Research and Military-Industrial Complex: A Springboard for Capability Development

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Abstract

Collaborative efforts are required to develop future technologies for securing a nation. To develop military technologies a nation is required to create a system where all stakeholders can jointly work together to find solutions for meeting national security challenges. It is a good idea to invest and incentivise the efforts of universities and industry to develop future defence technologies. The role of government research and development organisations is paramount to coordinate the research and development of usable technology for military services. The military-industrial complex can only become a springboard for capability development if there is strong indigenous R&D.

Introduction

To develop the full research capability of a nation, the optimal method is to gain benefit from a nation's three pillars of research: Government research laboratories, universities and industry researchers. Each of the

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three pillars has an interest in one or more of the levels of research, from basic research to full-scale development of products. Users of defence products, such as the members of the military services, are responsible for identifying gaps in capabilities and defining requirements for industry or universities to pursue new research that can solve or reduce the gaps in capabilities. The military may not be fully aware of future trends in technology, thus a closer interaction is required with the scientific community of the country to find solutions to the complex security problems. All these issues will be reviewed in this paper.

Key Policy Challenges for Research and Development

A good starting point may be to ask some key questions: how can a nation maximize its technological advancement, especially in the military element of power? Can industry alone propel a nation's Research and Development (R&D) of Science and Technology (S&T)? How can a government' motivate the maximum possible S&T effort from the industry, universities and their own research laboratories? These questions form the basis for the analysis of several subtopics that lead to answers to the questions. Some of the subtopics that require clear understanding are: What areas of S&T is the industry motivated to dedicate their R&D resources? What areas of S&T should remain the domain of governmental research institutions? What areas of S&T might best be obtained from international partners? These key policy guidelines can be laid down by the government in consultation with the military. However, it is also important to assess the levels of excellence or expertise acquired by the universities, industry and government research laboratories in the development of new-generation systems for military use. The classified projects may need governmental oversight to ensure that confidential R&D project details are not leaked to unauthorised entities.

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Approach to Building Strong R&D for Capability Development

The terms R&D and S&T are closely related and not clearly defined. Based on the application of the terms from historical experience within the US defence research establishment, the relationship between the terms is that research explores the disciplines of science. Science results in the discovery of new technologies. Potentially useful material solutions might result from some new technologies, and those solutions might result in useful applications for societies and defence establishments. Once science reveals useful technologies, the practical application of those technologies can be developed until the end users find it not compatible with the national security objectives.

Scientific research in a nation arises from three sources: government R&D laboratories, universities, and R&D assets within the industrial complex. To maximise a nation's R&D and S&T, universities, industry and government laboratories must be motivated either by funding research or some guarantee for the acquisition of products for military use so that industry or universities are motivated to make investments in research and development. In both these models there is a high possibility of failure and to keep universities and private players motivated, the government should compensate or incentivise their efforts.

The government laboratories should be the vanguard for laying down the technical parameters for R&D and should seek seed money funding for S&T capabilities useful to the defence establishments of a nation. The defence establishment scientists and engineers have a huge responsibility, to find answers to the following questions: what S&T is emerging from or could emerge from government laboratories, universities, and industry that would benefit the military services? Close coordination with the military services (end users) is crucial, with a view to filling gaps in military capabilities.

Military services may not be aware of the future trends in S&T and their applications. The defence research establishments should leverage the creative capabilities of scientists within the defence research establishments, universities, and industry in consultation with the military to identify the technologies required for building capabilities. Knowledge of the areas of research by other countries with advanced S&T can help initiate and expand the trend lines of S&T best pursued by other nations that could be tailored to the specific needs of a nation.

The glue binding all national S&T potential for defence applications is the government research laboratories that could act as a guide and central coordination agency for the development of specific technology required by the military. For example, defence research might be dedicated to (1) robust communications and surveillance capabilities; (2) lethal weapon technologies; (3) specialised land-based vehicles, tanks and trucks (4) maritime surface and subsurface warships and submarines, (5) aviation assets; (6) missiles and radars; (7) soldier systems; (8) medical; (9) information technology (IT) cyber and artificial intelligence (AI); (10) autonomous systems. The former list is not at all-inclusive but is an example to highlight what can be done by the government defence research laboratories and industry in collaboration with each other.

Since universities faculty and students often look for funding sources for their research, thus seed money from the government or industry defence research establishments is required to motivate university research fellows to pursue research in areas identified as the most critical for enhancing military capabilities. University faculty and research fellows can help identify a multitude of possible solutions to fill military capability gaps as identified either by the military or the defence research establishments.

Universities are best suited for the first stage of R&D, which is called basic research by the US defence research establishment. The most promising university theories can be tested and evaluated by defence research establishments with increased levels of funding to determine which theories are most promising for useful applications. Once theoretical research reveals the most useful applications, more funds from defence research establishments should be sought. Next, the defence research establishments should identify industries with core competence to develop technology with the potential for future military application. The transition from the first stage of research (basic research), to the second (applied), is an area where all three national assets may work in concert: the defence research establishment, universities, and industry. The first two stages are best categorised as research stages and the focus is on research and development.

The third, and last stage is the development of the applications determined to be most promising from the first two R&D stages, basic and applied. Once a technology is proven to have a greater application for the military service, the industry must receive more funds to develop the most useful, critical technologies identified in the first two stages of R&D. The defence research establishments should allocate more funds toward industries that are willing to dedicate their own internal R&D assets for the development of desired technologies for military application. If technology has application in more than one defence sector, securing R&D funding becomes much easier.

For the above-mentioned specific lines of research identified previously, numbers 1, 8, and 9 are likely to be most attractive for the industry to dedicate their internal R&D assets due to potential commercial applications. Numbers 2-7 and 10 may have to be primarily developed by the government R&D establishments and laboratories, and to a lesser degree by the industry's internal R&D assets. Considering the criticality of funding levels for R&D, both within the defence establishments and industry, the next section will address what the R&D funding levels are to create world-class R&D establishments. While allocating funds for R&D,

India must keep in view how much budget is being allocated for R&D by China a potential adversary.

R&D and S&T Require High Investment for High Dividends

It is important to understand that the level of investment in R&D done by a nation as compared to its adversary will determine the development of military technology. China is the main adversary of India, hence, India's investment in R&D must be proportionate to what China is spending on R&D and S&T; therefore, this article provides the most recent R&D expenditure data from three countries: the US, India, and China. The R&D data reported by China is likely to be understated as many intelligence sources believe China does not report its actual defence and R&D expenditures.

The narrative now shifts to a comparison of R&D expenditure levels for the three countries: In most cases, the R&D expenditure data is often either not clearly reported by countries or is reported differently by those organisations that track national defence R&D expenditures; therefore, the following is not an exact comparison over the same periods. Data was found for more years for the US and China than India, but the calculation of trends for each country is possible with the data shown below:

India (in billions of dollars*)	**China** (in billions of dollars)	**U.S.** (in billions of dollars)
		2022: $122.9
		2021: $114
		2020: $100
	2019: $24.24	2019: $95
2018: $1.816	2018: $21.54	2018: $88
2017: $1.613	2017: $19.51	2017: $70
2016: $1.629	2016: $18.51	2016: $63
2015: $1.625	2015: $15.81	2015: $63
	2014: $16.8	2014: $63
	2013: $16.33	2013: $70
	2012: $15.24	2012: $78
	2011: $13.38	2011: $79
	2010: $11.45	2010: $80

**Sources for the above data are Statista, SIPRI, and the Congressional Research Services.

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Some additional data of interest is that China's total defence spending is $240 billion in 2019, which was approximately 1.7 per cent of their GDP. China often conceals exact allocation for R&D and defence budget, hence the figures mentioned above may be lower than the actual figures. India's defence spending is 2.1 per cent of GDP, and defence spending has been growing from 2010 to 2020 at 9 per cent. The total budget spent on defence in 2022 indicates, the US is number one ($750 billion), China number 2 ($237 billion), Saudi Arabia number 3 ($67.6 billion), India number 4 ($61 billion), and Russia at number 8 ($48 billion). The data shown above indicates, if the budget allocation for R&D by India is going to be the same in terms of percentage, in that case, building matching capabilities with China is a far cry. Therefore, India needs to take a hard look at the budget allocation for defence R&D if it is aspiring to make the military-industrial complex a springboard for capability development.

Indigenous Research Efforts must be Complemented by other Stakeholders and International Partners

To maximise a country's defence capability, a convergence should exist between researchers within the defence establishments, universities, and industry. The efforts of the three pillars of R&D and S&T must complement each other instead of reinventing wheels in isolation. As stated before, universities are often interested in government-funded research, including areas that benefit the defence sector. The areas of communication, medicine, AI, and IT are attractive to university researchers, especially for basic research and early stages of applied research. Defence establishments researchers often have to perform the basic research for lethal technologies, warships, military aviation assets, specialised military vehicles, missiles and radars, and advanced soldier systems. But there are some cross-over sub-technologies where university faculty and researchers can help out in these defence-specific areas as well. The key is to develop a system where defence research scientists can determine and evaluate areas of research by universities to find alternative solutions and future technologies for use by the military. To assume military services are in the best position to determine what alternative solutions can solve current capability gaps is a huge mistake; often defence scientists, universities and industry research scientists will probably be in a better position to identify future technologies that can be used for military purposes.

Bringing together the best minds is essential because collective thinking can find better solutions to fill capability gaps. Therefore, there is a need to create an organisation where the military, government research scientists, university research fellows and industry R&D must have formal and informal interaction to determine what technology is required to fill the capability gaps and future security requirements.

Once the application of a technology is identified, the industry with core competence specific to that technology should be added to the consultation group where the best minds exchange views. Once technology blueprints are formulated, the industry must be tasked especially in communication, medicine, and IT sector to commence work on the development of usable technology by the military. The industry will have a pre-dominance role once the application is proven to benefit not only defence forces, but the commercial sector as well. Once the commercial benefits of technology are identified, the industry can expand the investment in research and final development of a product, for dual-use technologies. The key objective is to identify which niche technologies are most critical to the country's long-term security requirements. At the same time, these high-end technologies will also propel the expansion of military-industrial complexes for commercial purposes.

Alliances are one of the oldest systems of collective security and the development of military capabilities. One of the reasons for the collapse of the Roman Empire was the absence of alliances with potential allies. Today alliances are required for technology development and filling military capability gaps.

One of the most critical decisions any government can make is to decide which technologies are essential for bridging capability gaps. It may not be possible to master the technologies of all elements of military capabilities, therefore, areas and achievable goals can be set and at the same time, an international alliance be formulated for the co-development of military technology required to fill existing capability gaps. This process should be followed up with joint ventures for the development of products for military use.

An example is the North Pole Brigade (NORDPOLBDE) formed in 1996 during the days of the Bosnia/Herzegovina conflict, called the Implementation Force (IFOR). The NORDPOLBDE had five core nations: Sweden, Denmark, Finland, Norway, and Poland. Added to the Brigade were three other nations: Estonia, Latvia, and Lithuania. The mission was to create a secure environment for humanitarian organisations working within IFOR. Each country decided what areas they could contribute where they had expertise/capabilities. The battalions that initially came were mechanized battalions from Denmark, Sweden and Poland, with one Engineer Battalion from Finland and one Logistics Battalion from Norway. When IFOR became SFOR, in December of 1996, the Norwegians recalled the Logistics Battalion and replaced it with a Mechanised Infantry Battalion, and in June of 1998, the

Finns reorganised their Engineer Battalion into a Mechanised Infantry Battalion. The Baltic countries, Estonia, Latvia, and Lithuania provided a rifle company. These changes were warranted by the capabilities possessed by each country. One must remember that international operations and military cooperation are also a platform to showcase your military capabilities and technology. A nation will be included in alliance or for military cooperation if it has the capabilities and technology to meet complex security challenges.

The previous example highlighted that India should decide what niche areas are most desirable, and attractive for future international operations and foreign military trade. What advantages does India currently have, and in what areas of S&T nation will be able to showcase its indigenous R&D at global platforms? Some possibilities are communication, IT, and perhaps medical, but there may be many others that emerge from brainstorming between government, industry, and research scholars of universities.

Another issue requiring consideration is what S&T (Basic and Applied Research) should India choose to pursue with indigenous R&D versus the development of technology through reverse engineering. The development of its own technology will allow India to tailor research to its specific defence needs. Using reverse engineering as a primary method for fast-tracking the development of new capabilities prevents the maximisation of full scientific potential and may prevent India from solving capability gaps unique to its security requirements. One visible advantage of reverse engineering is that a country can save the money spent on basic and applied research but it is unlikely to give long-term dividends for capability development. Besides losing the ability to solve unique capability gaps, another disadvantage is the prevention of the Indian industry from gaining S&T advantages that could result in potential Foreign Military Sales (FMS).

Research Parks a Way Forward to Harness Full Potential of R&D

A question: how can a country optimally leverage all three sources of S&T? One best practice is to establish research parks that include all three members of the triad. To avoid duplication of efforts, all three pillars of the research triad should be closely linked to creating an overarching system, where the best brains of the country sit down together to find solutions to technology gaps. Few countries leverage all three assets and build modern military-industrial complexes for domestic and foreign trade. Most often a university's S&T assets operate independently from the other two, whereas the government and industry S&T assets should develop greater cooperation. At times universities are willing to modify or totally change their lines of research if there are monetary resources available to fund university research. Government seed money is critical to motivating university researchers to pursue S&T useful to the defence establishment of a country. The saying "a little seed money goes a long way" would be a good adage to follow.

Conclusion

Since no country in today's connected world can be an island of excellence in itself, the difficult task for the leaders of all countries is to decide which countries are most beneficial to partner with for technology development and joint ventures for the production of systems for military use. Even the forces for the international coalition are decided by the capabilities a nation possesses. The decisions along these lines will also make a country attractive for joint ventures, foreign military trade and international defence cooperation. Military capabilities and new-generation technologies have become strategic assets.

A country must not rely solely on reverse engineering to save investment in basic and applied research. Independently developed technology and systems allow the scientific community to serve the specific needs of a country. Industry can also focus on the lines of research once they know which niche areas are most attractive from a commercial point of view.

Investing in R&D and S&T prepares a nation for its future security. Without investing in a nation's future security, leaders render a less secure future for all citizens and create vulnerabilities and dependencies that are dangerous to future peace and posterity. The eternal battle is between the allocation of resources for current needs versus a nation's future security.

Recommendations

1. Increase the investment in Basic and Applied research to at least match the percentage of a nation's GDP as is being done by a potential adversary.
2. Find the most beneficial alliances with other nations to allow specialisation in the most useful niche technologies and capabilities.
3. To make technology as a springboard for capability development, use seed money to encourage researchers in industry and universities to combine their intellect with the best scientific minds within the ranks of the government scientific community through collaborative efforts.
4. Establish research parks where government, industry, and university scientists can work together.
5. Never forget that scarce resources require decisions to be made between current capabilities and long-term security challenges. An imbalanced division of resources between current capabilities and investments in future R&D can quickly render a nation less attractive, and irrelevant in tomorrow's world.

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