Commentaries

Nature and Scope of Disruptive Technologies in Contemporary Conflict

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Constituents of Disruptive Technology

'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. In the twentieth century this term was used only in the commercial context and in the military domain the closest concept was of referring to such technologies as technological innovations. Whilst a disruptive technology in commercial context improves a product or service in an unexpected or unanticipated manner, the disruptive technologies in the military domain provide a decisive advantage to the owner and would result in a swift and total victory. Thus, to prevent technological surprise, every nation strives to identify, develop/acquire and induct disruptive technologies ahead of its adversaries, failure in which could lead to a catastrophic defeat.

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NB: The views expressed in this article are those of the author in his personal capacity and do not carry any personal endorsement.

The term 'Disruptive Technology' was created by Clayton M. Christensen and Joseph Bower in their article, 'Disruptive Technologies: Catching the Wave' in *Harvard Business Review*, January-February 1995. It describes how new technologies or innovations made well-entrenched technologies, innovations and business methods obsolete in only a few year.[1] Such unique technologies can make entire industry segments obsolete in a very short timeframe. Historical military examples of disruptive technologies include the English longbow, the Japanese long lance torpedo, the American atomic bomb, stealth technologies, the Global Positioning System (GPS) and the Unmanned Systems. Commercial examples include the telephone, computers, and the mobile phones.

Major Samuel T. Mitchell II, US Army, in his Master's thesis argues that prior to 1995, the term 'military innovation' was probably the closest in defining areas of disruptive technology.[2] In *Innovation and the Modern Military: Winning the Next War*, Rosen studies innovation from the early 1900s to the mid 1950s. He divides innovations into three areas, namely, peace-time, war-time, and technological.[3] Within peace-time innovation, he highlights that defeat in war is neither required nor sufficient to produce innovation. He states that innovation is rarely driven from internal military leadership and is usually derived from civilian intervention within the military structure during peace-time. He identified a difference between militaries of World War I and World War II and the last quarter of the twentieth century; in that leadership frequently led their troops in battle and there was a large turnover in leadership due to casualties on the battlefield. Thus, military innovation within war-time is generally conducted by military leadership with great risk. This risk becomes more pronounced if the new military chain of command was not present at previous failures to learn from those failures and thus apply those lessons. The difference apparent between the militaries of the World War II and today is that there is more military innovation undertaken by military leaders to maintain the technological edge over adversaries.

History of Military Disruptive Technologies

Military Disruptive Technologies usually manifest in the core areas of

firepower, mobility, protection, command, control, communications, computers, information, intelligence, surveillance and reconnaissance (C4I2SR) and logistics. It can result from an unexpected improvement in the sustaining technologies in one of these areas (case in point is the atomic bomb) or, perhaps, from synergistic interactions between two or more of these areas.

The disruptive technologies when merged with the suitably adapted war-fighting concepts, organisations, and allocation of resources become capable of delivering revolution in military affairs. The historical record provides evidence of more than a dozen cases of revolutionary change in the conduct of war. The modern period in general, and the past two centuries in particular, has witnessed the greatest rate of change. Since the early fifteenth century, the conduct of war has been radically altered ten times. Seven of these transformations have occurred within the past 200 years, making the nineteenth and twentieth centuries, in effect, an Age of Military Revolutions.[4]

Vickers describes the revolutionary changes in warfare to include the advent of chariot warfare in the seventeenth century BC; the eruption of massed infantry in the early twelfth century BC; the development of the New Model Macedonian Army in the fourth century BC; the artillery revolution in AD fifteenth century; the guns and sails, and gunpowder-infantry revolutions during the early AD sixteenth century; the Napoleonic revolution during the late AD eighteenth and early nineteenth century; the railroad, rifle and telegraph revolution during the mid AD nineteenth century; the battleship-battle cruiser-submarine revolution during the early twentieth century; the revolutions in armoured warfare and air superiority and naval air power during the interwar years; and the atomic and thermonuclear/ballistic missile revolutions during the 1940s and 1950s.[5] All these revolutions had the benefit of a new technology proving to be disruptive in nature.

The ingredients of a disruptive technology are the technology itself, a concept of operations and an area of application. Blitzkrieg is a clear example of this concept; synergised application of Luftwaffe, Panzers and communication equipment into manoeuvre warfare annihilated the

largely defensive technologies of Germany's opponents (most famously, France's Maginot Line). The integration among these elements disrupted the balance of military power in Europe.

Identification of Disruptive Technologies

As discussed earlier, technological innovations are key causal agents of surprise and disruption and, therefore, these needs to be identified as such. In the military domain the lead as usual for identification of disruptive technologies was taken by the US 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 into how to build a persistent forecasting system to predict, analyse, 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 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 characterising their potential impact on future US war fighting and homeland defence capabilities.

The Rapid Reaction Technology Office of the US 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. The five technology areas with the potential to become disruptive that were identified are as follows:

1. *Additive Manufacturing:* This technology has huge potential to be disruptive and may work both ways. It could well be a huge boost to the non-state actors who can get this technology off the shelf and print themselves a variety of weapons. It has major implications for sustained operations in outer space too.
2. *Autonomous Systems:* These are likely to improve in an exponential manner with maturing of tag, track, and locate capabilities. Killer robots are also likely to appear on the scene in the near future.
3. *Directed Energy:* Although efforts of weaponisation of High Power Microwaves, Electro Magnetic Pulses and LASER have been on for the past 50 years and yet the huge potential of these becoming disruptive cannot be played down. The aspects of limitless munitions and stealth have too much of draw for war fighters of all hue.
4. *Cyber Capabilities:* Globally over 3.5 billion people are online today! This by itself lends any new cyber warfare capability to have disruptive attributes. The Internet of Things is a case in point.
5. *Human Performance Modification:* This refers to employment of methods to enhance or degrade human performance. Remarkable improvements in biology and genetics are opening unchartered territories in this field and what used to referred to as science fiction is now well within the realm of possibility.

In the commercial domain the Mckinsey Global Institute came out with analyses in May 2013 wherein, they identified the technologies having the greatest potential to drive substantial economic impact and disruption by 2025.[6] The report highlighted that the important technologies can emerge

from any scientific discipline/field, but they share four characteristics: high rate of technology change, broad potential scope of impact, large economic value that could be affected, and substantial potential for disruptive economic impact. Many technologies have the potential to meet these criteria eventually, but leaders need to focus on technologies with potential impact that is near enough at hand to be meaningfully anticipated and prepared for.[7] Therefore, the report focused on technologies that were believed to have significant potential to drive economic impact and disruption by 2025. The 12 technologies thus identified were as follows:

1. *Mobile Internet:* Increasingly inexpensive and capable mobile computing devices and internet connectivity.
2. *Automation of Knowledge:* Work intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgements. Advances in artificial intelligence, machine learning, and natural user interfaces (voice recognition) are making it possible to automate many knowledge worker tasks that have long been regarded as impossible or impractical for machines to perform. For instance, some computers can answer 'unstructured' questions (i.e. those posed in ordinary language, rather than precisely written as software queries).
3. *The Internet of Things:* Networks of low-cost sensors and actuators for data collection, monitoring, decision-making, and process optimisation.
4. *Cloud Technology:* Use of computer hardware and software resources delivered over a network or the internet, often as a service.
5. *Advanced Robotics:* Increasingly capable robots with enhanced senses, dexterity, and intelligence used to automate tasks or augment humans.
6. *Autonomous and Near-Autonomous Vehicles:* That can navigate and operate with reduced or no human intervention.
7. *Next-Generation Genomics:* Fast, low-cost gene sequencing, advanced big data analytics, and synthetic biology ('writing' DNA).
8. *Energy Storage Devices:* Systems that store energy for later use, including batteries.

9. *3D Printing:* Additive manufacturing techniques to create objects by printing layers of material based on digital models.
10. *Advanced Materials:* Materials designed to have superior characteristics (e.g. strength, weight, conductivity) or functionality.
11. *Advanced Oil and Gas Exploration and Recovery:* Exploration and recovery techniques that make extraction of unconventional oil and gas economical.
12. *Renewable Energy:* Generation of electricity from renewable sources with reduced harmful climate impact.

Scope in Contemporary Conflict

The weaponisation of technologies would most likely spur the commanders and military professionals to think and employ these at the operational and tactical level of warfare. However, the disruptive potential of these technologies requires an understanding of how they might fundamentally affect the strategic nature of warfare. Some of the important aspects are as under:

1. *Organisation and Human Resource:* Disruptive technologies in the fields of cyber/information warfare, autonomous systems, and developments in human performance modifications, discussed earlier, have implications for military organisations, their doctrines, and the human resource central to these organisations. The aspects of distance, perception, and ethics play a major role while employing disruptive war-fighting technologies.
2. *Equipping:* The availability of disruptive technologies may permit a nation to have much leaner and meaner armed forces and yet prevail upon the potential adversaries. This would also have an impact on the economics wherein the initial and long-term issues of budgeting would come in play.
3. *Posturing:* Based on the type of technology available the belligerents can adopt a posture accordingly. The concept of Anti-Access/Area Denial (A3D) is but a manifestation of the same. Conversely, this concept could be defeated by employing disruptive technologies such as the Directed Energy Weapons discussed earlier.

4. *Decision-Making:* The possession of disruptive technologies may change the escalatory matrix in a potential conflict. The response of the party in possession of these technologies may respond in a different domain to a provocation in a different domain. The 'Stuxnet' attack on the Iranian nuclear facilities is an illustrative example.
5. *Command and Control:* As the newer and increasingly lethal disruptive technologies proliferate, the pressure on the commanders would multiply to evaluate the situation in real time and act/react to it. This would make the argument of having autonomous systems in control, without humans in the loop, stronger! However, is that acceptable?

Conclusion

The defensive realists as well the revolution in military affairs scholars concur that disruptive technologies have a definite impact on comprehensive national power which further impacts the foreign policy choices. Also, military professionals and defence analysts are increasingly factoring in the role that would be played by these technologies in the current and future conflicts. However, identification, development/acquisition, and induction/application of these technologies together with relevant changes in organisation and concept of operations remain a challenge that must be overcome before achieving the cherished goal of total victory on the battlefield.

Notes

1. Joseph L. Bower and Clayton M. Christensen, 'Disruptive Technologies: Catching the Wave', *Harvard Business Review*, January-February 1995.
2. Major Samuel T Mitchell II, 'Identifying Disruptive Technologies Facing the United States in the Next 20 Years', Master's thesis, U.S. Army Command and General Staff College, 2009.
3. Stephen Peter Rosen, *Innovation and the Modern Military: Winning the Next War*, Ithaca, NY: Cornell University Press, 1991.
4. Michael Vickers and Robert Martinage, 'The Revolution in War', Center for Strategic and Budgetary Assessments, December 2004.
5. Ibid.
6. James Manyika, et al., *Disruptive Technologies: Advances That will Transform Life, Business, and the Global Economy*, McKinsey Global Institute, May 2013.
7. Ibid.