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Developing a Framework to Identify Innovation in the Defense Research, Development, and Acquisition Processes

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Summary

This brief offers an analytic methodology to characterize innovation factors in defense research, development, and acquisition (RDA) processes that shape a country's ability to design and produce technologies and weapon systems. The RDA framework provides a systematic, interdisciplinary approach to analysis by benchmarking past experiences to gain insight into future defense industrial capabilities. What sets countries with developing defense RDA capabilities apart from those with "developed RDA systems" is the ability to indigenously design complete systems without foreign assistance. Such independent capabilities exist in a select handful of states.

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WHAT ARE DEFENSE RDA PROCESSES?

In basic terms, defense RDA processes are the activities taken by developers to transform internal and external resources into weapons systems. Some elements of the defense RDA processes are influenced by historical precedence, cultural traits, and national economic and defense planning systems.

Underpinning the RDA process are certain necessary technical skills to enable design, development, and production of a weapons system. Portraying how successful a country's RDA system is at meeting its requirements requires incorporating the typology of hard and soft innovation capabilities for research and development (R&D) of technology, components, and systems.

THE GENERIC RDA PROCESSES FRAMEWORK

A review of several defense RDA systems indicates that the basic bureaucratic defense acquisition structure tends to be similar across country lines, although not all "developing" countries will follow a Western model.

Any analysis using a generic defense RDA model or innovation framework must incorporate a check for mirror imaging (i.e. avoid assuming that other countries think and operate the same as their Western counterparts) of those practices and identify how a country is creating an environment for innovation. For example, national priorities, coupled with technical and organizational capacity, may determine the acquisition process a country selects to meet its defense needs.

Decision-makers may choose any number of acquisition strategies, including indigenous development, copying, co-development, licensing, purchase, or a hybrid mix of approaches based on a country's national science and technology (S&T) capability. As R&D practices evolve, so too will the RDA structure. For example, new political and military leaders may wield more influence over R&D, including the push/pull of technology, funding for innovations, or the coordination of research between the civil and military infrastructures. This may lead to new organizations to meet national defense goals.

THE INNOVATION IN RDA PROCESSES FRAMEWORK

The goal of this study is to generate an analytic guide to benchmark design and production capabilities and to consider how past trends have formed foundations for the next level of innovative capability.

This new framework will allow analysts to take a systematic approach to evaluating change over a period of time by identifying the overlapping observable phenomena of hard and soft innovation capabilities found in the stages of a generic RDA process.

Table 1 depicts the linkage between common RDA elements and innovative factors (in italics) associated with weapons development.

The analysis of defense S&T capabilities begins with a study of the evolution of RDA processes and technical capabilities of a single weapons system over a defined period of time. The first step is to come up with a list of RDA elements and hard and soft innovation factors that might signal a change in development processes.

Following classification of observable indicators for each RDA development stage, the next step would be to develop a series of related questions to guide research on domestic technical capabilities. This practice should help to eliminate bias in research by transforming generalizations into specifics.

Table 2 represents a typical framework for analysis of RDA elements, innovation factors, and defining questions that could be used to direct research for each generation of the selected system.

A series of case studies for each generation of the selected weapons system can help the analyst to characterize defense industrial development practices in the context of the innovation typology. From these cumulative case studies, patterns of innovative change should begin to emerge. The final product—a synthesis of technology and system case studies—will provide greater insight into a country's potential future military capability.

Table 1. Linkages Between Common RDA Elements and Innovative Factors

Pre-program activities	Requirements/ Needs	Research and design	Development and demonstration	Production/ manufacturing	Operations and maintenance
Basic/Basic applied research *Development facilities* *Defense funding of civil-related technology research* *Organizations creating a "DARPA effect"* *Entrepreneurial skills to market technology advances* *Degree of foreign involvement*	The identification of equipment needs based on capability gaps and strategic priorities. Concepts are developed and submitted for consideration. *Political and military organizations* *Budgets for investment in defense programs* *Perceived threats* *Recent events that trigger a military response* *Contract mechanisms* *Import/export approval mechanisms* *Organizations approving program start-up* *Degree of foreign involvement*	The government accepts a design concept. A feasibility study is conducted. Plans are made to develop or acquire technology and insert into the program. Final specifications are accepted by the government. *Research laboratories and institutes* *Development facilities* *Design organizations* *Leading design personalities* *Defense funding of civil-related technology research* *Organizations creating a "DARPA effect"* *Regulations*	A program manager sets a development, industrial production schedule with milestones. Designs are finalized, demonstrated, and approved for production. Contracts are selected and a systems integration plan is set in place. *Human capital—level of expertise* *Production facilities* *Contributing enterprises* *Technical know-how* *Systems integration skills* *Funding sources* *Approval processes and organizations* *Demonstration*	A manufacturing plan is executed. All production-related activities are defined and monitored. Equipment is tested for final production and acceptance. *Manufacturing facilities and locations* *Approval processes* *Technical skills* *Oversight and approval for fielding* *Culture for presenting finished products* *Interaction between organizations* *Role of political and military leadership* *Degree of foreign involvement*	System is presented to the service for acceptance. Failures to meet performance requirements may result in rejection and modification. Systems are delivered for operational use. At the end of the spectrum, equipment is maintained and eventually disposed of according to the life-cycle plan. *Services involvement in acceptance and retirement of systems* *Skill set for maintenance* *Degree of foreign involvement*

Table 2. Pre-Program Activities

RDA elements	Hard and soft innovation factors	Defining questions
Funding	Funding sources	How is basic research funded? How is basic applied research funded in support of defense innovation? What is the degree of private industry R&D?
Organizations	Corporate organizations involved in R&D	Which organizations are involved in the transition of activities to articulation of a formal program requirement? Are there advanced R&D facilities with experienced scientists and engineers?
Joint organizations	Interaction between commercial and defense organizations	What is the degree of collaboration in developing requirements? What entrepreneurial incentives exist for basic research?
R&D	Risk	What is the willingness to take risks to develop break-through technologies? What is the education level of scientists and engineers?
Technology development plans	Technology breakthroughs or technology reliance	What is the degree of foreign technology reliance? What are the indicators that a program will integrate external technologies or components?

RECOGNIZING INNOVATION IN THE DEFENSE RDA FRAMEWORK: CHINA'S FIGHTER INDUSTRY

An initial examination of China's development strategy for its fighter industry suggests a trend from import to imitation to innovation. An expanded study of the generational changes of fighter programs will require additional interdisciplinary collaboration. The preliminary assessment of China's fighter industry demonstrates how a country with a limited industrial capability articulated requirements and took a variety of pathways to acquire and build its domestic capability.

For example, domestic research in the early stages of imitation began with China seeking opportunities with foreign suppliers of kits or licensed-production agreements to develop a foundation for its defense manufacturing practices. Oversight and collaboration with a foreign partner is paramount at this early stage to build an emerging industrial capability. Use of this framework will help analysts to understand the pattern of R&D in major defense industrial programs in China. The findings of this preliminary case study indicate that China has incrementally improved its ability to conceptualize and build increasing complex systems.

GENERAL CONCLUSIONS

This proposed analytic framework provides a foundation to move from theoretical generalizations about R&D and systems development to a more institutionalized analytic process that challenges assumptions, assesses changes, and considers future development strategies. Applying this framework requires collaboration between experts in various disciplines and the convergence of different theories and techniques to identify emerging innovation. The Innovation in RDA Processes Framework is a tool to transform generalizations about capabilities into more concrete and specific assessments. As analysts consider all the available information and begin to synthesize data, they can make adjustments to previous conclusions.

This framework provides a road map to incorporate elements such as human and financial

resources, government and private investment strategies, venture capital movement overseas, the relationship between manufacturing and R&D organizations, and relationships between research scientists and engineers that are not often considered in traditional defense industrial analysis. The application of the defense RDA model, coupled with the innovation typology, may bring to light the occurrence of factors and events for which there is no apparent relationship to a weapons program but nonetheless affect its development.

Maggie MARCUM is recognized as a subject matter expert on defense industrial programs in support of research, development, and acquisition strategies for weapons development—specializing in China. After retiring from the intelligence community, she founded iDETnet (International Defense Emerging Technology Network), an international collaborative forum whose mission is to promote and provide independent analysis of disruptive and emerging technologies with defense and security-related implications.