Transfer of Defence Technology to India

Prevalence, Significance and Insights

*Kevin A. Desouza**

Transfer of technology has been prevalent in numerous forms across the world, both in the civil as well as defence domains, and India is no exception. These transfers, primarily in the form of licenced manufacture, have provided a significant boost to the production capabilities and self-reliance of developing nations in the past and hold great promise, in the future, for nations that do not have a well-developed science and technology base. This article addresses transfers in the defence domain and delves into some of its fundamental aspects through a coverage of its prevalence in India; whether it contributes to the attaining of national goals; understanding its core fundamentals and connected nuances; and finally, benefits and costs, including restrictive issues.

India's journey towards the acquisition of competitive defence technology so as to gain assured capability against the military threats it confronts, has essentially two routes. The first route is indigenous development and the second, import of technology. Despite considerable thrust on the first, albeit with an understandably limited budget,[1] the progress towards self-reliance in defence technology has not reached the milestones that were set.[2] There is no doubt that overall indigenous development and production has significantly increased in technology levels and volumes over the decades. However, this has been offset by an even faster evolution of defence technology in the world. The Indian defence forces

* The author is a serving Colonel in the Corps of Electronics and Mechanical Engineers of the Indian Army. He is currently pursuing a research fellowship at IDSA. The views expressed here are his own.

ISSN 0976-1004 print

Journal of Defence Studies, Vol. 10, No. 4, October–December 2016, pp. 31–52

thus continue, as in the past, to depend on imported competitive defence technology systems.

Can this technology gap be reduced? There is no doubt that a deep commitment and investment in indigenisation can achieve this reduction, as has been demonstrated in the Indian space and, to some extent, nuclear technology domains. However, financial constraints in India's developing economy has precluded such an investment. Consequently, Indian defence technology still lags behind in most fields and many frustrating attempts to push harder on the indigenous route do not seem to help. It is in this discouraging environment that we find a few references which allude to the 'unnecessary need to re-invent the wheel' and the use of the second route, that is, import through transfer of technology (ToT), as a 'jumping board'[3] or a means of 'leap-frogging over the technology lag'.[4]

This article takes a close look at ToT, the second route, going through a brief historical perspective, an analysis of its alignment with national goals, defining it and understanding its nuances, its benefits and costs as well as trade practices which restrict its exploitation by the recipient country. Further nuances, such as the effect of export control regimes (Missile Technology Control Regime [MTCR], Wassenaar Arrangement et al.) and commercial modes such as foreign direct investment and joint ventures, are planned to be covered in a separate article subsequently. It is also planned to cover the current situation in the Indian defence industry subsequently since data is not yet available.[5]

Historical Perspective

India's journey towards production of competitive defence technologies commenced with the Ordnance Factories (OFs), which were established with British technology in the 1800s and 1900s. These were utilised to some extent for meeting the domestic needs of the subcontinent and that of the two world wars. Since their capabilities were limited, the decade post-independence saw the direct acquisition of weapons systems from major military powers.[6] Simultaneously, a start was made in the 1950s to establish a defence industrial base (DIB) by setting up of the Indian Defence Research and Development Organisation (DRDO), which was tasked to indigenously design and develop defence systems for the Indian military services. This was accompanied by the establishment of a few defence public sector undertakings (DPSUs), which would take on the manufacturing of defence systems.[7] The next few decades saw collaborative military production (a variant of today's ToT) programmes of foreign weapon systems such as the Alouette helicopters, 106 mm recoilless guns, Nissan jeeps, Shaktiman trucks and Gnat fighter aircraft from the French, the United States (US), Japan(Nissan), West Germany (MAN) and Britain (Folland Aircraft) respectively.[8] Early in the 1960s, India approached the British to allow licenced manufacture (LM) (another variant of ToT) of the Lightning fighter aircraft. This was refused; hence, the Soviet Union was approached and in 1962 an agreement was struck to produce the MiG-21 fighter aircraft in India.[9] This was the start of a long defence technology relationship with the Soviet Union. By the 1980s, nearly 70 per cent of Indian military hardware was of Soviet origin.[10] India, however, also maintained an open stance for receiving LM offers from other major powers, such as Britain, France, Germany and other European countries.

The LM (or ToT) as the preferred means of acquiring high-population major defence systems was not entirely successful. In the MiG-21 programme with the Soviet Union, shortages of trained manpower and poor-quality facilities hampered production, which was limited to the assembly of subsystems and major parts. Complaints of poor quality of the produced aircraft also plagued Hindustan Aeronautics Limited (HAL), the DPSU which produced the aircraft.[11] Delayed timelines due to various reasons forced the outright purchase of more aircraft, such as the 50 Hunters from the United Kingdom (UK) and 150 Su-70s from the Union of Soviet Socialist Republics (USSR).

In the 1980s and 1990s, the Indian DIB showed signs of being able to deliver some indigenous systems. Some of the well-known programmes are the main battle tank (MBT), the light combat aircraft (LCA) and a string of missiles systems under the Integrated Guided Missile Development Programme (IGMDP).[12] Progress, however, was slow and many voids in other fields of military capability existed. Hence, LM (ToT) continued for the induction of large-population systems such as the T-90 tanks, armoured fighting vehicle BMP-II, Bofors FH 177B artillery guns, Flycatcher radars and Reporter radars.

In 2001, the Indian government decided to take a quantum step ahead in its economic liberalisation policy by opening the defence sector to private companies.[13] In order to maintain a transparent and efficient process, the Ministry of Defence (MoD) drew up and promulgated the Defence Procurement Procedure (DPP) in 2003. This would guide all the connected agencies and enable faster processing of acquisitions in the desired competitive scenario. LM under the head 'ToT', was included in the DPP and its subsequent revisions.

In recent times, despite the introduction of a number of indigenous systems such as the MBT Arjun, advanced light helicopter (ALH) Dhruv and Akash air defence weapon systems, imports have continued unabated. In fact, India is one of the largest importers of military equipment in the world today.[14] Among the systems being imported, many are being manufactured or are proposed to be manufactured under ToT. These include the Sukhoi Su-30 fighter aircraft, the Scorpene submarine, the long range surface-to-air missile (LRSAM), the low-level transportable radar (LLTR) and many others.

In 2008, defence offsets were introduced in the DPP. These provisions were subsequently revised and a Defence Offset Guidelines issued in 2012. These guidelines listed six different avenues for their execution. Out of these, three pertain to some form of ToT, indicating the significance being accorded by the Indian government to the field. Whether offsets have been successful in enabling productive ToT, however, is not yet clear.[15]

On 25 September 2014, the Indian government launched the 'Make in India' campaign, with the primary goal of making India a global manufacturing hub by encouraging foreign private companies to manufacture within the country. Defence manufacturing was one of the 25 sectors focused on by the Make in India initiative.[16] Subsequently, a number of initiatives have been taken, one of the major ones being the striking of a defence deal with Russia in December 2015, for the manufacture of the Kamov Ka-226 multi-role helicopter in India. This has been widely seen as the first defence deal to be actually signed under the Make in India campaign.[17]

Today, India stands under a deluge of ToT proposals from a number of developed countries and their firms. Foremost is the US which has offered 17 technologies, with another 24 on the cards, as far back as in October 2015. These do not include four 'pathfinder' projects which were identified by India and the US for co-production of defence products based on comparatively simpler technologies.[18] Besides the US, firms from numerous other developed countries have also offered ToT for a number of defence systems, with some as significant as fighter aircraft and submarines. One of these firms has offered 'robust' and 'no-holds-barred' ToT,[19] while another has offered 'true'[20] or 'real' ToT with full control over system design and software.[21]

ToT and National Goals

At this juncture, we need to take a step back and deliberate the national goal that ToT activity should be aligned with. Should it be a single-minded thrust of developing superior military strength; or that of achieving strategic autonomy through, as we shall discuss later, the unattainable self-sufficiency, aka autarky; or maybe industrial growth and economic development; or perhaps a combination of them? The variables are numerous and this can be debated endlessly. An achievable combination of these, which is in keeping with India's industrial and security policy, can be best worded as 'self-reliance in production of competitive defence technologies'.

Self-reliance in competitive defence technology has been described by late K. Subrahmanyam, the Convener, National Security Advisory Board, in the year 2000, when he compared self-sufficiency and self-reliance. He described self-sufficiency as the in-house production of everything that is needed by the armed forces, a state which he averred was impractical for a developing nation possessing limited resources.[22] In a more generic sense, his stand is supported by Ron Matthews' view that 'though self sufficiency may be a country's proclaimed goal, it is invariably economically infeasible', to which he adds the example of the technology sharing within North Atlantic Treaty Organization (NATO) countries.[23] A further strengthening of this view comes from the examination of the import of defence systems by various countries today. Records indicate that there is, in fact, no country, developing or developed, which does not import some amount of defence equipment. In the year 2015, for instance, in the top developed countries, the US imported arms worth US$ 565 million, while Russia imported an equivalent of US$ 201 million.[24]

On the other hand, self-reliance, was defined by K. Subrahmanyam, as the equipping of the armed forces with a range of weapons and equipment either from foreign or indigenous sources, but with the condition that the operational exploitation and maintenance of the foreign equipment must not be held hostage under any circumstances.[25]

Another definition of self-reliance can be obtained indirectly from the objectives set by a self-reliance review committee headed by Dr A.P.J. Abdul Kalam in 1992. The committee, which defined the self-reliance index (SRI) as the percentage share of the indigenous content in the total procurement expenditure, suggested the objective of achieving an SRI of 70 per cent from the existing 30 per cent over a 10-year period ending in 2005.[26] This target has not been achieved till today and the Indian government, through the DPP 2016, now stipulates a minimum 30 per cent in the 'Buy Indian' and 'Make' categories and 50 per cent in the 'Buy and Make (Indian)' category. From all these indicators, being self-reliant can be taken to mean the country's ability to manufacture a significant portion of the components of defence systems.

So does ToT enable self-reliance? There is no doubt that ToT provides the capability of manufacturing a significant portion within the country, thus meeting the SRI objective. It is also well known that ToT contracts of the past have invariably included the requirements for operation and maintenance, thus meeting K. Subrahmanyam's perspective. However, having stated that, the probability that proprietary spare parts may not be available over the entire life of the equipment does exist, as has been unfortunately experienced by India with Soviet-origin equipment after the unexpected collapse of the USSR. It may be worth noting that this risk is not immune to mitigation and measures such as lifetime buys of spares or early development of import substitutes can be greatly effective in doing so.

A national goal higher than self-reliance is defence technology leadership, where Indian agencies achieve the capabilities of making breakthroughs in fundamental research in science, and then convert them through design, development and production into leading-edge defence technology weapons and defence systems. Technology leadership in even a few fields can greatly accelerate the development of leading-edge weapon systems through collaborative arrangements with foreign research and development (R&D) agencies willing to share, in return, some of their complementing technologies. Can ToT possibly help India achieve such a goal? Though apparently improbable, this article attempts to explore the nuances to arrive at an answer.

Defining ToT

ToT, as a phrase by itself, can generate widely differing perspectives from a recipient country's perspective. For the layperson, not acquainted with these matters, it can appear to be a transfer of information and hardware which allows the buyer to independently build up on for future upgrades or even superior designs. If this had been the case, India and many other countries would have been self-sufficient in fighter aircraft, helicopters, armoured tanks, artillery guns and numerous other systems which have been licence manufactured through ToT. Others may assume that there is nothing to gain from ToT since it only increases dependence on other nations. Yet another view is that ToT is a half measure, not capable of creating design and development capabilities.[27] Further compounding the confusion is, as stated by *Encyclopedia.com*, the difficulty in defining the exact nature of this activity, partly because the term has many different connotations.[28]

As per the United Nations Conference on Trade and Development (UNCTAD) document, *Transfer of Technology*, technology is the knowledge that goes into the creation and provision of a product or service.[29] Sakti and Indrani Mukherjee define 'technology' as 'an organised knowledge of production', and further describe it as 'a set of instruments or tools, materials, know-how and abilities' which may be 'bought and sold as capital goods, human labour and information'.[30]

In the international defence environment, there are references to 'technology' being specific information necessary for the 'development', 'production' or 'use' of a product.[31] This information could be in the form of technical data or technical assistance. 'Technical data' could take forms such as written plans, product diagrams, models, blueprints, formulae, tables and specifications as well as instruction manuals written or recorded on other media or devices such as disks, tape and read-only memories.

In the Indian defence environment, there are references to technology being the complete expertise (engineering–manufacturing documentation to enable fabrication, assembly and test of item) or expertise to maintain the system in service (called Maintenance ToT),[32] while another relates to it as the process of LM. Yet another (this by the DRDO) quotes the National Academy of Engineering (India) as defining it as: 'including all the infrastructure necessary for designing, manufacture and repair of technological artifacts—engineering know-how, manufacturing expertise and various technical skills—all are equally important part of technology'.[33] The Indian DPP[34] states that ToT (when contracted) shall be:

> comprehensive, covering all aspects of design, manufacturing know-how and detailed technical information which will enable the Production Agency to manufacture, assemble, integrate, test, install and commission, use, repair, overhaul, support and maintain the license product. Design data shall include the details that are needed to give design disposition during production on deviation/ concession; modify/upgrade the licence product and substitute

> parts and systems of the licence product as required by the certifying agency and the production agency.[35]

From these definitions, two distinct aspects of technology, in the context of ToT, come to the fore. One aspect covers its components such as knowledge, skill, expertise, know-how, methods, organisational capacity and infrastructure; and the other specifies the capability that it delivers, that is, development/creation of the product/manufacture/use/maintain/repair/overhaul, etc.

A closer examination of the first aspect, that is, the components, reveals three distinct categories: technical data or information; capital goods or infrastructure; and technical skills and abilities, each with their own nuances of transfer. Technical data or information can be transported through paper documents or digital media and pose no problems for effective transfer or absorption, unless they require translation. The second, capital goods or infrastructure, requires transportation by different modes and matching resources such as industrial power and water. The third category, technical skills and abilities, which can only be carried, transferred and absorbed by humans, is a little more challenging as regards to its transfer. Widely differing technical capabilities between the seller's reps and the buyer's reps, coupled with differing work cultures and languages, make the transfer and effective absorption of this category not an easy task. It is also interesting to note that technical skills such as know-how are also considered industrial (now intellectual) property (IP), along with technical data and information, and these are treated at par with property such as capital goods or machinery.

The second aspect of ToT, that is, the capability that it delivers, also needs further deliberation. Going by this aspect, we have definitions of two types of ToT which are already in common use. One is ToT for manufacture, which is generally referred to as ToT, and the second is ToT for maintenance/repair/overhaul (MRO), commonly referred to as MToT. Are there any other variants which exist? The definitions given earlier mention that ToT is implemented to enable the 'use' of the product. Should ToT also not cover an 'Operate ToT' or OToT, especially since such contracts for 'operate and maintain' have been executed in the past?[36] There are also MToT variants with differing depths for MRO of the product. For the sake of comprehensiveness, it is worthwhile covering all the variants.

The definitions of technology, discussed earlier, also include a 'development' capability and a 'design' component. Does that mean that ToT could also empower the technology recipient to design and develop its own products? A glance at the general nature of ToT arrangements discussed in various literature and the media would indicate to the contrary. No such factual instances of ToT with 'design' enabling 'product development' have been referred to or reported in the Indian defence environment, or for that matter, anywhere in the world. Yes, the passage of the DPP, which describes design data as conferring the 'disposition to deviate from specifications or modify or upgrade a part or substitute the part', does aspire for such a transfer but in a very limited sense, and more as a measure to overcome potential stoppages in manufacturing than for the development of new products.

Despite its apparent non-existence, it may be worthwhile defining such a transfer as 'Design and Development ToT' (D&D ToT), if only to refer to a transfer that is strongly aspired for by technology seekers. In the case of the DPP, the additional capability that is requested for may be termed as a ToT with capability for limited design deviations/modification/upgrade, which we could abbreviate as DToT (Limited).

So, a holistic view of ToT and its variants can be drawn up as in Table 1. The variants are listed in increasing order of capabilities conferred and depth of technology transferred. It has been the general observation that contracts for each level of ToT also, invariably, include the previous level. For example, an MToT would automatically involve an OToT, or a PToT would automatically involve an OToT and an MToT. The 'deeper' the ToT, the more is the capability (and hence self-reliance) conferred.

Table 1 Assigning of ToT Variant Definitions

Capability Desired	*ToT Needed*	
Operate	OToT	↓
Maintain	MToT (M)	
Repair	MToT (MR)	
Overhaul	MToT (MRO)	
Produce/manufacture/assemble/integrate	PToT	
Minor design deviation/modification	DToT (Limited)	
Upgrade/develop variants/develop alternate products	D&D ToT	*Deeper*

Intellectual Property (IP) Assignments and Licences

How are these technology transfers actually implemented? Since 'technology' exists in the form of property—physical and intellectual—ToT essentially translates into either an assignment of the property or licensing of the use of these properties by the technology holder to the technology recipient. An IP assignment is a permanent transfer of ownership of an IP, such as a patent, trademark, copyright or know-how, from one party (the assignor) to another party (the assignee). The assignee thus becomes the new owner of the IP. A licence agreement, on the other hand, is a contract under which the holder of the IP (licensor) grants permission to another party (licensee) for the use of its IP, within the limits set by the provisions of the contract.[37] Assignment and licensing are considered the primary forms of 'commercialisation' of technology.

'Know-Hows' and 'Know-Whys'

Achieving or acquiring the capability to design and develop its own systems is undoubtedly the ultimate goal for any country. What exactly are the components of knowledge which enable such a capability? And why is it not possible to acquire it through the apparently non-existent D&D ToT? The answer can be discerned from a close examination of the difference in D&D ToT and PToT. Manufacturing, enabled by PToT, primarily requires 'know-how', which can be defined as the practical knowledge on how to accomplish something.[38] The knowledge of 'how' to fabricate the concerned parts, 'how' to test them, 'how' to assemble the parts and 'how' to inspect and test them as an integrated whole are all elements of know-how required for production. In some cases, additional knowledge is provided in order to know 'how' to rectify or offset deviations in quality of the parts and 'how' to modify the system keeping within the specified limits. What this know-'how' does not include, however, is the knowledge required to carry out major modifications, or upgrades or manufacture future, more capable versions of the product. This additional knowledge which has been referred to as the 'know-whys' is, understandably so, not divulged by the technology seller simply because, by doing so, the technology recipient acquires the knowledge to design and build products which could compete with the original firm. Development of military systems necessitates an immense amount of investment in terms of money, time and resources. Why then would a developing firm or country fritter this investment away without securing the maximum returns possible?

A little more insight on what is meant by 'know-whys' is in order here. Let us take the simple example of a helicopter blade. The know-how needed to manufacture it would include the method to arrive at a specified metallurgical composition and the specified process of moulding or forging this composition into a desired shape, dimension and strength. This combination of the right composition, process, shape and strength would ensure the blade provides a certain amount of thrust at a certain speed of rotation without it deforming or breaking within a certain amount of usage. Possible compositions could number upto many hundreds, and so also would the types of processes, shapes and strengths. The developing firm would probably have taken many hundreds of iterative experiments and trials using extremely expensive laboratory instruments to meticulously document and arrive at a conclusion as to 'why' a particular combination of composition, process and shape is optimal. If this documented knowledge were to be obtained by the recipient firm, it would empower the firm to further improve the blade without depending on any inputs from the developer. In many cases, the knowledge acquired during development may not be fully documented, resulting in a component of knowledge known only to the developing scientist. This component, referred to as 'tacit' or 'implicit' knowledge, is acquired from 'learning by doing' patiently over many years and is generally difficult to acquire through formal ToT.[39]

Does the non-existence of D&D ToT mean that no transfers occur during and immediately after the R&D stage? Literature published in the field indicate that this is not necessarily true. Today, the proliferation of research activities among the small and even micro enterprises throws up situations where a company does not have the means to undertake commercialisation or prefers to receive a once-off lump sum payment for the innovative technology that they have developed.[40] In collaborative research too, situations arise where a transfer of IP ownership from one of the collaborative research partners to another is effected to allow the partner to go ahead alone.[41] Since technology also matures in stages, as is depicted in the Technology Readiness Levels concept of the US Department of Defense (DoD), it is quite possible that small research firms may not be in a position to take spin-off technologies to maturity, and therefore decide to assign (permanently transfer) their rights to another firm in return for suitable remuneration.[42]

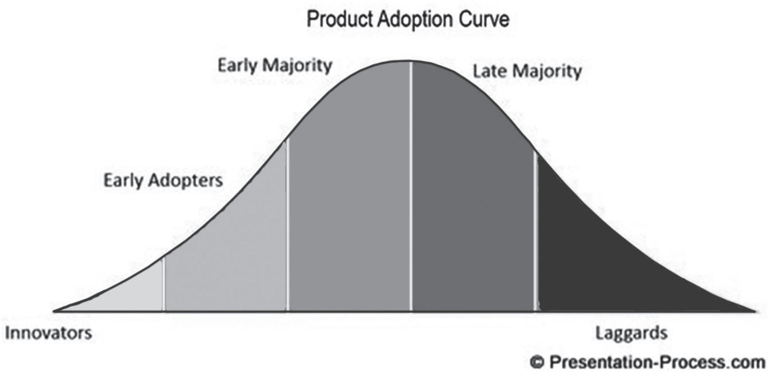

Figure 1 Everett Roger's Bell Curve for Innovation Adoption
Source: www.Presentation-Process.com

Technology Adoption Timeframe

Technologies go through a life cycle which initially starts as a phenomenon being discovered in a laboratory through fundamental or basic research. The concept of utilising this phenomenon for a specific purpose is then proven through applied research. If successful, the concept is developed into a prototype and tried in real-life conditions. If successful, it is then productionised. Even after production, technologies are continually improved upon, increasing their utility and reliability. As a new technology appears on the horizon, the current technology is exploited fully for maximum returns and then retired to give way for the new one.

The stage at which a technology is adopted is critical to its economic exploitation. Adopting a technology at a very nascent stage when the technology is not fully ready may throw up teething problems in manufacture[43] and poor reliability of the product, while its adoption at a very late stage will result in difficulties in maintaining it due to obsolescence issues. Figure 1 displays Everett Roger's bell curve which indicates the relative population of the innovation or product adopted at various stages of its life cycle.[44] To fully exploit the technology while it has the competitive edge would mean targeting the early adopters or at least, early majority categories.

ToT from the Seller's Perspective

In the context of defence technology where the competitive edge over an adversary is crucial, the importance of acquiring a 'new' technology which provides the critical edge is immense. Countries which have developed cutting-edge technologies are therefore reluctant to participate in deeper forms of ToT immediately, no matter the price offered.[45] However, they may be willing to do so at a later stage when they have developed a newer replacement. Commercially too, advanced or newer technologies would cost more and recipients may have to understand this during their acquisition cycles. Most developers will naturally attempt to squeeze the most out of their developed technologies and will be unwilling to assign their full and unfettered rights until the technology holds no promise for further development.

The primary benefit of ToT to technology sellers is the revenue through which they can recover their R&D costs and build profits. Besides this, some companies may use ToT to create an industry standard such as the global system for mobile communications (GSM) and code-division multiple access (CDMA) for mobile phones. An establishment of such a standard would increase their revenues, and also provide them a platform to build on. Some companies may wish to partner with a firm that has the resources or complementary assets needed to commercialise their technology.[46] Governments use ToT as an instrument in building strategic relations with another country, as is seen in numerous examples around the world. In doing so, they also provide a fillip to their own defence industries which supply proprietary parts and machinery for maintenance, repair and overhaul. Once the buyer countries become dependent, the seller country acquires the ability to apply pressure through linkage or leverage on the buyer country to accede to more agreeable policies.[47]

The Benefits to the Recipient

There is no doubt that ToT has some distinct benefits for the recipient country. Besides the primary benefit of meeting the particular need in a cheaper, faster and easier method than developing the product from scratch, ToT has many side benefits.[48]

First, the acquisition of technology in physical form leads to an awareness of its capabilities in the recipient country. This 'technology diffusion' provides a fillip to the overall technology awareness in the country and motivates people in various sectors to strive for higher, more productive means.[49] Second, new technology for manufacture brings in new industrial machines and processes, and thus helps to modernise the production system. Some processes may require particular skills which are acquired by the workforce of the recipient country.

Third, production lines invariably need subsidiary firms to manufacture ancillary parts and therefore, it promotes industrial growth and economic development. Fourth, increased production would increase employment and tax revenues. In cases where there is a potential for export, it could bring in precious foreign exchange and improve the country's trade deficit. Fifth, foreign technology invariably requires some level of adaption to match the local conditions. This adaption, enabled by the absorption of the new technology, can build up innovation and technological progress within the recipient country.[50]

The Costs

The flip side is that the price of ToT is often challenged as being exorbitant since firms selling technology have been known to take advantage of the oligopolistic nature of the imperfect high-technology market. Besides the basic cost (which is itself difficult to value accurately and can be easily inflated), technology suppliers have been known to extract excessive returns through a multitude of measures listed next:[51]

1. High royalties and fees for licensing subsequent batches of production cause a heavy burden.
2. Costs for right to use the trademarks.
3. Costs through artificially hiked up prices of parts from intra-company sales.
4. Costs for profits capitalised in the acquisition of shares in the receiving company.
5. Costs for some parts of the profit of fully owned subsidiaries which have no special provision to pay for technology transfer.
6. Costs due to overpricing of capital goods, that is, industrial machines and equipments.

One would assume that ToT to a less developed country with significantly cheaper labour and infrastructure, such as India, would enable manufacture of products at a cheaper price than that supplied directly by the foreign seller firm. This assumption, unfortunately, is not always true. Ron Matthews cites the examples of Gnat fighters which were produced at a unit cost of US$ 2.5 million, which was in excess of the import price, and of the Anglo-French Jaguar aircraft which, in 1980, was estimated to be produced at Rs 200 million which was double that of buying the plane from Britain.[52] Exact reasons for this increased price remain elusive, but an intelligent guess would assign the increase to the inflated costs of licences or royalties, inefficiencies of manufacturing at low scales, coupled with inefficiencies due to suboptimal management, work culture and workforce skills. The situation today remains much the same with foreign firms indicating higher prices of the Indian licence manufacture product and that larger localisation will increase prices.[53]

Restrictive Trade Practices and Restraints

Besides imposing apparently unreasonable costs, suppliers also attempt to guard the business angle of their technology by forcing the recipient to agree to numerous trade restrictions and restraints. While some are considered acceptable, many have been termed unreasonable or monopolistic/anti-competitive, and have been sought to be banned or restricted through appropriate legislations in the buyer countries as well as the UNCTAD Code of Conduct on ToT, with limited success. A glance at the list of restrictions that have been known to be imposed is enlightening.[54]

1. Restrictions on field of use, volume and territory over inordinately extended durations of time.
2. Restrictions on right of the recipient to sell the product of the ToT to persons other than those designated by the seller.
3. Restrictions on R&D in the field. Since this could very well fall under anti-competition practices, it is now being applied as restrictions on the right to any improvement, modification or enhancement of the know-how, and also restrictions to participate in the development or manufacture of a similar product or create derivative work based on the licenced equipment.[55]
4 Tying, that is, imposing on the technology recipient the obligation to purchase, apart from the technology wanted, additional inputs such as raw materials and machines.
5. Price fixing, that is, imposing on the technology recipient the prices fixed by the technology seller.
6. Restrictions after expiration of industrial/intellectual property rights.
7. Restrictions on the technology recipient to challenge the validity of the rights conferred by the ToT contract.
8. Grant-back provisions which impose on the technology recipient an obligation to transfer back to the seller any improvements, inventions, additional experience, etc., in the working of the

technology transferred. These are now being replaced with clauses prohibiting modification, disassembly and reverse engineering.[56]

9. Export restrictions or export permission for specified countries only, higher royalties for exported products, etc.

A close look at the restrictions against the opportunities that ToT may offer for improving capabilities in indigenous design and development reveals that the recipient's hands are well and truly tied. There is no freedom whatsoever for the recipient to channelise the know-how that has been obtained either for upgrading the product or for the development of other products. The best that can be expected are minor innovations through stretching the design deviation limits. This too, invariably, depends on the consent of the technology supplier.

In the 1960s and 1970s, India, like many other countries, enforced protective measures against unfair restrictive trade practices through appropriate legislation, though these were marred by numerous weaknesses. One such legislation was the Foreign Exchange Regulation Act (FERA) of 1973, which was revised in 1976 to regulate imports of technology. Some of its important provisions, later strengthened by government guidelines, were: the limiting of royalties; phased payment for technical know-how; freedom of Indian party to sub-licence; no restrictions on exports; and freedom to manufacture items patented in India. Unfortunately, the Act also provided a number of exceptions for sophisticated technology, thereby self-defeating its provisions.

Similarly, the Monopolies and Restrictive Trade Practices (MRTP) Act of 1969 specified eight cases that were exempt from its provisions. The Indian Patents and Designs Act also provided numerous exceptions and thus could not check monopolistic trends in the production and sale of patented articles.[57] Today, these legislations stand superseded to newer laws which have reduced the vulnerabilities that existed. The issue, however, has become increasingly complex due to the growing emphasis on IP protection over the past two decades, which negates to some extent the thrust on reducing anti-competitive practices.

Conclusion

The historical perspective indicates India's massive dependence on ToT through the decades. While this dependence has reduced marginally with the recent production of a few indigenous systems, it is unlikely that India will be able to do without ToT in the next decade or two. The

'Make in India' campaign, in fact, has encouraged foreign suppliers to offer India a plethora of ToT proposals and may end up ushering in an increased volume of ToT enabled production. Since many of the benefits of ToT can get negated by the costs and restrictions imposed in contracts, India would do well to deploy specially trained and experienced persons to negotiate arrangements which will benefit India's thrust for self-reliance.

As to the contribution of ToT to national goals, there is no doubt that it enables self-reliance in the production of competitive defence technologies. However, this is not to be construed as a dismissal of the utility of indigenous R&D. On the contrary, efforts at R&D in the field can complement the absorption of technology by reducing the technology gap between the technology supplier and the recipient.

That the constituents of 'technology' in ToT cover a varied mix of technical information, material and human skills is clear, but what has been a significant understanding is the capability that the ToT can (or cannot) confer. This needs to be understood in the DIB environment, and the formal classification of the types into OToT, MToT, PToT, DToT and D&D ToT by a government agency could greatly facilitate this. As regards building design and development capability for technology leadership, it would not be very off the mark to conclude, after the exploration documented in this article, that ToT cannot substitute nor facilitate it. That ToT can indeed help India to leapfrog ahead in indigenous development capability, as has been quoted in some works, is clearly an unviable proposition.

Notwithstanding the above-mentioned limitation, ToT has distinct benefits and can be utilised in the development of India's DIB. How and for which discipline of technology are questions that can be answered only after the nuances of each case are evaluated. These nuances could be: the significance and urgency of the specific defence technology for India's security needs; the life of the technology and stage at which it will be inducted; the time and funds required for an indigenous solution; the cost of ToT amortized over the population desired to be produced; the existing capability of the local firms to absorb the technology; the underlying dependence for proprietary spares and upgrades from the supplier; and the optimal mode of transfer and whether it is suitable to the Indian situation.

A broad assessment, thus, in the backdrop of India's emerging development capabilities in conventional weapons, could be that ToT is extremely desirable for:

1. young technologies;
2. critical and urgent to India's security needs;
3. for which matching indigenous development and production is not feasible within a major portion of its stated life;
4. required in high population for an extended period of time (for scales of economy);
5. supported for proprietary spares and parts from multiple friendly and dependable foreign sources; and
6. finally, at a cost which can be offset by the increased economic growth, employment and possibly, foreign exchange through exports.

The depth of ToT contracted should accordingly be arrived at depending on the magnitude of the above-mentioned factors. As for the offers of 'robust', 'real', 'no-holds barred' ToT, or ToT with 'full control over system design and software', the absence of clearly defined desirables such as know-whys of mature, yet promising technologies or contractual freedom to innovate on them, make these appear to be nothing more than specious proposals. These must be thoroughly evaluated for their merit from every angle.

Notes

1. Nabanita R. Krishnan, 'Critical Defence Technologies and National Security: The DRDO Perspective', *Journal of Defence Studies,* Vol. 3, No. 3, July 2009, p. 92.
2. Robin David, 'The Ministry of Defence is a Bad Organisation with No Accountability', *The Times of India*, 20 December 2015, available at http://timesofindia.indiatimes.com/india/The-ministry-of-defence-is-a-bad-organisation-with-no-accountability-Gen-V-P-Malik/articleshow/50251687.cms, last accessed on 1 October 2016.
3. Mrinal Suman, 'Will Offsets bring Technology to India', 6 March 2015 available at http://mrinalsuman.blogspot.in/2015/03/will-offsets-bring-technology-to-india.html, last accessed on 1 October 2016.
4. S.P. Ravindran, 'Technology Inflows: Issues, Challenges and Methodology', *Journal of Defence Studies*, Vol. 3, No. 1, January 2009, p. 138.
5. Attempts are being made to obtain the data on ToT contracts executed by the Indian Ordnance Factories (OFs) and defence public sector undertakings (DPSUs) through the Right to Information (RTI) Act and other official routes.

6. Ron Matthews, *Defence Production in India*, New Delhi: ABC Publishing House, 1989, pp. 35–37.
7. Laxman Kumar Behera, *Indian Defence Industry—Issues of Self Reliance*, New Delhi: IDSA, 2013.
8. Matthews, *Defence Production in India*, n. 6, p. 39.
9. Ibid., p. 42.
10. Behera, *Indian Defence Industry*, n. 7, p. 40.
11. Matthews, *Defence Production in India*, n. 6, pp. 60–61.
12. Ramadas P. Shenoy, *Defence Research & Development Organisation, 1958–1982,* New Delhi: DRDO, 2006.
13. Behera, *Indian Defence Industry*, n. 7, p. 44.
14. 'DefExpo Attracts 490 Foreign Firms', *The Times of India*, 24 March 2016, available at http://timesofindia.indiatimes.com/india/DefExpo-attracts-490-foreign-firms/articleshow/51534120.cms, last accessed on 1 October 2016.
15. Laxman Kumar Behera, *Defence Offsets: International Best Practices and Lessons for India*, IDSA Monograph Series No. 45, New Delhi, June 2015. The author mentions that Brauer and Dunne, whose edited book of 2004, he claims, is by far the most comprehensive study on the subject, categorically state that 'neither economic theory nor extant empirical evidence suggests that offset arrangements yield net benefits'.
16. Available at https://en.wikipedia.org/wiki/Make_in_India, accessed on 29 July 2016.
17. Ibid.
18. Amit Cowshish, 'Indo-US Defence Cooperation: Harvesting Defence Technologies', 13 October 2015, available at http://www.idsa.in/idsacomments/IndoUSDefenceCooperation_acowshish_131015, last accessed on 1 October 2016.
19. Manu Pubby, 'Germany Offers India Deal for Next Generation Submarines', *The Economic Times*, 6 May 2016, available athttp://economictimes.indiatimes.com/news/defence/germany-offers-india-deal-for-next-generation-submarines/articleshow/52138779.cms, last accessed on 1 October 2016.
20. P.R. Sanjai, 'Saab Offers to Make Gripen in India, with Transfer of Technology', *livemint*, 15 February 2016, available athttp://www.livemint.com/Companies/RPY9NAB0BQNaSrKaCThOAI/Saab-offers-to-make-Gripen-in-India-with-transfer-of-techno.html, last accessed on 1 October 2016.
21. 'IAF Modernisation Plan: Saab Offers Gripen Fighter Jets Under "Make in India" with Full Control', *The Economic Times*, 20 December

2015, available at http://economictimes.indiatimes.com/news/defence/iaf-modernisation-plan-saab-offers-gripen-fighter-jets-under-make-in-india-with-full-control/articleshow/50253759.cms, last accessed on 1 October 2016.

22. K. Subrahmanyam, 'Self-reliant Defence and Indian Industry', 2 October 2016, available at http://www.idsaindia, last accessed on 1 October 2016.

    org/an-oct-00-2.html.
23. Matthews, *Defence Production in India*, n. 6, p. 17, note 10.
24. See http://www.indexmundi.com/facts/indicators/MS.MIL.MPRT.KD/rankings.
25. Subrahmanyam, 'Self-reliant Defence and Indian Industry', n. 22.
26. Standing Committee on Defence 2006–07 (14th Lok Sabha), 'Defence Research and Development Organisation (DRDO)', New Delhi: Lok Sabha Secretariat, 2007, p. 3.
27. K.G. Narayanan, 'Doctrine of Self Reliance in Defence Technologies: Road to Nowhere or Way to Go?', *Journal of Defence Studies*, Vol. 4, No. 3, July 2010, p. 33.
28. Available at http://www.encyclopedia.com/topic/Technology_Transfer.aspx, accessed on 28 July 2016.
29. UNCTAD, *Transfer of Technology,* New York and Geneva: United Nations Publications, 2001, p. 5.
30. Sakti Mukherjee and Indrani Mukherjee, *International Transfer of Technology*, New Delhi: Mittal Publications, 1989, p. 2.
31. The Wassenaar Arrangement, 'Best Practices for implementing Intangible Transfer of Technology Controls', agreed in 2006 plenary, available at http://www.wassenaar.org/wp-content/uploads/2015/06/ITT_Best_Practices_for_public_statement_2006.pdf, last accessed on 1 October 2016.
32. Suman, 'Will Offsets bring Technology to India', n. 3.
33. S. Radhakrishnan Prahlada and Parimal Kumar, 'Leveraging Defence Offset Policy for Technology Acquisition', *Journal of Defence Studies*, Vol. 3, No. 1, January 2009, p. 115.
34. MoD, *Defence Procurement Procedure*, New Delhi: Government of India, 2008, p. 122.
35. Ibid.
36. A recent contract with a DPSU provides for an 'Operate and Maintain' function.
37. See European IPR HelpdeskFact Sheet, 'Commercialising Intellectual Property: Assignment Agreements', available at https://www.iprhelpdesk.

eu/sites/default/files/newsdocuments/Assignment_Agreements_0.pdf, accessed on 28 July 2016.

38. Available at https://en.wikipedia.org/wiki/Know-how.
39. Shenoy, *Defence Research & Development Organisation, 1958–1982,* n. 12, p. 177. Also, see S.A. Wahab, 'and others, Defining the Concepts of Technology and Technology Transfer: A Literature Analysis', *International Business Research*, Vol. 5, No. 1, January 2012, available at https://www.researchgate.net/publication/228450493_Defining_the_Concepts_of_Technology_and_Technology_Transfer_A_Literature_Analysis, accessed on 4 August 2016, who quotes Tihanyi and Roath (2002) as stating that that technology can include information that is not easily reproducible and transferable. Based on this argument, technology is seen as 'tacit knowledge (Polanyi, 1967) or firm-specific, secrets or knowledge known by one organization' (Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. Organization Science, 5, 14–37, http://dx.doi.org/10.1287/orsc.5.1.14). Also, technology as the intangible asset of the firm, is rooted in the firm's routines and is not easy to transfer due to the gradual learning process and higher cost associated with transferring tacit knowledge (Radosevic, S. (1999). International Technology Transfer and Catch-up in Economic Development. Nothampton, MA: Edward Edgar Publishing). Again valuable technological knowledge, which is the intangible asset of the firm, is never easily transferred from one firm to another because the technological learning process is needed to assimilate and internalise the transferred technology (Lin, W.B. (2003). Technology Transfer as Technological Learning: A Source of Competitive Advantage for Firms with limited R & D Resources. R & D Management, 33 (3), 327-341. http://dx.doi.org/10.1111/1467-9310.00301.)
40. See European IPR Helpdesk Fact Sheet, 'Commercialising Intellectual Property', n. 36.
41. See 'Licensing in the R&D Phase', available at https://en.wikipedia.org/wiki/Technology_life_cycle#cite_note-2, last accessed on 1 October 2016. It has been generally noticed that contractual provisions among the members of the consortium allow a member to exercise the option of independent development after joint consultation; in which case, the optee owns all subsequent development.
42. See https://en.wikipedia.org/wiki/Technology_readiness_level for a view of Technology Readiness Levels, last accessed on 1 October 2016.
43. Manufacturing Readiness Level (MRL) is an implemented index in the US DoD. Available at https://en.wikipedia.org/wiki/Manufacturing_Readiness_Level, last accessed on 1 October 2016.

44. Available at https://en.wikipedia.org/wiki/Technology_life_cycle#cite_note-2, last accessed on 1 October 2016.
45. Adapted from Wikipedia, 'Licensing in the Ascent Phase', available at https://en.wikipedia.org/wiki/Technology_life_cycle#cite_note-2, accessed on 28 July 2016.
46. See 'Technology Transfer', *Encyclopedia of Management*, available at http://www.encyclopedia.com/topic/Technology_Transfer.aspx, accessed on 26 July 2016.
47. Matthews, *Defence Production in India*, n. 6, p. 4.
48. Mukherjee and Mukherjee, *International Transfer of Technology*, n. 30, p. 9 and 'Technology Transfer', n. 45.
49. Technology diffusion is explained in UNCTAD, *Transfer of Technology,* n. 29, p. 7.
50. Ibid.
51. Mukherjee and Mukherjee, *International Transfer of Technology*, n. 30, pp. 10–11.
52. Matthews, *Defence Production in India*, n. 6, p. 17.
53. Based on feedback received during interaction in DefExpo 2016.
54. Mukherjee and Mukherjee, *International Transfer of Technology*, n. 30, pp. 38–72 and A.A. Kutty and S. Chakravarty, 'Emerging Challenges in Technology Transfer Licenses', *Journal of Intellectual Property Rights*, Vol. 16, May 2011, pp. 258–66.
55. These restrictions have been noticed in the contract document of a recent ToT project.
56. Ibid.
57. Mukherjee and Mukherjee, *International Transfer of Technology*, n. 30, pp. 76–78.