



# Changing characteristics of warfare and the future of Military R&D



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## ABSTRACT

Wars have been a part of humanity since prehistoric times, and are expected to remain an important component of future human societies. Since the beginning of the history wars have evolved in parallel with the changes in Society, Technology, Economy, Environment, Politics and Values (STEEPV). The changing circumstances unavoidably affect the characteristics of warfare through its motivations, shape and size. Armies have adapted themselves to these changing characteristics of warfare through Revolutions in Military Affairs (RMAs) by introducing new military concepts and technologies. Based on the overview of the evolution of military technologies and concepts as a response to changing conditions, the aim of the present study is to anticipate what and how future technologies and concepts will shape warfare and drive impending RMAs. To answer this question, first the RMA literature is reviewed within a broader historical context to understand the extent to which military concepts and technologies affected the RMAs. Then, a time-based technological trend analysis is conducted through the analysis of military patents to understand the impact of technological developments on military concepts. Following the historical analyses, two scenarios are developed for the future of military R&D based on 'concept-driven' and 'technology-driven' factors. The article is concluded with a discussion about the implications of future scenarios for military R&D, and likely RMAs through the changes of concepts and technologies, and possible consequences such as transformations in organizational structures of armies, new skill and capacity requirements, military education systems, and decision-making processes.

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## 1. Introduction

Wars have been a part of human life since prehistoric times and they are expected to play an important role in the future. The shape, characteristics, and size of wars have changed drastically over time due to transformations in Societies, Technologies, Economy, Environment, Politics and Values/Cultures (STEEPV). The military's response to changing characteristics of warfare has been through 'technology-driven' and 'concept-driven' approaches. There have been times when new technologies enabled armies to develop new war concepts; and times when new concepts required the development of new technologies. In both cases, armies have aimed to adapt themselves to changing characteristic of warfare through military Research and Development (R&D), which is called "Revolution in Military Affairs" (RMA) (Krepinevich, 1992).

Historical transformations show that from the battle of Greek phalanxes to nano-soldiers' network-centric warfare, there have been enormous shifts in the perception of threats and security. The key challenge for armies has been to remain resilient under changing circumstances of warfare due to transformations in STEEPV systems by adapting

themselves constantly through RMA. The key research questions of the present study are:

1. Why and how have military technologies and concepts driven RMA as a response to changing conditions?
2. What are the emerging technologies and concepts, which may change the nature of warfare?
3. How can the future military R&D agenda be configured to respond to changing conditions?

To answer these questions, the second section of the paper begins with a review of the RMA literature within a broader historical perspective. First the RMA concept is introduced, and then key drivers for RMA are discussed. Building upon this background, Section 3 describes the research methodology with the use of a combination of literature review, patent-based technology trend analysis and scenario techniques to investigate the emerging military technologies and concepts. A research model is presented to illustrate how the key research question is addressed.

Section 4 of the paper starts the analysis with a review of the generations of warfare. The aim is to understand the changing characteristics of warfare over a long period of time and how armies historically responded these changes. Thus, it aims to highlight the relationships between military concepts and RMAs, which in turn have implications for

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military R&D and affected the development of military technologies. Section 5 takes a closer look at the developments in military technologies as a driver for RMAs and discusses the implications of technologies on military R&D. This is done through a patent-based technological trend monitoring across time. While the review will indicate the 'concept-driven military R&D', the technological trend analysis will indicate the 'technology-driven military R&D'.

Following the discussions on the implications of conceptual and technological developments on RMAs and military R&D, Section 6 of the paper takes a prospective look at the longer term future by formulating two scenarios shaped by the 'concept-driven' and 'technology-driven' factors. The scenarios consider the changing military concepts and anticipated technological developments within a broader STEEPV context, and discuss how these may change the nature of warfare. Then, the paper is rounded off in Section 7 with a discussion about the implications of the future scenarios for military R&D, and possible consequences such as transformations in organizational structures of armies, new skill and capacity requirements, education systems, and decision-making processes, which may characterize future RMAs.

## 2. Background

*"War is a murder, unless the use of the most recent peaceful means."*  
[October 4th 1922/Mustafa Kemal Atatürk (Founder of Turkish Republic)]

As in the words of Atatürk, the population-centric perspective should be the more prominent motivator for war studies. Conflicts and wars have been in human life in all ages with various motivations such as seizing land, killing an enemy, or changing regimes, and they will continue in the future with similar or somewhat varying motivations. The changing motivations, shapes and sizes of wars required the introduction of new military concepts and technologies and forced armies to reform themselves through RMAs.

The RMA phenomenon can be traced in the literature beginning in Napoleonic times. Particularly starting from the 19th century, more systematic efforts have been made to adapt armies to changing characteristics of warfare through technological innovations in defense industries and organizational innovations in military concepts. Blasko (2011) described the relationship between defense technology and military concept as a "chicken-egg problem" (p. 355). Hence, there is no clear-cut distinction between the two; however, one usually drives the other interchangeably. Machine gun, airplane, submarine, and the Dreadnought class of ships were among the technologies, which altered the military concepts in the mid-19th and the early 20th centuries. There were significant changes in war concepts due to technological developments.

During WWI and WWII from 1917 to 1939, the exploitation of internal combustion engines, improved aircraft design, and radio and radar technologies made the blitzkrieg, carrier aviation, and strategic aerial bombardment possible. The difference between WWI and WWII itself is an important example of technological developments and the eventual change in military concepts. Whereas WWI indicated the characteristics of a more conventional war, WWII witnessed the synchronization of air, land, and sea forces. A number of technology-driven innovations can be found in WWII. For instance, the use of railroads, telegraph, warships/battleships, rifles and artillery transformed the concepts of the military fundamentally. Military forces were organized, equipped and employed to achieve maximum military effectiveness by using new technologies. Finally, the amplitude of nuclear violence with the use of nuclear weapons helped to demonstrate the decisive role of technology in warfare.

After a couple of decades, during the Vietnam War, the US confronted a new style of warfare called "guerrilla warfare" or "asymmetric warfare". The need for tracing and the rapid deployment of forces was the major driver that shaped the US army's strategy. This changing war concept

led to the use of helicopters at the battlefields in an offensive way for the first time, which can be considered an example of when the recognition of operational necessities shaped the use of technology in different or maybe more innovative ways. This search of innovative ways leads the nations to revolutionize their armies with the help of technology which was called Revolution in Military Affairs later.

RMA that can be said is explicitly rooted in Russia's Military Technological Revolution concept during the 1980s, when the Soviet hegemony in the world was mainly based on its superior military technology rather than economic strength. According to Chiang (1990), in the uniformed military in the post-Stalinist era, the General Staff has been in the center of weapon systems development, integration, procurement, and deployment, in addition to its normal military forces' planning and development. Therefore, it can be assumed that Soviet military system institutionalized the technological military system for several decades. This centralized structure could explain their shorter cycle in utilizing novel technologies and deploying new systems and also it could explain the logic of technological revolution in military affairs, because they embedded the technological developments into the military institutions. Likewise the Russian RMAs, the US has transformed its army around the same times due to the changing war concepts. They changed their understanding of warfare with a technological viewpoint and competitive superiority and their most prominent application was during the First Gulf War. According to Krepinevich (1992)'s report, the Gulf War victory clearly revealed the importance of the RMA concept.

Nearer to the present time, the likelihood of future world wars or other large scale mass destructive potential wars has decreased considerably. However, it has also been observed that the development of military technologies has continued at a growing rate. In parallel, the destruction potential of weapon systems has increased considerably. A technologically-equipped soldier today is more powerful than a battalion from Napoleonic times. Besides the technological developments, there have been considerable changes in the public perception of wars. The visibility of wars has increased dramatically compared to the Napoleonic times. Today, war scenes from all over the world are captured an ordinary mobile phone cameras and then shared with the rest of the world through the Internet. Thus, the society is getting more and more exposed to wars and loss of human lives, and is increasingly more sensitive towards war and less tolerant of fatalities.

The presence of a powerful military with an increasing visibility and social engagement are expected to be among the factors, which will transform the logic of military discourse. For instance, Kaldor (2010) proposes a shift in military discourse from border protection towards population security. The practical application of this and further ideas to transform armies requires changes in military concepts and technologies. Before discussing how those concepts and technologies may look in the future, the paper will begin with the review of the historical analysis of change in military concepts and an analysis of longitudinal data of military patents to identify technological trends. The review and technology trend analysis will provide input for the discussion on the future character of warfare.

## 3. Methodology

The aim of this study is to discuss how the characteristics of warfare are changing over time due to a number of transformations in STEEPV systems, and how the military adapts itself to this change through concept-driven and technology-driven responses, which may shape military R&D and thus introduce new RMAs. The proposed research model is illustrated in Fig. 1.

With regards to the proposed research model, the research methodology involves a combination of literature review, bibliometric analysis, patent analysis and scenario techniques.

The current paper reviews the RMA literature with a broader historical perspective to understand the changing characteristics of warfare. A closer look is taken at the evolution of military concepts and

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