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China's Evolving Space and Missile Industry

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SUMMARY

The People's Republic of China (PRC) is improving its ability to research, develop, and field innovative military capabilities and advanced weapon systems. Perhaps more than other sectors of its defense industrial complex, the Chinese space and missile industry is the most capable of absorbing and diffusing advanced technology for the purposes of research, development, manufacturing, and maintenance of advanced weapon and space systems. International cooperation and expanded collaboration between the People's Liberation Army (PLA), defense industry, and civilian universities has the potential to create synergies that could result in significant advances in key areas of defense technology. Organizational changes within the space and missile industry are significant and also could permit rapid advances. More effective and efficient defense industrial management could allow China to emerge as a technological competitor of the United States in certain niche areas, such as long-range precision strike capabilities.

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DRIVERS

Strategic interests, operational considerations, and global diffusion of technology shape China's aerospace technology requirements. Space technology, including a manned space program, often is viewed as a metric of national power, and reflects China's expanding status within the international community. The ability to project power over significant distances, without necessarily having to operate from fixed overseas bases, could mark China as a leading global player. Policymakers view aerospace power as one aspect of a broader international competition in comprehensive national strength and science and technology. In addition, an assured ability to deliver nuclear payloads has long been a major strategic driver behind prioritization of aerospace technology. Observers appear concerned over vulnerability to first strike against China's nuclear deterrent.

Operational requirements also are driving China's investment into aerospace technologies. Key is the ability to enforce sovereignty and territorial claims around China's periphery. Looking horizontally beyond its immediate periphery and vertically into space, Chinese analysts view disruption of U.S. ability to project conventional power as a legitimate force modernization requirement. Whoever dominates the skies over a given geographic space has a decisive advantage on the surface. Increasingly accurate and lethal ballistic and land attack cruise missiles have enabled the PLA to suppress air defenses and air operations even with relatively backward air forces. Over the next 10–15 years, more advanced conventional air assets, integrated with persistent surveillance, a single integrated air and space picture, and survivable communications architecture, could enable greater confidence in enforcing a broader range of territorial claims around China's periphery.

Finally, the aerospace industry, along with China's broader science and technology (S&T) elite, may serve as a major driver, rather than strategic or operational interests. A more efficient and effective system for leveraging military-related technologies may be driving new operational and organizational concepts that best accommodate new capabilities, such as long-range precision strike and counter-space systems. If the technological capacity exists, the incentives to develop systems to expand the country's aerospace power may prove irresistible.

AEROSPACE TECHNOLOGY ORGANIZATION

China's defense technology community is organized around a number of state-owned enterprises responsible for space and missiles; nuclear technology; electronics and information technology; aviation; and shipbuilding; just to name a few broad areas. It is within this organizational context that China's potential for fielding disruptive military capabilities should be analyzed. Influenced in large part by Soviet defense industrial practices, China's defense industry has advanced significantly over the years.

Organizations involved in aerospace technology development include the PLA and two corporate-level entities within the defense industry. China's defense research and development (R&D) establishment is breaking down barriers that have hampered the country's ability to field complex aerospace-related systems of systems. The PLA General Staff Department (GSD) and the Services develop short (five years) to long-term (15 or more years) operational requirements. The General Armaments Department (GAD) develops, coordinates, and oversees defense acquisition and technology policy in order to satisfy operational requirements. GAD is most likely the approval authority for service-level R&D and acquisition contracting.

The GAD Science and Technology Committee (STC) functions as the CMC's principal advisory group addressing China's long-term defense technology development. While GAD is responsible for acquisition and technology policy, service-level equipment departments have been granted greater leeway in overseeing preliminary research, R&D, and testing. Within these departments, equipment research academies appear to play a central role in program management and oversight of industrial R&D and manufacturing contracts.

The two key industrial groups that make up the space and missile industry include China Aerospace Science and Technology Corporation

(CASC) and China Aerospace Science and Industry Corporation (CASIC). With the GAD and Second Artillery as primary customers, CASC oversees space launch vehicles and strategic ballistic missiles, spacecraft, and satellites. CASIC specializes in conventional defense and aerospace systems, including tactical ballistic missiles, anti-ship and land attack cruise missiles, air defense missile systems, direct ascent anti-satellite interceptors, small tactical satellites, and associated tactical satellite launch vehicles.

Both CASC and CASIC are organized in a manner similar to U.S. defense corporations, with a corporate-level structure and various business divisions, referred to as academies. Each academy focuses on a core competency, such as medium-range ballistic missiles, short-range ballistic missiles, ICBMs and satellite launch vehicles, cruise missiles, and satellites. While U.S. defense companies tend to specialize further within a business division, CASC/CASIC academies are organized into R&D and/or design departments, research institutes focusing on specific sub-systems, sub-assemblies, components, or materials; and then testing and manufacturing facilities. The design department is the principal systems engineering entity within the academy.

CHINA'S PHASED APPROACH TO AEROSPACE TECHNOLOGY DEVELOPMENT

China's aerospace R&D strategy is broken into three general phases: 1) preliminary research; 2) system R&D involving design, development, testing, design reviews, and then finalization of the design; and 3) low rate initial production. The strategy, which is often referred to as "Three Moves in a Chess Game," calls for three variants of each model or system to be in the R&D cycle at any one time.

Preliminary research seeks to produce mature technologies, which in turn reduces R&D time and risk. The 863 Program is one key source of funding for preliminary research initiatives. After completion of preliminary research, a review process determines if risks have been sufficiently mitigated to move into the R&D stage. Once a program is approved for R&D, senior leaders appoint separate administrative and design teams. The chief designer and up to six deputy chief designers coordinate the technical aspects of R&D, including coordinating with a vast supply chain. The chief designer usually is a senior director within an academy's design department. The program manager ensures that timeliness and quality assurance standards are met, schedules testing, and manages the program budget. Design and program management teams work closely with PLA acquisition managers to ensure an economy of effort, timely production, and cost-effective use of resources.

The R&D phase draws to a close once a design is "finalized" after successful flight testing and approval by a PLA GAD or Service-led program review committee. After design finalization, a missile system enters into low rate initial production and, in the case of the Second Artillery, assigned to test and evaluation units. As a variant enters production, R&D can commence on a follow-on variant and preliminary research on a generation-after-next variant.

INTERNATIONAL COOPERATION

The Chinese space and missile industry has grown rapidly in recent years, and the global interconnectedness of the industry also appears to be increasing. China appears to be building relationships with international partners through provision of satellite launch services. China also appears to be marketing an array of satellite and missile technologies abroad, with a focus on developing countries and those of potential strategic interest. China also is engaged with international partners in cooperative technology development programs.

The expansion of international trade relationships brings with it greater revenues, as well as greater incentives for investment in profitable sectors. These revenues could be put back into R&D to train personnel or to acquire technology or know-how through other means, thus establishing a foundation for future innovation. As China comes to be seen as a more responsible international player, avenues will likely open up for increased interaction with major international companies and research institutions, foreign direct investment, cooperative research, and related interaction. This could bring more advanced technology and related knowledge into the hands of the Chinese, potentially facilitating the training of Chinese engineers in this technology and allowing for greater domestic innovation in the future.

CASE STUDY: CHINA'S ANTI-SHIP BALLISTIC MISSILE PROGRAM

China's innovative capacity within the aerospace industry may be illustrated by the design and development of complex long-range precision strike systems such as the anti-ship ballistic missile (ASBM). Based on a technological foundation established by national-level technology development efforts, such as the 863 Program, the PLA appears to have had the original requirement to disrupt U.S. carrier battle group operations in the wake of the 1996 Taiwan Strait crisis.

As an initial step to developing innovative means to satisfy operational requirements, the GSD, service arms, and GAD most likely sponsored a series of preliminary conceptual studies. Studies published by aerospace industry and engineering organizations within the Second Artillery indicate that an ASBM capability appears to be only one facet of a longer-term vision outlined by military planners. A survey of available literature offers indications that operational concepts drove a phased approach for development of a conventional global strike capability by 2025.

China's R&D community likely has been gradually accumulating the enabling technologies for an ASBM capability for more than 20 years. CASC's First Academy (China Academy of Launch Technology) produced one particularly compelling conceptual design study in 2000 that appeared to have validate the feasibility of ballistic missiles penetrating mid-course missile defense systems and striking moving targets at sea. Extended-range land attack cruise missiles adapted for anti-ship missions also were evaluated. Confident of potential success, GAD and the Second Artillery notionally began to evaluate potential lead systems integrators. Successful testing and fielding of a terminally guided MRBM—the DF-21C—by 2005 likely increased confidence that modifications to the DF-21 guidance, navigation, and control system that could enable engaging maritime targets were possible.

GAD's STC and other advisory boards likely offered formal opinions to the CMC as part of the final decision-making process. Potential lead systems integrators considered for the ASBM may have included the three business divisions with proven records in producing ballistic missile systems: CASIC Fourth Academy, CASC First Academy, which had been a key player in design feasibility studies, and the CASIC 066 Base. In the end, the CASIC Fourth Academy may have been selected for R&D and manufacturing based on the selected ASBM airframe, the DF-21.

With CMC approval and the Second Artillery Equipment Department overseeing R&D and manufacturing contracts, the CASIC Fourth Academy's design department most likely serves as lead systems integrator. Second Artillery Equipment Department's Equipment Research Academy engineers ostensibly exercised technical oversight of the R&D and manufacturing. A deputy director of CASIC or the Fourth Academy notionally could serve as program manager, who would manage the Second Artillery/GAD contract, coordinate scheduling of developmental flights with GAD and Second Artillery sponsors, and ensure that timelines and milestones are met.

Leveraging a broad supply chain that likely mostly resides within CASIC and CASC, the chief designer would serve as technical lead for a design team responsible for various sub-systems and tasks, such as solid rocket motor, guidance, navigation, and control sub-systems, launcher, testing, and manufacturing. The deputy chief designer for an ASBM's guidance, navigation, and control sub-system, including a missile-borne SAR system, ostensibly would be under CASIC's 17th Research Institute, CASC's 12th Research Institute under CALT, or 066 Base's Hongfeng Machine Factory in Hubei. The supply chain may rely on a wide range of vendors, including component suppliers, such as the CASC Tenth Academy for microprocessors, MEMS, and so on. The CASIC Sixth Academy may supply solid rocket motors for the DF-21D ASBM, and indications exist that modifications to the DF-21C solid rocket motor may have been necessary. Final assembly of the missile likely is carried out at the CASIC Fourth Academy's 307 Factory in Nanjing.

With the selection of the design team and supply chain responsibilities established, the Second Artillery likely formed a test and evaluation, or "seed" unit consisting mostly of specialized engineers. The seed unit may have been collocated with a well-established operational DF-21 brigade, with its members spending substantive time with the chief designer's team in Beijing, as well as with key institutes and factories throughout the country supporting the ASBM program. Upon completion of successful CASIC developmental flight testing, the Second Artillery seed unit, in conjunction with the aerospace industry design team and Equipment Research Academy, would conduct operational flights of the missile system. Once the system's design is finalized and enters low rate initial production, the seed unit would transform into an operational launch brigade and relocate to permanent garrison locations. At the same time, GAD and the Second Artillery may initiate formal R&D on a follow-on variant.

CONCLUSION

The Chinese aerospace industry appears increasingly capable of meeting long-term PLA operational demands. Through its participation in key advisory groups, such as the GAD STC and 863 Program, the industry also may push adoption of innovative technologies even in the absence of strategic or operational demands. With political support at senior levels, a more efficient and effective organization system may be a key driving force propelling innovative technological advances, such as long-range precision strike and counter-space systems.

Success in designing, fielding, and supporting a terminally-guided ballistic missile capable of engaging moving targets may serve as a prime example of China's emerging innovative capacity in defense technology. Its international cooperation and experience in large-scale systems integration projects, such as its manned space program, serve as additional illustrations of China's progress.

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