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North Korea's Approach to Defense Innovation: Foreign Absorption, Domestic Innovation, and the Nuclear and Ballistic Weapons Industrial Base

Stephan Haggard and Tai Ming Cheung

The international community has consistently underestimated North Korean nuclear and missile capabilities. How has an economically impoverished, technologically backward, and internationally isolated state been able to establish robust and increasingly competent nuclear weapons and ballistic missile programs, especially since the mid-2010s? Has North Korea predominantly relied on foreign sources of technology or are its nuclear and missile programs the result of domestic effort? Even when technologies have been borrowed, a detailed analysis of the evolution of the programs suggests sustained domestic investment has proven crucial. The result is a far-flung and large weapons of mass destruction (WMD) infrastructure. Any negotiations over the program must take the extent of this infrastructure into account and consider the challenges of how to inspect, verify, and limit them, including through repurposing these capabilities to civilian uses.

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FOREIGN AND DOMESTIC SOURCES OF INNOVATION

If North Korea's weapons program is placed in a wider context of late development, it quickly becomes clear that the question of whether it was largely foreign or domestic in origin presents a false dichotomy. All successful developing countries have effectively grown and developed new capabilities through technological copying. North Korea has been particularly adept in this regard and often through open source and illicit means as well as state-to-state transfers.¹

It is often thought that official support from the Soviet Union/Russia and/or China was instrumental to North Korea's WMD and missile programs, and there are points at which these relationships proved crucial. Yet the record also suggests that these two patrons were wary of North Korean ambitions, and that their assistance was indirect or else provided through non-state rather than official channels. The regime has been surprisingly adept at exploiting other illicit avenues—most notably Iran and Pakistan—and in taking advantage of open sources of information.

Rather, North Korea's strategic weapons innovation system ultimately rests on the steady accretion of domestic capabilities through what we call an authoritarian mobilization model. This is a highly centralized, state-led, and top-down "big engineering" approach that consists of the following core elements:

- The top leadership prioritizes the program, and the state mobilizes and concentrates the country's science, technology, and heavy industrial resources on a select—but in North Korea's case an ever-widening—number of programs.
- The nuclear and ballistic missile scientific community and

defense industrial complex are tightly integrated with the country's civilian and military leadership.

- The leadership places priority on research institutions—including key departments at major universities—and trading entities tasked with securing technology and needed inputs from abroad. These entities operate without constraint, and can pursue these objectives through official, informal, and illicit channels.
- The ability to absorb, reverse engineer, and ultimately innovate rests on a sprawling nuclear and missile infrastructure that spans the entire value chain in each industry. This infrastructure runs from basic to applied research and development (R&D), product development, testing, linked industries devoted to the production of relevant inputs, manufacture of components and subassemblies, and final output. There is a close affinity between the leadership's focus on heavy industry and its nuclear and military ambitions.

HOW STRUCTURED AND HOW BIG?

Two features of the North Korean political system are significant for understanding the evolution of the weapons program. First, the system has been highly centralized around the three Kims—Kim Il Sung (1948–1994), Kim Jong Il (1994–2011) and Kim Jong Un (2011–present)—who have typically held the top positions in the party, the state apparatus, and the military. This facilitates the country's authoritarian mobilization model: the ability of the leadership to prioritize and coordinate activity across institutions. Second, the system is state socialist,

meaning that all units involved in the research, development, production, and operation of the defense-industrial complex fall under the control of the party. Whatever the inefficiencies of such systems, they are effective in mobilizing and channeling resources.

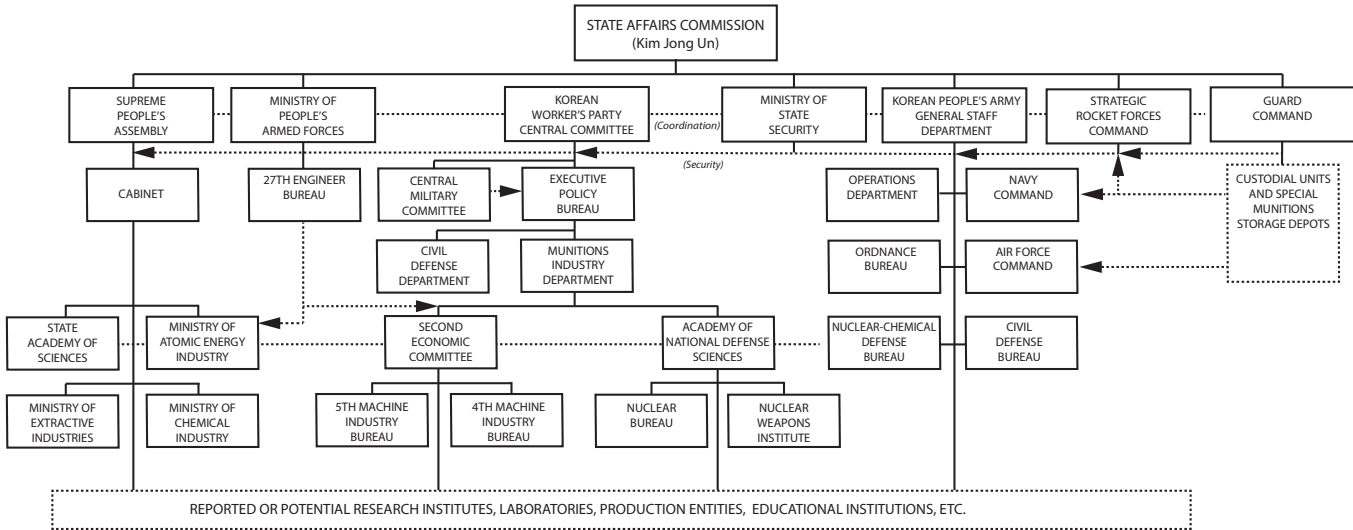
Figure 1 outlines the formal organization of the nuclear infrastructure and shows how elements of the program are spread across state, party and military institutions. On the left are several key supporting ministries that fall under the Cabinet, such as the Ministries of Chemical Industry and Extractive Industry that provide relevant inputs (for example, reprocessing technology and uranium). For example, the State Academy is involved in both basic and applied R&D, and is responsible for training scientists, technicians and support personnel; it also oversees the science departments in the major universities that are also effectively instruments of the program and appears to run some production facilities.

A second important cluster of institutions is controlled directly by the party. Most notable in this regard is the Munitions Industry Department, below which sit the Nuclear Bureau, Nuclear Weapons Institute, the Academy of National Defense Sciences—specifically devoted to weapons-related research—and the all-important Second Economic Committee, which oversees the defense-industrial complex. The 4th and 5th General Bureau of the Second Economic Committee are devoted to the missile and nuclear industries respectively, and thus sit atop a network of production facilities associated with those two programs.

The organization of the missile program shows some significant overlap with the overall organization just described, and only a few differences are worth underlining. First, the missile program rests on a different set of

¹ The authors wish to acknowledge the invaluable research assistance of Taseul Joo, who compiled key data sources and conducted extensive reviews of Korean language sources.

FIGURE 1. North Korea’s nuclear weapons infrastructure



Source: Joseph Bermudez, Jr., *Overview of North Korea’s NBC Infrastructure*, Johns Hopkins School of Advanced International Studies, US-Korea Institute, June 2017, 27.

research institutes that are primarily under the Academy of National Defense Sciences (also known in the past as the Second Academy of Natural Sciences) (Figure 2). Second, the missile program involves an ongoing manufacturing component, especially for shorter-range ballistic missiles that enjoyed the status of an export industry in the 1980s and 1990s before sanctions gradually reduced opportunities. This production apparatus means that the overall missile infrastructure is probably much larger than the nuclear one, which is confined primarily to research, development, engineering, and the operation and maintenance of existing facilities.

How large is this infrastructure? And what should the metric be? With respect to the nuclear program, Bermudez argues for a range of 100–150 “entities” and 9,000–15,000 personnel directly involved in the re-

search, development, testing, or production of nuclear weapons.² The Nuclear Threat Initiative has developed a list of 39 “facilities” that cover the entire spectrum of the nuclear fuel cycle, although roughly one-third of these are uranium mining sites.³

The size of the missile infrastructure is much harder to gauge because the linkages with a variety of heavy industries are tighter. South Korean media reports and articles by defecting North Korean missile researchers indicate that there are around 50 research institutes within the missile complex, of which the most important include the No. 120 (electrical engineering), No. 122 (mechanical engineering), No. 130 (precision machinery), No. 144 (metallurgical engineering), No. 166 (rocket R&D), and No. 185 (electronic engineering) institutes. Yet the scope of actual production facilities is larger still and must encompass linkages to other heavy

industries: steel, non-ferrous metals, machine tools, electronics, chemicals, and even automotive vehicles (for example, modified trucks for transporter-erector launchers) and shipbuilding (for the growing submarine fleet). If we narrow our metric to the dedicated missile research, development, and engineering community it is estimated to number around 15,000 personnel, of which around 3,000 are believed to be scientists and engineers.⁴

Finally, although we don’t address them here, Bermudez estimates that the biological weapons program consists of 25–50 entities and between 1,500–3,000 personnel while the chemical weapons complex consists of 25–50 entities and 3,500–5,000 personnel.⁵

INTO THE KIM JONG UN ERA

The growing political significance of the programs can also be measured

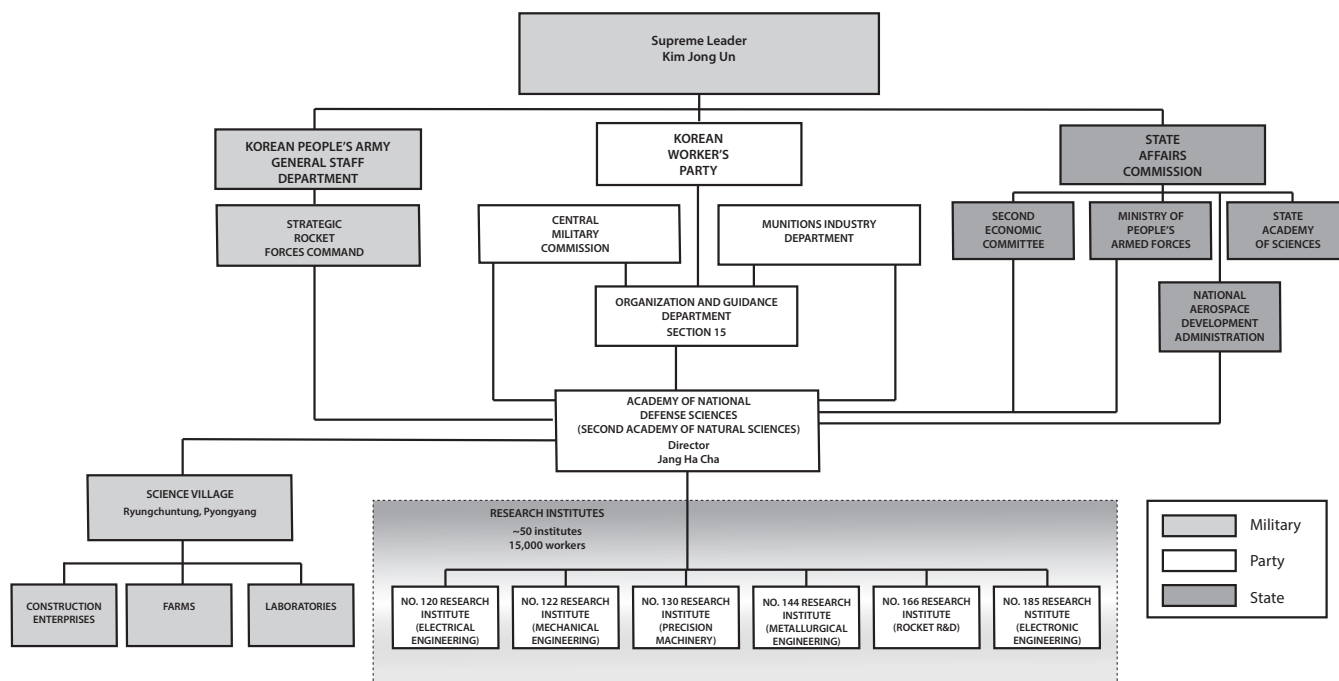
2 Joseph Bermudez, Jr., *Overview of North Korea’s NBC Infrastructure*, Johns Hopkins School of Advanced International Studies, US-Korea Institute, June 2017.

3 Nuclear Threat Initiative, “North Korea: Missiles,” last updated July 2017, <http://www.nti.org/learn/countries/north-korea/delivery-systems/>.

4 “North Korean ‘Missile Researcher’ Lays Bare Missile Development by the North Korean Military,” *Shindong-A*, March 9, 2015.

5 Bermudez, *Overview of North Korea’s NBC Infrastructure*, 11, 16.

FIGURE 2. North Korea's ballistic missile research and development system



by the attention given to them by Kim Jong Un. Of particular significance was the roll-out of the byungjin line at the plenum of the Workers' Party Central Committee and the Supreme People's Assembly (SPA) meetings in March-April 2013.⁶ The new policy line committed the country to *both* economic reconstruction and the pursuit of its nuclear program. The SPA item "On Consolidating the Position of Nuclear Weapons for Self-Defense" effectively codified these commitments and was quite explicit that the country's nuclear forces will not only be maintained but upgraded. Whether North Korea currently has a miniaturized warhead that can be mounted on an intercontinental ballistic missile (ICBM) and survive re-entry remains an issue of debate, but few doubt that the problems are insurmountable. In the missile domain, the pace of development is unprecedented and includes:

- Extending the range of the strategic rocket force. The most striking feature of the 2017

tests was what appeared to be unprecedented jumps in range, mirrored in the debate over whether North Korea did now have an ICBM range (tests of the Hwasong 12 in May and August, the Hwasong 14 twice in July, and the Hwasong 15 in October).

- The quest for road-mobile missiles with greater ranges in order to achieve survivability and a credible second-strike capability, with demands not only on the missile program but on transporter-erector launcher (TEL) technology as well.
- Closely related, the development of solid-fuel rocket technology, most notably to extend the range of the Russian KN-02 SRBM design that could be deployed both on mobile land launchers and as a submarine-launched ballistic missile (SLBM). Tests in 2017 included the first flight test of KN-15, a land-based version of the KN-11.

- The pursuit of naval platforms and even an SLBM capability, again motivated by achieving a credible second-strike.
- Continuing pursuit of the satellite and space launch vehicle program that increasingly appears to be a component of the ICBM program, with the December 2012 Kwangmyongsong-3 and September 2017 Kwangmyongsong-4 tests.

POLICY IMPLICATIONS OF DEALING WITH NORTH KOREA'S LARGE NUCLEAR AND MISSILE COMPLEX

All of these programs taken together strongly suggest that the North Korean nuclear and missile program has reached a critical juncture in its move up the innovation ladder. The missile sector in particular has already, at a minimum, reached the stage of advanced imitation where most if not all of its programs demonstrate a significant level of domestic

⁶ "Report of Plenary Meeting of WPK Central Committee," KCNA, March 31, 2013, and "Seventh Session of the 12th SPA of DPRK Held," April 1, 2013. On nuclear weapons in particular: "Law on Consolidating Position of Nuclear Weapons State Adopted," KCNA, April 1, 2013, and particularly "Nuke and Peace 1" and "Nuke and Peace 2," KCNA, April 26 and 27, 2013.

improvement on existing designs and the capacity to produce. The missile industry may also be well on its way to acquiring the expertise to engage in original indigenous innovation that would allow it to develop new capabilities on its own.

These achievements rest on a very large nuclear and missile infrastructure, one that is hard to fully identify let alone monitor. This focus on the WMD infrastructure has wide-ranging implications for negotiations with the North Koreans and for how the programs might ultimately be rolled back if the opportunity were to arise.

First and foremost, the extent of the investment in this capability dramatically increases the complexity of negotiations, and reduces the likelihood that North Korea will agree to “complete, verifiable, and irreversible dismantlement” of its program. The United States and its allies will need to think about whether they are willing to accept interim agreements, including a freeze on development and testing but also limits on certain categories of particularly threatening weapons, such as ICBMs and SLBMs.

Second, verification procedures for any agreement are complicated because the international community is not sure where all the key facilities are located. This is certainly true for the sprawling missile program, but includes the likelihood of a second cen-

trifuge facility and storage of fissile material and weapons themselves. In addition to a national declaration from North Korea, the international community will continue to rely on other sources of intelligence to identify key facilities. Even interim agreements will require detailed, up-front commitments to a robust verification regime.

Finally, if initial progress is made on shuttering Yongbyon and the most prominent nuclear facilities and securing a declaration on stocks of fissile material and weapons, the next step would turn to the large workforce of highly-skilled strategic weapons scientists and engineers. Aid to North Korea is not popular, especially to any entities connected to the military system, but a Cooperative Threat Reduction program similar to that offered to successor states of the former Soviet Union in the 1990s could provide a useful quid pro quo. Such a program would provide material support for the decommissioning and removal of nuclear, chemical, and biological weapons stockpiles and any delivery systems subject to limitations. It would also allow or support conversion to select civilian applications, including nuclear energy generation subject to International Atomic Energy Agency safeguards and a civilian space program. Such a prospect appears a remote possibility given

current geostrategic realities and the nature of the political regime in North Korea, but is worth contemplating in the event that Pyongyang one day is serious about denuclearization.

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