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What the Ukraine-Russia War Means for South Korea's Defense R&D

South Koreans are watching the war between Russia and Ukraine not as a far-off conflict, but as a possible model for future power struggles in East Asia—especially in the context of increasing rivalry between the United States and China. Many experts have been struck by the role technologies developed without explicit military applications in mind—nondefense technologies such as drones, information technology (e.g., through cyberattacks), and space communications—have come to play in the conflict alongside conventional weaponry such as missiles, tanks, artillery, and soldiers. Although nondefense technologies can escalate tensions, and sometimes even win battles, they may also serve as deterrents to conflict. For this reason, South Korean government officials and defense researchers are taking notes on the new ways science and technology are changing warfare and defense capability.

We would like to call out two aspects of the Ukrainian armed forces' robust defense against Russia's aggression to which South Korea should pay special attention. First, the Ukrainian defense has adopted high-tech weaponry that was developed for both military and civilian use. In the wake of the Russian surprise assault, Ukrainian forces responded with new applications of high-tech systems, including using 3D printers to add tail fins to drone bombs; employing artificial intelligence-based voice recognition and translation software to highlight information relevant to the Ukrainian forces from unencrypted Russian voice communications; deploying space remote sensing; and enabling satellite communication. Although more technology is no guarantee against low-tech attacks, these nondefense technologies have played important roles in the conflict so far.

Second, unlike other wars, this conflict includes a high degree of engagement by people outside the military. For example, Ukraine's Military Intelligence Team and Aerorozvidka (a special drone unit) consist of professionals from the private sector who are now engaged in civilian-military cooperation. In particular, the Ukrainian information technology unit widely known as the "IT Army" is operated mainly by private professionals supported by volunteer hackers from all around the world, and is not included in the formal organization of the Ukrainian armed forces. In addition, SpaceX, the American aerospace company owned by Elon Musk, supports Ukraine by providing seamless communication capabilities to both military command and the public.

In short, these technologies are not only changing the course of the conflict, but also blurring traditional demarcations between the military, nondefense ministries, and the private sector. As a harbinger of future conflict, the use of convergent and transboundary technology provides important lessons for South Korea's research and development system. To be ready for unpredictable future conflicts and technology-driven uncertainty, South Korea needs to examine and change the way it structures defense R&D. For many decades, the country has fundamentally separated defense R&D from the government's wider R&D processes. Adopting a more inclusive R&D structure, while shifting the system's focus toward future science and technology needs, can advance national security objectives. Making these changes will help ensure that South Korea remains prepared for future threats.

South Korea's defense R&D capability is limited by its history

The two Koreas—North and South—have been in a standoff since the 1953 armistice treaty, with periodic military collisions including the battles of the Korean West Sea in 1999 and 2002 and the Cheonan ship sinking in 2010. This nearly seven-decade standoff, against the backdrop of North Korea's many nuclear missile tests and development of intercontinental ballistic missiles, has meant that South Korea's military remains ever-vigilant. To maintain the same level of military strength as North Korea—especially given its relatively low birth rate and decreasing number of enlisted soldiers—the South has long invested a large amount of its government budget in military R&D.

A key strategy for enhancing South Korea's military power has been a separation of defense R&D from the government's wider R&D processes and plans. By taking this approach, the Ministry of National Defense maximizes the use of defense resources for internal production of high-tech weaponry, rather than purchasing weapons and equipment from other countries with advanced militaries. As a result of this strategy, South Korea had the world's ninth-largest defense R&D spending in 2015. But even though this strategy protects South Korea from dependence on foreign weapons or parts, the Ukraine-Russia conflict has revealed its limitations. Rather than fostering integration between defense and civilian technological development, the South Korean system is siloed, with defense R&D centralized in a few institutions. Furthermore, the process itself is narrowly focused on current rather than future needs.

While centralization helps defense R&D to respond quickly to urgent security and defense issues, it may hinder flexible utilization of some technologies mostly led by the nondefense private sector, such as artificial intelligence and big data. South Korea's defense R&D is centered in two government agencies, the Agency for Defense Development (ADD) and the Defense Agency for Technology and Quality, both of which are administered under the auspices of the Defense Acquisition Program Administration (DAPA). The ADD plays an especially important role in the defense R&D system: nurturing defense industries, cooperating with private companies, running R&D programs, and even facilitating industry-academic partnerships. Together, these agencies receive around 98% of the defense R&D budget.

This level of centralization simply cannot meet the demands of an open and collaborative R&D stream, which requires private-public partnership and civil-military cooperation. In addition, such centralized public services make corruption or other malfeasance more likely. For example, according to the annual Index of Public Integrity survey by the Korean Anti-Corruption and Civil Rights Commission, DAPA scored as one of the lowest-ranked public institutions in 2021.

As a result of this centralization, defense R&D in South Korea has a unique governance that may no longer serve its original intention. Nondefense government R&D programs and projects must go through a lengthy set of administrative steps for budget transparency and legislative consensus. By contrast, defense R&D is exempted from the Framework Act on Science and Technology, South Korea's highest science and technology law. This relative freedom of operation is designed to foster need-driven planning in service of the Korean armed forces, with the Korean government and military as the end consumers of defense R&D.

Within this scheme, defense R&D funding in South Korea tends to be seen as expenditures focused on current needs, rather than as investments that reflect careful calculations of risks and opportunities to meet future national security demands. As one example, the portion of the overall defense budget devoted to defense R&D is still small (around 8% in 2021); by contrast, the percentage of the budget devoted to maintaining key military strengths, like the response to weapons of mass destruction, stands at around 32%. In addition, within the defense R&D budget, the portion devoted to developing weapons systems such as tanks, ships, and airplanes (around 49%) remains larger than that for technology development (around 35%). Indeed, a recent analysis revealed that needs-based defense R&D, with those needs being solely those of the military, accounts for 88% of the total South Korean defense R&D expenditure, despite the changing nature of modern warfare. As technologies with dual uses among the military and civilians become increasingly common on battlefields, the South Korean system remains tightly focused on the practices of the past.

The upshot is that in South Korea, defense R&D is organized, governed, and focused independently from nondefense and private R&D. Needs-driven defense R&D under the auspices of the ADD and DAPA is done on a budget that is kept separate from the government's broader R&D investment plan. In addition, initiation of civil-military science and technology cooperation for small and medium-sized enterprises is still conducted by the ADD alone for the sake of efficient national security. But as the Ukraine-Russia conflict has revealed, this separation no longer reflects the nature of modern warfare. To be prepared for future conflicts, South Korea must revamp its R&D structure and reduce this separation.

Preparing for future conflict by enhancing defense R&D

If future wars follow the pattern of the Ukraine-Russia conflict, then armed forces and weaponry driven exclusively by traditional defense R&D will not be enough to deter or prevail in confrontations. In fact, nondefense technology and nonmilitary actors' engagement could be determining

factors in the outcome of future conflicts. To be ready, South Korea's defense R&D system must become better integrated with nondefense and private-sector R&D. We propose three steps to move in this direction: first, develop a more inclusive R&D structure; second, focus R&D on long-term challenges rather than immediate needs; and finally, diversify the defense R&D portfolio and use new conflict scenarios for dynamic planning.

Establishing inclusiveness within South Korea's defense R&D system means changing organizational culture and attitudes. This goes beyond structural changes such as decentralization or increasing communication between actors. It requires enhancing openness, participation, and diversity in the system. It also involves using practice exercises to stimulate open thought, adaptive attitudes, and agile behaviors. This will allow actors within the system to more readily accept different frames of belief, embrace multiple pathways for innovation, and establish expandable and flexible mechanisms for cooperation. In short, inclusive R&D is a collective intelligence process that makes tacit knowledge explicit through mutual and organizational learning.

A good starting point would be to integrate nondefense and private R&D into defense R&D by using new communication technologies. For example, for security reasons, sharing classified information on defense R&D with others is currently highly inconvenient. Using more current information security technologies such as digital rights management and nonfungible tokens on blockchain technology, however, could make sharing information in a secure environment easier. Blockchain technology can store data and transactions in each cryptographic block. This information block can only be updated or changed with the consensus of all participating actors, so data and information cannot be arbitrarily opened, modified, or deleted.

Second, defense R&D should be designed to implement programs focused on long-term challenges and future science and technology needs. South Korea's nondefense government R&D often skews toward such an approach, but sometimes fails to initiate such programs due to prevailing uncertainty and systemic disincentives, such as performance-based R&D budgeting. In this regard, the defense R&D system actually has distinctive merits. Despite being controlled or swayed by needs-based R&D, the defense sector operates on a relatively long time span and with a fairly secure market. Defense procurement contracts that are agreed to before R&D commences often oblige the armed forces to purchase the end products, which sometimes leads to even more funding to meet military requirements.

When it comes to encouraging risky R&D, nondefense R&D agencies could productively work with the armed forces and military contractors while using a longer R&D window. Operating this way could guarantee continued investment in and future consumption of the end products of R&D, such as high-tech prototypes. Therefore, the distinctive characteristics of defense R&D can help to hedge future risk and uncertainty by providing a test bed for new science and early technology—especially when the government is collaborating in a joint R&D project with private actors.

Third, South Korea's defense R&D planning should become more agile, dynamic, and resilient by diversifying the portfolio to encompass a wider range of conflict scenarios with different actors and technologies. Defense R&D should not adhere rigidly to one definitive concept of R&D, nor should it be inclined toward one specific probable future, such as a simple future extrapolation of ongoing social and technological trends. Rather, it must take an anticipatory and dynamic perspective to plan for multiple possible futures while remaining flexible enough to accommodate sudden changes.

In an era characterized by uncertainty and complexity, a fundamental discussion among government officials, military officials, researchers, defense industries, and the public is needed to reestablish and diversify defense R&D investment portfolios to be more future-oriented. Foresight activities such as technology forecasting and horizon scanning can serve as a good starting point to build such dynamic frameworks, including anticipation of multiple possible future conflict scenarios on uncertain battlefields and in complex future combat environments.

As the unorthodox progress of the Ukraine-Russia War demonstrates, military systems and equipment can now make use of advanced technologies in unprecedented and unforeseen ways. The days when the military was always at the cutting edge of technology are coming to an end, and battlefields on land, sea, air, space, and cyberspace are increasingly dominated by new technology that first appeared in nondefense government and private-sector R&D. The convergent and transboundary nature of technology, a feature of what is sometimes called the fourth industrial revolution, has blurred the lines between military and nondefense R&D. For South Korea, the challenge of integrating defense, nondefense government and private-sector R&D is urgent. Such integration, and the innovation that it sparks, will be a key factor in winning future conflicts, while also contributing to national competitiveness and political, economic, and social development.

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