RESEARCH BRIEF

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Experts in Defense: How China's Academicians Contribute to Its Defense Science and Technology Development

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China has long sought to harness its high-level academic and industrial talent to serve as leaders of its scientific and technological (S&T) development. The 1994 establishment of the academician title in the Chinese Academy of Sciences and Chinese Academy of Engineering provided a new way for China to recognize, reward, and utilize a select group of these experts. Beyond serving as the vanguard of S&T advancement, these academicians contribute to China's defense modernization efforts and are poised to play a role in its military development going forward. Four points provide evidence of the influence of China's academicians on its defense S&T development: 1) the numbers and characteristics of academicians working in defense S&T; 2) their positioning in stations of influence within China's military S&T policy structure; 3) military policies targeted at utilizing them; and 4) structural and qualitative trends that will serve to augment their influence in the future. This brief begins by providing background information on China's academician system and recent changes it has undergone, then assesses these four points in turn. Each is ultimately found to demonstrate an intentional and significant role played by China's academicians in the country's defense modernization efforts.

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BACKGROUND

The Chinese Academy of Sciences (CAS) was established in 1949, with roots in the Academia Sinica founded by the Nationalist government in 1928. The honorific *yuanshi* ("Academician") title currently given to its members was introduced in 1994. This same year saw the founding of the Chinese Academy of Engineering (CAE) as the honorific institution of the engineering community, with both CAS and CAE reporting to the State Council. As of 2013, CAS was home to 100 research institutes, 12 branch academies, two universities, and 11 supporting organizations, representing more than 85 percent of China's large-scale science facilities, with a staff of almost 61,000 spread over 23 provinces. CAE members do not work in CAE institutes but are spread throughout CAS branches and other outside locations. CAS members have a strong basic science orientation, while CAE members predominantly focus on applied research, providing a diversity of emphasis between the academies.

Academicians are lifetime members of these academies, honored either for their achievements in science and engineering or their contributions to China's national S&T development. There are currently 749 academicians in CAS and 830 in CAE. The system's evolution displays trends of increased professionalism and the entrenchment of scientific elitism, evidenced in the decline of the "red expert" and progressive limiting of Party involvement in the election of academicians. The title's coveted and elusive nature, however, has led to the persistence of several issues. Administrators are said to be concerned with the problem of *gongli*, literally "power," referring to academicians leveraging their titles to obtain privileges and monopolize government research funds. Some observers judge the election process to still be riddled with scandal and politicization. Moreover, despite the increased autonomy academicians enjoy in selecting new members, the state is still able to set the agenda for the content of their work through top-down administration of national research plans, funding incentives, and bureaucratic restrictions.

In June 2014, both academies implemented a new set of reforms that weigh heavily on this analysis of the impact of academicians. This process began with the 12th Five-Year Plan and culminated in the official adoption of these reforms at the 2014 Academicians Conference. President Xi Jinping officially endorsed the changes at the event, expressing the goals of addressing the *gongli* problem, making elections more merit-based, improving the age and subject matter range of academicians, and reducing government meddling. The rules overhaul breaks down into four areas: 1) tightening the circle of those given nomination abilities; 2) eliminating quotas: 3) broadening accession voting to all academicians; and 4) introducing new exit mechanisms. These reforms were seen as necessary in light of the alleged pervasive problems in the electoral system. While they further increase the autonomy of academicians in nominating and confirming candidates, the weakness of the last provision, which permits the revoking of the title only for the most egregious violations and allows for only suggestions of retirement, will likely reduce their desired effect on titleholders' behavior.

CHARACTERISTICS OF ACADEMICIANS CURRENTLY IN DEFENSE INSTITUTIONS

The importance of these elite scientists and engineers to China's defense modernization efforts is first evidenced by an examination of the numbers, age trends, biographical data, institutional affiliations, and specialty areas of "defense academicians," used here as a term to identify members known to currently work within either the military or defense industry (based on data compiled for this research). Members who no longer work in defense S&T or those who contribute to defense efforts in a non-public way are thus not counted.

Overall Numbers

Table 1 shows that significant numbers of academicians work in the military or defense industry, with 54 identified in CAS and 163 in CAE. Current percentages are actually slightly lower, however, than the last major academic assessment made by Richard Suttmeier and Cong Cao in 1997, which showed 10 percent of CAS and 26 percent of CAE members with this affiliation. These ratios have declined to 7 and 20 percent, respectively.

Age Gap

The ages of these defense academicians do not run in a smooth progression, as shown in Figure 1; the slight gap in members aged 60–70 reflects

TABLE 1. Academicians currently employed in defense S&T positions

	Current academicians (total)	Defense academicians	Percentage
Chinese Academy of Sciences	749	54	7.2
Chinese Academy of Engineering	830	163	19.6

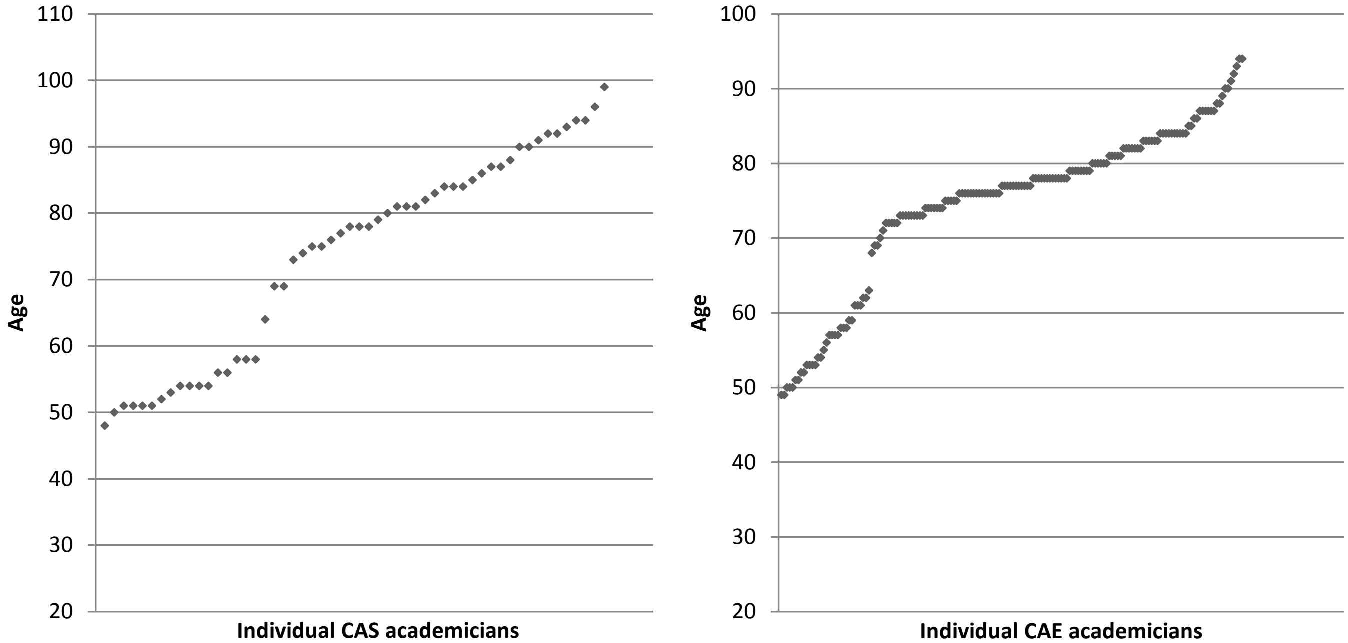

FIGURE 1. Current ages of CAS and CAE defense academicians

the tragic impact of the anti-elite policies of the Cultural Revolution, lasting from 1966–1976. This gap also provides an informative dividing line to distinguish between characteristics of older and younger members. Academicians on the younger side of this divide (those under 65) differ from their older counterparts in several significant ways. Younger members in CAS are eight times as likely to hold military rank and twice as likely to have a PhD; CAE members are twice and five times as likely, respectively. They diverge on Party affiliation and holding political offices, however, with younger CAS defense academicians slightly less likely and those in CAE slightly more likely to fall into these categories. They are far more likely to be affiliated with the relevant committees discussed in the next section than are their older counterparts.

In both academies, far fewer younger academicians specialize in missiles and nuclear-related applications, evidence that the "old guard," rewarded for contributing to China's development in these areas in the 1950s and 1960s, is fading away. In its place is a smaller, but better educated group, more diverse in subject matter expertise, and well-poised to impact defense S&T policy.

Biographical Trends

Biographical data for all defense academicians in several key categories are laid out in Table 2. Five relevant observations can be made:

1. At 74 for CAS and 75 for CAE, the average ages of military-affiliated academicians are quite high, . This is likely due to increasing longevity and does not substantially differ from trends among academicians as a whole, however; the average age of all CAS academicians was 72 in 2011.
2. The majority of these elite scientists and engineers have civilian educational backgrounds, with 67 percent of those in CAS and 58 percent of those in CAE having never attended a military institution. This indicates that the military does not predominantly rely on organically developed talent and that channels of impact on defense S&T are not restricted to experts with these backgrounds.
3. While the military titles given are typically civilian "professional ranks," these do indicate that members who hold them wield more influence over defense S&T decisions and carry more weight in making recommendations to military bodies.
4. Communist Party affiliation for defense S&T-affiliated members from CAS (41 percent) and CAE (40 percent) is at a much higher percentage than in the last available total compiled in 1997, in which 24 percent of CAS academicians were assessed to be Party members. Despite a decreased emphasis on Party affiliation within the academies, individual defense academicians with this affiliation are able to command better administrative posts and make weightier policy recommendations, thus strengthening their potential impact.
5. A number of defense academicians are or have been represented in the Central Committee (7), National Party Congress (15), National People's Congress (13), or Chinese People's Political

TABLE 2. Biographical data on CAS and CAE defense academicians

General			Highest Education Level			Political/Military Affiliations			
	Number of defense academicians	Average age	Undergraduate	Graduate	Doctorate	Some military education	Military rank holder	CCP member	Current/ former political office
CAS	54	73.7	27	4	23	18	11	22	17
			50%	7%	43%	33%	20%	41%	31%
			Of these: Attended military university						
			8	1	9				
			30%	25%	39%				
CAE	163	74.6	97	20	46	69	19	66	31
			60%	12%	28%	42%	12%	40%	19%
			Of these: Attended military university						
			34	9	26				
			35%	45%	57%				

Consultative Conference (24), giving these defense-affiliated members a direct line of political influence.

Institutional Affiliations

China's aerospace, aviation, and nuclear conglomerates, as well as research institutes of the People's Liberation Army (PLA) General Armament Department (GAD), lead as the defense institutions employing the most CAS academicians (Figure 2). "Researcher" and "Professor" are the most common job titles held by these members, but there are also notable standouts with higher positions, such as National University of Defense Technology Commandant Yang Xuejun, Xian Satellite Control Center Technology Department (a GAD unit) Chief Engineer Li Jisheng, China Nuclear Test Base (also GAD) Director Liu Guozhi, and Shenyang Aircraft Design Institute (part of the Aviation Industry Corporation of China) Deputy Director Li Tian.

Leading institutions employing CAE academicians are again aerospace, aviation, and nuclear industry companies and GAD institutes, but they are also well-represented in China's shipbuilding, ordnance, and electronics conglomerates (Figure 3). Representation in PLA General Staff Department's research institutes and the China Academy of Engineering Physics, which is subordinate to GAD and oversees nuclear weapons development, is far stronger, likely reflecting the orientation of these areas towards applied science and engineering.

Here again "Researcher" and "Professor" are the most common job titles, but several are Chief Engineers and Chief Designers as well. A few examples include Chief Engineer Chen Zuoning, PLA General Staff Department's 56th Research Institute; Chief Designer Shen Wensun, Dalian Shipbuilding Industry Co. (part of the China Shipbuilding Industry Corporation); and Chief Scientist Yang Xiaoniu, China Electronics and Technology Corporation.

Specialty Areas

Table 3 demonstrates that defense academicians focus in subject matter areas clearly at the forefront of China's defense S&T development push. Aside from the medical specialty, the specialty areas with the largest numbers of defense academicians, such as aircraft, space technology, missiles and rockets, and information technology and computing, are ones that have seen heavy investment and technological achievements in recent years. The J-20 fighter aircraft, Shenzhou space capsule, Dongfeng-21D anti-ship ballistic missile, and Tianhe-2 supercomputer are important examples.

CAE academicians Qi Faren (chief designer, China Academy of Space Technology), Zhang Luqian (control systems, China Aerospace Science and Technology Corporation), and Liu Shangge (suit safety evaluations, PLA Ordnance Engineering College), were involved with the Shenzhou project. CAE academicians Lu Xicheng and Song Junqiang from NUDT were involved in that university's Yinhe and Tianhe supercomputer programs, as were CAS academicians Yang Xuejun (NUDT) and Yang Yuanxi (GAD); Jin Yilian from CAS was instrumental in the development of the Shenwei computer line by the PLA General Staff Department's 56th Research Institute, of which he is now director.

To summarize, the relevance of defense academicians to China's de-

FIGURE 2. CAS defense academicians by institution

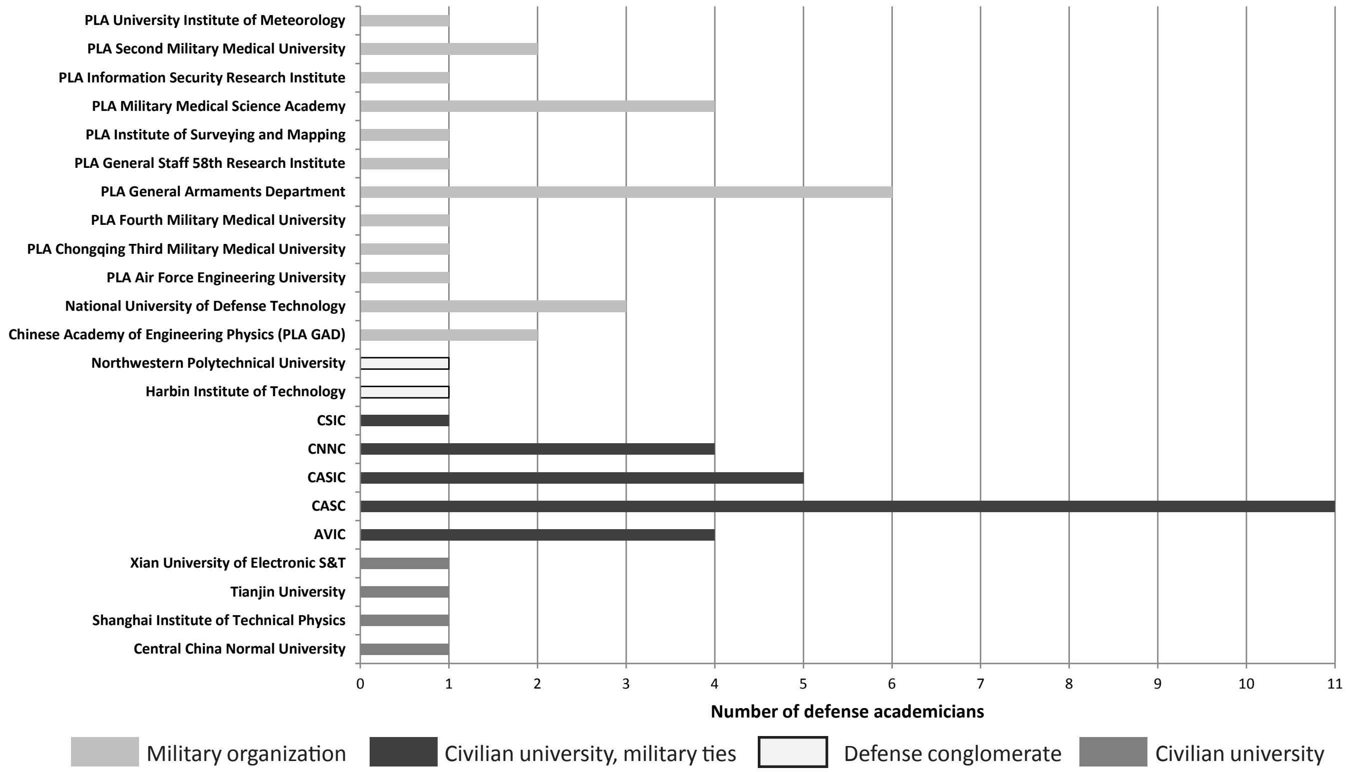

FIGURE 3. CAE defense academicians by institution

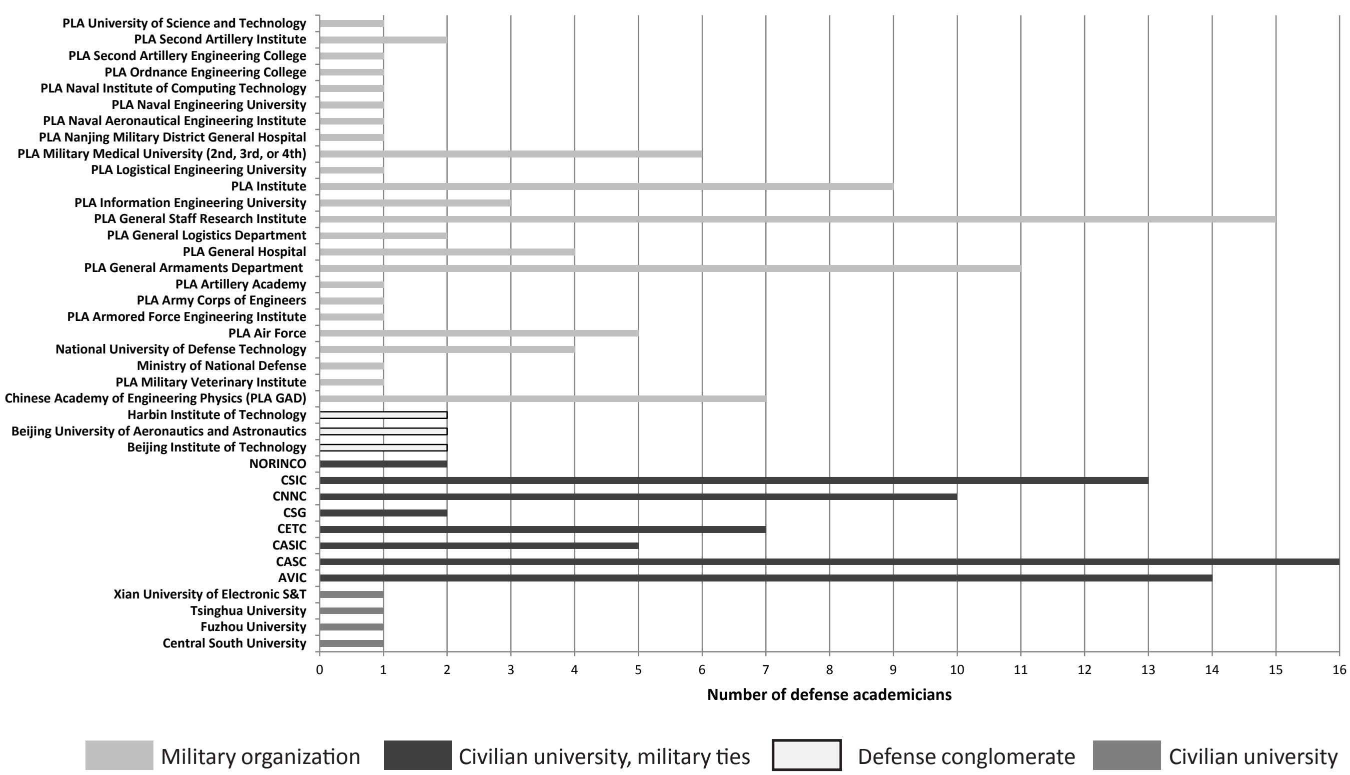

TABLE 3. Listed specialty areas of CAS and CAE defense academicians

CAS specialty area	Number of defense academicians	CAE specialty area	Number of defense academicians
Medical	8	Electronics	21
Missiles and rockets	7	Information technology and computing	19
Nuclear	6	Medical	19
Aircraft	5	Nuclear	13
Electronics	5	Aircraft	12
Information technology and computing	5	Missiles and rockets	12
Navigation, guidance, and control	4	Space technology	12
Space technology	4	Ship design	6
Physics	3	Physics	5
Materials science	2	Defense and geotechnical engineering	4
Geographic information systems	1	Navigation, guidance, and control	4
Meteorology	1	Undersea technologies	4
Nanomaterials	1	Chemical engineering	2
Ship design	1	Equipment diagnostics and maintenance	2
		Explosives	2
		Materials science	2

fense modernization efforts is supported by: 1) their overall numbers; 2) by positive trends in education, committee positions, and military rank among younger members; 3) by key qualifications such as party membership and political positions shown in the biographical data; 4) by the ability of the defense industry to draw on academicians outside of military education backgrounds, also shown in the biographical data; 5) by the significance of these members' institutional affiliations and high-level positions held; and 6) by the diversity and relevance of their specialty areas.

Academicians Positioned in Stations of Influence

The Science and Technology Committee (STC) of the GAD is an important organization within China's defense infrastructure as it reviews S&T contracting applications, identifies emerging technologies, and consults with the Central Military Commission, China's leading military body. Membership in this organization is a key indicator of the potential contributions defense academicians might make through their patterns of association. Many are indeed currently involved in the STC, as shown in Table 4.

Twelve defense academicians from CAS and 28 from CAE are shown here to be affiliated with the STC. These academicians are represented in 21 of the 58 known STC Leading Groups, and lead several that are critical to current defense S&T efforts, such as conventional propulsion, nuclear weapons, precision guidance, and radar sensing technology.

Defense academicians are present to a lesser extent in other influential committees as well. CAS has 6 members on the S&T committees of various defense conglomerates, 2 members of 863 Program Expert Groups, and 2 members on NUDT's S&T Committee. CAE has 19 members on defense S&T committees, 7 in 863 Program Expert Groups, 4 on SASTIND S&T or expert committees, and 2 in 973 Program Expert Groups. There are multiple indications, therefore, that academicians are positioned to contribute substantially to defense S&T through committee affiliations.

MILITARY POLICIES AIMED AT UTILIZING ACADEMICIANS

Military research in China has long enjoyed funding prioritization and political support relative to the civilian sector. China's leaders and defense experts place a premium on defense S&T *rencai* (talent), describing it in policy documents as a "valuable strategic resource," as "pioneers of advancement," as the army's "core of competitive ability," and as a group that will play an "important" or "decisive" role in China's military development. These writings also carry a strong sense of urgency and concern, as planners worry that an aging workforce, shortage of younger S&T talent, gaps in expertise in key subject matter areas, and, especially, a shortage of younger S&T talent within the

TABLE 4. Defense academicians on GAD Science and Technology Committee

		CAS	CAE
GAD STC permanent members		Member	Deputy director
GAD STC Leading Group members	Advanced manufacturing technology		Group leader, 2 deputy group leaders
	Advanced materials		Group leader
	Aircraft	Group member	Group member
	Chemical warfare technology		Deputy group leader
	Computer and software technology		Group member
	Conventional propulsion		Group leader
	Electronic warfare technology		Group member
	Equipment maintenance engineering		Group leader
	Firearms, artillery, and missiles		Group member
	Ground force support equipment	Expert	
	Low observeable technology		Deputy group leader
	Micro/nanotechnology		Group leader
	Military computers	Group member	
	Military microelectronics	Group leader	
	Missile equipment and security systems		Deputy group leader
	Missile technology	Group leader	
	Nuclear propulsion and basic nuclear technology		Group member
	Nuclear weapons technology		Group leader
	Precision guidance technology	Group leader, deputy group leader	
	Radar sensing technology		Group leader
	Satellite payload	Group member	Group member
GAD STC part-time members			5 members
GAD STC advisers		3 advisers	4 advisers
Total affiliated		**12**	**28**

military could limit China's military modernization and ability to meet the "challenges" of the global revolution in military affairs.

This impetus led to the establishment of the High-Level S&T Talent Innovation Engineering Project in 2009, which provides for the mentoring of select military personnel by both military and civilian academicians and other experts. To date, the project has reportedly enlisted 401 CAS and CAE academicians, as well as other senior experts, to its cause, with 78 of these assigned to the PLA Air Force alone. These academicians are said to have contributed to crucial subject matter areas such as PLA informationization, frontline weapons development, IT development, manned spaceflight, the lunar probe project, and the Tianhe supercomputing program. Three military conferences relating to this project, organized jointly by the PLA General Staff and General Political Departments, were held in 2011, 2012, and 2013 to provide concentrated training, with the 2013 event attended by 124 military personnel and 25 academicians. Since 2009, the project is reported to have yielded no less than 700 research projects, 300 patents, and 86 national awards.

FUTURE TRENDS POINTING TOWARDS GREATER INFLUENCE

Several structural factors will reinforce the ability of academicians to influence defense S&T progress going forward. The first of these is the influence of the GAD STC, where defense academicians are well-represented and predominantly young. Another is the relevance of qualifications such as Party affiliation, political offices held, education, and military rank in China's top-down science structure, and for these the age trends look largely positive as well. Third, China's leading defense conglomerates and military research institutes are paramount in defense R&D, and these will remain influential structures in which to work. Fourth, the subject matter areas in which defense academicians are congregated match the priorities of the military agenda. Finally, mentoring programs will ensure that significant numbers of academicians are directly involved in the most important defense S&T projects.

Several qualitative trends, referring to the abilities and expertise of these individuals operating within the structure, will play in as well. Trends towards increased professionalism and meritocracy within the academies will ensure that new defense academicians are of a higher quality, especially given recent reforms. Age trends also point towards increasing quality, as younger defense academicians are better educated, more diverse in subject matter expertise, more likely to research technologies deemed critical to the military, and better poised to exert influence through their higher levels of involvement with committees such as the GAD STC. The new mentoring program will certainly serve to boost the teaching ability and connections of these experts, and if successful will raise their profile and likely lead to enhanced future responsibilities.

Other factors could be argued to work against these trends, however. First, as pointed out earlier, the ratio of defense academicians has declined overall. Recent reforms will make it even more difficult for military scientists to become academicians, as they already cannot present classified achievements when applying for accession. This has been a major complaint in the past, and assistance from outside officials more familiar with their work will now be reduced by the limiting of nominations to existing members. Second, some domestic writings describe a gap in young S&T talent within the military, which could reduce the pool from which future defense academicians could be drawn. Third, despite the general aligning of defense academicians' areas of focus with key military efforts, there are entire subject matter areas that planners lament are not covered, including general fields such as military aviation, basic software, high-end components, and high-performance materials, as well as more specific needs in space-based early warning, strategic anti-missile capabilities, long-range strategic delivery, aircraft carrier battle groups, and unmanned aerial vehicles. With difficulties in accession for military experts, insufficient up-and-coming military S&T talent, and lack of relevance in new and emerging subject matter areas, the role of the academies in defense S&T could be projected to diminish.

This counterargument can be addressed with the following points. First, as the biographical data on educational backgrounds and the mentoring program illustrate, military and defense industry institutions are perfectly able to draw upon civilian S&T talent, even at the highest levels, to benefit their projects. This will allow academicians as a group to play a role even if defense experts are at a disadvantage in achieving the title. Second, an examination of S&T talent development in China overall indicates that trends in R&D funding, professionalism, scientific elitism, scientific and engineering graduates, publications, defense modernization, civil-military integration, and other relevant indicators have been pointing upwards for some time. China is not facing a shortage of young researchers. Over time, this wave should provide enough new talent to make up the deficit in potential academician candidates and fill in neglected research fields.

CONCLUSION

China's science and engineering elite have an intentional and significant role in China's defense modernization efforts. This is first supported by descriptive statistics on the Academies' current memberships, which reveal significant numbers of defense-affiliated academicians, positive trends toward younger members, key political and military qualifications, diversity and importance of workplaces and jobs, and relevance of areas of specialty. Defense academicians are well-represented in the GAD STC and present to a lesser extent in other influential committees, giving them direct involvement in defense S&T planning and administration. China's military and political leaderships are committed to utilizing this resource, as evidenced by the High-Level S&T Talent Innovation Engineering Project and the strong emphasis placed on military research and talent development in general. Finally, institutional realities, political drivers, and recent reforms will serve to broaden opportunities for these members to be utilized in the future. China's academicians are poised to contribute to its science and technology development and lend to its military strength for years to come.

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