballistic missiles with a range of 2,000km as a long term project, along with a rocket capability that could launch intelligence satellites.[193] According to a letter from Congressman Anthony Beilenson to Secretary of State Cyrus Vance in August 1979, "certain

[193] Interview with Ku Sang-hoe in 2001 cited by Seung-Young Kim, "Security, Nationalism and the Pursuit of Nuclear Weapons and Missiles: The South Korean Case, 1970-82," *Diplomacy & Statecraft* 12, No.4 (December 2001): 53-80, p. 56.

U.S. firms in the Los Angeles area are exporting technologies to the Republic of Korea that might be employed by the Korean government for the purpose of developing intermediate or long range, ballistic missiles." Beilenson also noted that "the Korean government now has in its possession the specification, engineering drawings, instructions and designs, blueprints and certain assembly equipment employed in the United States Atlas Centaur program."[194]

Park and ADD's missile aspirations were, however, suddenly reined in due to the domestic South Korean politics after Kim Chaekyu, the director of the Korean CIA, assassinated Park on October 26 1979. Prime Minister Choi Kyuha was quickly elected president by the National Conference for Unification. However, martial law was declared throughout the country and politics came under the control of the military. On December 12 1979, Major General Chun Doohwan took power through a coup against Martial Law Commander, General Chong Sunghwa, and was inaugurated for a regular seven-year term as president in 1980. Once General Chun Doo-hwan seized power, he delegated the defense industries to the Department of Defense and the Ministry of Commerce and Industry, and ensured that missile development programs, inherited from the Park era, were scrapped.[195]

The missile programs were halted as the ADD was put through two major organizational overhauls. In August 1980, about 30 senior researchers involved with missile development were fired though without clear reasons. Despite losing the core researchers,

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[194] "A. Beilenson, letter to Cyrus Vance," (August 20, 1979), released under US Freedom of Information Act request to Nautilus Institute, (May 21, 1982) Available online: http://nautilus.org/wp-content/uploads/2011/09/Cyrus_Vance_letter.pdf (last accessed on October 15, 2015); Cited also in Peter Hayes and Chung-in Moon, "Park Chung Hee, the CIA, and the Bomb," NAPS Net Special Reports (September 23, 2011).

[195] See Don Oberdorfer, *The Two Koreas: A Contemporary History*

ADD managed to continue to develop and succeeded in test-launching the NHK-2 missile equipped with the INS system provided by British firm Ferranti on October 30 1982. All the same, two months later the newly appointed head of ADD, Kim Sung-jin laid off more than 800 researchers.[196] Most of them were engineers and technicians in *Daejeon* Machine Tool Center, a major facility for missile development among the four centers of ADD. Through the two sharp reductions of ADD personnel, the subsequent missile plans of NHK-2, 3 and 5 were also halted and South Korea's rocket research was crippled.[197]

The rationale for downsizing missile projects is still not clear from official documents, but Chun was said to have a negative bias about the missile program as influenced by a report that NHK-1 was a mere fake.[198] He used to mention to people close to him that "*Paekkom* was not self-reliance, but they disguised this by painting an NH missile. The ADD wasted a huge amount of money and deceived the president for the purpose of developing the guided missile that was beyond their capability."[199] At that time, there was a widespread rumor within the ADD that rivalry and confrontation between the old military friendly with Park and the new military supportive to Chun resulted in downsizing the ADD.[200] Indeed, Kim Sung-jin who laid off more than 800 researchers in 1982 was a classmate of Chun in the

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196 Interview with Dr. An Dongman by author (November 13, 2014) Dr. An barely escaped from the lay-off thanks to technical training abroad.

197 Ku Sang-hoe, "A Retrospective of Dr. Ku Snag-hoe: A Living Witness of Korean Missile Development"

198 Oh Won Chul, "Chun Doo-hwan and the U.S. Intervention in the Development of Ballistic Missiles"

199 Ibid.

200 Interview with An Dongman (November 13, 2014)

military academy. However, a more important reason seems to be the diplomatic relations between Chun's government and U.S. President Reagan's government; the purge of the missile program was the Chun regime's effort to win recognition and secure support from the Reagan Administration.[201]

When Chun seized power in 1980, he faced a serious problem of legitimacy. Not only did he wage a military coup, but also he ordered special-forces to kill hundreds of civilians in Kwangju city in May 1980 given his bloody path to presidential power. To overcome this problem, he was desperate to seek recognition from the U.S. When Reagan assumed the presidency, he was to issue a new security assistance policy that superseded the arms transfer policy of the Carter Administration. Whereas Carter emphasized arms sales restrictions, Reagan would evaluate arms sales requests primarily in terms of their net contribution to enhanced deterrence and defense.[202] Inviting Chun to Washington, Reagan assured him that "the U.S. has no plan to withdraw U.S. ground combat forces from the Korean peninsula," and confirmed that it would "make available for sale to Korea appropriate weapons systems

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201 This gives a strong sense of déjà vu as Park dismissed the National Defense Scientific Research Institute (NDSRI) right after he seized power via military coup in 1960. The NDSRI which had been strongly supported by the former president Lee Syngman launched its first modern rocket successfully in 1958. However, the Park's government which clearly wanted and needed the U.S.'s approval for the military government as well as its assistance, did not have a rationale to run a institute for research of up-to-date weapons such as NDSRI. They were determined to comply with the U.S. policy which would provide for consumable military items but not to build up basic levels of armaments or Korean defense industries. See Chapter 1 of this dissertation.

202 Robert G. Rich, "U.S. Ground Force Withdrawal from Korea: A Case Study in National Security Decision Making," Executive Seminar in National and International Affairs, Twenty-Fourth Session, (United States Department of State Foreign Service Institute, June 1982), p. 31.

and defense industry technology necessary for enhancing Korea's capabilities to deter aggression."[203]

Thus, South Korea's defense policy turned towards maintaining a friendly relationship with the Conservative Reagan administration which showed a solid defense commitment to Korea by introducing high-tech weapons for the U.S. troops in Korea. To cement the alliance and secure a degree of U.S. support for his dictatorship, he was ready to suspend missile development which had been a headache between two countries since 1970s.[204] Moreover, compared with the 1970s, the security concerns became significantly relieved as the economic gap between the South and North Korea was already huge. Consequently, the Chun Government began to trim its defense budget share of GNP from 5.79% in 1983 to 4.5% in 1984, and cut defense spending from $4.8 billion in 1983 to $4.1 billion in 1984.[205]

However, Chun's policy for missile development was briefly changed by the bloody North Korean terrorist attack to assassinate him, killing seventeen South Korean officials in Burma on October 9, 1983. Escaping death by minutes, Chun traveled directly from the airport to a meeting of the surviving members of his security team at the Blue House. At the meeting, Minister of Defense Yun Songmin proposed that the South Korean Air Force bomb the North in retaliation, but Chun rejected the proposal. Instead, Chun ordered the ADD to

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[203] "Joint Communique Following Discussions With President Chun Doo Hwan of the Republic of Korea," (February 2, 1981) in *Public Papers of the Presidents of the United States* (Administration of Ronald Reagan, 1981), p. 86.

[204] Hayes, Moon, and Bruce, "Park Chung Hee, the US-ROS Strategic Relationship, and the Bomb."

[205] Chung-in Moon and Sangkeun Lee, "Military Spending and the Arms Race on the Korean Peninsula," *Asian Perspective* 33, no. 4 (2009): 69-100.

reconstitute the missile team and develop upgraded surface-to-surface guided missiles by the Seoul Olympic Games in 1988.[206] Since most of the core planning staff had already left the ADD — some had moved to universities and firms, and others even abroad —, Ku Sang-hoe, who had barely kept his position in the ADD, led the missile team. In November 1983, the Ministry of National Defense approved a program to develop an improved version of *Paekkom*, NHK-2 called *Hyounmu*. After a successful test launch in 1986, one battery of NHK-2 was deployed on the frontline on October 1987.[207]

Conclusion

In the 1970s, South Korea developed its own surface-to-surface guided rockets, under the vision of self-reliant national defense; however, the success came at the cost of tight military restrictions, because South Korea had accepted the U.S. demand to limit the missile range to 180km as a precondition of purchasing U.S. missile technology. Nevertheless, throughout the period South Korea created the infrastructure and human resources skilled in the ways of modern industrial production, subsequently for promoting space technology.

In the early 1970s, military production in South Korea suffered from a shortage of skilled engineers, planners and managers. According to a briefing given Senator Glenn by

[206] Ku, "A Retrospective of Dr. Ku Snag-hoe, a Living Witness of Korean Missile Development".

[207] Daniel Pinkston, "North and South Korean Space Development: Prospects for Cooperation and Conflict," *Astropolitics: The International Journal of Space Politics and Policy* 4, no. 2 (August 1, 2006): 207–227.

U.S. military personnel in 1972[208], South Korea was "a long way from self-sufficiency in medium or heavy equipment." The briefing pointed to two basic deficiencies in Korea's defense industry: insufficient quality control procedures and weak management. It notes "unless both these tasks are accomplished, the goal of self-reliance will be time consuming, prohibitive in costs, and ultimately a failure." Although the notion of developing independent arms production capabilities for South Korea was not central to U.S policy, its military assistance allowed South Korea's local firms to create its capability related to missile technology. It began with a MAAG-supervised maintenance facility for the Hawk and Nike Hercules missile systems in 1972. A local firm, Gold Star Precision Industries, which took on the commercial maintenance facility of missiles in Korea, received personnel training from the Raytheon Corporation for maintenance and operation in 1975.[209]

The political leader's strong support for the firms was also critical to establishing the industrial infra-structure for producing the missile. For producing indigenous components of *Paekkom*, the government subsidized its civilian counterparts as it procured the updated equipment and tools needed for them. [210] The propellant factory which had moved from Lockheed for the *Paekkom* project was even transferred to private ownership, Korea Explosive Co. As a result, in the early 1980s South Korea became a country with an indigenous capability for missile design and production as it created major producers such as

208 Senate Committee on Foreign Relation, *U.S. troop withdrawal from the Republic of Korea: an Update, 1979 : a Report to the Committee on Foreign Relations, United States Senate by Senator John Glenn*, p. 52.

209 Ibid, p. 53.

210 Interview with An Dongman (November 13, 2014)

Dae-Dong Industrial, Korea Air Line, Gold Star, Hyundai Shipbuilding Heavy Industries for aeromechanics, and Korea Explosives for propellants.[211]

The growth of human resources in these sectors also helped established networks for defense production as the production of missiles became subsequently interwoven into the development of sounding rockets and space launch vehicles.[212] Later, a number of scientists and engineers involved in the *Paekkom* and *Hyonmu* project of ADD moved to the Korea Aerospace Research Institute (KARI) and were given the task of building the first Korean sounding rocket program. It was hoped that this expertise might lead towards a space-launch capability subsequently. For example, Dr. Ryu Jangsu and Dr. Moon Sinhaeng, who were responsible for the general practice of developing Hyonmu, had a pivotal role in developing KARI's sounding rockets in 1990s and the KSLV rocket program in 2000s.

After South Korea developed the Hyonmu in the mid-1980s, Korea did not actively pursue ballistic missiles research until the late 1990s. This was mainly because of the Memorandum of Understanding signed between the U.S. and South Korea in 1979. It retarded South Korea's capability to produce ballistic missiles without outside assistance.[213] Instead, the government first began to express an interest in a space program for economic growth. In 1985, the Ministry of Science and Technology (MOST) issued a Long-term Plan

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211 Peter Hayes, "International Missile Trade and the Two Koreas, *The Koreans Journal of Defense Analysis*, Volume 5, Issue 1, (1993)

212 During the 1970s, these R&D efforts were almost entirely under government control, however, with only marginal links with the private sector. No effort was made to include South Korea's university community. Michael Brzoska and Thomas Ohlson, (eds.), *Arms Production in the Third World* (London: SIPRI, 1986), p. 230.

213 Rumsfeld Commission Report: Commission to Assess the Ballistic Missile Threat to the United States, Appendix III: Unclassified Working Papers: System Planning Corporation: Non-Proliferation Issues—South Korea. (15 July, 1998)

for the Development of Science and Technology toward the 2000s that called for a series of specific space-related projects. Eventually, space's turn had come. This will be the beginning of the story for the next chapter.

CHAPTER 4

Space Development for Economic Security 1985-1997

The end of the Cold War led to profound changes in the space policies of both the major space-faring countries and the developing countries. The focus of space missions has slowly moved away from military objectives to civilian ones, like scientific missions, telecommunications, meteorology and other civil applications related to the observation of the Earth. South Korea did not have an adequate infrastructural network for space development before the 1980s. However, the nation recognized that the civilian demand for space services provided by satellite and space launchers would increase and South Korea could exploit the defense industry established for the development of the first surface-to-surface guided missile in the 1970s.[214]

Technological advances were expected to reduce entry barriers, so, in the mid-1980s, the government began to formulate industrial policies for the aerospace sector. In 1985, it announced the Long-term Plan for the Development of Science and Technology toward the 2000s which emphasized space development as a way to reinforce South Korean's industrial competiveness. In 1987, it also adopted the Aerospace Industry Development and Promotion Act which included the first significant funding for a national space program. The policies emphasized that the Korean nation was *imagined* as a cohesive community of shared economic interests and developmental goals, and space development was justified for

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[214] Kim Doohwan, "Perspect of Aerospace Industry," *Dong-a Daily (*October 22, 1979). (in Korean)

"economic and social security" in response to the fierce international competition in technology. The term "security" referred to the fear of falling behind so far that there was no hope of ever catching up with advanced space-faring nations.

The strategies adopted focused on the development of satellites and sounding rockets that would lead to space launch vehicles. Space development proceeded with a strong industrial policy component, resembling South Korea's entry as a late developer into other sectors, such as heavy and chemical industries, shipbuilding, automobiles, electronics, and telecommunications.[215] Initially relying on foreign technical assistance, the three main actors in the Korean space program, SaTReC, KT, and KARI, sequentially launched a micro-satellite KITsat-1 (1992), a communication satellite KOREAsat-1 (1995), and multipurpose observation satellite KOMPsat-1 (1999). Based on the technical and industrial base established through the NHK-1 project in the 1970s, it also developed sounding rockets, KSR-1 (1993) and KSR-2 (1998) as precursors to a space launch vehicle.

The aim of this chapter is to provide an overview of the early development of the Korean space program between 1985 and 1998. I shall proceed in the following way. First, I will show how the first signs of the national vision for space development emerged and were promoted with the country beginning to move from military leadership to civilian control in the late 1980s and early 1990s. Focusing on the role of scientific experts in presidential decision-making, I will examine the ways in which the vision of space development for economic security provided a strong boost to various space projects. Second, this chapter

[215] Juan Felipe Lopez-Aymes, "Automobile, Information and Communication Technology and Space Industries as Icons of South Korean Economic Nationalism," *Pacific Focus* 25, no. 2 (July 26, 2010): 289–312.

describes the institutionalization process in Korean space development and the characteristics of this process as manifested in the changing status and role of various actors. And third, I will illustrate how these national actors provided South Korea with a platform for an autonomous and indigenous space capability through international bonds and collaborative practices in an interconnected global network.

Development of Science and Technology toward the 2000s

During the 1980s, South Korea struggled to change its industrial strategy for innovation from 'imitation' to 'defense.'[216] The Korean economy, which was characterized by an emphasis on low-cost labor, assembly-type operations during the 1970s, was now in the midst of a significant transformation reflecting a new commitment to skill-intensive and knowledge-intensive industries.[217] This was to counter the technology protectionism that had emerged internationally after the experience of two rounds of an oil crisis, along with the fact that South Korea's industry was based on low-cost labor that could barely compete with China, who had just entered the world trade market.

Increasing international technology protectionism led South Korean leaders to see the failure to escape from underdevelopment and to catch up with advanced industrial nations as one of the most serious risks they faced. The Chun Doohwan government promoted the

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[216] Chris Freeman distinguishes five types of national strategies towards innovation: offensive, defensive, imitative, dependent, and traditional. Christopher Freeman, *The Economics of Industrial Innovation* (Francis Pinter, 1989).

[217] Denis Simon and Changrok Soh, "Korea's Technological Development," *The Pacific Review* 7, no. 1 (1994): 89-103, p. 90.

development of science and technology in terms of sovereignty, and shifted its policy direction from technology learning to the expansion of its own scientific and technological capacity in high-technology sectors. This required an indigenous R&D capability. The total R&D expenditure of South Korea continued to increase from 0.56% of GDP in 1981 to 1.65% in 1987 during his rule.[218]

Having secured his office through a military coup, President Chun devised a slogan that emphasized Korea's science and technology-driven economic development as a way of compensating for his lack of legitimacy.[219] His administration began to outline an economic rationale for moving the country into the field of science and technology as the nation evolved from military leadership to civilian control. The Science and Technology Promotion Review Council (STPRC) was established to create policy coordinator and research administrator positions for specific technology fields. The Chun Doohwan administration used this council as a tool to secure a consensus for the S&T policy agenda.

On 19 December, 1985, at the 2nd meeting of STPRC, the Ministry of Science and Technology (MOST) presented the Long-term Plan for the Development of Science and Technology toward the 2000s which suggested goals and directions for achieving the status as a developed country by the turn of the century.[220] The plan was crystallized thanks to joint research conducted by over 523 relevant scholars during six months plus five public hearings.

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[218] Sung Keuk Hahm and Da Sung Yang, "A Study of the Presidential Leadership for Science and Technology in Korea: Comparative Study Before and After the Political Democratization in 1987," *Korean Political Science Review* (46), no. 1 (2012):5-38, p. 19. (in Korean)

[219] Ibid; Ji Woong Yoon, "Evolution of Science and Technology Policy in Korea," *The Korean Journal of Policy Studies*, Vol. 29, No. 1 (2014): 147-172.

[220] "Towards the World's Top 10 Developed Country," *Kyounghyang Daily* (December 20, 1985) (in Korean)

It was published in December 1986.[221] In the first part, it defined the meaning of the 2000s, and approached the new changes in the environment in terms of scientific and technological, economic and social dimensions: "we will face the economic and social transformation in a time of rapid change in 15 years …," and "… science and technology is the most critical factor that will lead to economic and social transformation."[222]

It also predicted that the situation which it termed a "technical monopoly" would intensify. In this situation, the economic barriers for entering an industry or conducting product development were so high that it was not profitable for developing countries to make the attempt. In accordance with this view, it was proposed to turn South Korea into one of "the world's top 10 developed countries in the implementation of technology." Space development became one of the suggested large-scale R&D programs for achieving this goal along with ocean development and both were viewed as a way to reinforce South Korea's industrial competiveness.

88 Seoul Olympic Games and Satellite

South Korea's interest in the commercial utilization of space began in earnest when the International Olympic Committee, which met in Baden- Baden, voted to award the 1988 Olympics to Seoul in September 1981. Two months later, the South Korean government set up a research committee to examine the feasibility of developing a communications satellite

[221] MOST, *The Long-term Plan for the Development of Science and Technology toward the 2000s* (1996) (in Korean)

[222] Ibid, p. 3.

for broadcasting the Olympic Games.[223] The Ministry of Communication (MOC) subsequently confirmed the viability of the communications satellite business based on the results of the feasibility study made by a Canadian company, Telesat Inc., and the American company Teleconsult. It planned to promote a private sector-led approach to development whereby private companies provided significant contributions to investment.[224] The five domestic electronics companies including Goldstar, Samsung, Daewoo, Hyundai, and Dongyang Precision had expressed their intention to participate in the satellite business. As South Korea's interest in the space industry increased, Europe and the United States simultaneously led efforts to get a major presence in the South Korean satellite market. Arianespace, a French company founded in 1980 as the world's first commercial provider of space transportation, and SatCom, a communication satellite provider, offered a communication satellite and its launch at 20-25% cheaper than NASA.[225] NASA suggested that it would provide a supporting loan, and additionally let a Korean scientist fly on board the Space Shuttle, if South Korea would launch its own satellite using the NASA shuttle in 1988.[226]

There were risks. Some experts insisted that it would be too difficult, both financially and technically to develop and launch satellites, or possess (purchase) independent satellites by 1988, having little experience in the satellite business. The feasibility studies

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[223] Jungwoong Na, "A Perspective on Korean Space Technology," *The Magazine of the IEEK*, Vol. 13, No. 4 (August 1986): 22-27. (in Korean)

[224] "Communications Satellites Are Indispensable," *Dong-a Daily* (May 30, 1983). (in Korean)

[225] "Catch the Korean Market," *Maeil Kyoungjae Daily* (August 30, 1983). (in Korean)

[226] "Communications Satellite, Led by the Private Sector," *Dong-a Daily* (January 20, 1984). (in Korean)

independently performed by the Electronics and Telecommunications Research Institute (ETRI) and the Korea Development Institute (KDI) raised three common problems.[227] First, the domestic demand for satellite communications was so small that it was not economically viable at present. Second, the overall technological circumstances were not mature enough to promote the satellite business.

Finally, the huge investment in the satellite business risked upsetting the balanced development of the other telecommunication sectors. The South Korean government finally decided to lease nine IntelSat satellites to broadcast the Seoul Olympic events, four in the Atlantic Ocean region, three in the Indian Ocean region, and two in the Pacific Ocean region.[228] In February 1984, President Chun invited firms to find a way to resolve the problem of Korea being on the fringe as regards reception of telecom signals, by first installing television relay stations in the short term," adding that "the satellite communications business should be approached carefully aiming for the mid-1990s."[229]

The First Comprehensive Feasibility Study for the National Space Program

Although the dream of broadcasting the Seoul Olympic Games through its own satellite did not come true, South Korea started to recognize that an expanded 'national space program' including communication and broadcasting satellite as well as science and

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[227] KT Satellite Project Team, *White Paper of KOREAsat-1* (KT, 1996). (in Korean)

[228] James F Larson and Heung-Soo Park, *Global Television and the Politics of the Seoul Olympics,* (Boulder, Colo.: Westview Press, 1993), p. 140.

[229] "President Chun Orders to Postpone Communication Satellite Project to 1990s," *Maeil kyoungjae Daily* (February 14, 1984). (in Korean)

technology satellites and sounding rockets were needed. While the MOT worked on the communications satellite for the Olympics, the MOST emerged as a new and engaged actor. In early 1985, the MOST funded the Korea Institute of Science and Technology (KIST) to conduct a feasibility study for possible mid-term and long-term goals, and asked it to define the budget needed for South Korea to develop a respectable space program.[230]

Dr. Kim Doohwan of the National Astronomical Observatory (NAO) was keen to promote space development as a long term national project and founded a space science and technology center. Dr. Kim graduated from Seoul National University and received his Ph.D. in astronomy from University of Tokyo in Japan in 1979. After coming back home, he joined the NAO in 1982 and became the director of the NAO in 1985. With a very limited budget, and only a handful of poorly trained astronomers and scientists with a Ph.D. in astronomy, the NAO had not accumulated research achievements since its establishment in 1974.[231] Dr. Kim recognized that the bureaucratized system of the NAO was a cause of the problem, and waited for an opportunity to reform it. As national interest in space development grew and the MOST created a positive atmosphere for the establishment of a national space center, he planned to abolish the NAO and rebuild it as a new government-funded research institute to direct overall national space development.[232]

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[230] KIST, *A Feasibility Study on the Korean Space Program*, (MOST, July 1985). (in Korean)

[231] Doohwan Kim, "A Memoir of KSA," in *The Memoirs of the Korean Astronomical Society 40th Anniversary* (NSA, 2005): 437-422. (in Korean)

[232] Doohwan Kim, "The Birth of ISSA," in *The Memoirs of the Korean Astronomical Society 40th Anniversary* (NSA, 2005): p. 451-456. (in Korean)

As a joint researcher of the KIST's feasibility study, he tried to inject his project to reform the NAO into the study.[233] The study, which was the first comprehensive feasibility study for a national space program, concluded that the plan of MOT for the direct development of the satellite and the rocket to launch the communication satellite into geo-synchronous orbit foe the Olympics was not feasible for some time in Korea.[234] Rather, "developing space science and technology and its industrialization," it suggested, "should be planned as a long term national project, and to achieve this objective more effectively, a supporting law for the national space program" was required. To begin with a "scientific satellite is essential and various experiments by sounding rockets are unavoidable, and it is important to recognize that this program for rockets should not be for military purposes, but for peaceful space exploration since the transfer of its technology from advanced country would be more feasible." Also, the establishment of a "space science and technology center" as a nationally supported institute was suggested to carry out research and development work as well as planning, adjusting and coordinating at the working level.

Establishment of ISSA as a National Space Center

Based on the study, Dr. Kim persuaded the government officials to build a long-term national comprehensive program for space development and to reform the NAO to be the national space center for the purpose. Finally, in March 1986 the government decided to abolish the NAO and to establish the Institute of Space Science & Astronomy (ISSA) a

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[233] Interview with Dr. Kim Doohwan by author (June 1, 2015)

[234] KIST, *A Feasibility Study on the Korean Space Program*, pp. 14-17. (in Korean)

subsidiary of the Electronics and Telecommunications Research Institute (ETRI). Dr. Kim was selected as the first director of the institute. The ISSA initially consisted of two main departments — the Astronomy Research Department and the Space Science Technology Department. While the Astronomy Research Department took the function of the NAO as it was, the Space Science Technology Department would conduct research on communication satellites, remote sensing, launch vehicles and guidance and control. Starting with only 17 researchers, Dr. Kim hoped to develop the ISSA as the NASA of Korea in the near future.[235]

A Study on the Korean Space Science and Technology Development Program published by the ISSA in May 1987 included the first Korean mid- and long-term plan for space development. The study was conducted to formulate a plan, which suggested sets of realistic measures and schemes within the capabilities of present authorities and the resources available to the MOST. However, the plan went beyond such constraints to identify the ISSA as the unique civilian R&D institute in the nation, one that would lead the national R&D activities of the space science and technology programs in the future. According to the plan, the Korean space industry would provide not only economic benefits from the operation of communication and observation satellites, but also "economic and social security" in response to the fierce international competition in technology.[236] Note that it introduced the term "security" to emphasize the necessity of space development. This was indicative of the fear of falling behind so far that one could no longer hope of catching up with the advanced nations.

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[235] Kim Doohee, "Interview with Kim Doohwan," *Science Donga Magazine* (May 1986): 24-27. (in Korean)

[236] ISSA, *A Study on the Korea Space Science and Technology Development Program*, (MOST, May 1987), p. 14. (in Korean)

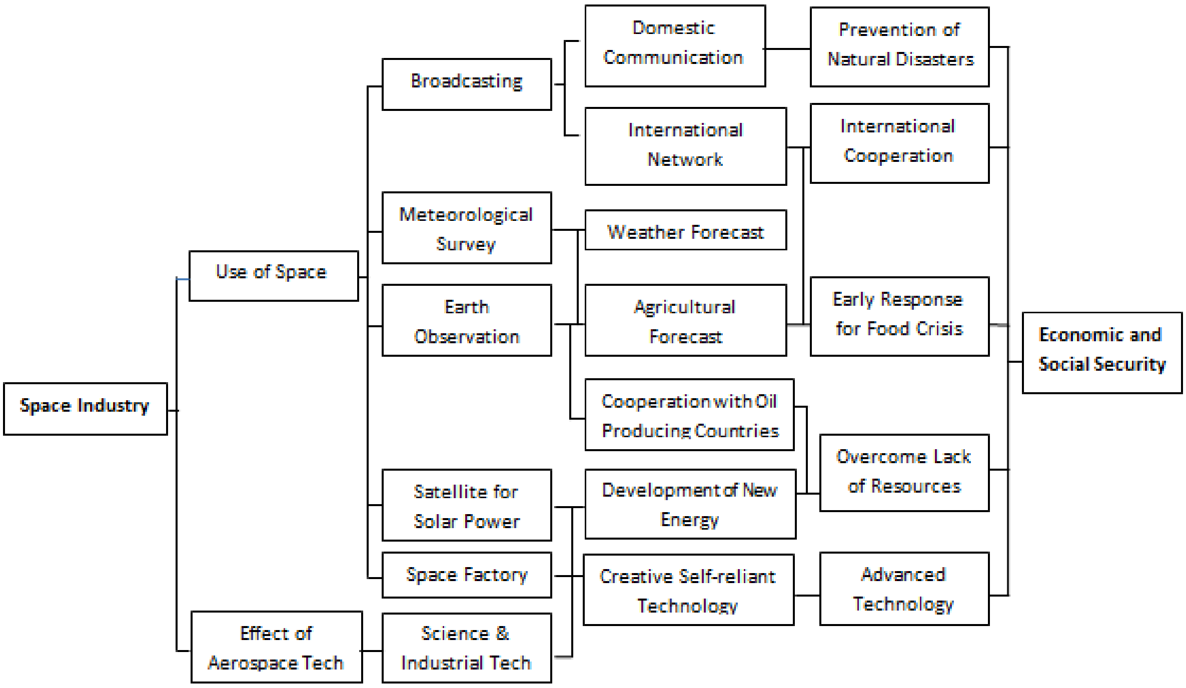

Figure 7: Space Development and Economic and Social Security, Source: ISSA (1987, p. 13)

The plan predicted that the space industry would grow up to $200 billion in the year 2000, and suggested setting the long-term national goal as being a “nation of space technology,” which would provide space related products to overseas markets in nations who were exploiting space resources. A three-step approach was recommended, along with intermediate goals set for the years 1991, 1996, and 2001, respectively. The first step was to launch a domestically developed “sounding rocket” by 1991. The second step came during 1996: A tiny experimental spacecraft was put into earth orbit. Finally, in 2001, the third step consisted of the domestic configuration of a “communications satellite system” that was developed and launched jointly with overseas expert organizations. Though the ISSA's ambitious plan for Korea's first national space development received considerable attention from interested parties, some cast doubt on how to secure the budget for the plan. In fact, the legal base and system for promoting space development was not properly prepared or fleshed out.[237]

The Aerospace Industry Development and Promotion Act

The Aircraft Industry Promotion Act of 1978 was the first piece of Korean legislation intended to assist and fund the domestic aerospace industry.[238] The Act was passed by Park Chung Hee's government as it began to push for the development of an indigenous defense industrial capacity with the decline in the credibility of the American commitment to defend South Korea after the promulgation of the Nixon Doctrine. Since the Act focused on a development program of defense industrial sectors using licensed production of foreign systems, new legislation was asked for to support civil space development.

It was Dr. Ryu Jangsoo of ADD who made the most substantial contribution to legislation for supporting space activities.[239] Dr. Ryu was involved in developing the NHK-1 guided missile during 1970s, but was sidelined when the Chun regime downsized the missile

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[237] "Editorial: An Ambitious Plan to Participate in Space Development," *Kyounghynag Daily* (21 May, 1987). (in Korean)

[238] Tae Hwan Cho, "Ch. 14. Challenges in Research and Development for the Korean Aircraft Industry," in Natalie W. Crawford and Chung-In Moon (eds.), *Emerging Threats, Force Structures, and the Role of Air Power in Korea*, (RAND Corporation, 2000): 325-343.

[239] He later became the general manager of the Korean Sounding Rocket-1 project and the KOMPsat project of KARI.

project to win recognition and secure the support of the Reagan Administration.[240] In August 1985, as thinking that a change of direction in civil space development could make a significant breakthrough in the rebuilding of ADD, he paid a chance visit to the then-ruling Democratic and Justice Party.[241]

Discussing the issue with Dr. Ryu, Yi Sanghee, a member of the National Assembly as well as the chairman of the Committee for the Long-term Plan for the Development of Science and Technology toward the 2000s, he was entrusted with the task of drawing up legislation for the promotion of space development. Working for about two years as Yi's legislative adviser, Dr. Ryu gave priority to a shift of the focus on aerospace development from the military to science and industry. To justify space development, he referred to the examples of acts used in advanced countries such as the U.S.' National Aeronautics and Space Act and the French Space Operation Act.

Finally, in December 1987, South Korea's legislature finally approved The Aerospace Industry Development and Promotion Act (the Act of 1987) to complement the previous act for the aircraft industry. The purpose of this Act was to contribute to "the sound development of the national economy and the improvement of national life by supporting and promoting rationally the aerospace industry, and researching and developing efficiently aerospace science and technology."[242] The Act required that an Aerospace Industry Development Policy Council be established and placed under the control of the Prime Minister. It would

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240 Regarding the overhaul dismissing of the ADD in the early 1980s, see chapter 2 of this dissertation.

241 Interview with Dr. Ryu Jangsoo by author (June 10, 2015).

242 MCIE, Aerospace Industry Promotion Act (I), 1988-1988, National Archives of Korea (BA0786617) (in Korean)

define the basic plan and see to the coordination of the accompanying important policies of the Government and the tasks of specific ministries and agencies. It would also secure a robust commitment by the government to space activities, and long-term, low interest rates to support R and D in civilian businesses and institutes.

The Presidency and Space Development

The year of 1987 was a time of optimism when South Korea dreamed of entering the ranks of advanced countries through space development with legislation favoring the development of the aerospace sector, while also building a democratic nation through an amendment of the constitution to change the presidential election system to one of direct elections. In June 1987, President Chun, who seized power via a military coup in 1979, announced his choice of Roh Tae-woo as the presidential candidate of the ruling Democratic and Justice Party.[243] Roh, a member of the *Hanahoe* (a secret military group), gave critical support to a coup in December 1979 when Chun became the de facto ruler of South Korea. He also helped Chun to lead troops against the *Gwangju* Democratization Movement in 1980. Thus, Chun's nomination was widely perceived as handing Roh the presidency, and triggered large pro-democracy rallies in Seoul and other cities in the 1987 June Democracy Movement. In response, on June 29, Roh made the 6.29 Declaration, officially named the Special Declaration of Grand National Harmony and Progress towards a Great Nation, promising a wide program of political reforms with his eight-point proposal that included direct

243 "Roh Tae Woo" YourDictionary, n.d. Web. (11 August 2015). http://biography.yourdictionary.com/roh-tae-woo

presidential elections. With the 6.29 Declaration, Roh successfully upstaged Chun and thereby boosted his own image as reformer to ensure a smooth succession of political power.[244]

Being eager to distance himself from his past military career and ties with Chun, Roh effectively took up the ideas in the air about future-oriented space issues. His political affiliation and the ruling party, the Democratic and Justice Party, developed its contribution to the passing of the Act of 1987 into a preemptive political agenda. In the 1987 presidential race shortly after the Act of 1987 was adopted, Roh differentiated himself from other candidates by making the electoral commitment that he would actively pursue national space development through promoting independent communication and broadcasting satellites and the relevant cutting-edge industries. The space issue appeared in a presidential election campaign for the first time in South Korea. The content contained in Roh's presidential election commitments was as follows:[245]

> Step 1 (1988-1992): Building the infrastructure for possession of an independent satellite
>
> Step 2 (1993-1997): Manufacturing a satellite and constructing a ground network
>
> Step 3 (1998-): Securing the first independent communication satellite

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[244] Uk Heo and Terence Reohrig, *South Korea since 1980,* (Cambridge University Press, 2010), p. 38.

[245] KT Satellite Project Team, *White Paper of KOREAsat-1* (KT, 1999). (in Korean)

In the election, the two leading opposition figures, Kim Young-sam and Kim Dae-jung (both of whom later became the President of Korea), were unable to overcome their differences and ran separate campaigns and split the electorate. This enabled Roh to win by a narrow margin and become the country's first cleanly elected president. As the president elected in South Korea's first ever peaceful transition of power, Roh publicly stated three policy goals; further democratization, continued economic growth, and progress toward reunification.[246] Along with these policy initiatives, Roh appointed Yi Sanghee as the first Minister of Science and Technology for his administration and let Yi plan and conduct space-related activities.

Young Astronauts Korea and Technolympic

Besides pushing ahead in accordance with Roh's campaign promise, Minister Yi actively planned various projects to foster a public atmosphere congenial to space development. For example, he established a group called the foundation of Young Astronauts Korea (YAK) in 1989. The formation of YAK was discussed first when Jack Anderson, a U.S. columnist and the chairman of the Young Astronaut Council (YAC), visited Seoul to request South Korea to participate in its international program in 1985.[247] The YAC was established by the White House in 1984 in an effort to promote greater proficiency and interest in science,

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[246] Michael Breen, "Roh Tae-woo: president who followed his script," *The Korea Times*, (November 9, 2011)

[247] *Dong-a Daily* (November 21, 1988) (in Korean)

math and technology using space as the underlying theme.[248] Since then, tens of thousands of Young Astronaut Chapters were formed in every state and around the world. When he requested participation in YAC, Anderson also proposed that the Korean government should select ‘space’ as a theme for the Seoul Olympic Games, using gold medals that had been sent into space and returned, and letting a Korean astronaut who had flown on the Space Shuttle lead the Olympic parade.[249]

Although the Chun’s government did not accept Anderson’s proposal, Yi Sanghee, then a member of National Assembly, considered the foundation of YAK seriously. Soon after becoming the Minister, he accelerated the preparation of the bill to support YAK and set it up on 23, September 1989. Its object was “to foster global human resources by encouraging a focus on exploring creative research, improving and supplying space scientific education programs, hosting various nationwide competitions, training instructors and developing vibrant international exchanges to advance the advent of a bright space science era.” At the foundation ceremony of YAK, President Roh declared that “Our government will establish the Korea Aerospace Research Institute (KARI) within this year to prepare the coming space era, and plan to have independent satellites for communication and scientific research in the mid-1990s.” He added that “I hope that we can make a satellite with our hands and launch it in our hands within this century.”[250] Roh became the honorary president of YAK that same day.

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[248] Jack Anderson and Joseph Spear, “Young Astronauts,” *The Free Lance-Star* (Dec 26, 1985)

[249] STEPI, *Study on Science Activity Development Program for Young Boys & Girls* (December 1989), p. 35. (in Korean)

[250] *Hankyorae Daily* (September 24, 1989); *Dong-a Daily* (September 23, 1989). (in Korean)

Figure 7 President Roh at the Ceremony of Young Astronauts Korea, Source: National Archive of Korea

Another example of Yi's efforts to promote a space boom was the Space Technolympic. Drawing on the enthusiasm for the 88 Seoul Olympics, the MOST planned to hold the Space Technolympic in 1993.[251] Its purpose was to "acquire advanced space technology and make it available for domestic industries and to promote technical cooperation for the peaceful use for mankind." [252] The basic concept of the Space Technolympic was to be an initiator in all political, economic, and social fields, including national defense, as well as science and technology towards the new millennium. It included 6 main events; a space industrial exhibition, a space science symposium, a scientific satellite launching, a Space Jamboree, the formation of an Asian Space Agency, and launching a Korean scientist in the U.S. Space Shuttle. Although the plan was nipped in the bud due to the failure to secure the budget, various space activities that South Korea could were highlighted.

The passing of the Act of 1987 and the government's public activities related to space development contributed to create a space boom. Before 1987, there had been only a handful of departments of aeronautics in universities and no department and major with "space" in its name in South Korea. By 1990, however, about twenty space-related departments had been newly established or some had changed their name to department of aerospace engineering. The department of aerospace engineering recorded the highest rank in qualifications needed for admission to the Seoul National University in 1991,[253] which shows the heightened public interest in space development. A news report described aerospace engineering as the "flower of the future" as Korea moved towards the 2000s

[251] "Planning hold Space Technoloympic in 1993," *Kyounghyang Daily* (26 January, 1989). (in Korean)

[252] MOST, *Study on Basic Plans for '93 Space Technolympic* (July 1989) (in Korean).

[253] *Kyounghyang Daily* (January 11, 1991) (in Korean)

followed by electric and automobile engineering which had led South Korea to becoming an industrial country.[254]

Three Main Players in Space Development

T*he* Act of 1987 included the first significant funding for space projects in South Korea. To use the funds effectively, the Act required the government to draft an aerospace development plan, and a 15-member committee led by the Prime Minister was formed to oversee the drafting of the plan. While the Prime Minister nominally headed the committee, the MOST, MOC (later Ministry of Information and Communication), and the Ministry of Commerce, Industry, and Energy (MCIE) drafted most of the plan's details. The first national mid and long term space plan for Korea was established in 1996. Before then, the national space program had been driven largely by the three main players, Korea Telecom (KT), Satellite Technology Research Center (SaTReC) in KAIST (Korea Advanced Institute of Science and Technology), and Korea Aerospace Research Institute (KARI), respectively pursuing the development of communication satellites, scientific satellites, and sounding rockets.

For the communication satellite, the MOC that had pursued the project since the early 1980s announced the KOREAsat project in 1989. KT was chosen as the sole investor for purchasing a satellite from an advanced country. For the scientific satellite, KIST and KAIST initially stepped up to the plate. Ever since late 1980s, Dr. Na Jungwoong of KIST had

[254] "Promising College Majors in 2000s?" *Hankyrae Daily* (14 November, 1991) (in Korean)

exchanged ideas about small sized scientific satellites with Weber State College in the U.S., and started a 20-inch sized cubesat project named KORsat in 1990.[255] Around the same time, the SaTReC founded by Dr. Choi Soondal, a Professor of KAIST, cooperated with Surrey University in the U.K. to develop KITsat. The MOST unified the two efforts into one project led by SaTReC in 1990.[256] Regarding sounding rockets, though KAIST surveyed the basic research underway,[257] the ISSA soon took the lead. Along with its own plan,[258] the Space Engineering Section of ISSA started research on developing an unguided solid-propellant two-staged rocket system with the assistance of the ADD. The rocket team was led by Dr. Ryu Jangsoo who had worked on enabling the Act of 1987 and had moved to the ISSA.

As KARI emerged as a comprehensive aerospace institute in 1989, the early institutional landscape of the space program changed. Ever since the ISSA had been established in 1987, some of the aerospace engineering community complained that an astronomer (Dr. Kim Doohwan, the director of ISSA) was leading the national space program.[259] They did all they could to encourage the idea that engineers should take up the initiative. These movements triggered a discussion about the establishment of a specialized aerospace research institution to perform space development as part of the Act of 1987. The 17th proposition of that Act stated that "the government could establish a comprehensive or

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[255] "Interview with Dr. Na Jungwoong," *Kyounghayng Daily* (August 24, 1989) (in Korean)

[256] KAIST, *A Study on the Development of Experimental Satellite Korsat-E1 (I)*, (1991) (in Korean)

[257] KAIST, *Survey on Basic Technologies for Development of Sounding Rocket System*, (1987) (in Korean)

[258] ISSA, *A Study on the Korea Space Science and Technology Development Program*, MOST (May 1987), (In Korean)

[259] Interview with Dr. Kim Doohwan by author, (June 1, 2015)

specialized research institution for more efficient aerospace research." At the Ministers' meeting in November 1988, Yi Sanghee, the Minister of Science and Technology submitted a proposal for the foundation of KARI as a subsidiary of the Korea Institute of Machinery & Material (KIMM). In response, the Ministry of National Defense (MND) joined the conversation and sought to take active control of the new institute, arguing that the ADD with the highest technology for guided rocket and aviation systems was affiliated to the MND.

While the MOST urged the foundation of an integrated institute that would consolidate the existing aviation section of the ADD and the other aerospace-related organizations of KIMM and ISSA, the MND wanted a dual alternative that maintained the ADD untouched.[260] After a long discussion, the final decision on the establishment of the KARI was made leaving the ADD to stay as it was. Consequently, the development of military aerospace applications was confined to the ADD under the responsibility of the MND, while the activities for distinct civil aerospace development was entrusted to the KARI officially founded as a subsidiary of KIMM in October 1989. The initial foundation of the institute was in the aviation section of the KIMM, and in January 1990 it consolidated the Space Engineering Section of ISSA. The director of ISSA, Kim Doohwan, who dreamed of developing the ISSA into the NASA of Korea and had already seen strong opposition to this idea, finally resigned his job in late 1989.[261] Losing its engineering part, the ISAA remained as a research institute for astronomy and became Korea Astronomy & Space Science Institute (KASI) later. From this time on, South Korea came to have separate institutional systems for astronomy and aerospace engineering.

[260] KARI, *10 Years of KARI*, (1999): 67. (in Korean)

[261] Interview with Dr. Kim Doohwan by author, (June 1, 2015)

The activities for developing civil aerospace were initiated by mainly three actors: a scientific research institute (KARI), a university (KAIST), and an industrial company (KT). Focusing on satellite development offered prospects for direct benefits, since it led to three separate programs; the experimental KITsat (*Uribyol*), the communication KOREAsat (*Mugunghwa*), and the multi-purpose Earth observation KOMPsat (*Arirang*). The South Korean space launch vehicle program also started with the KSR (Korean Sounding Rocket) series in early 1990s. KARI launched its first single stage sounding rocket, the KSR-1 in 1992. Beginning in the 1990s, most development projects were proposed by these entities, rather than by a political leader or government decision makers. I will describe each the three institutions' activity in what follows.

SaTReC in KAIST -The Birthplace of the First Korean Satellite

The Satellite Technology Research Center (SaTReC) inside KAIST was a university-based research facility meant to promote the education and training of satellite engineers through research programs in satellite engineering, space science, and remote sensing. Before the late 1980s, the Korean Government rarely supported the research functions of universities for space development. With SaTReC, a university became one of the main actors for spacecraft technology.

Establishment of SaTReC

The founder of SaTReC was Professor Choi Soondal at KAIST, who received a Ph.D. in electric engineering from Stanford and worked for a satellite team at JPL for six years as of

1969. In 1976, he returned home to be the director of GoldStar Corporation Research Institute, which took charge of developing Valcan Radar in Park Chung Hee's regime. After Chun Doohwan seized power in 1980, Choi, a senior at Chun's middle school, built a distinguished career as the head of The Korea Electric Power Corporation, the Minister of Communication, the head of the Korea Science and Engineering Foundation (KOSEF), and the head of *Il-hae* Foundation, etc. When he returned to KAIST as a professor in 1989, Choi chose low-cost small satellites as his major research topic.[262]

In 1983, a feasibility study for the communication satellite business was conducted for the first time in Korea, Choi the then Minister of Communications did not accept it because he thought that to improve the coverage of land-based telephone lines was more urgent than to develop a communication satellite. However, he appreciated that the time was now ripe, and that there was a need for a fast and reliable way to acquire the expertise for the communication satellite business of the MOC.[263] Despite his research experience acquired at JPL for several years, Choi had been working in an unrelated field for over ten years and needed to bring himself up to speed as regards recent trends in satellite development. He went to the U.K. to take a short-term lecture series on small satellite engineering provided by University of Southampton and University of Surrey in July 1989.[264]

262 Choi Soon Dal, Na Jungwoong, and Sung Dankeun, "Development of Experimental Satellite in University," *Transactions of KIEE*, Vol. 39, No. 5. (May 1990) (in Korean)

263 Choi Soon Dal, *This Boy Would Launch the First Korean Satellite after 48 Years*, (Haenggan Punggyung, 2005) (in Korean)

264 SaTReC, *We Launched a Star: Young Geniuses' Dream and Ambition for Uribyul-1*, (Mihaksa, 1993), p. 210 (in Korean)

Beginning in 1978, Professor Sir Martin Sweeting at the University of Surrey had been developing the Surrey Space Center for the design, manufacture and operations of micro-satellites.[265] Surrey's first experimental microsatellites UoSAT-1 (1981) and 2 (1984) were constructed with highly innovative features in terms of cost and performance compared to traditional satellites thanks to the emergence of integrated circuits and elementary microprocessors. However, Surrey needed to establish a commercial company to attract and handle external funding to build satellites. Buoyed by the success of UoSAT Sweeting could see the commercial value in developing his satellite technology.

Early in 1985, his team created Surrey Satellite Technology Ltd. (SSTL), a company that worked closely with academic research teams and undertook industrial contracts to provide satellite design, construction, integration and launch services, satellite ground station, and orbital operations. SSTL provided a formal mechanism to handle the transfer of small satellite technologies from the University's academic research laboratories into industry in a professional manner via commercial contracts through the development and marketing of cost-effective small satellites. Since UoSat-5, all the Surrey micro satellites have been designed and built for individual commercial customers.[266]

During his stay abroad Choi was quick to recognize the benefits of entering the space-faring business with an affordable, low-risk 'first step' via an extremely inexpensive yet realistic micro-satellite program. On July 28, 1989, Sweeting and Choi had a meeting of minds to make KAIST one of the first customers of SSTL, hiring the company to train

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[265] Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America,* (London; Chichester: Springer; Praxis, 2009), p. 491.

[266] Martin Sweeting, "Space at Surrey: Micro-Mini Satellites for Affordable Access to Space," *Air & Space Europe* Vol. 2 No.1 (2000): 38-52.

engineers and students in the construction and the launch operation of the Korea Institute of Technology Satellite (KITsat) costing £2.3 million in August 1993.[267] SSTL would design the satellite, which would be built by students from KAIST, working under a technology transfer program at the University of Surrey's Spacecraft Engineering Research Group. The students were involved in the UoSat-5 mission through taking the MSc courses at Surrey.

However, it was no simple matter for a mere professor to secure such a large amount of money for about four years. It happened that the KOSEF initiated a support program for large long-term research projects leading to the development of science and technology in the country. To apply to the program, Choi founded the Satellite Technology Research Center (SaTReC) in KAIST in August 1989. The SaTReC had the advantage of being a university research institute which could be devoted to basic research and education specialized in satellite engineering. Choi wanted SaTReC to become a research institute like the Institute of Space and Aeronautical Science (ISAS) at the University of Tokyo and JPL at Caltech.[268] SaTReC was selected as an Engineering Research Center (ERC) funded by KOSEF and began its research in March 1990.

The government also began to show an interest in Choi's satellite project which could very quickly develop and launch a satellite before KOREAsat scheduled for the mid-1990s. Finally, the Korean Ministry of Posts and Telecommunications (MPT) and the MOST decided to support SaTReC as a national research project in August 1990, on condition that

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[267] Choi Soondal, "The *First* Korean Satellite, 'Uribyol'," *KASA (The Korean Society for Aeronautical & Space Sciences) Magazine* 4, no. 1, (January 2010), p. 15. (in Korean)

[268] Choi Soon Dal, *This Boy Would Launch the First Korean Satellite after 48 Years*, p. 204

the launch schedule of 1993 should be advanced by one year so as to be before the end of Roh's presidency.

Comprehensive and In-depth Training in Surrey

Surrey and SSTL's know-how transfer and training (KHTT) program was particularly suitable for SeTReC team who wished to develop and establish a national expertise in space technology through an affordable small satellite program. The program focused on the education and training of scientists and engineers by providing a means for direct, hands-on experience of all stages and aspects of a real satellite mission from design, construction, test and launch through to orbital operation. The first phase typically comprises: Academic Education (MSc, PhD degrees); Hands-on Training (seconded to SSTL), Ground station (installed in country), Microsatellites (1st at SSTL, 2nd in country), Know-how transfer (satellite design license) Once developing space nations have mastered microsatellite technology, the mini satellite provides a logical next step in the development of an increasingly capable national space infrastructure.[269] KITsat-1 was the first KHTT satellite. (Table 4)

The first five graduating students of KAIST, selected by Choi, went to the University of Surrey in the fall semester of 1989, and four more students and two researchers of SaTReC

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[269] Nine highly successful international know-how transfer programs had been completed by Surrey and SSTL. A total of 70 engineers have been trained through the in-depth KHTT programs at Surrey – a further 320 students from countries worldwide have graduated from the MSc course in Satellite Communications Engineering unrelated to these KHTT program. Martin Sweeting, "Space at Surrey: Micro-Mini Satellites for Affordable Access to Space," *Air & Space Europe* Vol. 2 No.1 (2000): 38-52.

arrived in March 1990. Twenty seven students in total were sent to foreign universities for the training and development of satellite experts supported by SaTReC. In addition to the University of Surrey that hosted most of the students, the list includes University College of London, Imperial College, University of Tokyo, Iowa State University, and Columbia University.[270] They were all eager to become a new, first generation of experts that could help inform the country's use of space technology to address local challenges.

Table 4: SSTL Know-how Transfer and Training Programs. (Source: Martin Sweeting, "Space at Surrey: Micro-Mini Satellites for Affordable Access to Space")

Country	Dates	Satellites
Pakistan	1985-89	BADR-1
South Africa	1989-91	UoSAT-3/4/5
South Korea	1990-94	KITsat-1/2
Portugal	1993-94	PoSAT-1
Chile	1995-97	FASat-Alfa/Bravo
Thailand	1995-98	TMSAT-1
Singapore	1995-99	Merlion payload
Malaysia	1996-98	TiungSAT-1
China	1998-99	Tsinghua-1

[270] SaTReC, *Development Study of a Small Satellite for Science Technology Experiment (IV)*, MOST (1994) (in Korean)

The SSTL modular microsatellite did not have a traditional inflexible 'skeleton' structure, but rather used a layered module-box structure concept. This involved a series of identical outline machined module boxes stacked one on top of the other to form a body onto which solar panels and instruments could be mounted.[271] Each module box housed the various microsatellite subsystems such as batteries, power conditioning, on-board data handling, communications and attitude control. Payloads were housed either in similar modules or on top of the platform alongside antennas and attitude sensors as appropriate. Electronically, the microsatellite used modern, sophisticated, but not necessarily space-proven, electronic circuits to provide a high degree of capability. These were underpinned by space-proven subsystems – resulting in a layered architecture that achieved high performance with operational redundancy.

This structural characteristic of the SSTL microsatellite enabled the SaTReC team to use alternative technologies rather than simple duplication.(Figure 9) Also it was a great opportunity to acquire practical knowledge on satellite design and on manufacturing a satellite since they were involved in the UoSat-5 project until July 1991.[272] As the UoSaT-4 failed due to an electrical fault after two days in orbit in January 1990, the SSTL started an unscheduled project UoSat-5 to perform the experiments of the UoSat-4 project of October 1990. The Surrey team involved the SaTReC personnel in the UoSat-5 project, so that they had one more chance to manufacture a satellite before KITsat. Based on their hands-on

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[271] M.N. Sweeting, "Keynote Address: Micro/Nanosatellites-The New World," in M. Rycroft and N. Crosby (eds.), *Smaller Satellites: Bigger Business? Concepts, Applications and Markets for Micro/Nanosatellites in a New Information World* (Kluwer Academic Publishers, 2002): 1-20.

[272] Tae Euikyoung, A Study of the Process of Obtaining and Improving Satellite Technologies at KAIST SaTReC, *Journal of the Korean History of Science Society*, Vol. 37. Vol. 1 (2015): 85-117. (in Korean)

experience, the SaTReC team could take a lead in all the processes of KITsat development including mission determination, manufacture of engineering model and flying model, environmental tests, and launch.

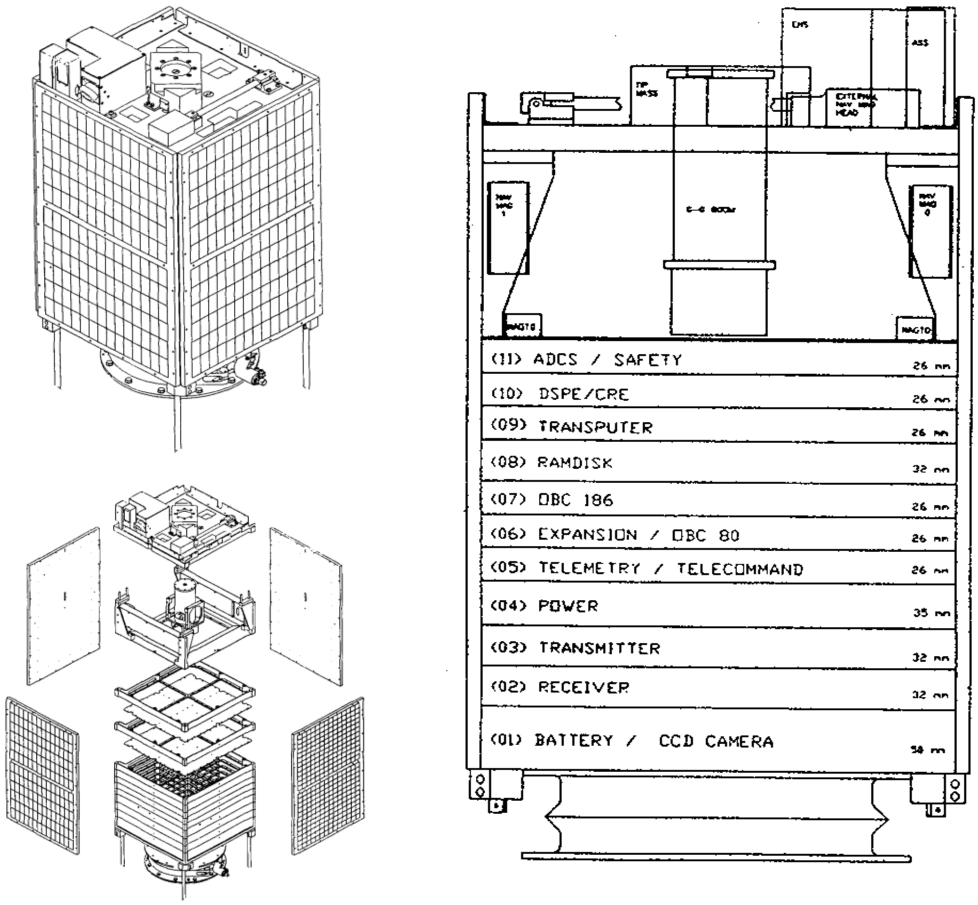

Figure 8: Structure of KITsat-1. Source: Development Study of a Small Satellite for Science Technology Experiment (IV), (SaTReC, 1994), p. 88.

Whilst KITsat-1 used the same microsatellite platform as the UoSAT-5, a number of improvements and modification were incorporated to support the four main missions;[273] 1) Digital Store & Forward Communication (DSFC): supports the 9600 baud FSK packet radio system profiling the digital store-and-forward communications operating in the Amateur Satellite Service. 2) Digital Signal Processing Experiment (DSPE): transmits voice messages containing bulletins, telemetry and spacecraft, information spoken by its Digital Signal Processing Experiment module in Korean, English and other languages. 3) CCD Earth Imaging Experiment (CEIE): carries two experimental CCD cameras to provide two different images of the Earth's surface with high resolution (400m) and low resolution (4km). 4) Cosmic Ray Experiment (CRE): the investigation of the near Earth environment, and its effects on satellite systems through a Cosmic Particle Experiment and Total Dose Experiment. This technology for the control of two CCD cameras, the first ever mounted on a microsatellite, and the cosmic particle detection instrument were developed by the SaTReC team and transferred to the SSTL.[274]

"Another Opening of Heaven"

On August 11, 1992, KITsat-1, weighing 48.6kg, was successfully launched from Kourou, in French Guiana, by the Ariane 42P rocket as an auxiliary payload to TOPEX/POSEIDON, the French spacecraft designed for oceanography measurements. Choi

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[273] SaTReC, *Development Study of a Small Satellite for Science Technology Experiment (IV)*, MOST (1994) (in Korean)

[274] Choi Soon Dal, *This Boy Would Launch the First Korean Satellite after 48 Years*, p. 204.

renamed KITsat-1 Uribyul-1[Our Star-1] in April 1992 in response to a newspaper reader's request to give the first Korean satellite a Korean name.[275] The achievements of Uribyul-1 were feted in all the media as a source of pride for the country. On the day KITsat launched, a Korean runner Hwang Youngjo won the gold medal in the marathon race at the Barcelona Olympic Games in Spain. South Korea finished 7th from the top overall in Barcelona. President Roh highly praised SaTReC, making a special address on TV. "SaTReC had helped open a new era of space exploration and indeed demonstrated the level of Korean science and technology to the world," he said, adding that "we finally have launched a dream of being among the top 7 countries in science and technology toward the new millennium on the day we ranked 7th in the Olympics."[276] As it happens 7th in the world was the object of a major R&D effort nationwide at the time. In 1990, President Roh proclaimed the 'G7 project' intended to catch up with advanced industrialized countries by the beginning of the 21st century.[277] It supported dozens of research programs in key technologies including aerospace.

The scientific mission of the first national satellite was also expected to promote space awareness among decision makers and stimulate public interest. On National Foundation Day, October 3, 1992, a congratulatory poem entitled "A Second National Founding" by poet Jo Byoungha[278] and songs by elementary school students could be heard

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[275] "Choi Made the Name of the 'Uribyol-1'," *Kyunghyang Daily*, (April 30, 1992).

[276] "President Roh Tae-woo, Congratulatory Message for the Successful Launch of KITSAT-1, the First Science Satellite," National Archive of Korea, available online: http://pa.go.kr/online_contents/speech/speech02/1314539_4248.html (last accessed on October 15, 2015)

[277] Sung Keuk Hahm and Da Sung Yang, "A Study of the Presidential Leadership for Science and Technology in Korea: Comparative Study Before and After the Political Democratization in 1987," *Korean Political Science Review*, Vol. 46, No. 1 (2012): 5-38, p. 19.

[278] Another Opening of Heaven (translated by author)

on FM435MHZ when the satellite went over the country.[279] The first satellite image of the Korean peninsula from *Uribyul*-1 was also released to the public that day. During the Daejeon Expo in Korea, an international exposition held between August 7 and November 7 in 1993, the model of KITsat-1 was exhibited, and a ground station was set up and operated as a demonstration. The exhibition of space exploration artifacts at the 1993 Daejeon Expo, such as a mock-up of KITsat-1 and 2, was very popular, drawing 16,000 visitors a day on average.[280]

KITsat*l*-1 was also criticized by some for being a satellite developed using the "technology of others." It is not our star but someone else's star since domestic parts account for only one percent of the total components of the satellite, they said. A journalist remarked that KITsat-1 was a co-product created by the Bureau of Public Information and the media to sensationalize a presidential legacy,[281] referring to an interview with Yi Sanghee who led the legislation of the 1987 Act and the establishment of KARI. KITsat-1 was "nothing more than a mere a scientific satellite which foreign experts assess as an expensive toy," he said. A professor at Seoul National University, Kim Seoung Jo, who became the director of KARI in

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Wooribyeol -1 finally soared into space through the sky.
Our country opened the heaven again, and now it is into space.
Ah, the splendid and great power of Korea.
Higher and wider to space, our country, for now, is opening its bright territory.
Freely send and receive the clear, bright and broad news from the universe.
With Uribyul-1 as our hear of dream,
We shall attain prosperity clearly, brightly, and widely forever.

[279] SaTReC, *We Launched a Star: Young Geniuses' Dream and Ambition for Uribyul-1*, (Mihaksa, 1993), p. 210 (in Korean)

[280] Memorial Project for Daejeon Expo '93, http://www.expo93.co.kr (last accessed on October 18, 2015)

[281] Hyunsook Lee, "the Bureau of Public Information Launched the Uribyul-1," *Monthly Gil*, Vol. 92, No. 10 (1992): 128-131. (in Korean)

the late 2000s, worried that "such exaggerated publicity might distort the flow of funding for science and technology."[282]

Dealing with the Criticism

In the face of such criticisms, SaTReC took on the burden of domestically producing complete satellite parts and developing an indigenous model as soon as possible. It started the next micro-satellite KITsat-2 project on 13 September, 1992 with about 40 researchers including 9 members from the KITsat-1 team. Although KITsat-2, also named Uribyol-2, weighing 47.5 kg was nearly identical to the first satellite, KITsat-1, the challenge for SaTReC was to develop and build its own spacecraft from start to finish, replacing the technology used in the KITsat-1 mission with domestic components. Choi laid down three ground rules for KITsat-2 as follows;[283] 1) definite improvement on the problems of KitSat-1 2) use of domestic components to the utmost 3) development of indigenous satellite bus system. Both KITsat 1 and 2 carried simple space science experimental modules to measure radiation particles, but they were in such different orbits that together they could provide a unique opportunity to study the effects of the radiation environment as characterized by the orbit. KITsat 2 was launched by Ariane 4 on September 28, 1993, as an auxiliary payload to SPOT-3 and successfully placed into orbit. SaTReC used 827 domestic parts out of approximately 12,000 parts for KITsat-2, including the KAIST Satellite 32bit-computer

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[282] Kim Seungjo, "A Comment on Exaggerated Publicity of Science and Technology for Uribyul Launch," *Daehak Shinmoon* (Seoul National University, October 26, 1992) (in Korean)

[283] SaTReC, *Development Study of a Small Satellite for Science Technology Experiment (IV)*, (MOST, 1994) (in Korean)

(KAScom), a digital signal processing experiment with a 200m resolution, an Infrared Sensor Experiment (IREX), etc.[284]

Based on the achievements of the KITsat-1 and 2 missions, SaTReC began to develop KITsat-3 in 1994. With the KITsat-3 mission, SaTReC demonstrated its technological know-how in the design, development and operation of microsatellites for high-quality Earth observations. Further, SaTReC acquired the technology for 3-axis attitude control, the embodiment of high-speed data transmission using the X-band, and developed an Earth observation camera with a ground resolution of 13m. In addition to the multichannel Earth observation camera, KITsat-3 had a payload that allowed for space environment monitoring and scientific research. After almost being cancelled (see below) KITsat-3 was launched on May 26, 1999, by an Indian PSLV rocket.[285]

In addition to the accumulation of technical skills, the indigenous achievements of the KITsat program marked the beginning of commercial space activities in South Korea. In January 2000, the SaTReC Initiative (SaTReC-i) was established as a space technology spin-off of KAIST, led by the team of experienced engineers who carried out the successful development of the first three microsatellites in South Korea. SaTReC became the technological backbone for the KARI space systems, with the Science and Technology Satellite (STsat) program in the 2000s, while the SaTReC-i became the commercial arm of the Korean satellite industry through its microsatellite platforms and payload development in

[284] Choi Soon Dal, “Development of KITsat: The First Korean Satellite and Space Development Strategy,” *The Journal of Korean Association of Air and Space Law* 6 (1994), p. 271. (in Korean)

[285] Kim Kyounghee, “Uribyol, Seed of the Domestic Space Development,” *Satellite Communications and Space Industries* Vol. 13, no. 1 (June 2006): 40–45. (in Korean)

the 2000s.[286] In the early 1990s, Korea was one of the first to send engineers to Surrey to build satellites. South Korea has since cultivated a national satellite program, and has gone on to train engineers from other developing countries.

KT – the Groundwork for Communication Satellite

South Korea began to advance toward new capabilities with the KOREAsat series of geostationary communications satellites with the intention of offering permanent satellite broadcasting services (DBS) as well as a variety of voice and data communication services to a nationwide audience. The satellite is also called *Mugunghwa* which means the 'Rose of Sharon,' the country's national flower. In a gesture evocative of the national pride associated with development of its own satellite technology, this name for the country's first communication satellite was chosen from among submissions from citizens nationwide. KOREAsat had to establish the groundwork for South Korea to enter the worldwide business of space communications and to push the country into the rank of technologically advanced nations in geosynchronous orbit.

Buying Satellites from Foreign Companies

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[286] The SaTReC-i developed and delivered Lazak-Sat, a 100kg class micro-satellite for remote sensing, for Malaysia in 2005 and is the only Korean company thus far to have developed and exported a satellite independently of outside technological assistance. "SaTReC-i Homepage", n.d., http://satreci.com/eng/ds1_1.html?tno=4.http://satreci.com/eng/ds1_1.html?tno=4 (last accessed on October 18, 2015)

As mentioned earlier, in the early 1980s South Korea was keen to develop a communication satellite for broadcasting the 1988 Seoul Olympic Games. The project was dropped when it was judged that the economic conditions for satellite business in Korea were not yet mature. The climate changed dramatically in the late 1980s, however. The government proposed restructuring the broadcasting and communication industry, mainly through the introduction of a competitive market, launching 27 channel cable television and a 12-channel capacity KOREAsat DBS project, and forming a global network of Korean television channels to promote Korean culture and cultural products world-wide. In addition, it was believed that DBS would play a significant role in future communications between North and South Korea, which currently have different and incompatible broadcasting and communication systems. The death of North Korean leader Kim Il Sung in mid-1994 underscored what was thought to be the single greatest environmental change in Korean national reunification.[287]

Against this background, the government officially announced the KOREAsat project in 1989, and KT was chosen as the sole investor for the project and owner of the satellite in July 1990. Created as a public enterprise wholly owned by the government in 1982, KT had been responsible for the operation of Korea's telecommunications networks and various other activities. KT began a satellite communication service in September 1992 by leasing one

[287] James F. Larson, "Telecommunications for the 'New Korea'," *Asian Journal of Communication*, Vol. 4, No. 2 (2009): 33-59.

transponder of the INTELSAT-VA system, which enabled KT to acquire operational technology and created service demand in the future for KOREAsat.[288]

The plans for KOREAsat crystallized when KT asked satellite suppliers to supply a turnkey satellite communications system operating in Ku-band frequencies for a total investment of $260 million.[289] The KOREAsat project included two stages of competitive bidding. A consortium to manufacture the satellites was chosen from among four Korean industrial teams and domestic companies that submitted joint proposals with foreign partners: GE Astro (now Lockheed Martin), Space Systems/Loral and Hughes (Boeing) in the U.S., and British Aerospace (Astrium Satellites) in the U.K. In December, 1991, a consortium consisting of Goldstar information & Communications, Korean Air, and GE was selected for two AS-3000 series satellites. In bidding to select a consortium to launch the satellites, four companies (McDonnell Douglas, General Dynamics, Arianespace and Glavkosmos) together with domestic companies participated. KT signed a contract with a consortium made up of Halla Heavy Industry and McDonnell Douglas that would launch the satellite using the Delta II 7925 rocket in August 1992. The launch contract included technology transfer conditions, and engineers were involved in all processes ranging from designing to manufacturing the satellites and launch vehicles for three years from September 1992; 30 engineers were selected by KT, KARI, ETRI (Electronics and Telecommunications Research Institute) and industries (Korean Air, Samsung Aerospace, Hyundai Electronics Industries, Hyundai, LG,

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[288] Doo Hwan Kim, "Liability for Compensation for Damage Caused by Space Debris," in Chia-Jui Cheng (ed.), The Use of Air and Outer Space Cooperation and Competition: Proceedings of the International Conference on Air and Outer Space at the Service of World Peace and Prosperity, Held in Beijing from 21-23 August 1995, (Martinus Nijhoff Publishers, 1998): 305-342.

[289] Brain Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, (London; Chichester: Springer; Praxis, 2009): p. 513.

Korean Broadcasting System) for the satellites and 24 engineers were selected for the launch vehicles.[290]

Recovering from Partial Failure

On August 5, 1995, the KOREAsat-1 was launched from Cape Canaveral, Florida. The launch of the first Korean communication satellite was also planned as a national event for the 50th anniversary of independence on August 15. However, the launch of KOREAsat-1 was a partial failure. One of the three air-started solid motors failed to jettison, resulting in KOREAsat-1 being placed in an orbit that was about 6,351 km short of its planned GTO apogee of 35,786km. The failure was attributed to an explosive transfer line (a type of detonation cord) possibly having been exposed to high temperatures due to a lack of insulation on the rocket's booster separation circuits.[291] After 49 consecutive successes, it was the first Delta failure since 1986.[292] The flawed launch required the satellite to use much of its maneuvering and attitude control propellant to reach its final geostationary orbit over the Solomon Islands 25 days after the launch. This resulted in a reduction of its expected 10-year-and-seven-month lifespan by more than half.[293]

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[290] KT Satellite Project Team, *White Paper of KOREAsat-1*, (KT, 1999). (in Korean)

[291] Ibid.

[292] ED Kyle, "Delta 2 Productive Years: Fourteenth in a Series Reviewing Thor Family History," Space Launch Report (updated 03/04/2013) http://www.spacelaunchreport.com/thorh14.html (last accessed on October 18, 2015)

[293] KT Satellite Project Team, *White Paper of KOREAsat-1*, KT (1999). (in Korean)

Although KT could have abandoned the spacecraft and received an insurance payout due to the accident in accordance with the contract, it took into consideration KOREAsat's symbolic meaning and decided to maintain ownership, receiving 60% of its claim.[294] Fortunately, KOREAsat-2, which was manufactured as a backup for KOREAsat-1, was successfully put into orbit on January 14, 1996, so that KT did not suffer any setback in providing satellite services. Thus, the KT started its operation of the KOREAsat-2 from July 1996 two years earlier than the original plan. Both KOREAsat-1 and 2 had a 12-channel capacity with three transponders for broadcasting, with each transponder delivering four digital channels. With this launch, South Korea became the 22nd country in the world with its own domestic satellite and the second with a digital direct broadcast satellite (DBS) system.[295]

As KOREAsat-1's lifetime was shortened, KT decided to advance the launch date of KOREAsat-3, which would carry 33 transponders, so accommodating the capacity of KOREAsat-1 and 2.[296] The KOREAsat-3 program marks the continuation of a long-term relationship between KT and Lockheed Martin, which began with KOREAsat-1 and 2. In addition to providing the satellite, the program also involved upgrading existing ground systems. For a total of $ 216 million, KOREAsat-3 was manufactured with the participation of a Korean team that included: Daewoo Heavy Industries, Doowon, ETRI, Halla

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294 "A History of Mugungwha Satellite," *I-news24* (August 22, 2006) (in Korean)

295 Seunghye Sohn, "Lost in the Sky: the KOREAsat Project," *Telecommunications Policy* 24 (2000): 189-201.

296 *30th Anniversary KT: 1981-2011* (KT 2012), p. 451 (in Korean)

Engineering and Heavy Industries, Hyundai Electronics Industries, KARI, and Korean Air.[297] Technical personnel of these companies were involved in the whole process of satellite design and manufacture in technical cooperation with Lockheed Martin. By participating in satellite production subcontracting of $1600 million, they contributed to boosting the level of domestic aerospace technology.[298]

On 4 September, 1999, KOREAsat-3 was launched by an Ariane 42 rocket from French Guyana to replace the expired KOREAsat-1.[299] The satellite, weighing 2,790kg at launch, was fitted with a steerable antenna to improve coverage capability on the Asian continent. While KOREAsat 1 and 2 were designed solely for domestic purposes, so could not relay any international signals, KOREAsat 3 had a wider footage area covering the North-East region of Asia and a longer life time (15 years). In December 1999, KOREAsat-3 completely replaced the services provided by the KOREAsat-1, and in May 2010, the satellite was sold to Asia Broadcast Satellite (ABS) and renamed ABS-7.[300]

The KOREAsat project established the groundwork for South Korea to enter the worldwide business of space communications and to push the country into the rank of

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[297] "Koreasat 3 (Mugungwha 3) → ABS 7" Gunter's Space Page. http://space.skyrocket.de/doc_sdat/koreasat-3.htm (last accessed on October 15, 2015)

[298] Choi Soon Dal and Kim Doohwan, *A National Strategy for the Advancement of Space Observation Technology: Focused on Scientific Observation Satellite*, (SaTReC, 1995), p. 147. (in Korean)

[299] KOREASat-1 became superfluous and was sold to a French satellite operating company. It was sold by KT in mid-2000 to the Europe Star company owned by Alcatel, before becoming in 2005 part of the Panamsat/Intelsat system in order to develop Ku-band services in Eastern Europe. KOREAsat-2 was sold to the Asia Broadcast Satellite company of Hong Kong, which operated it for occasional services under the name of ABS-1A. Gunter's Space Page. http://space.skyrocket.de/doc_sdat/koreasat-1.htm (last accessed on October 15, 2015)

[300] *30th Anniversary KT: 1981-2011* (KT, 2012) p. 129 (in Korean)

technologically advanced nations in regards to the geosynchronous orbit. During the KOREAsat program period, KT and other involved industries accumulated satellite technology through on the job training and monitoring work with the cooperation of contractors. Their experience established the groundwork for the next generation of satellites.

KARI- The Key Institute of the Korean Space Program

KARI realized the South Korean space dream. On October 10, 1989, less than three months after the creation of SaTReC, the KARI was established as the key institute to "promote advanced aerospace research activities as well as to create a competitive air and space industry" in South Korea. It was a subsidiary of the Korea Institute of Machinery & Metals (KIMM) and it became an independent aerospace agency responsible for the long-term development of the Korean space program in October 1996. KARI's main objectives included advancing indigenous satellite technology in space applications, especially for Earth observations, and ensuring autonomous access to space with sounding rockets and satellite launch vehicles.[301] While SaTReC developed Korea's capability in the niche of experimental microsatellites (KITsat) using miniaturized components, and KT acquired operational technology of communication and broadcasting satellites (KOREAsat), KARI worked specifically on space applications with the Korean Multi-purpose Satellite (KOMPsat) program and on rocket propulsion with the Korean Sounding Rocket (KSR) program.

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[301] "KARI in History," in KARI homepage, http://www.kari.re.kr/data/eng/contents/About_KARI_004.asp?catcode=1313000000&depthno=3 (last accessed on October 18, 2015)

KOMPsat to Have "Multi-Purposes"

Despite its ambitious plan to cover all areas of the aerospace sector,[302] the KARI continually struggled to clearly define its mission and to secure funds in its early years. It was supposed to integrate the Aerospace Research Center of KIMM with the Space Engineering Section of ISSA with only 44 personnel. KARI started two main projects, a small aircraft project named Changong-91 and a Korean Sounding Rocket,[303] which was already developed by the existing research personnel transferred from KIMM and ISSA. Nevertheless, repeated failures to take on new projects dulled its enthusiasm to be the main player in the national aerospace sector.[304] KARI was thwarted by ADD in its attempt to participate in the Korean Fighter Program (KFP), which was to purchase the McDonnell Douglas FA-18 to improve the ability of the Republic of Korea to defend itself and support its own defense systems.[305] Regarding the scientific satellite project, KARI promoted it as a joint project with SaTReC, but the government concluded that SaTReC should assume full charge of the project named KITsat.

In this situation, KARI needed to plan a new large project for its survival. Indeed once it lost the leadership of the scientific satellite project, KARI was concerned that its KSR

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302 KARI, *Research on Essential Technology and Planning for the Space Development*, (MOST, 1990) (in Korean)

303 *10 Years of KARI*, (KARI, 1999), p. 78. (in Korean)

304 "KARI in Hibernating One Year after its Foundation," *Hankyrae Daily* (December 18, 1990) (in Korean)

305 KARI, *Research for the Development Strategy of the National Aerospace Technology through KFP Project* (MOST, December 1990) (in Korean)

project might be suspected as being for military purposes by other advanced countries.[306] At about the same time the MND and the ADD were interested in independently developing a satellite that could monitor North Korea's nuclear weapons and missile programs.[307] For these reasons, KARI hastily decided to embark on a remote sensing mission from space not only to meet the needs of South Korea in geo management and environmental control but also to conduct permanent observations of neighboring North Korea; they named the satellite project the Korean Multipurpose Satellite (KOMPsat). Technically this meant that the same bus could be utilized for many different applications—mainly for low Earth observations but also extended to geostationary earth orbit (GEO) applications.

The new government that took office in 1993 announced the Five-Year Plan for the New Economy which included the goal of promoting the aerospace industry so as to enter the ranks of the top 10 countries in that domain.[308] Along with the plan, Hong Jaehak, the director of KARI reported the Development Strategy for the Aerospace Industry to President Kim Young-sam during his presidential visit to the manufacturing factory of Samsung Aerospace at *Changwon* in *Kyoungnam* Province on March 12, 1993. The President endorsed the Strategy which included KARI's plan for two big projects, one for developing a mid-size aircraft with 50 seats the other a LEO (low earth orbit) observation satellite, KOMPsat.[309]

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[306] Interview with Hong Jaehak (3 July, 2014)

[307] "Planning to Develop Military Satellite," *Hankyrae Daily* (August 30, 1992)

[308] KOTRA, *Korea Trade & Business* 11 (1993), p. 37.

[309] "3 Trillion Won Investment for Aerospace Industry," *Mailkyoungjae Daily* (March 12, 1993) (in Korean)

The KOMPsat program was initiated in May 1994 as a major investment in space research in KARI as well as South Korea. It was developed from November 1994 to January 2000 and its total budget was 224.2 billion won (about $ 0.2 billion).[310] Its main objective was to develop and operate a national space segment for Earth observation as well as to indigenize the main components in the spacecraft and payload for use inKOMPsat-2. KOMPsat-1 was planned to carry a panchromatic camera of 6.6m resolution, a six-band ocean-scanning multispectral camera with 1km resolution and 800km swath, and physics sensors. In technical terms, they were called Electro-Optical Cameras (EOC), an Ocean Scanning Multispectral Imager (OSMI), and a Space Physics Sensor (SPS).

EOC had a cartography mission to provide images for the production of scale maps, including digital elevation models, of the Korean peninsula from a remote earth location in the KOMPsat orbit. OSMI's mission was worldwide ocean color monitoring for ocean ecological observation, ocean resource management, and ocean atmosphere environment analyses. SPS consisted of two observation sensors, a High Energy Particle Detector (HEPD) to study the effects of the radiation environment on microelectronics and an Ionosphere Measurement Sensor (IMS) to measure densities and temperatures of electrons in the ionosphere and to monitor ionospheric irregularities.[311] The data from these instruments would provide valuable services to remote-sensing users in various fields of applications, including research on Earth resources and surveys of natural resources, conducting

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[310] KARI, *White Paper of KOMPsat-1*, (1999), p. 51. (in Korean)

[311] Hong-Yul Paik et al., "Characteristics of the KOMPsat-1 Payloads and its Application," in *Microsatellites as Research Tools: Proceedings of COSPAR Colloquium on Microsatellites as Research Tools*, held in Tainan, Taiwan, 14-17 December 1997, Fei-Bin Hsiao (ed), Institute of Aeronautics and Astronautics, National Cheng Kung University, (Pergamon, 1997): 247-257.

surveillance of large-scale disasters and mitigation efforts, collecting high-resolution images for South Korea's GIS (geographical information system) and contributing to the publication of printed and digitized maps. [312]

Strategy for the "Koreanization" of KOMPsat

KARI relied on international cooperation to accelerate the KOMPsat program. In March 1995, it signed a contract with the U.S. Company, TRW to develop KOMPsat jointly, and in December 1996 it worked with Orbital Sciences Corporation (OSC) to launch the satellite using a Torus rocket. KOMPsat was KARI's first joint satellite development project to acquire expertise in designing, building and using satellites as well as a key step forward for South Korea in its quest to become a self-sufficient, space-faring nation. Thus, KARI desperately negotiated with TRW to secure stable technology transfer and to acquire technology ownership.

For example, the contract was to build two satellites, a flight model (FM) and a proto flight model (PFM), based on TRW's modular, lightweight satellite bus technology. TRW would conduct assembly, integration and test (AIT) of the PFM in the U.S. in the presence of KARI and Korean industry engineers, while KARI would do the same for the flight model at the KARI facility drawing on the skills obtained from TRW. To ensure that TRW shared technology as it had promised, KARI required that TRW pay an indemnity if the user [KARI]

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[312] Brian Harvey, Emerging Space Powers the New Space Programs of Asia, the Middle East and South America (London; Chichester: Springer; Praxis, 2009), p. 503.

could not operate the FM normally after launch.[313] Since the successful contract with KARI was very significant to TRW, which had a strong commitment to develop new Asian markets, the U.S. firm could not but agree with the offer.

Under the contract with TRW, KARI mobilized its researchers; 25 technical staff members and some 50 researchers from KARI joined the 125-member TRW team in order to study satellite design data at TRW and learn about satellite systems and components. Seven Korean industrial enterprises also dispatched 30 engineers for the same program for the "Koreanization" of the satellite components.[314] Through TRW's 'Train-the-Trainer' program engineers shared office space, ensuring strong day-to-day collaboration on the project. Korean engineers developed 30 out of 48 major components including solar panel support, thermistor, flight software, piping system, and S-band antenna and transponder.[315] The Korean industrial partners produced some hardware for the satellites' electrical, thermal, structural, and propulsion subsystems in Korea.[316] TRW provided on-site assistance to these Korean partners to ensure that the components were properly produced and prepared for integration into the satellite.

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313 Ryu Jangso, "Behind story of Arirang-1 Development," *KASA Magazine* Vol. 6, No.1 (2012): 12-23. (in Korean)

314 Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, pp. 503–504.

315 Byung Kyo Kim, "An Overview of the Korea Multi-Purpose Satellite, in Fei-Bin Hsiao (ed), *Microsatellites as Research Tools: Proceedings of COSPAR Colloquium on Microsatellites as Research Tools*, held in Tainan, Taiwan, 14-17 December 1997, Institute of Aeronautics and Astronautics, National Cheng Kung University, (Pergamon, 1997): 66-73.

316 Ibid; KOMPsat program was performed by participation of Korean industries: Korean Air & Doowon for structure and mechanisms, Smasung Aerospace for telemetry, command and ranging, Daewoo H.I. for attitude and orbit control, Hyundai Aerospace for electrical power, Halla H. I. & Hanwha Ltd. for propulsion SaTReC, ETRI, Seoul National University, KAIST, Inha University, Yonsei University etc.

Thanks to the joint development with TRW, KARI could mobilize enough infrastructure, manpower, and technology to develop satellite systems for practical applications.[317] On 21 December, 1999, KOMPsat-1, weighing 510kg, was launched by a solid-fuelled Taurus launcher provided by Orbital Sciences into an orbit at 685km. It was renamed Arirang-1, which is the name of a Korean folk song sometimes considered to be the unofficial national anthem of Korea. It represented South Korea's first step toward an independent Earth-imaging capability suitable for civilian remote sensing and future military reconnaissance.[318]

Competition for the Satellite Leadership between SaTReC and KARI

By successfully supervising the organization of the KOMPsat program, the first fully government-led Korean space development project, KARI began to get the upper hand over SaTReC in planning and undertaking national satellite projects. Indeed, there were serious confrontations between SaTReC and KARI as regards taking the leadership of national space development.[319] Until the mid-1990s, when SaTReC had successfully developed and

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317 Hong-Yul Paik, "Space Development in Korea," in Dana Johnson and Ariel Levite (eds.)*Toward Fusion of Air and Space: Surveying Developments and Assessing Choices for Small and Middle Powers*, (RAND, 2003): 107-118.

318 James Moltz, *Asia's Space Race : National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2011), p. 144.

319 Regarding the conflict and competition for the satellite leadership between SaTReC and KARI until the end of 1990s, there exist two solid researches to be reviewed in this chapter. Euikyoung Tae, "A Study of the Process of Obtaining and Improving Satellite Technologies at KAIST SaTReC," *Journal of the Korean History of Science Society,* Vol. 37. No. 1 (2015): 85-117 (in Korean); Seungmi Chung, "Looking into SaTReC to Track Korean Space Development: From the Only One to One of Them," Master Thesis of Graduate School of Science and Technology Policy, (KAIST, 2012)

launched KITSAT-1 and KITSAT-2, KARI did not show marked achievements in the satellite research field, even though it was a national research institute. In 1993, SaTReC negotiated with the Chinese Research Institute of Space Technology to develop a joint satellite for its next project KITsat-3. However, the government objected that KITSAT-3 duplicated KARI's KOMPsat project and terminated funding for the KITsat-3 project.

This resulted not only in the cancellation of a collaborative satellite development project between SaTReC and China, but also a crisis in the development of KITsat-3. The government began to insist that the representative of the Korean space effort should be the national research institute, KARI, and it pressured SaTReC towards downsizing or even shutting down to avoid overlapping investments. SaTReC managed to survive thanks to the timely inauguration of a Minister of Science and Technology, Jung Geunmo who was a strong supporter of SaTReC's achievements,[320] and very much favored the KITsat-3 project, which was reinstated and finally successfully completed in 1999.

SaTReC's intention to remain as an autonomous organization while expanding the scope of its research soon came into conflict again with a government that wanted to fully control and manage the long-term planning of the nation's space development directly under KARI's leadership. Seo Jeonguk who was inaugurated as Science and Technology Minister succeeding Jung Geunmo in March 1999 proposed that SaTReC merge with KARI to reduce costs. Most SaTReC members reacted strongly against the government's proposal and refused to move to KARI because they wanted to continue doing pure research in an autonomous organization rather than in what they saw as a bureaucratic one.

[320] Notably, Jung and Choi got related by marriage.

After going on a one-month strike, SaTReC's founders decided to create a satellite company, SaTReC-i, to continue their work. Hardly even an affiliated research center of KAIST not KARI, the members left at SaTReC had to reduce the scope of their research and focus more on training satellite research experts. Instead of receiving funding directly from the government, SaTReC obtained funding from KARI. Its following project, KITSAT-4 was turned into KARI's Science Technology Satellite-1 (STsat-1) project though SaTReC did actual development work for the satellite. As the end of the day the conflict between SaTReC and KARI resulted in a strengthened government-led system in which KARI was the representative research institute and SaTReC a research center focusing on the education and training of satellite engineers.

KSR-1 and 2 Based on the Infra of *Paekkom*

Before embarking on the acquisition of satellite technology through KOMPsat, KARI started to develop rocket systems for indigenous access to space in 1990, with the KSR program as the first step to a national satellite launch vehicle. The program included KSR-1, KSR-2, and KSR-3, with a total of five launches performed. Two flew in the KSR-1 series, two in KSR-2, and one in KSR-3. The main mission objective was "to provide an opportunity for scientists to research earth sciences and astrophysics and to improve Korean rocket development technologies, including payload instruments, flight systems, ground systems, operational techniques and interfaces between sub-systems."[321] All of the KSR series craft were developed by KARI without technically significant support from foreign countries.

South Korea acquired the solid-rocket technology through development of the K-1 missile (*Paekkom*) by the ADD in 1970s. It had not conducted rocket research for scientific purpose apart from that done with a few experimental pencil rockets developed by the Korea Air Force Academy. There was also a study made of the basic disciplines necessary for the design of the sounding rocket in the early 1980s.[322] South Korea's first authentic research into sounding rockets for scientific purpose started with the Korea Space Science and Technology Development Program ISSA announced in 1987.[323] According to the plan, the final purpose of Korean rocketry activities had to be to develop not a ballistic missile, but a small launcher that could place a multi-purpose satellite of several hundred kilograms in orbit in a decade. The Space Engineering Section of ISSA led by Dr. Ryu Jangsoo conducted some basic theoretical research for preliminary design of a 2-stage solid propellant sounding rocket.[324]

Based on the research, Dr. Ryu's team initiated a 3-year plan for a sounding rocket program with the budget of 47.3 million won (about 40,000 dollars) in February 1987. This

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[321] KARI, *Research and Development of Sounding Rocket(I)*, (MOST, 1991) (in Korean)

[322] KAIST, *Survey on Basic Technologies for Development of Sounding Rocket System* (1987) (in Korean)

[323] ISSA, *A Study on the Korea Space Science and Technology Development Program*, (MOST, May 1987), p. 14. (in Korean)

[324] ISSA, *Research on Basic Technologies of Sounding Rocket System*, (MOST, 1988) (in Korean)

was the first sounding rocket project in South Korea funded by the government.[325] In the first year, the specifications of the sounding rocket were fixed. At the design stage, the main rocket could reach about 100-150km with a 150kg payload. The diameter of the selected rocket motor was 0.42m, the overall length 7.18m, and weight 1240 kg.[326] In the 2nd year, the ground test model was developed and tested by the team, which was transferred to KARI, newly established in December 1989.[327] They succeeded in manufacturing and static firing testing of the booster motor on April 26, 1990. Through these researches, the essential technologies were developed for a sounding rocket that would be used in the KSR program, itself the first step to a national satellite launch vehicle.

As the key institute to the promote national space plan, KARI decided to drop ISSA's 3 year plan, and officially started the KSR-1 project with a 2.85 million dollar budget in July 1990.[328] The aim of KSR-1, also named KSR-420s[329], was to develop the technologies for a solid-propellant sounding rocket capable of reaching an altitude of 80-90km carrying a scientific payload of about 50-70kg weight. Dr. Ryu moved to KARI and continued to be the general manager for the KSR-1 project. For the development and manufacture of KSR-1, the rocket team used the infrastructure and human resources skilled in the ways of modern

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[325] "1987 Specific R&D Projects Selection: Studies on High-altitude Sounding Rocket Development," MOST (Machinery 16042-1795, 19 February, 1987) from Kim Doohwan's private archive (in Korean)

[326] ISSA, *Research on Essential Technologies for the Development of Sounding Rocket (I)*, (MOST, 1989) (in Korean)

[327] KARI, *Research on Essential Technologies for the Development of Sounding Rocket (II)*, (MOST, 1990) (in Korean)

[328] KARI, *Research and Development of Sounding Rocket (I)*, (MOST, 1991) (in Korean)

[329] The name of the rocket, KSR-420S stands for the single-stage Korean Sounding Rocket with its body diameter of 420mm. Interview with Chae Yonsuk (November 26, 2014)

industrial production created through the efforts to develop the K-1 missile in 1970s. For example, Hanwha played a key role in managing the development of propellants along with Samsung Aerospace and Daesung Precision. Doowon Heavy Industry manufactured flight body parts and a launch pad. The ADD provided the KARI's rocket team with its ground test facilities for combustion tube and propellant tests.[330]

An ozone sensor was the main scientific instrument on board. It would monitor the ozone layer and observe the ionosphere over the Korean peninsula. The sensor consisted of four radiometers for measuring the attenuation of solar ultraviolet radiation as a function of altitude during ascent. ISSA and the Korea Research Institute of Standards and Science (KRISS) developed the ozone sensor with universities such as the Seoul National, Yeonsei and Kyounghee Universities.[331] The KSR program thus sought to provide the opportunity for Korean scientists and engineers to research Earth sciences and astrophysics as well as to improve Korean rocket development technologies, including payload instruments, flight systems, ground systems, operational techniques and interfaces between subsystems.

On June 4, 1993, KARI launched the first KSR-1 from the *Anheung* launching site in the central of *Chungcheong* Province. This first Korean indigenous sounding rocket was unguided, single staged, 6.7m long, 42cm in diameter, and weighed 1.1 tons. It attained an altitude of 39km with the solid propellant. Two stratospheric ozone profiles successfully measured the ozone concentration between 15 and 30km over Korea using rocket-based solar absorption UV radiometry. The second KSR-1 which was launched on September 1, 1993,

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[330] Interview with Ryu Jangsoo by author (June 10, 2015)

[331] ISSA, *A Study on the Scientific Instrument and its Application to the Sounding Rocket*, (MOST, 1991) (in Korean)

and attained a 49.4km altitude, also successfully obtained the ozone profile.[332] From the results from two KSR-1s, it was found that the maximum of the ozone distribution occurred near 25km, which was quite consistent with the mean value in the mid-latitude regions.[333]

KARI developed the KSR-2 from December 1993 to June 1998 with a 5.22 million dollar budget.[334] Its general manager was Dr. Moon Shinhaeng, who had been responsible for the development of the *Hyonmu* missile in ADD during the 1980s, who also helped with the KSR-1 project, and finally moved to KARI in 1992. KSR-2 was the upgraded version of the KSR-1, with a two-staged solid propellant. Dr. Moon decided to use the rocket motor used in KSR-1 as KSR-2's second-stage rocket propulsion system. NKH-1's first-stage solid propellant motor, developed by ADD in 1970s, was used for KSR-2's first-stage rocket motor.[335] The inertial navigation system and flight termination system were newly developed for this system. The 2-ton KSR-2, 11m long, 42cm diameter, had a payload of an X-ray observation system developed at the Korea Astronomy Observatory of KRISS[336] between 1995 and 1997. The instrument, which was composed of detector and signal processing parts, was designed for the observation of compact X-ray sources.

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332 Gwang-Rae Cho et al., "The Korean Sounding Rocket Program," *Acta Astronautica* 62, no. 12 (June 2008): 706–714.

333 Ki-Yiung Lee et al., "Ozone Measurement s in the Stratosphere from KSR420s-1 and -2, *Journal of Astronomy and Space Science*, vol. 11, no. 1, (June 1994): 53-70.

334 KARI, *Research and Development of Sounding Rocket (IV)*, MOST (November 1997) (in Korean)

335 Yeonsuk Chae, "KARI's Sounding Rocket Program," *KASA Magazine*, Vol. 3, no. 2 (July 2009): 8–20. (in Korean)

336 In 1991, ISSA was reorganized into Korea Astronomy Observatory as a subsidiary of KRISS, and it finally became an independent institute, Korean Astronomy & Space Science Institute (KASI) in 1999.

The first flight on July 9, 1997 was a failure. An abrupt cut-off of telemetry and radar communication occurred 20.85 seconds after lift-off. After the analysis of the anomalies, some improvements such as separation of power sources between telemetry transmitter and radar transponder were applied on the second flight hardware. On June 11, 1998, the second flight of KSR-2 was successful reaching an apogee of 137.2km before falling into the Yellow Sea, 123.9km from the launch pad.[337]

Transition from Solid to Liquid

Although the final purpose of the KSR program was to develop the technology for a small launcher able to place a multi-purpose satellite of several hundred kilograms in orbit in 2000s, some wondered whether it might not violate the 1979 Memorandum of Understanding signed between the U.S. and South Korea that prohibited Seoul from developing ballistic missiles with ranges greater than 180 km.[338] This risk of dual-use was a lively issue in the late 1990s. The Commission to Assess the Ballistic Missile Threat to the United States, also called the Rumsfeld Commission, — an independent commission formed by the U.S. Congress at this time —,[339] reported that South Korea appeared to "want to obtain some level of technical independence from the United States on the missile issue so that it can build missiles to strike targets throughout North Korea." Jane's Strategic Weapons Systems also

[337] Chae Yeonsuk, "KARI's Sounding Rocket Program," *KASA Magazine*, Vol. 3, no. 2 (July 2009): 8–20. (in Korean)

[338] Regarding the 1979 Missile Guideline, See Chapter 2.

[339] Rumsfeld Commission Report: Commission to Assess the Ballistic Missile Threat to the United States, Appendix III: Unclassified Working Papers: System Planning Corporation: Non-Proliferation Issues—South Korea. (15 July, 1998)

stated that the "ROK could modify the KSR-1 to a ballistic missile to carry a 200 kg payload a range of 150 km." If South Korea converted the KSR-2 into a ballistic missile, "unconfirmed reports suggest that a secondary use might be for a series of ballistic missiles with ranges from 100 to 900 km."[340] Even a Korean news outlet suggested that it may have a military purpose and that "KSR is likely to be military behind its name of science."[341]

The key goal of the final KSR program, KSR-3, was to develop technologies applicable to a space launch vehicle. KARI's original concept for the first Korean space launch vehicle was to cluster indigenous KSR-3 rockets with a solid propellant to form a multistage launcher. However, in general since solid-fuel rockets can remain in storage for long periods and then reliably launch on short notice, they have been frequently used in military applications. A class of solid propellant rockets like KSR-3 can easily cause suspicion since they can be converted into a medium-range ballistic missile (MRBM) or an intercontinental ballistic missile (ICBM). Thus, to ensure the peaceful purpose of the KSR program, in December 1997, KARI embarked on its first liquid-fuel rocket project, KSR-3 with a total investment of 78 billion won ($64 million). Its main objective was "to acquire technological expertise in liquid rocketry and incorporate core technologies for the satellite launch vehicle in areas such as propulsion, guidance/control, and mission design."[342] The KSR-3 would have a pressure-fed type of liquid rocket engine using gaseous helium as a pressurizer, with LoX and kerosene as propellants.

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340 Jane's Strategic Weapons Systems (Jane's Information Group Limited, Surrey, UK, May 1997), JSWS-Issue 24.

341 Choi Soomook, "The Story of KSR-2 Failure," *Shindonga* (September 1997): 556-564. (in Korean)

342 MOST, "Research and Development of KSR- III, 1997-1997," National Archives of Korea (DA0122112) (in Korean)

The Challenge of Developing an Indigenous Liquid-rocket System

The manager of the KSR-3 was Dr. Chae Yonsuk who received his Ph.D. in aerospace engineering from Mississippi State University in 1987 and had been in charge of developing rocket engines for KSR-1 and 2. He noticed that the development of big solid propellant motors was considered unfavorable compared to the liquid propulsion system in view of economic and international non-proliferation policy environments in the early 1990s. This led him to start a small-scale research project on liquid propulsion systems in 1991.[343] Although the research was for the development of an apogee kick engine of liquid bi-propellants for satellite orbit change,[344] it was "an essential stage for us [KARI] to overcome the technology barrier of technologically advanced nations on space vehicles positively and to carry out serious space development effectively in the near future."[345] The apogee kick motor was designed to have a thrust of 1,790N (180kg) using hypergolic type of liquid bipropellants composed of a compound of triethylene amine and xylidine as fuel and nitric acid as oxidizer. The design performance was validated in the hot fire tests conducted in September 1995 and in October 1996.

However, it was a huge challenge to move from a small kick motor to the liquid-fuel rocket for space launch purpose. Chae's team faced significant technical challenges in developing a liquid-fuel rocket independently. It was virtually impossible for South Korea, not a member of international Missile Technology Control Regime (MCTR), to purchase

343 Interview with Chae Yonsuk (November 26, 2014)

344 KARI, *Research on Development of a Propulsion System for Satellite* (MOST 1992) (in Korean)

345 KARI, *Research on Performance Analysis of a Small Liquid Rocket Engine for Satellite Orbit Change (II)*, (MOST, 1996) (in Korean)

essential parts from advanced countries for the more controllable liquid-fuel rockets that were optimal for civilian space-launch purposes. [346] As they would design and manufacture all the parts for the rocket domestically, they had to increase the weight of the system several times, which meant designing a bigger rocket.

They initiated the project for a rocket with only 7 tons of thrust in December 1997. Two years later the thrust had almost doubled to 12.7 tons.[347] The project was accomplished by going through many development stages, such as subscale model and full-scale engine combustion tests, propellant feeding system tests, integrated power plant tests, and eventually a flight test. Each development stage underwent various technical difficulties and challenges that had to be resolved and verified with reliable processes to minimize trials and errors. Throughout the program, three different versions of full-scale chambers were designed and manufactured for the optimization of performance and weight. A composite baffle successfully suppressed troublesome high frequency combustion instability, one the major bottlenecks in development.[348]

Eventually, on 28 November 2002, the KSR-3 rocket 14m long, 1m in diameter, and weighing 6 tons was launched from the *Anheung* Proving Ground on the west coast of the

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[346] The Missile Technology Control Regime established in 1987 is an informal and voluntary association of countries which share the goals of non-proliferation of unmanned delivery systems capable of delivering weapons of mass destruction, and which seek to coordinate national export licensing efforts aimed at preventing their proliferation. http://www.mtcr.info (last accessed on October 15, 2015)

[347] Chae Yeonsuk, "KARI's Sounding Rocket Program," *KASA Magazine*, Vol. 3, no. 2 (July 2009): 8–20. (in Korean)

[348] Choi Hwan-Seok, Seol Woo-Seok, and Lee Soo-Yong, "Development of Liquid Propellant Rocket Engine for KSR-III," *Journal of the Korean Society of Propulsion Engineers*, Vol. 8, No. 3, (September 2004): 75-86 (in Korean)

Korean Peninsula. It used a pressure-fed-type liquid rocket engine with gaseous helium as a pressurizer, with liquid oxygen and kerosene as propellants. The payload on board the rocket included an ozone detector and two magnetometers along with other various sensors installed to measure physical characteristics such as temperature, pressure, strain, and acceleration. As it reached an altitude of 42.7km and flew a distance of more than 84km, the payload data were transmitted to the ground station in real time by an onboard telemetry system. The scientific instruments like a UV radiometer and magnetometer acquired data about ozone concentrations and the earth's magnetic fields during the flight.[349]

KSR-3 was the first Korean sounding rocket propelled by a liquid propellant propulsion system and it had been developed over 5 years using purely domestic technologies except several wind tunnel tests.[350] Even though KSR-3 had no complicated turbo-pump machinery, so that it had limited power and flexibility, KARI was able to achieve the basic technology required for building a liquid engine for a space launch vehicle.[351] The acquired technologies would be applied to the development of higher performance liquid rocket engines necessary for following space development programs such as that of a Korean Space Launch Vehicles (KSLV).

Conclusion

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349 Seung-Hyun Hwnag et al., "Overview of Scientific Payloads onboard the KSR-III Rocket," *Acta Astronautica*, Vol. 60, Issues 10-11 (May-June 2007): 880-888.

350 For example, stage separation system of KSR-3 was tested at S2ma wind tunnel, ONERA, France.Interview with Chae Yonsuk (November 26, 2014)

351 Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, (London; Chichester: Springer; Praxis, 2009), p. 512.

Although Korean rocket development for military use started in the 1970s, South Korea began to outline an economic rationale for moving the country into the field of space technology in the mid-1980s. Due to increasing international technology protectionism, Korean policy makers perceived the failure to escape from underdevelopment and to catch up with advanced industrial nations as one of the most serious risks to economic growth. In this atmosphere, they began to view space as a realm calling for cutting-edge technologies that South Korea had to master to join the ranks of the advanced countries. In the Long-term Plan for the Development of Science and Technology toward the 2000s, which first called for specific space-related projects, the Korean nation was *imagined* as a cohesive community of shared economic interests and developmental goals. Space development was a crucial constitutive element in this developmental national imagination, and the actors engaged in this plan were reminded that they had a responsibility to support and assist the state-led space policies. Based on the study, in December 1987, South Korean legislature finally approved the Aerospace Industry Development and Promotion Act, which included the first significant funding for space projects.

As the first Korean research institute to specialize in space development, ISSA played a pivotal role in planning national space programs in late 1980s. However, with the establishment of the KARI in 1989, which would become the main actor in the civilian space program, SaTReC in KAIST and KT emerged as the central figures and replaced the role of ISSA. Initially relying on the import of technology from foreign countries, South Korea soon aspired to attaining an autonomous and indigenous satellite capability for space development. Satellite development was initiated by SaTReC with the KITsat-1, which was developed in a collaborative program with SSTL, UK. South Korean then launched a broadcasting and telecommunication satellite KOREAsat-1 (1995) purchased from U.S. satellite company by KT, and a multipurpose observation satellite KOMPsat-1 (1999) jointly developed by KARI and the U.S. firm TRW. KARI also conducted several sounding rocket projects, KSR-1 (1992), KSR-2 (1998), and KSR-3 (2002) without technically significant support from foreign countries. The first two were solid propellant rockets, but the latter was a liquid propellant rocket.

The ADD and several government funded research institutes such as ETRI, KRISS, and KASI, and industrial firms such as KAI, Korean Air, Hanwha, Doowon Heavy Industirial, and SeTReC-I also strengthened their cooperation with these actors during the 1990s. In this process, the aerospace sectors have developed thanks to a strong commitment by a government intent on industrialization. For example, in October 1999, after many years of sensitive discussions, the government strongly suggested that Daewoo Heavy Industries, Samsung Aerospace and Hyundai Space Aircraft pool their aerospace operations into a new, independent company, Korean Aerospace Industries Ltd (KAI). The three firms hold equal shares in KAI for combined annual sales of approximately 700 million dollars, with a total employment of 3200 people. The goal was to build KAI into a total integrator for the development and production of aircraft and space systems by the merger of three leading aerospace companies.[352]

Bolstered by the progress in space technology for a decade since 1985, South Korea finally announced its first Basic Plan on Mid-to-Long-Term National Space Development on 30 April, 1996. Korean space policy was shaped so that the government makes decisions on a

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352 Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, p. 501.

long-term and mid-term plan, and then related organizations and private experts join the project and work on specific details.[353] The plan, which incorporates basic activities in space up to 2015, was the beginning of a comprehensive national space program. The long-term objectives of space development are to acquire the independent technological capabilities for space development and to join the top 10 countries in the space industry by competing in the global market. In order to accomplish these objectives, South Korea would develop 19 satellites by the year 2015, and launch KSLV-1 with a satellite developed independently at a local launch site in 2010.[354] Eventually, South Korea rushed into the 21st-century space race as an emerging power.

353 STEPI, *Study on the Efficient Implementation Mechanism for Korea's Space Development*, (MOST, 2006). (in Korean)

354 Doo Hwan Kim, "Korea's Space Development Programme: Policy and Law," *Space Policy* 22, no. 2 (May 2006): 110–117.

CHAPTER 5

Seeking National Prestige in Space 1998-2013

As of the mid-1980s, the South Korean government has taken advantage of the symbolism of space development as the national vision for science and technology, a vision which sees South Korea as being an advanced country in the 21st Century. The first dedicated Basic Plan on Mid-to-Long-Term National Space Development in 1996 included priority areas such as the development and launch of KSLV-1 (Korean Space Launch Vehicle) by 2010. Using the slogan of "Launching Our Own Satellite with Our Own Rocket from Our Own Country,"[355] the plan aimed to join the top ten countries in the global space industry market by acquiring independent technological capabilities for space development. KARI supported this ambitious plan including commercial, research and governmental space activities with an emphasis on economic benefits and public service, while ADD was separately engaged in the development of military aerospace applications under the responsibility of the Ministry of Defense.

Despite the financial crisis of 1997 and the government's decision to accept an International Monetary Fund bailout, the tendency to emphasize the economic benefits of space persisted. Pessimists in South Korea looked at the economic crisis as a sign that Korea

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[355] KARI, "Proposal of Korean Mid- and Long-term Space Development Plan Modification" (MOST, 2000). (in Korean)

had insufficient resources to transform her economy into an advanced model.[356] However, Kim Dae-jung, who won the presidential election in the winter of 1997, designed a National Basic Plan for Science and Technology to boost the ruined economy emphasizing the promotion of the so-called '6Ts' – IT [information Technology], BT [Bio], NT [Nano], ET [Environmental], CT [Culture], and ST [Space].[357] Space development was influenced by these changes, including a more government-led space program following governmental needs.

National security concerns soon intervened to renew South Korea's emphasis on the development of space capabilities. In August 1998, North Korea's *Taepodong-1* missile test and attempted satellite launch shocked South Korea, laying bare the country's fundamental reliance upon the U.S. for space-derived intelligence on its neighbor. The South Korean government brought its independent launch of KSLV-1 forward by five years from 2010 to 2015, and demanded that the U.S. revise the 1979 Missile Note and allow South Korea entry into the Missile Technology Control Regime (MTCR)[358]. To meet the deadline, South Korea dropped its commitment to 'independence' and decided to purchase technologies from Russia. The Russian side agreed to provide the standard URM booster from its Angara project to

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[356] David Swinbanks, "South Korea Keeps a Cool Head in a Crisis," *Nature* Vol. 391, Issue 625 (February 12, 1998)

[357] This scheme was inherited by the Roh Moo-hyun administration, which was inaugurated after the election in the winter of 2002. Roh put great emphasis on science and technology as the bedrock of the President's policy. Tae-Ho Kim, "How Could a Scientist Become a National Celebrity?," *East Asian Science, Technology and Society: An International Journal* 2, no. 1 (June 6, 2008): 39.

[358] The Missile Technology Control Regime (MTCR) established in 1987 is an informal and voluntary association of countries which share the goals of non-proliferation of unmanned delivery systems capable of delivering weapons of mass destruction, and which seek to coordinate national export licensing efforts aimed at preventing their proliferation. http://www.mtcr.info/ (last accessed on October 18, 2015)

serve as the first stage of the Korean launch vehicle, while South Korea would develop its own solid-fuel Kick Motor for the second stage. Nevertheless, the successful launch of KSLV-1 was delayed for eight years due to lengthy negotiations on technology transfer between the two countries, technical problems, and two failed attempts in 2009 and 2010. Finally, South Korea succeeded in joining the world's elite 'space club' when KSLV-1 blasted off smoothly and put a satellite into orbit in January, 2013.

This chapter aims to offer an historical overview of the emergence of South Korea as a new space-faring nation by launching its first space launch vehicle, KSLV-1. It focuses particular attention on the how the KSLV-1 project evolved in the complicated contexts of national motivations and global pressures, which led South Korea to collaborate with Russia. To begin with a brief review of the history of the North Korean rocket program will be provided before I look into the North's *Taepodong*-1's influence on the South Korean space program in terms of inter-Korean relations.

"*Taepodong* Shock" and a Ghost Satellite

On August 31, 1998, North Korea launched a medium-range ballistic missile from the north-eastern part of the country. Although the launch took place without any advance warning, the launch preparations for the missile had been detected by U.S., Japan, and South Korean intelligence with satellite observations and signal monitoring four days earlier.[359] By

[359] "U.S.-S. Korea, obtained Information in Early August," *Hankyrae Daily* (September 2, 1998) (in Korean); David Wright, "Taepodong 1 Test Flight," 1998 North Korea Special Weapons Nuclear, Biological, Chemical and Missile Proliferation News, Federation of American Scientists (September 2,

tracking the flight of the missile from the ground and in space, it was believed to be the maiden test flight of a new long-range missile, the *Taepodong-1/Paektusan-1*.[360] The first stage fell into international waters 300 km east of *Musudan-ri* and the second stage flew over the Japanese island of Honshu and fell into the water 330 km away from the Japanese port of Hachinohe for a total distance of approximately 1,646 km.[361] North Korea's missile program attracted particular concern because the *Taepodong-1* design objectives were apparently for a system that could deliver a 1000-1500kg warhead at a range of 1500-2500km. If missile guidance was improved North Korea could have developed the ability to strike American military bases in Japan.[362] North Korea was also widely thought to have been developing nuclear weapons, though it is not clear whether it had the ability to build a nuclear weapon small enough to be delivered by one of its missiles. North Korea offered no detailed explanation until the official announcement was made four days after the launch.

Surprisingly, on 4 September, 1998, the North Korean Central News Agency broadcast a report claiming that what had been thought to have been a missile launch had actually been a first

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1998) Available online: http://www.fas.org/news/dprk/1998/980831-dprk-dcw.htm (last accessed on October 18, 2015)

[360] North Korea began developing *Taepodong*-1 missile in early 1990s, but the name for the missile was not known. Analysts coined the term "*Taepodong*," which is the name of an administrative district in *Musudan-ri*, North *Hamgyong* Province where its development was first detected. The North Korean names of the missiles later were revealed as the *Paektusan-1*. *Paektusan* (Mt. Peakdu) is the highest mountain in Korea peninsula where is insisted that the birthplace of Kim Jong Il by North Korean hagiographic propaganda. On the birthday, it claimed that a bright lode star (*Kwangmyoungsong*) appeared in the sky. Yoo Youngwon and Shin Bhumchul, *North Korean Army Secret Report*, (Seoul: Planet Media, 2013), p. 135. (in Korean)

[361] Steven A. Hildreth, *North Korean Ballistic Missile Threat to the United States*, CRS Report for Congress, (February 24, 2009), p. 2.

[362] "North Korea Fires Missile Over Japanese Territory," *The New York Times* (August 31, 1998)

satellite launch “for [the] peaceful use of outer space.”[363] It went on to claim that it successfully launched the first North Korean artificial satellite, *Kwangmyoungsong-1*[Lode Star], transmitting the melody of the immortal revolutionary hymns ‘Song of General Kim Il Sung’ and ‘Song of General Kim Jong Il’ and the morse signals ‘*Juche* Korea’[364] in 27MHz as it orbited the earth. The report stated that “the rocket and satellite which our scientists and technicians correctly put into orbit at one launch are 100% a fruition of our wisdom and technology,” and “the successful launch of the first artificial satellite by North Korea greatly encourages the Korean people in their efforts to build a powerful socialist state under the wise leadership of General Secretary Kim Jong Il.” Even though U.S. intelligence and the South Korean government had detected North Korea’s preparations of a new missile flight test in advance, nobody expected the missile to be configured as a space launch vehicle with a third stage.[365]

On September 8, the North Korean *Rodong Sinmun* carried an interview with the scientists and technicians who had been involved with the satellite launch, Dr. Kwon Tong Hwa, Dr. Han Hae Chol, and Dr. Kim Haeng Gyong. They referred to the purpose of the launch of the satellite as following;

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[363] Korean Central News Agency, Pyoungyang (September 4, 1998) available from http://cns.miis.edu/archive/country_north_korea/factsht.htm

[364] The term “*Juche*,” which literally means “self-reliance” or “independence,” developed into an important ideology of North Korean politics and government.

[365] “Pandemonium Caused by North Korean Satellite,” *Dong-a Daily* (September 5, 1998); Robert D. Walpole, “North Korea's Taep-o'dong Launch and Some Implications on the Ballistic Missile Threat to the United States,” Speech delivered at the Center for Strategic and International Studies, (December 8, 1998) in Factsheet - Center for Nonproliferation Studies http://cns.miis.edu/archive/country_north_korea/taep2.htm (last accessed on October 18, 2015)

> First, it is to perfect the structural engineering design of a multi-stage carrier rocket. Second, it is to perfect the structural engineering design of a multi-stage carrier rocket and its control technology. Third, it is to study the space environment and verify if its electronic devices correctly operate in space. Fourth, it is to complete the observation system of the carrier rocket and satellite. For this purpose, necessary observation devices were installed on the carrier rocket and satellite.[366]

However, U.S. Space command announced that it had not detected any object orbiting the Earth that correlated with the orbital data the North Koreans had provided nor any radio transmissions at 27 MHz.[367] While North Korea claimed that Kwangmyongsong-1 made 100 rounds of the earth by September 13, the U.S. State Department officially announced that the North Korean launch had indeed been a satellite attempt, but that the launch had failed to place anything into orbit.[368] Amid the hoax of the 'Ghost Satellite,' North Korea received worldwide criticism including from South Korea who charged that "their desire to reach space gave them an opportunity to hide the reality of ballistic rockets, which represented a major threat for the neighboring countries."[369] Responding to the criticism, a North Korean delegation participating in the UNISPACE III (Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space) conference held in Vienna from 19 to 30 July 1999 commented that "the level of the technology in the U.S. to track spacecraft is

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[366] Korean Central News Agency, Pyoungyang (September 4, 1998) Quoted by Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, (London; Chichester: Springer; Praxis, 2009), p. 444.

[367] USSPACECOM News Release 25-98. (September 8, 1998) Quoted by Phillip Clark, "North Korea's First Satellite: Fact and Fiction," *Space Policy* 15 (1999): 141–147.

[368] "U.S. Calls North Korean Rocket a Failed Satellite," *The New York Times* (September 15, 1998)

[369] "Satellite or Missile?" *Hankyrae Daily* (September 8, 1998) (in Korean)

sophisticated but not efficient," adding that if South Koreans "were true Koreans, they would be happy to see the first Korean satellite launched into orbit on our first attempt."[370]

North and South Korea have both developed rocket technology for military and civilian application, but their space programs differ in many important respects. The North and South Korean space launch vehicle programs are linked to ballistic missile development that began in the 1960s and early 1970s, respectively. However, their space launch capabilities are not merely intended to increase their missile's range. Its mission depends on a number of variables including domestic politics, budget constraints, the overall strategic environment, as well as opportunities in the realm of international space cooperation. These differences mean that while North Korea has an extensive ballistic missile program with one attempted satellite launch, South Korea has a more extensive satellite program with an industrial policy to support its development. Before looking into the influence of Taepodong-1 on the South Korean space program in terms of inter-Korean relations, it might be useful to briefly review the history of the North Korean rocket program.

Origin and Evolution of the North Korean Missile Program

Although there are significant uncertainties about the history and extent of North Korea's space capabilities, it is widely believed that the history of the North Korean space launch vehicle program can be traced back to its ballistic missile development that began in

[370] Report and interview of Theo Pirard who attended in the Unispace III. Quoted from Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, (London; Chichester: Springer; Praxis, 2009), p. 449.

the 1960s. Despite North Korea's security alliances with China and the Soviet Union since the Korean War (1950 to 1953), North Korean Premier Kim Il Sung was dissatisfied with his alliance partners. He believed that North Korea failed to unify Korea because of insufficient assistance against the U.S. military during the War. The asymmetry in the credibility of the alliance relationship led North Korea to perceive the utility of an indigenous ballistic missile program. It viewed ballistic missiles as weapons to deter or defeat foreign forces from intervening in another Korean conflict.[371]

Beginning in the early 1960s, North Korea began to take a number of steps to decrease its dependence on its superpower patron the Soviet Union for weapons. It undertook to strengthen the military along the so-called 'Four Great Military Lines' doctrine; (1) improve political and technical discipline in the military; (2) modernize the military; (3) arm all the people with class consciousness and military technology; and (4) fortify the whole country.[372] The military modernization program included expanded missile procurement and import substitution plans for arms production in general. According to the testimony of Ko Young Hwan, a former North Korean diplomat who served in the Ministry of Foreign Affairs from 1978 to 1991, Kim Il Sung said to Kim Chang-bong, National Defense Minister, "it is imperative for us to develop rockets for war." In 1965, the Premier established the *Hamhung* Military Academy to train personnel in rocket and missile development.[373] He told Kim

[371] Daniel Pinkston, "The North Korean Ballistic Missile Program" (Strategic Studies Institute, February 2008), pp. 2-5.

[372] *Overview of North Korea 2000* (South Korea Ministry of Unification, December 1999), pp. 160-161; pp. 262-263.

[373] In January 1968, it was moved to the city of *Kangkye* where defense facilities were concentrated, and became the National Defense University.

Chang-bong that "if a war breaks out, the U.S. and Japan will also be involved. In order to prevent their involvement, we have to be able to produce rockets which fly as far as Japan. Therefore, it is the mandate for the Academy to nurture those personnel who are able to develop mid- and long-range missiles."[374] The young elites screened to enter the seven-year program studied designs of German V-1 and V-2 type missiles and of Soviet-made FROG (Free Rocket Over Ground) missiles. They played a pivotal role in attempts to reverse-engineer the FROG in the mid-1970s and to build their own version of the Scud missile in 1980s.

In 1968, North Korea obtained the FROG-5/7 short-range missile system with a range of up to 60km and a payload of 400kg from the Soviet Union.[375] As North Korea–Soviet relations began to sour in the late 1960s, the Soviet Union declined to provide additional missile systems or upgrades for those already delivered. Thus, North Korea turned to China to obtain access to more advanced missile technology. In September 1971, North Korea signed an agreement for missile technology transfer and the sale of missiles with China,[376] and in April 1975, the two countries made a deal enabling North Korean participation in a Chinese missile project for developing the DF-61(*Dong Feng*-61). This was a liquid-fueled ballistic missile with a range of 600km and a payload of 1000kg based on

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374 US Senate, *North Korean Missile Proliferation: Hearing before the Subcommittee on International Security*, Proliferation and Federal Services of the Committee on Governmental Affairs United States Senate, 105 Congress First Session (October 21, 1997), pp. 8-9.

375 Lee Jonghun, "From the FROG to the Taepodong: North Korea's Missile Game," *Shindonga* (August 1999): 190-211, p. 201.

376 Joseph S. Bermudez, Jr., "A History of Ballistic Missile Development in the DPRK," Occasional Paper No. 2, (Center for Nonproliferation Studies, November 1999), p. 3.

Soviet Scud technology.[377] At the same time, North Korea began a program to reverse-engineer FROG-7A rockets. The joint program with China was terminated when its main Chinese political supporter General Chen Xilian was expelled from power in 1978. The FROG reverse-engineering program was eventually canceled, though North Korean engineers probably gained knowledge that was later applied to their own version of the Scud.[378]

North Korea continued to actively pursue Scud B technology to create a basis for its own in-house ballistic missile program, though the continuing difficulties in Pyongyang's relationship with the Soviet Union and China disrupted the flow of missiles and missile technology to North Korea. Meanwhile South Korea successfully developed a guided missile, NHK-1 (*Paekkom*) in 1978.[379] This strongly influenced the overall direction of North Korea's ballistic missile program. It turned to Egypt, whom it had assisted during the 1973 Arab-Israeli War, for assistance in continuing the development of its missile program. Egypt had wanted to produce long-range ballistic missiles since the war, but the Soviet Union refused to transfer the Scud missiles after the new president, Anwar Sadat, started re-orienting the country toward the West.[380] Both countries wanted to reverse-engineer the Soviet Scud-B with greater ranges and improved accuracies, and concluded a series of new agreements to cooperate in missile development. Egypt transferred a small number of R-17

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[377] Hua Di, "One Superpower Worse that Two," *Asia-Pacific Defense Reporter* 18(2), (September 1991): 14-15.

[378] Christoph Bluth, *Korea* (Polity Press, 2008), p.160; John Wilson Lewis and Hua Di, "Beijing's Defense Establishment: Solving the Arms Export Enigma," *International Security* (Fall 1992): 5-40.

[379] See Chapter 2 of this dissertation regarding South Korea's efforts to develop its first guided rocket K-1 during 1970s. South Korea began the K-1 project partly because of North Korea's deployment of FROG missile from Soviet Union in late 1960s.

[380] Lee Jonghun, "From the FROG to the Taepodong: North Korea's Missile Game," *Shindonga* (August 1999): 190-211.

missiles (the version of the Scud B exported by the Soviets to Egypt in the mid-1970s) to North Korea around 1981. By 1984 engineers of the Guided Missile Division of the Academy of Defense Sciences and the Fourth Machine Industry Bureau had successfully reverse engineered the device,[381] producing the *Hwasong-5*.[382] This was an indigenous version of the Scud-B, with a range of 320km and able to carry a payload of 1000kg.

Just as North Korea began to manufacture the *Hwasong-5* in 1985, it reached an agreement with Iran to obtain financial assistance for missile development and production in exchange for Iran's option to purchase North Korean missiles for "the war of the cities" with Iraq.[383] North Korea supplied *Hwasong-5* to Iran during the war, and these sales provided it with millions of dollars of foreign exchange income as well as considerable technical data on the system's performance through combat use.[384] With this technical and financial assistance, North Korea's missile development accelerated rapidly to produce Scud variants with extended ranges; By 1993, it successfully tested the *Hwasong-6* (Scud-C) with a range of 500km and a warhead of 770kg and Scud-D with a range of 1000km and warhead of 500kg. What is more, while producing a variety of short-range missiles, North Korea began to focus on research, development, and the eventual production of medium-range missiles. Work on an Intermediate Range Ballistic Missile, the *Nodong* with a range of 1300km and a warhead

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381 Cheol-wun Jang, "A Study on the Origins of SSM Development in North Korea," *North Korean Studies Review*, Vol. 17 No. 3 (2014): 233-267.

382 *Hwasong* means Mars in Korean. It seems that North Korea used the number from 1 to 4 for *Hwasong* series to its test version of reverse-engineered missiles.

383 Joseph S. Bermudez, Jr., "A History of Ballistic Missile Development in the DPRK," Occasional Paper No. 2, (Center for Nonproliferation Studies, November 1999), pp. 9-10.

384 Daniel Pinkston, "The North Korean Ballistic Missile Program" (Strategic Studies Institute, February 2008), p. 16.

of 700kg, reportedly began in 1988.[385] To accomplish the task, North Korea focused on using scaled-up versions of existing short-range missiles (mainly Scud-D), with more powerful engines and improved guidance systems. It reportedly clinched *Nodong* sales contracts with Libya, Iran, Syria, and Pakistan[386] even before the Scud-D, the basis of *Nodong*, was successfully flight-tested on May 30, 1993.[387] With the assistance of scientists and engineers from countries including Russia and the Ukraine after the collapse of the Soviet Union, North Korea could deploy the first *Nodong* in February 1995 after a relatively short development period.[388]

North Korea's desire to go into space is believed to begin with the *Taepodong* program, which was based on the technology of the *Nodong*. During the early 1990s, just after successfully testing the *Nodong* rockets, North Korea initiated the development of two multi-stage rockets that would become the *Taepodong-1* and 2.[389] *Taepodong-1* appears to be designed as a two or three-stage missile with a *Nodong* as the first stage and a *Hwasong-6* as the second stage. *Taepodong-2* calls for complete new systems that would require extensive

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[385] Lee Jonghun, "From the FROG to the Taepodong: North Korea's Missile Game," *Shindonga* (August 1999): 190-211. (in Korean)

[386] The *Nodong* is believed to be the basis of Iran's Shahab-3 missile and Pakistan's Ghauri missile. Sharon A. Squassoni, "Weapons of Mass Destruction: Trade Between North Korea and Pakistan," CRS Report for Congress (October 11, 2006)

[387] Some analysts have labeled the Scud variant test-launched on May 30, 1993 the *Nodong-1*, because they viewed that the missile flew only about 500km much less than its estimated range of 1,000km. However, the Ministry of National Defense of South Korea officially labeled the missile Scud-D and the newly developed missile with extended range of 1300km *Nodong*.

[388] Markus Schiller, *Characterizing the North Korean Nuclear Missile Threat* (RAND, 2012), pp.25-30.

[389] Steven A. Hildreth, *North Korean Ballistic Missile Threat to the United States,* CRS Report for Congress, (February 24, 2009)

design, development, and testing. The first stage may use four *Nodong* engines, while the second stage could be based on a *Nodong* design as well. *Taepodong-1* is a preliminary step in the development plan of an ICBM, *Taepodong-2*. Reportedly, at a late-1993 or early-1994 meeting of the Korean Workers' Party (KWP) Central Committee, Kim Il Sung first expressed his desire to place a satellite into orbit, and the Central Committee decided to use *Taepodong* as a space launch vehicle.[390] By adding a solid upper stage, it would be able to put a 20-25kg payload into low Earth orbit.

There is a high probability that Kim began to be interested in the symbolic value of space development over and above its obvious military applications.[391] It is worth of noting that South Korea received international recognition through the successful launch of its first satellites KITsat-1(*Uribyul-1*) in 1992 and KITsat-2 1993 after it had announced its ambitious plan for space development in late 1980s.[392] After Kim Il Sung's death in 1994, space technology assumed a very high symbolic value for Kim Jong Il. He has marketed himself as a progressive promoter of technological advancement, and has implemented two new state ideologies to coincide with the institutional changes of 1998 when the North decided to go into space.[393] North Korea's economy was in severe difficulties in the early 1990s; internal

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390 Joseph S. Bermudez, Jr., "A History of Ballistic Missile Development in the DPRK," Occasional Paper No. 2, (Center for Nonproliferation Studies, November 1999), pp 27-28.

391 One American scholar views that North Korea appears to have five motivations for developing an indigenous ballistic missile program; as an offensive weapon, as a defensive weapon or deterrent, as a source of foreign exchange income, as the prestige of the regime at home and abroad, and as diplomatic leverage. John M. Sanford, *North Korea's Military Threat: Pyongyang's Conventional Forces*, (Strategic Studies Institute, April 2007), p. 118.

392 Regarding South Korea's development of KITsat series, see the Chapter 3 of this dissertation.

393 Daniel Pinkston, "The North Korean Ballistic Missile Program," (Strategic Studies Institute, February 2008), pp. 9-10.

insecurity was exacerbated by the death of Kim Il Sung in 1994 and by floods in 1995-1996 that turned chronically poor harvests into disasters. As the official Kim Jong Il era was beginning in 1998, the concept of *Kangsongdaeguk* or building a "strong and powerful country" was introduced along with *Songunjongchi* ("military first politics"). *Songunjongchi* seems to mean that national security is an economic priority, though the slogans "put the army first" and "put the army in the center" are not limited to military affairs.[394] After all, at the time of the launch of *Taepodong-1* and *Kwangmyoungsung-1*, North Korea held major political celebrations on the occasion of the 50th anniversary of the establishment of the communist state, and the increased political status of General Secretary Kim Jong Il.

South Korean Reaction to the *Taepodong* Shock

The so-called *Taepodong Shock* strongly influenced the Korean space program. The maiden launch of *Taepodong-1* demonstrated the technological progress of North Korea in multi-stage rocketry and guidance systems, although South Korea concluded that the North Korean *Kwangmyoungsong-1* satellite failed to achieve orbit. This surprise challenge to South Korea's technological position represented a wake-up call, showing that South Korea was no longer alone in its space ambitions in the peninsula. Chae Yeonsuk, the manager developing the KSR-3 rocket in KARI, insisted that North Korean rocket launch technology

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[394] Kang Ho-Jye, "The Latter of the 1990s, the Basic Political Line of North Korea was the Songun Policy," *Tongilkwa Pyoungwha* 3:1 (2001) (in Korean)

was 5 to 7 years ahead of South Korean technology.[395] Furthermore, the South Korean people felt increasingly uncomfortable knowing that their government could not even keep up to date with developments without U.S. tracking information; Seoul had to wait to receive critical information from U.S. forces regarding the launch site's preparation, as well as data about the flight itself.[396]

The South Korean government reacted immediately. On September 23, 1998, the MOST announced the revised Basic Plan on Mid-to-Long-Term National Space Development, which brought its independent launch of SLV forward by five years, from 2010 to 2005.[397] Also, South Korea began to insist that the U.S. revise the 1979 Missile Guideline, which had stopped it developing missiles with ranges over 180km, or payloads over 500kg, in exchange for technological assistance. Although the two countries had already had five rounds of discussions about the revision of the agreement between November 1995 and August 1998, no definitive conclusion had been reached. The U.S. proposed that South Korea join the MTCR,[398] but still adhere to the 180km ceiling. This was unacceptable to South Korean negotiators. They believed the Missile Note was anachronistic and should be scrapped so that South Korea could increase the range of its ballistic missiles. After all, the MTCR allowed the development of missiles with a range of 300km for military purposes, and up to 500km for research objectives. South Korea wanted access to the technologies and

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395 "Interview with Chae," *Kyunghyang Daily*, (September 8, 1998). (in Korean)

396 "Shame on 'Self-Defense'," *Dong-a Daily* (September 8, 1998). (in Korean)

397 "Independent Launching STsat-2 by 2005," *Yeonhap News*, (September 23, 1998). (in Korean)

398 The MTCR rests on adherence to common export policy guidelines applied to an integral common list of controlled items. Regarding the MTCR guidelines, see http://www.mtcr.info/ (last accessed on October 18, 2015)

components needed for the development of their SLVs, needed to sign on to the MTCR to acquire them, but resented the lower range being imposed by the U.S. as a condition for assistance. .

On 8 September 1998, Hong Sunyoung, the Minister of Foreign Affairs and Trade, visited the U.S. and told the National Press Club in Washington that "to extend the range of Korea's missile development to 300km, is one of the countermeasures to North Korea's threat."[399] President Kim Dae-jung affirmed the government's position that "we should be allowed to develop and test-fire one for research and development in the 500 km range" during the July 1999 Kim-Clinton meeting at the White House. The U.S. agreed to the expansion of the range to 300km with a payload of 500kg and South Korea's participation in the MTCR, but only under certain conditions; South Korea should share all information about its indigenous missile development and promise in writing not to divert scientific civilian rocket technology to military use. After several rounds of talks, the two countries finally reached a bilateral agreement on the new missile guidelines in January 2001, followed by South Korea's entry into the MTCR in March 2001. South Korea would now be able to develop missiles of 300km range and 500kg payloads, and would also be allowed to develop peaceful SLVs with no limits on rocket ranges as in the MTCR guidelines. In return, South Korea conceded the following demands by the U.S.:[400]

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399 "Need to Extend the Range of Korea's Missile Development," *Dong-a Daily* (September 16, 1998). (in Korean)

400 Daniel Pinkston, "The New South Korean Missile Guidelines and Future Prospects for Regional Stability," *Strong & Prosperous* (International Crisis Group, 25 October, 2012).

1. The U.S. would have the right to inspect missile production facilities;
2. The ROK would have to provide information at each step prior to research, development, production, and deployment;
3. The ROK could not conduct research on missile systems with a range greater than 300km; and
4. [The] ROK would have to disclose information on civilian rocket research.

Reflecting this change, on December 19, 2000, the National Science and Technology Committee, which included President Kim, proposed the second revision to the 1996 Basic Plan on Mid-to-Long-Term National Space Development. The main objective of the revised plan was to launch a KSLV-1 with a 100kg satellite by 2005, a KSLV-2 with a one-ton satellite by 2010, and a KSLV-3 with a 1.5 ton satellite by 2015. The committee suggested that a long-term vision for space development was needed, due to the South Korean publics' growing interest in space. In the meeting, President Kim stressed that "to promote national prestige, we should succeed in launching our own satellite with our own rocket from our own country by 2005."[401]

The Change to International Cooperation for the KSLV Project

Bringing its independent launch of KSLV-1 forward by five years resulted in a pivotal change in space policy for South Korea. In order to meet the due date, KARI suggested that it would have to intensify its research in critical technologies and strengthen international

[401] NSTC, "6th Meeting of the National Science and Technology Committee," National Archive of Korea; (DA0058856), pp. 221-228. (in Korean)

cooperation to achieve South Korea's space objectives after joining the MTCR.[402] However, international cooperation had a significant implication because it meant that the KSR-3 project, deemed to be a precursor to South Korea's fully-fledged space launch programs, might be abandoned in favor of using foreign rocketry to accelerate KSLV-1 development.

The initial objective of the KSR-3 project proposed by MOST and KARI in 1997, and revised in 1999 was to develop two types, the base form and the applied form; a 13-ton-thrust liquid single-stage propellant engine (base form), and a small three-stage launcher that combined the base forms with solid KSR boosters (applied form).[403] The KSLV-1 concept would use the liquid engine developed for KSR-3 as the core vehicle, with a pair of strap-on boosters derived from the KSR-3, and with a solid KSR-1 as an upper stage.[404] However, KARI experienced more difficulties than expected in SLV development, because it required much stronger propellant power than KSR-3 possessed to launch a satellite into orbit. The most critical problem was that KSR-3 used a pressure-fed-type liquid rocket engine with gaseous helium as a pressurizer. Its high pressure propellant tanks required thicker walls and stronger alloys which made the vehicle tanks heavier, thereby reducing performance and payload capacity. Finally, in May 2001 the government decided to develop a new liquid

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[402] KARI, "Proposal of Korean Mid-and Long-term Space Development Plan Modification" (MOST, 2000).

[403] MOST, "The Basic Plan for Development of Three-stage Launcher," National Archive of Korea; (DA0122112) (December 1997) (in Korean)

[404] Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, (London; Chichester: Springer; Praxis, 2009), p. 517.

rocket engine using a turbo-pump pressurizer for KSLV-1, and to downsize the KSR-3 project to developing and testing only the single-stage engine (the basic form) in 2002.[405]

It was a great challenge for KARI to develop a more complicated rocket engine for KSLV-1 in limited time. Accordingly it began to look into the possibility of international cooperation to purchase technologies from other countries for non-military rockets after joining the MTCR. Firstly, the South Korean government turned to the U.S. for possible assistance. However, contrary to South Korea's expectations, in October 2010 the U.S. announced that it would probably refuse to help.[406] Increased restriction imposed by the U.S. International Traffic in Arms Regulations (ITAR) after 1999 made U.S. companies unwilling, or unable, to complete a deal with South Korea for the delivery of a rocket stage.[407] Thus KARI turned to other space faring countries including Russia, France, Japan, China, and India for help. It only received a positive answer from Russia's Khrunichev Design Bureau, a company hit hard by the Russian recession of the 1990s. Russia had signed a $350-million deal with India for a five-year joint project that included the transfer of three liquid-hydrogen cryogenic rocket engines and the technology for their construction in 1992. It sought to exploit commercial opportunities again.[408]

The partnership for KSLV-1 development between the two countries did not work smoothly. Negotiations for the joint development of KSLV-1 began in 2002, yet it took two

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[405] MOST, "The Revision of the Plan for Development of KSR-3," National Archive of Korea; (DA0868457) (May 2001). (in Korean)

[406] KARI, *Naro Development White Paper*, (2014), p. 65. (in Korean)

[407] James Moltz, *Asia's Space Race : National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2011), p. 145.

[408] KARI, *Naro Development White Paper*, (2014), p. 66. (in Korean)

years to reach agreement. The Russian government ratified the cooperation of Khrunichev with KARI in July 2003, and the final contract for the joint development of the Korea Space Launch vehicle System (KSLS) was signed in 2004. The most critical issue was about responsibility and a re-flight option if the launch failed. KARI wanted Russia to take full technical responsibility for the entire launch system with the option of re-flight in case of failure.[409] Russia would accept the re-flight option only if the failure could be traced to Russian components. After long negotiations, the final contract for the joint development of the Korea Space Launch vehicle System (KSLS) was signed on October 26 2004. KSLV-1 would be launched twice, and if one of them failed, Russia would provide a third launcher free of additional cost.

The $200 million deal included terms for the joint development of a liquid-propellant rocket engine for the KSLV-1, as well as for cooperation in the construction of the launch facility at the Naro Space Center. KSLV-1 would be a two-stage launcher, 33m high with a maximum diameter of 2.9m, and a mass of 140 tons at lift-off. The first stage was derived from the Russian URM-1(Universal Rocket Module) developed by Khrunichev for the Angara family of modular launch vehicles, to be operated by the Russian Space Forces from the Northern Cosmodrome of Plesetsk. KARI was responsible for the design, development, test and production of the solid Kick Motor (KM) that formed the second stage and upper part of the rocket. The 'made in Korea' KM is an enlarged by-product of the solid KSR-1 booster. The second stage was made up of core parts entirely developed in Korea, which includes the Inertial Navigation System, the power, control and flight safety systems, plus the nose

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409 Ibid*;* 64-67.

fairing.[410] Right up until the final agreement was signed, KARI continued to save an alternative plan to use an upgraded KSR-3 for the first stage of KSLV-1 in case the negotiations broke down. Although the alternative plan was appropriate for the slogan of independent development, it was finally abandoned.[411]

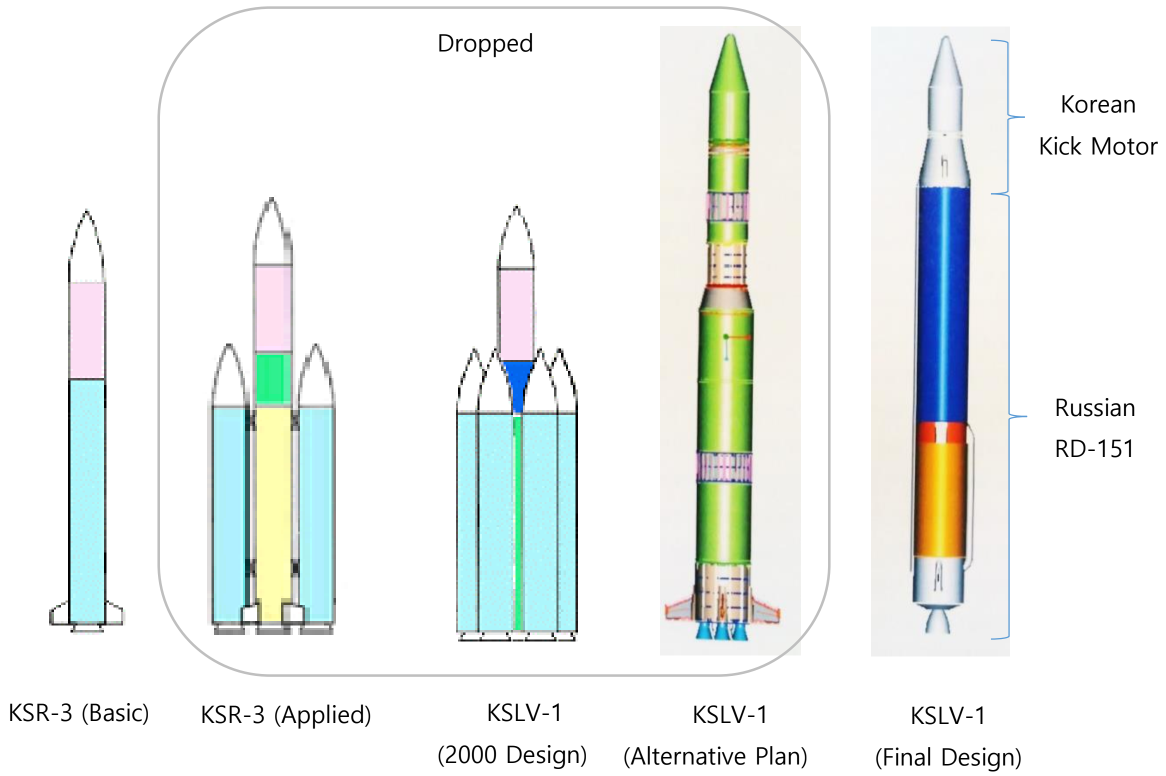

Figure 9 Changing Process of KSR-3 and KSLV-1 Design (Source: MOST, "The Revision of the Plan for Development of KSR-3," National Archive of Korea, (DA0868457) (May 2001); *Naro Development White Paper*, KARI, (2009))

410 Brian Harvey, *Emerging Space Powers the New Space Programs of Asia, the Middle East and South America*, (London; Chichester: Springer; Praxis, 2009): 521–524.

411 MOST, "The Revision of the Plan for Development of KSR-3," (May 2001) National Archive of Korea; (DA0868457)

The KSLV-1 launch would be an important event for both Russia and South Korea. For Russia, it would be the maiden flight of the RD-191 engine as well as the URM-1/Angara model, which is the first new orbit-capable rocket to be developed by Russia since the fall of the Soviet Union.[412] The Angara family of rockets is based on the Universal Rocket Module (URM) powered by a single RD-191 engine; the URM-1 forms the first stage of all Angara configurations. Although KSLV-1 would use the URM-1 with a reduced thrust RD-191, called the RD-151, as its first stage, it would be essentially the first member of the Angara family to fly. For South Korea, the cooperation with Russia was a magnificent opportunity to secure core technologies required to develop the fully 'made in Korea' KSLV-2 in the future.

2005, the First Year of Space Korea

KSLV-1 was the most prominent project of the whole Korean space development program. However, the maiden KSLV-1 flight which was originally planned for 2010 was brought forward to 2005 under the influence of the *Taepodong* Shock, which caused the Korean government to change its independent development plan into international cooperation with Russia. The date had to be postponed to 2007 due to delays in the negotiations defining the partnership between the two countries. To reflect the changes in the national and international environment as well as the possibility of implementing space technology development, the National Science and Technology Committee proposed a third

[412] Angara's first launch by Russia was attempted in 2014 on the Angara 1.2PP suborbital test flight. William Graham, "Angara Rocket Launches on Maiden Flight," *NASA Spaceflight* (July 9, 2014)

revision to The 1996 Basic Plan on Mid-to-Long-Term National Space Development on May 17 2005.[413]

The revised plan was divided over 20 years (1996-2015) and comprised a long-term plan, and a medium-term plan (2005-2010). The long-term objectives are to acquire the independent technological capabilities for space development and to join the top 10 countries in the space industry by competing in the global market by 2015. The mid-term objectives were more specific. By 2007, Korea would acquire the capability to launch micro-satellites by accomplishing the KSLV-1 project, and by the year 2010 it would develop 13 satellites (five satellites in the initial phase in 2005) including seven multi-purpose satellites (KOMPsat-series), four science and technology satellites (STsat-series) and two geostationary satellites (COMS-series).[414] Earth observations and scientific measurements from space have been the priority of KARI with the KOMPsat and KITsat/STsat program since 1990s, yet the COMS (Communication, Ocean and Meteorological Satellite) program would create a multipurpose platform in geosynchronous orbit to accommodate the public and civilian demand for satellite utilization and maintain the continuity of satellite services. When the medium-term was completed, Korea would have acquired the technical basis to compete in the global space market.

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413 "The Third Revision of Basic Plan on Mid-to-Long-Term National Space Development," National Science and Technology Committee, (May 17, 2005) (in Korean)

414 The KOREAsat series, commercial turnkey satellites for telecommunications and broadcasts operated by Korea Telecom, have been excluded from the Basic Plan on National Space Development since 2005. Regarding its role to establish the groundwork for South Korea to enter the worldwide business of space communications in 1990s, see Chapter 3 in this dissertation.

Along with the progress in developing KSLV-1 with Russian technical assistance, South Korea also needed a basic space law for an orderly promotion of space development and effective international cooperation. Although the 1987 Aerospace Industry Promotion Act had contributed toward the development of aerospace technology and industry, it did not designate an aerospace authority nor did it provide guidelines for engaging with international treaties, conventions and principles. To this end the government passed the Korean Space Development Promotion Act on May 31, 2005. The purpose of this Act was to "facilitate the peaceful use and scientific exploration of outer space, to contribute to national security, and to the sound development of the national economy and the improvement of people's living, by promoting space development in a systematic way, ensuring the efficient use and administration of space objects."[415] The Act covered a number of issues such as government responsibilities, the establishment of a basic plan for promoting space development, the designation of a development institute for space exploration, the domestic and international registration of space objects, licensing of space launch vehicles and cancellation of licenses, and compensation for damages as a result of space accidents.[416] By establishing a legal basis for carrying out its fundamental space development and promotion plan which is in accordance with international obligations under the various UN Space treaties and

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[415] *Space Development Promotion Act*, Statutes of the Republic of Korea (May 31, 2005), available online in English; http://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=28236&type=part&key=36 (last accessed on October 18, 2015)

[416] The Article about compensation for damages of the Act (Article 15) was deleted by cause of the enactment of Compensation for Damage Caused by Space Objects Act on December 21, 2007. http://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=28237&type=lawname&key=space (last accessed on October 18, 2015)

conventions,[417] South Korea declared its strong will as a space developing country to carry out the duty of supervision by the states regulated by international treaty.

The Act stipulated that the government must draft a Middle and Long Term Space Development Plan (Space Development Plan for brevity) every five years. It would replace the old Basic Plan on Mid-to-Long-Term National Space Development by a new plan based on the newly-enacted Space Act. The plan had to be reviewed by the supreme government body for deciding space policy, namely the Korea National Space Committee (KNSC) which is placed under the control of the President and chaired by the Minster of Science and Technology. The KNSC, which would consist of around 15 committee members including nine ministers of related ministries, also assesses the use and management of space development projects, and reviews the availability of the financial resources necessary for space development as well as investment plans.

The first Space Development Plan was drafted on June 20, 2007.[418] It announced a plan to launch a lunar orbiter by 2020 and to send a probe to the moon five years after that. Compared to the Basic Plan on Mid-to-Long-Term National Space Development when it was established first in 1996, the new version of 2007 increased the budget for the national space program by a factor of five. Along with rearranging the legal basis for space development, the government started numerous publicity campaigns to justify its ambitious space projects.

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[417] South Korea has signed various space treaties, such as Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967); Agreement on the Rescue of Astronauts, the Return Astronauts and the Return of Objects Launch into Outer Space (1968), Convention on International Liability for Damage Caused by Space Objects (1972), Convention on Registration of Objects Launched into Outer Space (1975)

[418] MOST, *The First Middle and Long Term Space Development Plan* (June 20, 2007) (in Korean)

It declared the year 2005 as the new beginning of the space development project, and started a space culture movement with the slogan “Space Korea.” It held various events, including World Space Week, loading a human chip in a KOMPsat, and the selection of an honorary ambassador for space development on the internet.[419]

In December 2007, Professor Huh Hwanil of Choongnam University started a research project to restore *Singijeon* [ghost-like machine arrow], one of the world’s first successful multi-launch rocket systems developed in fifteenth-century South Korea, with funding from KARI and MOST. Historical documents show that the large *Singijeon,* with a powder container made out of paper, was the world’s largest rocket at that time, while *Sanhwa Singijeon* was the world’s first two-stage rocket. The research team restored the large *Singijeon* by traditional methods based on the original blueprint, and launched it successfully in September 2008.[420] Based on this historical background, a commercial film '*Singijeon*' was released in early September 2008. The synopsis relies on patriotism. During the reign of King *Sejong*, the *Choseon* dynasty presented an obstacle to the territorial expansion of Ming China, the aspiring imperial power. Ming China demanded submission and interfered with the internal affairs of *Choseon*. Disgusted by the Chinese interference, King *Sejong* secretly develops the *Singijeon,* and uses it to take back *Choseon*’s land and supremacy. The film production team restored the original *Singijeon* with the help of Professor Huh’s team. Director Kim Yu-jin said “it was very challenging to run the restored rocket system, and my impression is that our forefathers had better technology in dealing with the timed detonation

[419] MOST, *The Yearbook of Science and Technology,* (MOST, 2005), pp. 117-118. (in Korean)

[420] Yi Yongwoo et al., “Restoration Project of the Dae-Singijeon (the 15th Korean Missle),” *Korea Aerospace Conference Proceedings,* (2009): 701–704. (in Korean)

for the *Singijeon.*"[421] The film was quite successful, topping box office receipts on its opening weekend. It also won the award for Best Film at the 2009 Grand Bell Awards, which have been called the Korean equivalent of the American Academy Awards. Given that Korea had one of the world's most advanced explosive weapons, it implied that the science and technology of that time were among the world finest, and that the root of KSLV-1 can be found in *Singijeon*.[422]

The First Korean Astronaut Program

The real exposure of space development to the general public occurred with a landmark event; the first Korean Astronaut Program (KAP). The KAP was made possible by the Russia-South Korea space agreement of 2004 for the selection of a South Korean astronaut to ride a Soyuz spacecraft to the International Space Station (ISS). In November 2005, KARI and MOST started the program with a $20.7 million contract with the Russian Space Agency (RSA) for the purpose of developing manned space technologies and the public outreach of space exploration.[423] This program includes all phases of human spaceflight, such as the astronaut selection process, basic/advanced training, boarding a Russian spacecraft (Soyuz), staying in the International Space Station, carrying out eighteen space experiments as a governmental mission for the astronaut, and the return to Earth.

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[421] "Movie Sheds Light on Old Military Technology," *The Korea Herald* (April 4, 2010)

[422] Huh Hwanil, "Singijeon and Naro: Where Is King Sejong's Dream?," *Newsletter of Seoul National University College of Engineering* 80 (Winter 2010): 37–40. (in Korean)

[423] KARI, *The Korean Astronaut Project White Paper* (2009).

KARI justified the KAP using rhetoric intended to stir up emotions of national pride. South Korea would be the thirty-sixth astronaut-producing country in the world, and the eleventh country to carry out a manned space experiment. However, this figure did not satisfy South Korea's national pride as some less developed countries, such as Malaysia, Vietnam, Mongolia, and Afghanistan, already had astronauts. Thus, it was somewhat late for South Korea, as the eleventh-ranked economic country, to have its own astronaut. Furthermore, KARI provided an optimistic vision that established South Korea as one of the top ten space powers in the world. Even though "a late comer in human space flight", South Korea could eventually catch up with other developed countries as it experienced rapid economic growth in a very short time. The Astronauts Program was classified as a national project after the Mid-to-Long-Term plan, so by steadily following the plan South Korea could be a space power, launching a 100% Korean SLV, with a Korean astronaut in the near future.

The KARI drew the public directly into the KAP by allowing "any Korean male or female over nineteen who is intellectually, morally, and physically fit" to apply. The statement, "Anyone can be an astronaut", was a rhetorical strategy to try and win over as many people as possible to secure a democratic foundation for the KAP. The selection notice was posted in 2006 for 3 months, from April 21 to July 14. In all 29,280 males and 6,926 females (36,206 people) applied for the astronaut contest.[424] From the beginning of the program to the selection of the final candidates, the whole process was broadcast by Seoul Broadcasting System (SBS) in its program entitled, "2008 Space Korea." KARI and SBS

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[424] When compared with figures from England (12,000 people) and Malaysia (11,000 people), who both chose the same method to select an astronaut from their citizens, the results were amazing.

conducted the selection of astronauts in the format of ‘a reality show’ such as ‘Survivor’ and ‘American Idol.’

On December 24, 2006, the high-publicity competition eventually yielded two finalists; Ko San, a thirty-year-old male artificial-intelligence scientist in the Samsung Advanced Institute of Technology, and Yi Soyeon, a twenty-nine-year-old female graduate student majoring in biotechnology in KAIST. They started their training in Moscow for the Soyuz TMA spaceship and in Houston for conditions on the ISS (International Space Station). On September 5, 2007, the MOST announced Ko as primary astronaut and Yi as backup, following their performance in tests during training in Russia. Ko indicated the important symbolic value of the flight to South Korea by stating that he would “bring soil from each side of the divided Korean peninsula and mix them together in space during his flight.”[425]

However, on March 10, 2008, less than one month before the flight, this decision was reversed, after the Federal Space Agency asked for a replacement. Ko twice violated the regulations of the training protocol in Russia by reading, without authorization, some sensitive documents and by mailing one to Korea. It was the first time a candidate for spaceflight had to be replaced for a breach of training regulations. Baek Hong-ryeol, head of the KARI explained that “the Russian side judged that Ko’s self-driven behavior could cause serious results to other spacemen in the real situation and requested the replacement.”[426] Ko also reiterated that the KARI had nothing to do with the case, and said he hoped to use the know-how he had learned about manned space flight. Conspiracy theorists argued that Ko

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[425] “First Korean Astronaut to Take Soil into Space,” *Reuters* (January 16, 2008.)

[426] “Backup Astronaut Yi So-yeon Replaces Ko San,” *Dong-a Daily*, (March 11, 2008).

was a spy for the Korean government, and given that he had shown a solid and disciplined personality, was unlikely to disobey rules twice of his own volition.[427]

Yi moved into Ko's slot and became a member of the Soyuz TMA-12 crew with Russian Sergei Volkov, commander, and Oleg Kononenko, flight engineer. On April 8, 2008, the Soyuz rocket carrying them was launched from Baikonur in Kazakhstan. They spent two days in the Soyuz spacecraft until docking with the ISS, arriving there on April 10. Yi spent about nine days aboard the ISS and conducted 13 scientific experiments in biology, life science, material science, earth science and system engineering, five educational space experiments, and three kinds of international collaboration experiments.[428] She succeeded in all of these experiments during the nine days and successfully sent all of the results to scientists on the ground.[429]

One experiment was nearly cancelled because of political interference. The experiment entitled "Small-Organism-Culture-Medium that Can Be Used in Space" involved creating equipment that could culture animal and plant cells in a low-gravity environment. This equipment was developed nationally for two years and was able to culture adult stem cells of *Donghaeana dokdonensis*, a new kind of micro-organism discovered in Korean waters in 2004. It was named after *Dokdo*, a Korean island in the East Sea (Sea of Japan), where the Japanese government has challenged Korea's territorial sovereignty. The KARI

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427 "Ko San Mystery," *Dong-a Daily*, (March 11, 2008); "Doubt on the Replacement of the Primary Astronaut," *Seoul Daily* (March 14, 2008).

428 Joo Hee Lee et al., "An Overview of Korean Astronaut's Space Experiments," *Acta Astronautica* 67, no. 7–8 (October 2010): 934–941.

429 As of April 2009, six of the results were published and presented (nine are in preparation); one SCI-level journal was published (three are in preparation), and four were registered as patents. KARI, *The Korean Astronaut Project White Paper* (2009)

tried to advertise the experiment widely but ran into obstacles: months before the launch, the Japanese government requested its withdrawal as a condition for Yi being able to visit the ISS. (Japan has the authority, as a nation within the ISS, to restrict the activities of astronauts from nations who are not members of the ISS.) The KARI considered the political situation between Japan and Korea, and sought permission to continue the experiments on condition that the results would not be publicized. Japan accepted this proposal, making it possible to proceed with the experiment.[430]

In addition to scientific experiments, Yi conducted many performances and activities in the ISS, such as giving space lectures, performances with various flags including the Korean national flag, doing ham radio communication with Korean students, participating in live TV broadcasts, and so on. She remarked that "Korea, as seen from space, is one country", and she wanted people in North Korea to be "happy" with her mission and share in her "triumph." She voiced the hope that one day the two halves of her divided peninsula would reunite.[431] The highlights of the mission for Yi, and the entire South Korean nation, was a traditional Korean *kimchi* dinner Yi hosted on 12 April in the space station, in honor of the first Russian in space, Yuri Gagarin. *Kimchi* is a signature national dish of fermented cabbage, marinated in red pepper and garlic. Korean culinary scientists recently perfected a way to make *kimchi* and other Korean dishes such as soybean soup, hot pepper paste, sticky rice and Korean ginseng suitable for space travel.

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[430] "Japan Attempted to Keep Yi from Going to Space," *Chosun Daily* (April 18, 2009).

[431] "Yi, 'Korea, as Seen in Space, Is One Country'," *Dong-a Daily* (April 21, 2008).

Immediately after Yi returned on April 24, 2008, her flight was covered extensively by the South Korean media, making Yi a national hero. Despite the controversy over whether Yi was an astronaut or a space traveler[432], the effort made by the Korean government to promote space development to the general public was successful, as measured by the level of public attention. According to a survey of 500 adults by Hankook Research in 2008, 99% of the respondents knew that the first Korean astronaut had accomplished a space flight, and 82.2% of those who answered said that their interest in space had increased. South Korea does not have further plans for human space flight.

The "Success of the Troika"

In an attempt to continue the success of the astronaut program, KARI pushed on with the launch of KSLV-1, notwithstanding disputes with the Russians over technology transfer. The detailed design of the first stage of KSLV-1 was completed by December 2005, yet Russia refused to deliver the design and production technology until the Russian parliament had ratified the technology cooperation pact that protected its sensitive rocket technology and parts. Without this design data, South Korea was unable to complete the interface between the first and second stages or the construction of the launch facility. In October 17, 2006, South Korea signed the Technology Safeguards Agreement (TSA) that Russia would supply components and materials needed for the development "without transferring technology" so

[432] An Hyoung Joon, "Is Yi Soyeon an Astronaut or a Space Tourist?: The First Korean Astronaut Debate on the View of ANT," *The Korean Journal of Science and Technology Studies* 9 (2009): 57–81. (in Korean)

as to have the maiden KSLV-1 flight by late 2007 as planned.[433] The date for the flight slipped to August 2009. Russia called for postponements six times due to technical problems in developing the first-stage rocket.[434]

Meanwhile, 'made in Korea' parts were successfully completed one by one under the catchphrase "Korean satellite is launched by Korean launch vehicle at Korean space center." The Korean engineers called this success the "Success of the Troika."[435] For the payload of KSLV-1, SaTReC developed STsat-2 (Science and Technology Satellite-2) in October 2002 as a sequel mission to KITsat-4, also known as STsat-1, in orbit since September 2003.[436] The 100-kilogram satellite STsat-2 would carry two main payloads; DREAM (Dual-channel Radiometer for Earth and Atmosphere Monitoring) which can measure the moisture level of the earth's atmosphere and cloud, and, secondly, LRA (Laser Reflector Array) which provides precise orbit information of the STsat-2. During the two years spent on its ellipsoidal orbit of 300-1500km LRA was expected to optimize the performance of the

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[433] Hur Mansub, "U.S., Concerned about WMD Development, Blocked Rocket Technology Transfers from Russia to South Korea", *Shindonga*, (November 1, 2006): 82-92. (in Korean)

[434] "Naro's Sixth Delay... the Desired Domestic Technology," *The Korea Economic Daily*, (August 5, 2009).

[435] Joo-Jin Lee, "2005; The Year "Zero" of Space Korea," *Proceedings of 2nd International Conference on Recent Advances in Space Technologies* (9-11 June, 2005): 7-9.

[436] Starting with the first Korean satellite named KITsat-1 developed through the collaboration with Surrey University, UK, in 1992, SaTReC has successfully built its indigenous capability for micro satellites through KITSAT-2(1993), KITSAT-3(1999), and KITsat-4/STsat-1(2003). See Chapter 3 of this dissertation.

technologies proven in the small satellite projects previously developed by the SaTReC, and to test advanced bus technologies for small satellites.[437]

The first space launching base, the Naro Space Center, was built on a remote island named *Oenarodo* [outer Naro island], in the South *Jeolla* Province on the southern coast of the Korean peninsula. South Korea had a rocket launching site at the *Anheung* Test Center of the Agency for Defense Development (ADD) on the west coast of the Korean Peninsula, where it launched the Korean Sounding Rockets (KSR-1, 2, 3). However, the space center was built far from any military base as South Korea was not supposed to develop space programs supported by, or interconnected with, the military. Also the KSLV-1 would be launched in a southern direction to place satellites into polar orbits so avoiding strong protests from China on westbound flights and from Japan on eastbound launches.[438] Beginning work on the center in 2000, Hyundai Heavy Industries completed the construction of the facilities in 2007 with a blueprint provided by the Khrunichev Space Center, except for the launch pad and erector, which could be done after delivery of the first-stage from Russia. The second stage of the KSLV-1 was already completed by April 2008. The final comprehensive operational tests took place to check the overall operation and function at each stage of the flight sequence after the launch, including fairing separation, ignition of the Kick Motor of the upper stage, satellite separation and flight completion. In June 2009, the Russian first stage of KSLV-1 was delivered from Khrunichev Space center by aircraft to Pusan

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[437] Jong Tae Lim et al., "Exploring Space on a Small Satellite, STSat-2: A Test Bed for New Technologies," *Proceedings of AIAA/USU Conference on Small Satellites*, Logan UT, Aug. 11-14, 2003, SSC03-VI-5

[438] KARI, *Feasibility Study for the Korea Space Center*, (December 1999) (in Korean)

International Airport, and moved by ship to Naro space center to be integrated with second stage of the satellite and the fairing.[439]

Finally, on August 25, 2009, South Korea's first space rocket, Naro-1 renamed through an online bidding process in May 2009,[440] blasted off with STsat-2A at the Naro Space Center, the country's first spaceport. The launch seemed successful. Min Kyung-Ju, head of the Naro Space Center, said "If the launch is successful, South Korea will become a member of the 'space club' whose members have developed their own rockets and satellites and sent this into space from a launch facility on their own soil." However, the satellite failed to achieve the desired orbit; one of the two payload fairings that covered the satellite failed to separate, and the second stage did not have enough fuel to overcome the additional weight. The spacecraft was then 342km above waters near Australia instead of the 306km altitude it was supposed to reach. In a Cabinet meeting shortly after the official announcement of the failure, President Lee Myung-Bak called for renewed and redoubled efforts to advance the country's space technology: "We must realize our dream of becoming a leading country in space technology, even if it takes an eighth attempt after seven failures or a ninth attempt after eight failures."

The second launch of a *Naro*-1 with a payload of STsat-2B that was identical to STsat-2A took place on June 10, 2010; yet it also ended in failure. According to the KARI, it exploded 137 seconds after liftoff, when it was believed to be at an altitude of around 70km. South Korea and Russia failed to agree on the cause of the aborted launch of the *Naro*. A

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439 "S. Korea Completes Work on Naro Space Center," *Yonhap News* (September 28, 2015)

440 "Korea`s First Space Rocket to be Named `Naro`," *Korea Herald* (May 26 2009).

joint committee of Russian and South Korean experts consisting of thirty engineers from each country began an investigation into the cause of the failure in August 2010, but had not reached agreement by June 2011.[441] While Russians claimed that the malfunction in the flight termination system in the Korean upper stage rocket might have caused an explosion, KARI claimed that a malfunction in the oxidation and compression systems in the Russian first-stage rocket might have led to the failure. The investigation team found it very difficult and time-consuming to verify the exact causes of the failure. Finally it could only recommend that the two countries do what they could to avoid another failure.

Although the definitive cause of the second failed launch had not been determined, the two countries agreed to push for a third attempt as outlined in a bilateral agreement. A third launch of Naro-1 was scheduled to take place by the end of 2012. The government said that if this third launch also ended in failure, the *Naro* project would be terminated, although it had already given approval for a new generation of space vehicles. The first attempt on 26 October was delayed only hours before its scheduled lift off due to a leak detected in a connection between the first-stage rocket and the launch pad. A second attempt on 29 November, 2012 was also suspended due to problems in the upper second-stage of the rocket. Finally, on January 30, 2013, after a decade of development and two failed attempts, the *Naro* blasted off smoothly and placed the STsat-2C into orbit. The Korean government announced that "in spite of its short history of 25 years in space development, Korea has secured outstanding space development abilities, becoming the 11th member of the 'Space

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441 "Three Possible Causes Pinned Down for Naro Rocket Launch Failure," *The Korea Herald* (June 9, 2011)

Club' with own satellites, a space center, and launch vehicle by successfully launching *Naro* (KSLV-1)."[442]

Conclusion

Initially focusing on purchasing foreign technology, South Korea has made major efforts in the last decade to develop independent capabilities for the production and orbiting of satellites using its own launcher. During the 1990s, South Korea began a space program with KITsat-1 and 2 with the assistance of Surrey University in the U.K., and KOMPsat-1 (1999) cooperating with American and French manufacturers of space systems. In this century, it has increased its technological capabilities with the success of fourteen national satellites projects including KITsat-3 and KOREAsat-3 (1999), KITsat-4/STsat-1(2003), MBsat (2004), KOMPsat-2 and KOREAsat-5 (2006), KOREAsat-6 and COMS-1 (2010), KOMPsat-3 (2012), STsat-2c, KOMPsat-5, and STsat-3 (2013), and KOMPsat-3A (2015). KOMPsat enables Korea to monitor the ground, ocean, and general environment with high accuracy as well as to strengthen the nation's security and international competitiveness in space technology. STsat is devoted to preliminary research and space experiments, and COMS serves the needs of meteorological observation, monitoring, and the development of next-generation geostationary satellite communications.[443]

[442] KARI, "The Government, Establishing a Foothold for the Takeoff of Korea as an Aerospace Powerhouse," Press Release (November 26, 2013) (in Korean)

[443] Hyun-Ok Kim, Hee-Seob Kim, Hyo-Suk Lim, and Hae-Jin Choi, "Space-Based Earth Observation Activities in South Korea," *IEEE Geoscience and Remote Sensing Magazine* (March 2015)

Although the scale of the space industry in Korea is still very limited (o.45% share in the global space market based on sales in 2013[444]), the government continuously creates a demand for the space industry by supporting the export of aerospace products. In 2008, the Korean Ministry of Education, Science and Technology (MEST) signed contracts totaling $22 million with three overseas institutions, including the European Space Agency (ESA), to supply KOMPsat-2 satellite images over the next three years.[445] For private use and other uses, KAI (Korea Aerospace Industries), acting as the sales agent for KMPsat-2 images in Korea, distributes them at a commercial price. The SaTReC-I, a private spin-off firm established by former KAIST engineers, became the first Korean company to enter the foreign satellite market winning many contracts for the complete or partial development of satellites for medium-resolution Earth observations from more than 20 global customers in Asia, the Middle East, and Europe.[446]

However, launch technology is much more difficult to acquire through technology transfer than satellite technology because it is dual-use. Like other space-faring countries, South Korea has been subject to bilateral control regimes such as the 1979 Missile Note that prevented technology being diverted to missile development. This affected the indigenous NHK-1 that was built by modifying the U.S. Nike Hercules ballistic missile. Using the industrial and technical infrastructure put in place for the NHK-1 project, South Korea initiated its sounding rocket project for scientific purpose, KSR in the 1990s. KARI

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444 "The Government, Establishing a Foothold for the Takeoff of Korea as an Aerospace Powerhouse," Ministry of Science, ICT, and Future Planning of Korea, Press Release (November 26, 2013)

445 KOMPsat-2 provides 1m resolution panchromatic and 4m resolution multispectral images.

446 SaTRec-I homepage (https://www.satreci.com/eng/) (last accessed on October 18, 2015)

successfully launched the solid-fuelled sounding rockets KSR-1 in 1993, KSR-2 in 1998, and liquid-fuelled KSR-3 in 2002. The indigenous propulsion, control and guidance technologies used in the KSR series would also be utilized for the first Korean space launcher. Thus, the KSLV-1 project has been crucial to South Korea as a new entrant to the space community to build its prestige and boost the national image abroad. Along with the nationalistic slogan of "Launching Our Own Satellite with Our Own Rocket from Our Own Country," KARI conducted landmark events for the exposure of space development to the public, for example, the project to restore *Singijeon*, a 15th-century South Korean rocket system, and the first Korean Astronaut Program.

North Korea's attempt to orbit its first satellite in 1998, so-called *Taepodong* Shock, directly affected the basic direction of independent development of KSLV-1. South Korea brought its independent launch of KSLV-1 forward by five years, and urged the U.S. to revise the 1979 Missile Note and allow its entrance into the MTCR. Indeed, this political drive led South Korea to turn to international cooperation with Russia rather than overcome technical difficulties in developing an indigenous liquid-fueled rocket for KSLV-1. As it turned out international cooperation in building a rocket came at the cost of an eight-year delay and a 40% budget increase. South Korea initially planned to have a launcher capable of lifting a 100kg payload into low earth orbit by 2005, but only achieved this goal in 2013 due to prolonged negotiations over the partnership with the Russians and significant problems with rocket engine development. In that time the initial budget of 359.4 billion won (about $370 million) grew to 509.8 billion won (about $524 million).[447]

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[447] KARI, *Naro Development White Paper* (2009) (in Korean)

Thomas Hughes suggests that it is extremely rare for the large technological systems to be countered. He elaborates with an analogy that places large technological systems alongside dinosaurs; “To counter large technological systems, forces analogous to those that killed off the dinosaurs are needed.”[448] When a big science project such as space exploration gets underway, it is difficult to stop the project even with institutional means such as evaluation and audit. In terms of project management, the delay of the KSLV-1 project can attributed to an over-optimistic plan based on the best-case scenario, undefined objectives and performance specifications, and cursory evaluation.[449] Indeed, as in 2007, the long negotiations over technology transfer agreed that Russia would supply components and materials needed for the development “without transferring technology,” Critics suggested that the Russians were using Korean money to get precious expertise for their own rockets, without transferring rocket technology to South Korea.[450] A joint committee investigating the cause of the second failure of KSLV-1 in 2010 even suggested reducing interactions between the Russian first stage and Korean second stage for higher credibility of the system.[451] Despite of delays due to problems with the “made in Russia” first stage, KARI postponed its schedule for launch many times rather than abandon the project which had already been set up in 2005.

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448 Thomas Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm* (Penguin Books, 1989[2004]), p. 462.

449 Jung Byung-kul and Kil Jong-baik, “The R&D Mega-project Paradox and It's Managerial Implications,” *Korean Journal of Public Administration*, Vol.48, Issue 3 (2010): 252-273 (in Korean)

450 “Naro, Made in Russia? Long Way to Achieve Technological Independence,” *Hangyeore Daily* (August 12, 2009) (in Korean)

451 KARI, *Naro Development White Paper*, (2014), p. 315. (in Korean)

As James Moltz points out, the Korean space program has been "motivated by the joint but sometimes contradictory goals of building its prestige and promoting international cooperation."[452] KSLV-1 has been, indeed, at the intersection of such complicated national and global contradictions. The motivations for the project were the aspiration to develop a space industry on a par with the advanced countries, unsettled historical and geopolitical rivalries with North Korea, and a desire to emerge from a long dependency on foreign technology. And its success has been closely intertwined with the global environment in which South Korea collaborated with Russia under the MTCR. Park Jeong-joo, head of KSLV Propulsion Div., estimated that "[KSLV-1] was a collaborative effort, one that was necessary for a giant leap. We did obtain invaluable knowledge from them, and worked our way up to emulating their technologies. It was rather lucky to fail at two attempts in 2009 and 2010, because we had a maximum chance to learn from Russia through those failures."[453]

2013 marks another significant year in the history of the Korean space program. On November 2013, the Ministry of Science, ICT, and Future Planning announced the second Middle and Long Term space Development Plan.[454] The next step for South Korea is developing its own indigenous rocket, the KSLV-2, a three-stage rocket with a liquid-fuel engine carrying an application satellite by 2020. South Korea aims to develop an indigenous 10-ton thrust liquid fueled rocket engine by 2016, a 75-ton thrust engine by 2018, and a 300-ton thrust engine that can carry a 1.5-ton satellite into outer space by 2020. In the meantime,

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[452] James Moltz, *Asia's Space Race : National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2011), p. 153.

[453] Interview with Park Jeong-joo by author (May 28, 2015).

[454] KARI, "The Government, Establishing a Foothold for the Takeoff of Korea as an Aerospace Powerhouse," Press Release (November 26, 2013) (in Korean)

North Korea launched a three-stage rocket Unha-3 with the Kwangmyongsong-3 satellite into orbit on 12 December 2012, and U.S. defense officials confirmed the object in orbit.[455] On 7 October, 2012, South Korea and U.S. reached an agreement allowing South Korea to extend the range of its ballistic missiles to 800 kilometers with a 500 kilogram payload.[456] It remains to be seen how South Korea's space program will evolve over time in this complicated local and global context.

455 "North Korea Successfully Launches Three-stage Rocket," *The Telegraph* (December 12, 2012)

456 "U.S. Agrees to Let South Korea Extend Range of Ballistic Missiles," *The New York Times* (October 7, 2012).

CHAPTER 6: Conclusion

This dissertation has detailed the story of the origin and development of the Korean space program from its early years to the present (1958-2013). My primary approach to this narrative has been a close examination of how different imagineries of space development have evolved with the Korean state's efforts at nation-building. The Korean state mobilized these imaginaries at successive crossroads in the nation-building process. I have highlighted the centrality of the goals of modernity, self-defense, economic security, and national prestige as drivers of space development, taking it to a new level each time. My critical argument has been that, while these imaginaries were deployed for nationalistic reasons, there was always a hidden transnational context.

The Sputnik Shock of 1957 directly motivated the political leaders to develop guided weapons for national security. Furthermore it inspired the Korean people who became fascinated with rocket development under the slogan of an "aspiration for a Western modernity." This aspiration would help them emerge from the "backwardness" of Korea's long colonization followed by civil war and subsequent division. The development team in the NDSRI launched their first modern rocket successfully in 1958 under President Rhee's strong support. The social response to several amateur rocketeers' efforts to launch their self-produced rudimentary rockets was very enthusiastic, and some amateur rocket clubs and scholarly associations, such as KAS and KSSSS championed a boom in popular space science. However, the military government that seized power through a coup in 1961 dismissed NDSRI in order to secure the U.S.'s approval and continued assistance. The military government echoed Kennedy's changed foreign policy which denied cutting edge equipment in exchange for consumable military supplies. Stunted, the rocket boom did not advance into a national space policy in the 1960s.

It was only in the early 1970s that South Korea began to again pursue the development of a new generation of guided missiles. This time the rationale was based on the principle of "self-defense" because of serious concerns over the increasing threat from North Korea - and U.S. forces' withdrawal from South Korea after the implementation of the Nixon doctrine. South Korea established the ADD in 1970 to pursue modernization programs for the armed forces, and initiated both nuclear weapons and surface-to-surface missile programs. Although the ADD, under pressure from the United States, suspended the pursuit of nuclear weapons in the mid-1970s, it did successfully develop the surface-to-surface guided missile K-1, a modification of the U.S.-produced Nike Hercules missile, in 1978. Recognizing U.S. fears of proliferation and regional tensions, South Korea signed the Missile Note in 1979 which allowed only for the development of missiles with a short range of 180km.

In the 1980s, South Korea began to outline a new economic rationale for moving the country into the field of space technology, this time based on high-tech infrastructure and skilled workers trained through the growing defense industry in the 1970s. As the majority of South Korean industry based on low-cost labor was only able to compete in world markets thanks to global technology protectionism in the 1980s, the country emphasized space development as a way to reinforce South Korean's "economic security." Space development would give South Korea a chance to catch up with advanced industrial nations and withstand the fierce international competition in new technology. Although initially relying on the import of technology from foreign countries, South Korea soon aspired to attaining an indigenous capability for space development. In 1996, the government announced its first Basic Plan on Mid-to-Long-Term National Space Development, of which the main objective was to join the top 10 countries in the space industry and to launch KSLV-1 from a local launch site with a satellite developed independently in 2010.

When North Korea attempted to launch the *Taepodong*-1 space launch vehicle with a satellite in 1998, South Korea brought its launch of KSLV-1 forward by five years from 2010 to 2005. Also South Korea revised the 1979 Missile Guideline and joined the MCTR to extend the range of Korea's rocket development. The dominant imagination for Korean space development was now "national prestige." Even though South Korea turned to international cooperation with Russia rather than indigenous development of the rocket engine for KSLV-1 to meet its new deadline, the imaginary of national prestige endured with public events - such as the restoration project of *Singijeon* and the first Korean Astronaut Program. Despite of delays due to a long period of negotiation on technology transfer with Russia, some technical problems, and two failed attempts in 2009 and 2010, in 2013 South Korea succeeded in launching KSLV-1 and delivering a satellite into orbit.

I have argued here that the fifty-five years of South Korea's aspiration for space is divisible into four periods according to changing dominant national imaginations in political and social contexts; "modernization" during the 1950s~1960s, "self-defense" during 1970~1984, "economic security" during 1985~1997, and "national prestige" during 1998~2013. These nationalistic imaginations were invoked and re-presented at key turning points in policy formation. The characteristics and transitions of Korean space development, as examined through four phases in terms of five categories, are summarized in Table 5.

Here one can observe some of the turning points in deploying the imaginations of South Korean space development.

Table 5: The Change in Korean Space Development

	1958~1969	1970~1984	1985~1997	1998~2013
Imaginaries	Modernity	Self-defense	Economic Security	National Prestige
Turning point		Established ADD (1970)	Establishing the first national long-term plan for space development (1985)	*Taepodong Shock*(1998)
Critical Events	The Sputnik Shock (1957) Established a rocket team in NDSRI (1958) Dismissed NDSRI (1961)	Increasing threats from North Korea (1969) Nixon Doctrine (1969) Missile Agreement (1979) Downsizing missile projects (1980)	Global technology protectionism (1980s) The Seoul Olympic Games(1988)	Revision of Missile Agreement and entry into the MTCR(2001)
Space-related Act and Policy		*The Promotional Plan for the Aerospace Industry (1972)*	*Long-term plan for the development of science and technology toward the 2000s (1985),* *Basic plan on mid-to-long-term national space development(1996)*	*Basic plan on mid-to-long-term national space development modification (1998,2000,2005),* *Space Development Promotion Act (2005)*
National Space Projects		*Paekkom* missile (1978)	Satellites (KoreaSat, KITsat, KOMPsat series), Sounding Rockets (KSR –I,-II)	Satellites (KOMPsat, KoreaSat, STsat, COMSat series), Sounding Rockets (KSR-III), Naro-1, The First Korean Astronaut Project

My case study of the Korean space program suggests that these national imaginations tended to be adapted, maintained, and transformed at the national level as powerful instruments of “meaning-making and goal-selecting in the process of nation-building.”[457] Asif Sidiqqi has argued that the link between nationalism and competence in space activities has been articulated by four elements ubiquitous in the public conceptions of any national space program: the iconography of a founding father, the claim of indignity, the link with national identity, and the necessity of justifications.[458] These elements obviously include the perception of a powerful relationship between science and technology and nationalism, and they have constructed a master narrative of the history of space exploration and informed major decisions regarding national space policy. The history of the Korean space program shows that the nation retains a very strong position as the primary enabler of space development in spite of increased international cooperation coming out of the fifty years of spaceflight.[459] Also, the national imaginations enabling a country’s space program have been changing because they are deeply connected to collective visions of desired futures.

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457 Recent studies of “sociotechnical imaginaries,” which is a concept originated by science and technology studies (STS) scholars Shilla Jasanoff and Sang-Hyun Kim, illuminate the question of how policies for the stimulation or control of scientific and technological progress contain collective visions of the good society. For sociotechnical imaginaries, see the first book-length treatment of sociotechnical imaginaries, Sheila Jasanoff and Sang-Hyun Kim (eds.), *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, The University of Chicago Press (2015)

458 Asif Siddiqi, “Spaceflight in the National Imagination,” in Steven J. Dick, ed., *Remembering the Space Age: Proceedings of the Fiftieth Anniversary Conference*, (NASA SP-2008-4703, 2008), pp. 17-35.

459 For a strong case study of technonationalism as an ideological weapon in nuclear development of South Korea, see Buhm Soon Park, “Technonationalism, Technology Gaps, and the Nuclear Bureaucracy in Korea, 1955-1973,” in eds. Youngsoo Bae and Buhm Soon Park (eds.), Bridging the

Paradoxically speaking, however, this path of nation-building to enable a country's space program cannot be fully captured within "the walls of national containers," because a nationalistic narrative sometimes "occlude[s] the multiple borrowings and transnational interactions that are sustained by interpersonal, inter-institutional and inter-firm relations." [460] The dominant imaginations in each period of the history of the Korean space program commonly view the science and technology related to the space industry as primarily a form of national power and as instruments to serve state-led development. Also, the stability and instability of an imagination cannot help being heavily dependent on the multifaceted processes of co-producing space technology and nationhood. As John Krige recently stressed, however, scientific and technological practices in space exploration (as well as nuclear science) in reality have been "embedded in global networks through which knowledge in all its forms circulated."[461] For this reason, he proposed that one "study the history of space through a lens that describes the tissue of global linkages that make 'national' space programs possible and that sustain them."

The many cases in the history of Korean space program, as described in this dissertation, show that Korean space technology has been at the intersection of multiple flows of knowledge, materials, and human resources from a variety of sources across borders. For

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Technology Gap: Historical Perspectives on Modern Asia (Seoul: Seoul National University Press, 2013): 153-197.

[460] Asif Siddiqi, "Competing Technologies, National(ist) Narratives, and Universal Claims. Towards a Global History of Space Exploration," *Technology and Culture* (2010): 425-443.

[461] John Krige, "Embedding the National in the Global: US-France Collaboration in Space in the 1960s", in Naomi Oreskes and John Krige (eds.), *Science and Technology in the Global Cold War* (MIT Press, 2014), p. 228.

example, the K-1 missile described in Chapter 2 of this dissertation is characterized by such cross-border flows. The K-1 is still widely known as the first "Korean" missile developed by Korean engineers' dedicated efforts despite the pressure from U.S. fears of proliferation in the 1970s. The news media have rarely covered the dependence of its production programs on foreign countries. Yet, as I have shown, the ADD at the time actively sought to purchase the necessary propellant and guidance technologies, parts and components on the international market including both the U.S. and France. Foreign policy scholar Janne Nolan criticized a film shown to him when he visited the Korean Institute for Defense Analysis in March 1982: "the film was an enthusiastic interpretation of the arms production capabilities of South Korean industries. It managed completely to avoid reference to U.S. assistance and components."[462] It is not surprising that the government and the news media demonstrate the independence and nationalistic pride of the weapon more than foreign assistance for it. As Nolan points out, the importance of the missile has "far more to do with political symbolism than with any objective calculation of military utility."

The motives for South Korea commencing independent arms production in the early 1970s can be analyzed in terms of three main factors: the increasing threats from North Korea, the insecurity of its alliance with the U.S., and Park's urge towards self-reliance. The involvement of these factors in key aspects of South Korea's development of the missile created a sense of urgency that led the country to make efforts to acquire the components for the most advanced weapons from those available in the international market. The development of K-1 was feasible with the circulation of flows of people, ideas and objects

[462] Janne Nolan, "South Korea: an Ambitious Client of the United States," in Michael Brzoska and Thomas Ohlson (eds.), *Arms Production in the Third World* (London: SIPRI, 1986), p. 231 note 26.

across national boundaries, with the structures that support these flows and with the different scales across which structures and flows operate. Thus, in John Krige's notion, the K-1 missile was a "global hybrid," embedded in a network of interconnections that overflowed territorial boundaries, rather than a national product.[463] The first "Korean" satellite KITsat-1 developed by a contract between two universities in Korea and the U.K. and the first "Korean" space launch vehicle KSLV-1 which has a Russian-built first stage also provide fertile examples of the global hybrid, despite their nationalistic significance.

The contradiction between the nationalistic core of the imaginations of the Korean space program, and the reality of the transnational character built into the technical hardware, demanded that a good deal of social work be done to align the conquest of space by Korea with a nationalistic rhetoric. Even though South Korea furthered its capabilities and expertise towards a space-launch in developing its own surface-to-surface guided rocket K-1 in 1970s, popular enthusiasm for space exploration that was created by the Korean people themselves did not directly affect the top-level decision to go to space later. It is simply because before the 1980s the only external force that affected military rocket projects was the Korean Government itself. However, the public has emerged as one of the most important external forces since the government first began to express an interest in a civilian space program in the mid-1980s. As exposure to the public became a very important feature of Korean space development, such development is never far removed from the public consciousness.

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[463] John Krige, "Embedding the National in the Global: US-France Collaboration in Space in the 1960s", in Naomi Oreskes and John Krige (eds.), *Nation and Knowledge: Science and Technology in the Global Cold War* (MIT Press 2015). See also John Krige, "Hybrid Knowledge: The Transnational Coproduction of the Gas Centrifuge for Uranium Enrichment in the 1960s," *British Journal for the History of Science*, Vol. 45, no. 3 (2012): 337-357.

For example, the KITsat-1 in 1992 given the nickname *Uribyeol* (Our Star in Korean), was stigmatized as a "foreign star," [464] and Korea's first astronaut, Dr. Yi So-Yeon, who took part in space activities in the ISS in 2008, was also criticized for being a "space tourist" not an astronaut, because she travelled aboard a Russian spacecraft.[465] MEST and KARI made the communication strategy for KSLV-1 using the slogan of "Our Own Rocket" despite its first stage being made in Russia. This communication strategy for KSLV-1 led to a deep distrust of MEST and KARI by the public, who also began to doubt their technical capability. The successive delays of the launch led people to suspect that that the Russians were using Korean money to get precious expertise for their own rockets without transferring rocket technology to South Korea. Finally after the first failure, the distrust of the public partly resulted in the request for a change of organization in KARI. In 2011, the leadership of KARI was handed over to external specialists in order to strengthen local cooperation among industry, university, and government institutes for the success of the future of Korean space exploration.[466]

In this way, changing imaginations were embedded in the political culture of a nation. The history of the Korean space program, which has been "motivated by the joint, but sometimes contradictory, goals of building its prestige and promoting international cooperation," can be understood to be closely intertwined with the global environment in

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[464] Hyunsook Lee, "the Bureau of Public Information Launched the Uribyul-1," *Monthly Gil*, Vol. 92, No. 10 (1992): 128-131. (in Korean)

[465] Hyoung Joon An, "Is Yi Soyeon an Astronaut or a Space Tourist?: The First Korean Astronaut Debate on the View of ANT," *The Korean Journal of Science and Technology Studies* 9 (2009): 57–81. (in Korean)

[466] Kim Hoongi, "The Strategy of Science Communication and the Formation of Public Opinion: Focused on the Cases of NARO's Launch," *Journal of the Korean History of Science Society*, Vol. 34, Issue 1, (2012): 141-166. (in Korean)

which Korean space policy has evolved in the process of the construction of national imaginations. The nation helps to reconfigure actors' sense of the possible space of action by mobilizing resources, but it also sometimes triggers resistance when it calls for movement across borders. The nation-state in transnational history is like a "porous membrane permitting a two-way flow of the stuff of knowledge."[467]

A major difficulty in the transnational perspective is that de-centering the nation-state can lead to abandoning the national as a category of analysis altogether.[468] However, writing a transnational history of space exploration does not mean only rupturing the national frame. Rather, transnational history requires placing the nation-state in its proper global context. As John Krige has stressed one seeks "to embed the national into the transnational narrative-not as a bounded container but as one node in an interconnected global network. We must position our national actors on a global stage of competing and collaborating, actual and aspirant space powers, and follow them as they choose, or refuse, to establish links with institutions and individuals in other countries. A global space history must retain the national as key analytic category-not as an autonomous but as an interdependent actor, whose practices are inspired by national interest and framed by foreign policy."[469]

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[467] John Krige's remark at Francis Bacon Conference at California Institute of Technology, 7-9 May 2010, cited in Matthew Shindell, "How the Cold War Transformed Science" *Newsletter of the History of Science Society* Vol. 39, No.3, (July 2010).

[468] Erik Van der Vleuten. "Towards a Transnational History of Technology: Meanings, Promises, Pitfalls." *Technology and Culture,* 49:4 (2008): 974-994, p. 984.

[469] John Krige, "Embedding the National in the Global: US-France Collaboration in Space in the 1960s", in Naomi Oreskes and John Krige (eds.), *Science and Technology in the Global Cold War* (MIT Press, 2014), pp. 28-29.

The new era for space exploration will be international and participatory; thus, the influence of cultural values and national aspirations of various countries must be considered in long-term cooperative exploration activities. The Korean space program will be also deeply connected to the coproduction of science, technology, and national identity that will be driven by a collective imagination of a desired future, one which entails complex international interactions in a constantly changing global context.

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