MANAGEMENT OF STRATEGIC RESEARCH AND DEVELOPMENT IN DEFENCE

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INTRODUCTION

Any organisation undertaking Research and Development (R&D) has a strategic focus on its respective field or context. National level R&D for a critical sector like defence acquires a larger dimension than mere business gains. It impacts the very root of independence: the foreign policy decision-making and the geo-political posturing. A nation self-sufficient in defence-application technologies does not need to make compromises for acquiring these from nations that may extract their price in more ways than one. Similarly, it would have one less variable to contend with when planning its capability projection missions in any theatre.

With this as the context, one needs to critically examine why India, a superpower in the making, continues to lag behind in such a critical area even after spending a large amount of funds on defence R&D. It has lagged behind other nations that started out on the same page but have now surpassed it. The dichotomy is stark if one is to consider the success stories being scripted in many

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other sectors viz. automobiles, pharmaceuticals, information technology, etc. In most of these sectors, Indian suppliers/manufacturers, skill-sets, and abundance of human resource put it in a coveted position in the global hierarchy. What is also immediately clear from these examples is that none of these sectors has direct governmental presence and markets have driven the growth vector. This may be somewhat of an oversimplification as there are success stories in the Indian Space Research Organisation (ISRO), which belie this hypothesis. However, it is an important point that would be elaborated upon later in the paper.

The Defence Research and Development Organisation (DRDO) is the nodal government department under the Ministry of Defence (MoD), which undertakes research and development for fulfilling the needs of the three military Services. Defence being a sensitive sector, the government has held the view that R&D in this sector should be directly controlled. Only very recently, steps have been undertaken to allow other players in this field. The Intellectual Property Rights (IPR) in the defence sector are very rigidly controlled in every nation and cartelisation is the norm. DRDO has faced these issues for a very long time and although some nations have managed to break out of the consequent laggard status, India has not yet been able to stay ahead of the technology curve.

THE COMPLEXITIES

While it is easy to strike off the lackadaisical progress in defence R&D under the public vs private sector debate, the matter is far more complex. There are some specific factors that go in favour of defence R&D and should have enabled it to come of age. Some of these are identified below:

- No dearth of funding[1] and not much pressure on its accountability. R&D is not a field where one can apply the economic laws of returns

1. "India's Growing Defence Industry Base", *Defence Review Asia*, November 1, 2010 http://www.defencereviewasia.com/articles/55/India-s-Growing-Defence-Industry-Base. Accessed on November 15, 2014.

in a steadfast manner. However, funding is a critical resource and its availability is essential to the success of any R&D project. So this is not considered to be a stumbling block in the case of DRDO.

- Critical requirement of end products. The three Services are entirely dependent on DRDO for their technological and hardware needs. Other options like imports are explored if the requirement cannot be met by DRDO or it is of a specific urgent operational nature.
- Lack of a customer concept, which removes a lot of pressure on DRDO. Since DRDO is another department under the MoD, it does not treat the three Services like customers, which they indeed are. In the corporate world, progressive industrial R&D labs are answerable to both internal and external customers at each stage of development. However, R&D does not really take off in an overtly pressurised environment. Thus, even this factor has always been in favour (probably a tad bit more) of DRDO.

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With the above-mentioned factors aligned in its favour, it is important to examine the R&D management that has been followed in the defence sector. This exercise should then lead to policy-level recommendations that would allow the defence R&D to be commensurate with the requirements of the nation. It should be clarified at the outset that the growing trend the world over is towards spill-over technologies, those that find markets in both civil and defence applications. So any R&D effort in the field of defence would automatically have some takeaways in related civil applications, leading to a cascading effect in other industrial sectors and, thus, has the potential to add to the nation's might. Therefore, the canvas is wide while considering investments in defence R&D.

It should also be noted that there are many civil application technologies that are finding their way in defence applications. Hence, the very categorisation of a conglomerate of R&D labs based on a particular nomenclature like defence

or similar sectors is to be avoided. There are labs in DRDO specialising in the fields of bio-sciences, agriculture and even food packaging. Such labs being categorised as defence labs acts as a boundary to the type of work that they are capable of. It also restricts the openness that they can display for harnessing their intellectual property rights in a market driven economy. Exports are restricted owing to the fact that the product was developed by DRDO and, thus, would need specific clearances. The scientists also know that such products are not really a priority and this stifles their creativity in such fields. This point would be referred to again later in the article.

AN OPEN SYSTEM

In the systems theory, an open system is described in simple terms as one that interacts with external systems or with its environment[2]. It has porous boundaries that allow useful feedback to be exchanged with its surroundings and, also to be understood. The erstwhile R&D organisations were operated within silos and comprised an example of a closed system. This has changed in many progressive organisations around the world and the focus has now shifted to collaboration and free exchange of ideas at various stages of product development. The consequences have been faster time to delivery and reduced/shared costs. The example of the Joint Strike Fighter (JSF) being developed by the US is an example of an open model of development[3] as is possible to be applied in the defence sector.

DRDO still follows the old model of product development. It works within the confines of its own labs. It employs scientists at the *ab-initio* stage and they grow in the field designated or projects given to them. The 'defence tag' does not allow them free access to many international quarters or collaborations even for dual use technologies. It works mostly on projects that are the direct need of the Services. It is not inclined to develop futuristic technologies or do technology forecasting for defence applications. A knowledge collaboration model would have, probably, allowed this to happen but this is not possible in the structure that is

2. An environment is external to the system as otherwise it would be part of the system.
3. The details of the collaboration are available at http://www.jsf.mil/program/prog_intl.htm. Accessed on July 10, 2015.

mandated for the organisation. Knowledge, human resource, market access, and technology development are undertaken in silos—sometimes mandated as a consequence of being a government department under the MoD, but mostly due to its unique position of being the only 'defence' research organisation in the country. An open R&D environment would force any organisation to be alive to the needs of the 'customers' and work towards generating innovative ideas for the survival of the organisation; DRDO is no different. The question is: how to ensure such an environment for a unique organisation like DRDO? This is a complex subject and only a few facets of this issue would be discussed in this article.

Purely as a comparison, let us take the case of the Fraunhofer Society in Germany that undertakes research in many civil and defence technology areas. Two-thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects.

On the other hand, DRDO is dependent almost completely upon the central government for its budget, even if the output from its completed projects may not be commensurate. What is its motivation to show research output? The state of technological growth in the country requires leapfrogging certain stages of R&D lest we take another 30 years to develop a Light Combat Aircraft (LCA). It needs to be analysed whether DRDO and specifically its human resource are prepared for this.

HUMAN RESOURCE

The scientific human resource for DRDO is chosen from the large number of engineering graduates passing out of engineering colleges/universities. The lure of a 'government job' has all but faded for the top engineering college graduates. The few who still opt for a government job, would rather work in the Indian Administrative/Police/Allied Services than as scientists in a government organisation. This is a peculiarity of the Indian education and job hierarchy system but its analysis is out of the scope of this article. DRDO controls a Deemed University (DU) in Pune called Defence Institute of Advanced Technology (DIAT). It is meant only for post graduate studies

(M.Tech) and research in the fields that mirror the work undertaken in different research labs of DRDO. DIAT is open to direct entry and the three Services' engineering graduates. It also undertakes many short-term courses for government undertakings and departments. Not many direct entry engineering graduates opt for this institute as the courses do not have wide applicability in the normal corporate stream. On the other hand, the custom-made M.Tech courses are very much in line with the requirements of DRDO. It would seem that this is an ideal situation for DRDO to induct trained scientists from the institute, specially since the former has a say in course curriculum. However, this is not the case. Intake from DIAT in DRDO does take place but is extremely meagre. Considering that courses in the institute are customised for defence applications, this is a dichotomy. On the one hand, good engineering graduates do not join the institute as the job opportunities after the specialised courses are limited and, on the other, the organisation (DRDO) for which the courses are specialised, is not interested in picking up the graduates from the institute.

DRDO normally hires graduates from good engineering institutes and then trains them at DIAT and at its labs, in the specific fields in which they are likely to work. There is no embargo on a person leaving the organisation at any stage. In this sense, knowledge management is not well done. The point to analyse is that why the graduates hired by DRDO are not really motivated to deliver even though they have been chosen over better trained engineers from DIAT. DRDO being a government organisation, works in a bureaucratic structure which is not always conducive for strategic R&D. It is difficult for such an organisation to hire human resource based on the perceived skill deficiency at the mid-level, as such provisions are rarely put to use. Lack of competition also does not stretch the goal for these scientists, giving them a sense of complacency. The job is not glamorous as these scientists are not exposed to the end results of their efforts, which has a huge impact on the three Services and the security of the nation. The role of the defence scientists in the overall strategic picture of the nation is never highlighted for providing self-motivation for the DRDO scientists. Even institutes like DIAT do not motivate young engineers to engage in research that would further

the strategic interests of the nation. Then, what is the difference between a scientist working in any other central government lab (in any department like agriculture, health or food, etc) and one working in DRDO? R&D work in every sector adds to national capabilities but as already explained in the beginning, research efforts in critical fields like defence (that is faced with technology denial regimes) have strategic connotation for the nation.

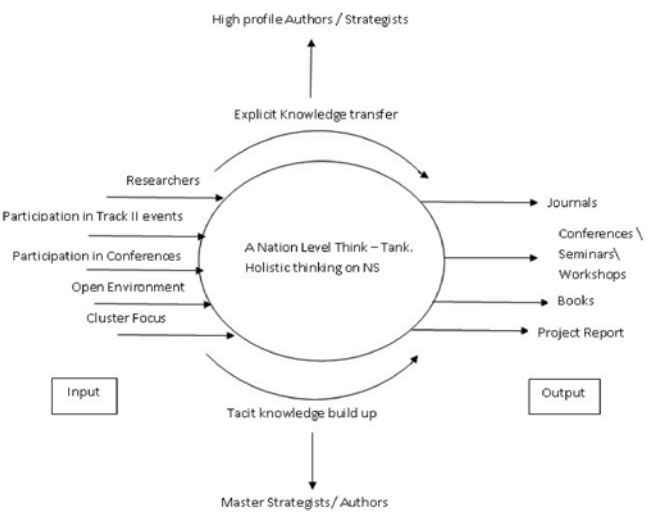
The main stumbling block for DRDO in acquiring quality engineers/ scientists is the perception of the students that in a government department, mired in the 'system', R&D is not possible. Even if the research results are positive, what recognition would be bestowed upon the inventor? The earnings come as a distant third in this 'motivation to join' process. Are these the reasons why ISRO (an organisation seen to be delivering) set up its own engineering college in 2007, with a unique model of intake? Young DRDO scientists have hardly any understanding of how his/her work is useful for national security. At this stage, their focus is narrow and limited to what is required of them by their superiors in the lab. This is a recipe for frustration to set in. The alignment of personal goals with those of the organisation and then an understanding of how the organisational goals are attuned to the national strategy need to be part of their training. In the absence of a suitable training establishment which can provide them knowledge on organisational and national strategies, this is not possible. This would also add 'glamour/charm' to the work of a scientist whose accomplishment may be known only to a chosen few (owing to the nature of the product), probably not even to the customers—the three Services.

STRATEGIC FOCUS

The issue that has emerged so far is that even though human resource management in DRDO can be more attuned to the resources already available, there is a dire need to provide a strategic focus to the scientists and students in institutes like DIAT so that they are better motivated, and can feel proud of their achievements. Many national level think-tanks are working in the strategic defence fields. Their work is on many levels of national defence strategies, including those dealing with cutting

edge technologies being applied in various defence applications around the world. They conceptualise ideas in the defence arena and specialise in international affairs. Centres like the Institute for Defence Studies and Analyses (IDSA), Centre for Air Power Studies (CAPS) and Centre for Land Warfare Studies (CLAWS),[4] etc are working on national security issues and their researchers are exposed to work in the defence industry, the three Services, government policy-making and international efforts in the field of defence. Their output is in the form of written reports, journals, project reports, books, seminars and conferences and policy recommendations. Each researcher works on a specific field and acquires in-depth knowledge in it. With long-term exposure to connected strategic issues of national security, their horizons expand and they acquire a strategic focus. Some of them go on to become respected strategists of international repute. They are consulted or their views ascertained for many governmental policies and rules that are framed. Strategists like the late K Subrahmanyam and Air Cmde Jasjit Singh and a few others fall in this category. A top level system model of a typical think-tank is shown in Fig 1 below.

Fig.1: System Model of Think-Tanks



4. http://www.idsa.in/ , http://capsindia.org/ ,www.claws.in/

It is evident that such conceptual level work in defence applications arms these think-tanks with strategic knowledge that should be shared with organisations like DRDO, DIAT and other academic institutes/ industry and the three Services. At present, the academia is not exposed to such think-tanks and DRDO only interacts with them on specific projects. A wide exposure to the strategies at play at the national defence arena level as well as at the international level, for the 'knowledge-based' human resource—the so-called 'gold collar' workers—is available in the universities and research organisations. A special emphasis on exposing the knowledge workers to these aspects is necessary due to the fact that such human resource is not really motivated by the conventional sources viz. money and similar materialistic provisions. Making them realise that their contribution to nation building is important would make a very big difference to their zeal in developing technologies required for the nation's defence and similar dual use technologies. It would make the nation truly independent, by ensuring self-reliance. The strategists may not provide any technical breakthroughs but they are well suited to provide knowledge of contemporary technologies and products being developed and/or the methodologies for their development undertaken by the developed nations or even by our geo-political competitors.

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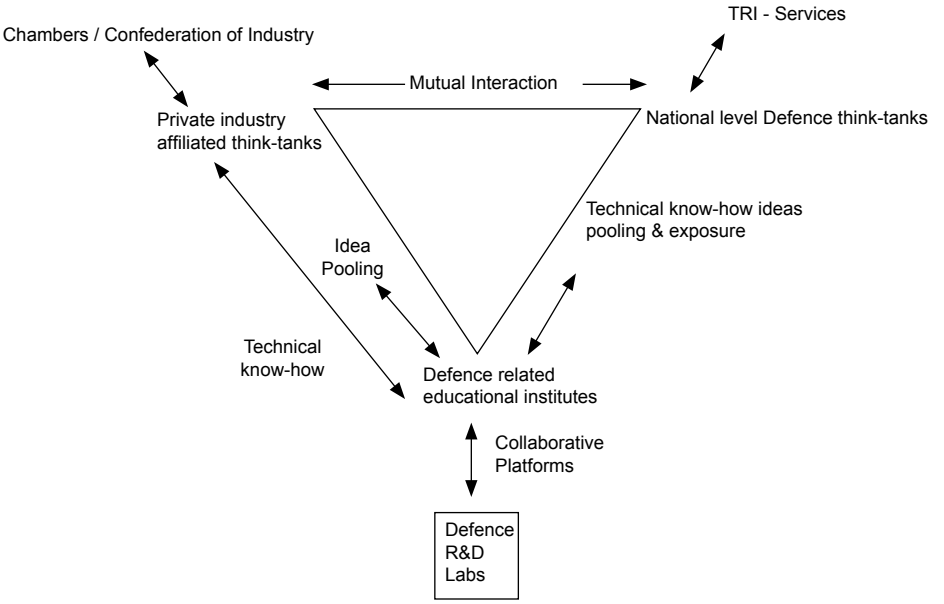
THE NEW R&D MODEL

The R&D model that emerges in the abovementioned context, stands on the three pillars of universities (academics), research labs (government and industry) and think-tanks (strategic focus). The users are exposed to all three and have the freedom to independently choose the combination that can deliver a project/ product. Even the labs have the freedom to choose

their partners and funding is based on bagging and delivering successful projects. They also have freedom to choose their human resource, customers, and markets. The government becomes a facilitator of this ecosystem. This R&D model would necessarily result in a competitive R&D environment and is depicted in Fig 2 below.

Fig 2: The New R&D Model



The important thing to observe in this model is the absolute freedom of the labs to engage with any partner for fructification of a project. The technology transfer for bulk manufacturing can then take place from the labs/ academic institutions to private industry/ ordnance factories/ defence public sector undertakings, depending on the product/ governmental regulations and also the respective capabilities of the manufacturers. At no stage is there an embargo on these labs undertaking projects exclusively for defence applications and there is full freedom for developing dual use technologies. The market forces would automatically determine such investments and forays. The defence sector would not be at a loss here as it is one of the most capital intensive sectors in the country.

The three Services would have to bring out their Request for Proposal (RFP) as per the existing methodology. The difference would be that they would not have to seek DRDO's go-ahead for categorising a particular project in ways specified in defence procurement procedures[5]. At the outset itself, DRDO and industry would be allowed to bid for an R&D or even a pure development project. All labs would also have the freedom to develop products that work on cutting edge technologies and take their own proposal to the Services/ users. After all, that is what industry does to develop new markets for any product. The government would pitch in with the necessary capital on a case by case basis and also control the export of pure defence application technologies/ products. There would still be some products, which would continue to be purely in DRDO's domain, depending on the sensitivities involved, but these would be few and it would not be difficult for the government to create a similar ecosystem in the private sector too, unilaterally or in partnership with their own undertakings.

The model described above was actually facilitated by the Japanese government after World War II. It was seen that the government facilitated technology transfer from US defence majors to their private industry, which then went on to master these technologies and is now a world leader, even partnering the same US firms[6]. India lost out by following a rigid government controlled structure of R&D. There are many such examples around the world where the defence sector has benefitted from the lead taken by the private industry, with the government playing the facilitator's role. The Israeli and German defence industries are fine examples of such a model.

It would be clear that the users would more than welcome any move that allows them to get world class products within a fixed time span. The "Make in India" initiative can truly benefit with such changes in defence R&D. One of the biggest beneficiaries would be the industry that develops dual use technologies as India promises to be one of the biggest markets

5. http://www.mod.nic.in/writereaddata/DPP2013.pdf. Accessed in June 2015.
6. *Arming Our Allies: Cooperation and Competition in Defense Technology*, OTA-ISC-449 (Washington DC: US Government Printing Office, May 1990).

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in most sectors of the economy. The dual use technologies/ products, with safeguards, can even be exported to friendly countries, providing the economy of scale. The private industry would find such markets, as this has a lot to do with the profits on investments that make a difference to private industry, unlike a government entity. Overall, the nation gains, economically and geo-politically through such ventures.

The new model being suggested here may appear quite revolutionary at first. However, the Services are already contemplating such changes, much to the surprise of DRDO.[7]The kind of governmental funding that has been allowed for DRDO or any similar R&D lab set-up, has outlived its usefulness in a market driven economy, which India has now become. This change should have, thus, been ushered in when liberalisation and globalisation were introduced in India in the beginning of the 1990s. The government resources are not endless and there are many other social avenues that need higher funding and lower taxation.

The R&D labs working on defence applications should have complete freedom to undertake work as per their core competency. In effect, it means that if they have the capability and idea for a New Product Development (NPD) that is not a specific need of the three Services and is of dual use purpose, they should develop it as per the need of the market. This can only happen if they have an ear to the industry and a customer orientation. There are success stories by DRDO in food technologies that have dual use and can be (and also have been) easily absorbed by the industry.[8] At present, DRDO does not even perceive the three Services as customers, its understanding the market is a far cry. A list of 507 technologies is

7. "Army Invites Proposals for Designing Tanks, DRDO Surprised", *The Times of India*, June 26, 2015. http://timesofindia.indiatimes.com/india/Army-invites-proposals-for-designing-tanks-DRDO-surprised/articleshow/47831996.cms. Accessed on June 27, 2015.
8. "Food Technologies", February-April, 2001 http://www.drdo.gov.in/drdo/pub/techfocus/apr2001/food.htm. Accessed on July 22, 2015.

available on the DRDO website that have been transferred to the industry[9]. This does not give a true commercial value of the Intellectual Property (IP) generated. Since most of these products have been made for the armed forces and the production is not done by DRDO, they have to be transferred to the industry/ Defence Sector Public Undertakings (DPSUs)/Ordnance Factories (OFs) for production and supply. Whether these would go forward to bigger and newer markets is not DRDO's concern, as this is not its mandate. This again leads us to one point—that funding without result orientation would lead to lack of accountability, while competitive R&D is the need of the hour.

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INCLUSIVE EXISTENCE OF THINK-TANKS

As already mentioned, there is a handful of think-tanks working in the field of national security. All of them have MoD linkages owing to the focus of their work and financial effects. However, the industry linked think-tanks like the Observer Research Foundation (ORF) also work on multi-dimensional subjects, including national security. Their focus is wider and their systems much more collaborative. All the defence related think-tanks in Delhi have a formal/informal working relationship. They collaborate for specific projects of national security. Some of their work is also on similar subjects and, thus, these collaborations help in developing a deeper understanding of the subject. The system is not ideal but is workable.

A formalised interaction of the industry and national think-tanks would help broaden the horizons of work in the strategic domain. The stringency

9. "List of Technologies Transferred to Industries" http://drdo.gov.in/drdo/English/list-of-technologies.pdf. Accessed on July 22, 2015.

involved due to government decision-making may sometimes hinder collaboration, which the private think-tanks would not be encumbered with. Private industry think-tanks have better financial resources and are, thus, able to take on more research projects. However, the kind of leverage with the Services that is enjoyed by the other think-tanks provides them an edge in deeper understanding of the pertinent issues. It would be clear by now that it is a win-win situation if the two enter into a synergistic partnership for projects. This is already happening but at a very reduced pace. This is one area that should gather momentum.

It is also a fact that almost none of these think-tanks venture into the domain of defence technology. The ones that do, look at it holistically as an industry sector[10] but do not work in specific fields of defence technology. An interaction with the academia is expected to enrich and expose their researchers to the fields that are considered worthy of exploration by the academia. This would ensure that think-tanks study these fields for the type of work going on at the international competitive level. Then they would be in a better position to support, and provide strategic focus to, the academic institutes and industry alike.

The industry's tie-up with academic institutes, facilitated by the government, is being considered for the premium institutes.[11] But for other institutes, this is still not the norm. While the industry and government labs, both feel the lack of trained personnel, institutes like the National Institutes of Technology (NITs) and DIAT can go in for such collaborative efforts, being facilitated by the industry chambers/ confederations and the government. As the "Make in India" efforts gather traction, opportunities for such collaboration would increase. The think-tanks can also provide platforms for such collaboration to take place by joint hosting of events and aligning the efforts towards the gaps noticed in defence acquisition/ technologies. DIAT has a special role to play here

10. Air Cmde Jasjit Singh (Retd), *Energising Indian Aerospace Industry* (New Delhi: KW Publishers, 2007).
11. National Centre for Aerospace Care - A Department of Science and Technology, IIT Mumbai and Boeing Collaboration. For more details, please visit http://www.ncair.in/ . Accessed on July 1, 2015.

as it specifically prepares students in the field of defence technologies; it is a different matter that the same has not found resonance in DRDO labs.

CONCLUSION

National level R&D for a critical sector like defence acquires a larger dimension than mere business gains. Any R&D effort in the field of defence would automatically have some takeaways in related civil applications, industrial sectors and, thus, would make the nation stronger. Investments in defence R&D will enhance the nation's potential in a cascading manner. Defence R&D forays should, therefore, not be seen in isolation as has been done till very recently. They should be used as a medium to take economic development to a higher level.

DRDO still operates within silos and follows the old model (closed system) of product development. It works within the confines of its own labs. The focus of R&D has to be shifted to collaboration and free exchange of ideas at various stages of product development i.e. an open model of development. As the complexities increase and the technologies become obsolete faster, a closed model would increasingly come under pressure. The sensitivities associated with defence would have to be managed in an altogether different manner.

The requirement of competition to bring out hidden potential to the fore has often been noticed. The same applies to R&D efforts in the defence sector. For far too long, DRDO has been nurtured with central funding, without it being driven by market forces. The demand by the industry for a level playing field is truly borne out when one considers the economics of doing research in the defence sector where economy of scale in production is not always favourable. DRDO has never been exposed to such economics and has worked in a protected environment, sure of the product finding a market with the Services if it meets 'most' of the requirements. Any management guru would tell us that till the goals are stretched a bit, the efforts by any individual or organisation remain mediocre.

The focus has to be on much better management of existing resources. The existing academic infrastructure allows for channelised research activities to take place in the applied sciences. A synergistic approach would require the coming together of industry and government research labs on a platform being provided by the academic institutions. Existing institutions like the Indian Institutes of Technology (IITs) and DIAT can play a much bigger role than what is happening at present. While a few IITs are quite active in this collaborative model of research, others are yet to participate. DIAT, being a nodal academic institution under the MoD, is ideally suited to exploit the situation and help in this nation building effort. Unfortunately, the present structure of defence R&D does not allow this to happen.

The think-tanks working in the field of defence in India have been doing yeomen service to the nation by working on national level strategies through concentrated research. The knowledge that is gained in these institutions has to be gainfully utilised by aligning the focus of research in academic institutions towards strategic goals. This would also ensure that scientists take pride in their work after appreciating their role in nation building. Thus, the R&D model that emerges places these think-tanks as an important pillar in the national efforts for self-reliance in defence technologies. Their collaboration with academia and industry would provide the synergistic vision to all the parties involved. The industry and governmental/ autonomous think-tanks can also come together to provide a focus to the labs working even in the development of dual use technologies. The government has to play the role of a facilitator in these efforts. Any retrograde rules that inhibit the open model of research in the defence sector should not be imposed. The think-tanks also need to be encouraged by the government by building suitable facilitative infrastructure for free interaction to take place between all the parties working on the subject of defence R&D and strategic technologies. This is the need of the hour.