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Frameworks for Analyzing Chinese Defense and Military Innovation

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SUMMARY

This policy brief puts forward an analytical framework to capture the nature, dimensions, and spectrum of innovation in the military and broader defense spheres. Insights are drawn from a range of disciplines, including history, social science, business, and strategic studies. The analytical framework is composed of six lenses through which to view the inputs, process, and output of innovation: 1) the components of innovation: technology, doctrine, and organization; 2) the capacity to innovate: that is, innovation potential; 3) the process of innovation: speculation, experimentation, and implementation; 4) the degree of innovation: from duplicative imitation to radical innovation; 5) the scope of innovation; and 6) systems of innovation.

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DEFINITIONS

Innovation refers to new ways and means of accomplishing a task. Important distinctions include those between product innovation (improved means) and process innovation (improved ways), as well as between sustaining and disruptive technologies (or innovation). In the defense sphere, it is useful to distinguish among three types of national security innovation: strategic, defense, and military. Strategic innovation is focused on grand strategy, whereas defense innovation is the transformation of ideas and knowledge into new or improved products, processes, and services for military and dual-use applications, and military innovation is intended to enhance the military's ability to prepare for, fight, and win wars.

A FRAMEWORK FOR UNDERSTANDING DEFENSE AND MILITARY INNOVATION

Because defense and military innovation is a highly diverse phenomenon, scholars and analysts need a framework for understanding and classifying cases of innovation. We provide the needed framework in the form of six lenses through which we can understand the inputs, process, and outcome of defense and military innovation.

1. The Ingredients: The Innovation Triad

One way to think about defense and military innovation is in terms of its constituent parts: technology, organization, and doctrine (see Figure 1). Technology, in the form of weapons and weapons systems, provides the hardware dimension of defense and military innovation and its concrete products. Organizational and doctrinal changes, the software of innovation, feature process innovation.

Of the three, it is technology that is military innovation's most visible component. Yet new technology is rarely the sine qua non of military innovation. Realizing the full potential of new technology often requires organizational adaptation as well as the doctrinal development. Rarely do these components of military innovation change simultaneously; most often, one tends to lead while the others follow.

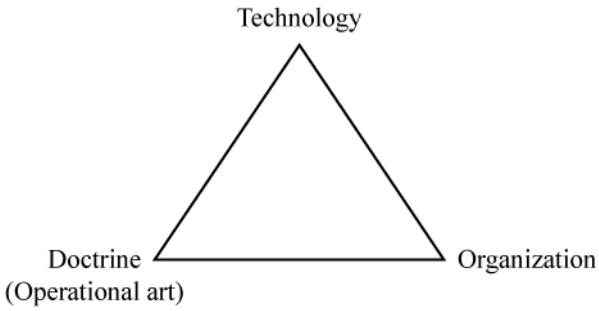


Figure 1. The military innovation triad

2. Inputs: Hard and Soft Capabilities

A second way to understand the inputs of innovation is by differentiating between "hard" and "soft" capabilities. Hard innovation capabilities are input and infrastructure factors intended to advance technological and product development. This includes research and development facilities such as laboratories, research institutes and universities; human capital; firm-level capabilities and participation; manufacturing capabilities; access to foreign technology and knowledge markets; availability of funding sources from state and non-state sources; and geographical proximity, such as through clusters. These hard innovation capabilities attract the most analytical attention because they are tangible and can be measured and quantified.

Soft innovation capabilities are broader in scope than hard factors and cover political, institutional, relational, social, ideational, and other factors that shape non-technological and process-related innovative activity. These soft capabilities include organizational, marketing, and entrepreneurial skills as well as governance factors such as the existence and effectiveness of legal and regulatory regimes, the role of political leadership, promotion of standards, and corporate governance mechanisms.

3. The Process of Innovation

A third way to think about innovation features the process by which it occurs. Past cases of military innovation show that defense establishments tend to develop new approaches to combat in three distinct but often overlapping phases: speculation,

Phase	Potential indicators of innovation
I. Speculation	• Publication of concept papers, books, journal articles, speeches, and studies regarding new combat methods • Formation of groups to study the lessons of recent wars • Establishment of intelligence collection requirements focused upon foreign innovation activities
II. Experimentation	• Existence of an organization charged with innovation and experimentation • Establishment of experimental organizations and testing grounds • Field training exercises to explore new warfare concepts • War gaming by war colleges, the defense industry, and think tanks regarding new warfare areas
III. Implementation	• Establishment of new units to exploit and/or counter innovative mission areas • Revision of doctrine to include new missions • Establishment of new branches and career paths • Changes in the curriculum of professional military education institutions • Field training exercises to practice and refine concepts

Table 1. Potential indicators of innovation

experimentation, and implementation (see Table 1). Each phase yields indicators that can give us an estimation of the pace and scope of innovation.

4. Output: The Degree of Innovation

A fourth way to understand an innovation focuses on the nature and degree of the innovative change that is being carried out. Seven categories of imitation or innovation can be defined:

1. ***Duplicative Imitation:*** Products, usually obtained from foreign sources, are closely copied with little or no technological improvements. This is the starting point of industrial and technological development for latecomers such as China.
2. ***Creative Imitation:*** A more sophisticated form of imitation that generates imitative products with new performance features.
3. ***Creative Adaptation:*** Products are inspired by existing foreign-derived technologies but differ from them significantly.
4. ***Incremental Innovation:*** The limited updating of existing indigenously developed systems and processes. This form of innovation is often the result of organizational and management inputs aimed at producing different versions of products tailored to different markets and users, rather than significant technological improvements through original research and development (R&D).
5. ***Architectural Innovation:*** "Innovations that change the way in which the components of a product are linked together, while leaving the core design concepts (and thus the basic knowledge underlying the components) untouched."
6. ***Component or Modular Innovation:*** The development of new component technology that can be installed into existing system architecture. Modular innovation emphasizes hard innovation capabilities such as advanced R&D facilities, a cadre of experienced scientists and engineers, and large-scale investment outlays.
7. ***Radical Innovation:*** Major breakthroughs in both new component technology and architecture; only countries with broad-based, world-class R&D capabilities and personnel along with deep financial resources and a willingness to take risk can engage in this activity.

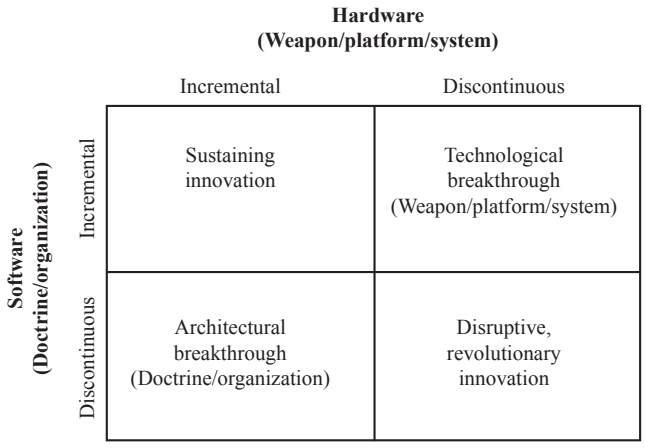
Where states and their defense innovation strategies fit into this typology depend on a number of key structural factors: 1) their level and approach to economic and technological development; 2) their external security situation; and 3) the nature of their integration in the global economy and technological order.

5. Output: The Scope of Innovation

A fifth way of comprehending innovation is through its scope (see Figure 2).

Most military innovation consists of incremental, often near-continuous, improvements in existing capabilities. Discontinuous weapons, platforms, or systems change, even in the context of incremental doctrinal and/or organizational change, constitutes what in the matrix is labeled a "technological breakthrough." Discontinuous doctrinal and/or organizational—or software—innovations represent what are depicted as architectural breakthroughs. Discontinuous technological and architectural innovations both occur much less frequently than sustaining innovation. Disruptive, revolutionary innovation is the result of the confluence of discontinuous technological, doctrinal, and organizational changes; it occurs when discontinuous hardware and architectural changes coalesce and come together in a coherent, integrated whole.

Figure 2. Military innovation matrix



6. A Systems Approach: National, Sectoral, and Defense Innovation Systems

A sixth and final way to understanding innovation is through the lens of systems of innovation. Of particular relevance in the examination of defense innovation is the national innovation system (NIS) and defense innovation system (DIS) models of analysis (See Policy Brief No. 24 for the Chinese case). NIS views technological development and innovation as a dynamic and constantly evolving process.

In applying the innovation system model to the defense field, a number of factors have an important impact in shaping innovation and catching-up activities:

1. The general innovation dynamics of the industrial sector, especially the frequency of innovation and the predictability of its technological trajectory.
2. The extent and quality of the sector's technological capabilities.
3. The extent of access to the sector's internal and external knowledge base.
4. The role of institutional instruments.
5. Technological congruence.
6. The external security and threat environment.

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