CENTRE FOR LAND WARFARE STUDIES

ISSUE BRIEF

No. 127 February 2018

Forecasting Technology for the Indian Army

Col **Sandeep Tyagi** is a Senior Fellow at the Centre for Land Warfare Studies, New Delhi.

The future belongs to science, and those who make friends with science

— Pandit Jawahar Lal Nehru

The identification and absorption of technological innovation by the Indian Army (IA) is a *Sine-Qua-Non* for future warfighting across the entire spectrum of conflict. Therefore, there is a need to evolve a mechanism that could capture the technological trends and innovations as they first emerge and wargame their impact on military doctrine and strategy. This mechanism should empower the planners to identify both sustaining and disruptive technologies that have the potential to change the paradigm. This of necessity would involve IA's domain experts, Defence Research & Development Organisation (DRDO) scientists, Defence Public Sector Undertakings (DPSUs), Academic Researchers and Private Defence Industries.

One of the most important challenges to the Perspective Planning Organisation of the IA is that of integrating its Long Term Perspective Plan with that of the Long Term Developmental Plan of the DRDO and vice-versa. This is critical

Key Points

1. Technology forecasting is an absolutely essential exercise which needs to be undertaken while IA prepares its Long Term Perspective Plans.
2. Forecast is required in case of both, evolutionary as well as revolutionary technologies.
3. All stake holders i.e. Indian Army, DRDO, DPSUs, Private Defence Industry and the Academia must integrate synergistically to achieve the desired goals.
4. Both Qualitative and Quantitative techniques are important for technology forecasting
5. Army Design Bureau is ideally suited to play the all important role of a facilitator to the technology forecasting eco-system

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Website: www.claws.in Contact us: landwarfare@gmail.com

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in order to be able to evolve an effective and efficient mechanism for improving the current weapon systems and equipment, identification of future technologies, carrying out formal analyses to assess their impact upon the IA and develop strategies to apply mid course corrections.

Importance of Technology Forecasting

The perspective planning as such includes a detailed appreciation of future threats and challenges, over the next 15–20 years and the resultant strategic environment in which IA would be required to operate both individually as a service and jointly with the sister services including strategic forces. This must therefore lead to a clear understanding as to what role technology (both existing and emerging) would play in shaping this environment. It would also involve those technologies whose application may not be evident in the present time frame; however these may either have an indirect impact or a future relevance for the IA. A combination of the appreciated futuristic strategic environment and the technological impact on the same would enable the IA to evolve the requisite doctrine to cater for the full spectrum of conflict which shall then guide its capability building and acquisition process in the short, medium and long term.

Is Technology Forecasting Feasible

Various subject matter experts are of the opinion that 'technology forecasting time frames' are very important. Forecasts of the next five to 10 years are usually predictable and can be classified as market research, whereas a time frame more than 30 or 40 years may be speculative. Therefore, next 10 to 30-year window may be the one on which focus can be maintained while forecasting technology. This also puts emphasis on the issue of linking current scientific realities to the science fiction of the distant future through a middle ground wherein the innovative scientific concepts can be converted to practical war fighting tools. There are various methodologies for forecasting which will be discussed in this brief.

Evolutionary v/s Revolutionary Technologies

Evolutionary Technology

These technologies are also referred to as sustaining technologies (a term borrowed from the commercial sector). This refers to periodic and incremental improvements made to an existing technology to meet the user requirements. At times it may also be the result of a combination of two or more technologies resulting in an improved weapon system or change in the concept of employment of a weapon system on the battlefield. The short to medium term defence technology forecasting falls in this category. This is due to the tendency of the army to address the current and foreseeable future warfighting requirements with the existing or 'on the horizon' technologies. However, the inherent flaw in this type of forecasting is the fact that it cannot predict the impact of a technology which is 'over the horizon' or which is available but its employment in a different manner by the army has not been envisaged.

Revolutionary Technology

This is also referred to as Disruptive technology a term which was coined by by Clayton M Christensen and Joseph Bower in their article, 'Disruptive Technologies: Catching the Wave' in Harvard Business Review, January-February 1995. Disruptive Technology refers to a new technology which invariably makes the entrenched or sustaining technology obsolete. It is also referred to as innovative technology that triggers sudden and unexpected effects and thus is characteristically hard to predict and occur infrequently, in turn making it difficult to identify or foresee. The disruptive technologies when married with the suitably adapted war fighting concepts, organizations, and allocation of resources are capable of delivering revolution in military affairs and therefore can be referred to as revolutionary technologies. Thus revolutionary technology contrasts sharply with evolutionary technology. While evolutionary technology has an

aspect of continuity associated with it, disruptive technology emerges more or less in unexpected manner. In the military domain the lead as usual for identification of disruptive technologies was taken by the USA wherein, in the year 2009, the Office of the Director, Defence Research and Engineering (DDR&E) and the Defence Intelligence Agency (DIA) tasked the Committee for Forecasting Future Disruptive Technologies (CFFDT), National Research Council (NRC) with providing guidance and insight on how to build a persistent forecasting system to predict, analyze, and reduce the impact of the most dramatically disruptive technologies. The Chinese too are not far behind in this field, however not much information is available of the same in the public domain. The CFFDT analysed various forecasting methodologies, the nature of disruptive technologies and the characteristics of a persistent forecasting system for disruptive technology. The CFFDT, in the year 2010, came out with two reports on the subject. The first report of the series, *Persistent Forecasting of Disruptive Technologies*, discussed how technology forecasts were historically made, assessed various existing forecasting systems, and identified desirable attributes of a next-generation persistent long-term forecasting system for disruptive technologies. This second report described the high-level forecasting system designs. In addition, the second report provides further evaluation of the system attributes defined in the first report, and evidence of the feasibility of creating a system with those attributes. Together, the reports are intended to help identify and develop a forecasting system that will assist in detecting and tracking global technology trends, producing persistent long-term forecasts of disruptive technologies, and characterizing their potential impact on future U.S. war fighting and homeland defence capabilities

The Rapid Reaction Technology Office of the USA also initiated a NeXTech project to identify technology areas with the potential to affect the future strategic environment. NeXTech developed and tested concepts through four war games, which considered definitions, legal, ethical, moral and policy implications of disruptive technology. These war games brought together military professionals, policymakers, scientists, engineers, investors, ethicists and lawyers from a variety of backgrounds to identify and debate the issues that define disruptive technology.

Technology Forecasting Process

As discussed above, in addition to the time of the forecast, three other factors are important for forecasting technology. These are: the technology being forecasted, a statement of the characteristics of the technology, and a statement of the probability associated with the forecast. Therefore, the following process needs to be gone through:

Establishing the Need

To be able to commence the process, IA must identify the criticality of the technologies being sought and their state of maturity as well as the rate of change in the respective technology domains. The complexities of the technologies and the financial effect should dictate the corresponding R&D strategies.

Identifying the Resources

The in-house technical and Subject Matter Experts (SMEs) of the IA, DRDO, DPSUs, Private Defence Industry and the academia needs to be engaged and coordinated based on the need analysed earlier. The coordination may be done by the Army Design Bureau (ADB), wherein some or all of the entities mentioned above may come in play.

Establishing the Process

The establishment of the forecasting process has two primary activities, viz. information gathering and analysis, customised to the IA's needs. These activities are required to be running in parallel and are iterative in nature.

Information Gathering

This activity would involve the following:

- Identification of type and relevance of technological development data.
- Identification of various data sources.
- Establishing the accuracy of the data.
- Trends in sustaining and emerging technologies.
- Setting up information sharing protocols.
- What internal data to collect and external data to acquire.
- Tracking contemporary weapon systems and platforms.

Analysis

This activity would involve the following:

- Creating a pool of experts.
- Identifying appropriate methodologies and techniques for analysis.
- Establishing the criteria for evaluation of the analysis conducted.

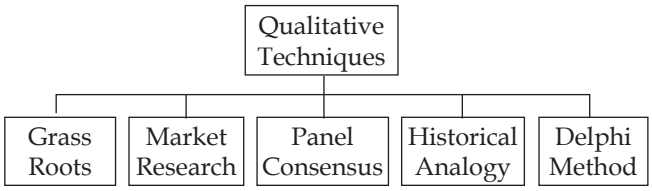
Technology Forecasting Techniques

There are two primary techniques for technology forecasting:

Qualitative Technique

These forecasting methods are based on human judgments, opinions, intuition, emotions, or personal experiences (refer to figure 1.1 below). Therefore, these are subjective in nature. These methods do not involve any rigorous mathematical computations.

Fig 1.1: Qualitative Methods of Forecasting.



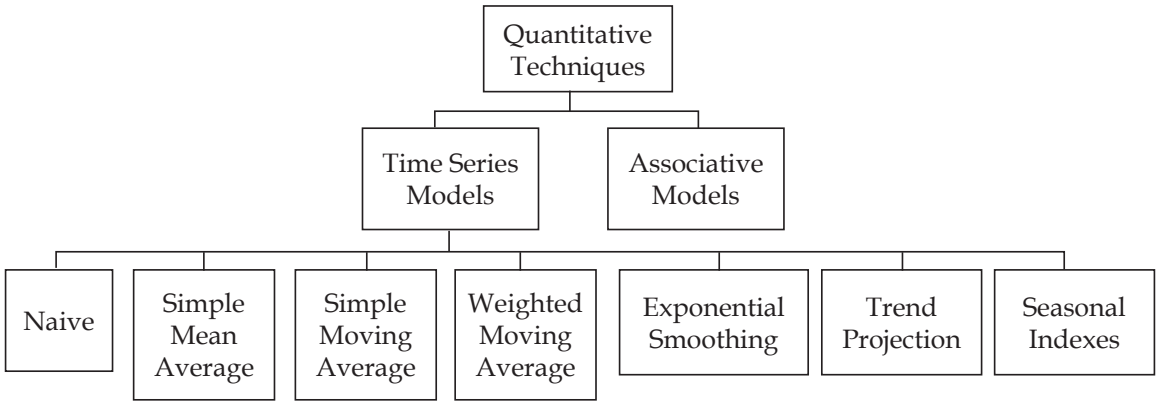
While in the commercial domain all of the above forecasting methods are employed, in case of defence technologies forecasting, Delphi method is preferred the world over. The Delphi method was developed at the beginning of the Cold War to forecast the impact of technology on warfare. The RAND Corporation developed the Delphi Technique in the 1950s–1960s. In this technique, a survey is conducted comprising a group of experts who respond to a series of questionnaires. The experts do not interact with each other. The results of the first questionnaire are compiled, and a second questionnaire based on the results of the first is presented to the experts, who are asked to re-evaluate their responses to the first questionnaire. This questioning, compilation and re-questioning continue until the researchers have a narrow range of opinions. A country which has the longest experience of employing this technique for Science & Technology (S&T) forecasting is Japan. This process has been incorporated into the Japanese S&T surveys since 1971. Europe also took up this technique in the early 1990s starting with Germany and followed by France and the UK coming up their respective national technology forecasts. IA should adopt this technique with ADB playing the role of the facilitator and a No. of panels of experts may be constituted to tackle different technological domains. This activity may be conducted on regular basis by the ADB and the frequency could be every five years as well as on 'as required' basis. These panels would comprise of IA's experts, scientists from the DRDO, DPSU Personnel, Academia and the private Defence Industry as discussed earlier. While Delphi technique has some accuracy issues primarily due to its inability to make complex forecasts with multiple factors, it remains the most widely accepted tool for S&T forecasting.

Quantitative Technique

These forecasting methods (refer to figure 1.2 below) are based on quantifiable data employing mathematical models. Therefore, these are objective in nature. These methods are almost entirely based on mathematical computations.

Conducting a quantitative technology forecast includes identifying technology of interest,

Fig 1.2: Quantitative Methods of Forecasting.



collecting historic data related to adoption of identified technology as well as modifications made to that technology. Identifying favourable spin offs of the technology change and comparing the rate of technology change over time against established patterns of technology change and diffusion also forms part of this process. Once a recognisable pattern is established, an acceptable projection

Fig 1.3: Suggested Model for the IA.

of technology transformation can be made and appropriate action taken to cater for or achieve specific technology function or weapon system/ platform. These techniques are very much part of the repertoire of IA officers who have undergone courses at College of Defence Management, especially the Higher Defence Management Course (HDMC). ADB must exert itself to collect all relevant data for the identified technological domains and then exploit the in house expertise in conjunction with the DRDO and the Academia to come up with quantitative forecasts in these technology domains.

A Suggested Model

Refer to Fig 1.3 above. While ADB led forecasting activity is highly recommended for the IA, the question that naturally arises is how to bring this forecast into fruition? The aim should be to not let this exercise degenerate into a wish list or a shopping list for various weapon systems and equipment. More often than not weapon systems and equipment desired by the IA are not realised 'on ground'. The primary reason is that of disconnect between the perspective plans of the IA and that of the DRDO (the agency responsible for all defence R&D). This gets further aggravated by the near absence of private defence industry participation due to lack of/difficulty in, obtaining government funding and high infrastructural cost implications for the industry. Therefore, be it a case of developing a technology from the basic scientific areas, from the enabling technology state or even in case of a mature technology in an existing weapon system the above mentioned (Fig 1.3) closed loop model is suggested.

Conclusion

Given the lead times necessary for technological development, need for mission oriented and focused R&D for the Indian Army has never been greater. Today technology is advancing so quickly that the structures and institutions available to manage technology have not kept pace. The technology forecasting endeavour on part of the IA would allow it put in place the necessary infrastructure to identify and exploit fleeting technological opportunities. IA would also need to balance R&D efforts and investment for these efforts between the uncertain disruptive technologies based force multipliers that have war winning potential and those sustaining technologies that provide marginal advancement in capability, but with significantly less investment and lesser risk. IA's approach should be 'systematic' and the usual political and bureaucratic pitfalls must be avoided. To derive maximum benefit from the exercise, forecasting must remain a continuous process. The continuity itself and the fact that a larger data base would then be available 'in time' will pave the way for improved and more accurate forecasts. Also, IA could compare the previous forecasts with what has been realised 'on ground' to fine tune the process and make necessary corrections. The goal should be an overarching R&D strategy that spans multiple stakeholders and is capable of delivering financially viable and technologically superior weapon systems in an acceptable time frame.

CENTRE FOR LAND WARFARE STUDIES (CLAWS)
RPSO Complex, Parade Road, Delhi Cantt, New Delhi 110010
Tel.: +91-11-25691308, Fax: +91-11-25692347, Email: landwarfare@gmail.com
Website: www.claws.in
CLAWS Army No. 33098