Academic Paper

The Future of Military Technological Development and its Impact on International Stability

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Introduction

Historical studies indicate that since his existence, man has sought to protect himself using various tools. However, tracing the development of these defensive or offensive tools reveals a relationship between three aspects: the tool, the distance and the goals.

In the beginning, the tool of conflict and fighting was the hands; thus, the distance between the combatants was the length of the arms. When the sharpened stone and the sword were discovered, the distance widened, it became the length of the arm added to the ability to throw the stone for a longer distance or the length of the sword. The number of those threatened was related to being within these distances, and the number increased when spears and arrows were discovered, as the distance widened and range of these new weapons increased. Matters developed with the gun, cannon and plane, until every place in the world became threatened, due to intercontinental missiles in addition to nuclear, chemical and bacterial weapons. Man began to consider building new bases in outer space.[2]

The historical development in military technology indicates that the mega trend is the discovery of war tools reaching farther places, and increasing the number of those threatened, which raises the central question: Where is this historical mega trend going, at least for the next decade?

Remarkably, technology accessibility due to the spread of universities and military laboratories, and the ability to convert a civilian product into a military product, made the ability to control this trend more complicated. Given that total global military spending was $2.113 trillion as of the end of 2021 compared to $798 billion in 2000, this means an annual increase is estimated at $65.8 billion since 2000.[3]

Scientific Fields Most Likely to Impact Military Technology Development

A study issued by the US Congress and another by the European Union estimated that the fields of technology that will be the focus of military technology development in the future are:[4]

1. Artificial Intelligence: "Slaughterbots," also called "lethal autonomous weapon systems" or killer robots, are weapons that use Artificial Intelligence (AI) to identify, select, and kill human targets without human intervention. Alhough these weapons seem futuristic in some countries, reports of their use are on the rise. While the Future of Life Institute considers slaughterbots an immoral weapon and a major threat to global security,[5] the trend towards owning them is increasing.

Some researchers believe that these lethal autonomous weapons (LAWs) are a type of independent military technical systems that are able to independently search for targets and engage with them based on their software, which may work in all conditions, whether in the air, on land, on water, underwater or in space. Since 2018, these systems have been operating under one constraint, which is the attack command determined by man (the military command), meaning that the human role is limited to giving the final command to attack, although there are exceptions with some "defensive" systems operating autonomously without human intervention.

2. Hypersonic weapons:[6] These weapons are primarily advantageous for their speed, reaching between 5 and 25 times the speed of sound (Mach), or about 1 to 5 miles per second (1.6 to 8 km/s). According to military institutes and defense laboratories, there are several types of hypersonic weapons that are being developed successively:

   a. Hypersonic boost-glide vehicles: These are missiles which maneuver and glide through the atmosphere at high speeds after an initial ballistic launch phase.

   b. Hypersonic cruise missiles or Hypersonic "airbreathing" weapons use supersonic combustion ramjet ("scramjet") engines that combust fuel within a stream of supersonic air passing through the vehicles. In these engines, the speed of airflow

naturally compresses the air for combustion. Therefore, the engines do not need the motorized fan blades that traditional jet engines use for pre-combustion compression. They need some form of accelerator such as an initial rocket or—more likely for weapons—a launch vehicle that can release it at the edge of hypersonic travel. "Airbreathing" hypersonic vehicles are expected to reach speeds of Mach 15 (about 10 thousand miles per hour), to date they have only achieved test speeds of Mach 9.6. Ground tests of jet combustion devices have demonstrated this potential.

- c. Airbreathing hypersonic aircraft that use scramjet engines to reach high speeds.
- d. Guns launched missiles: These weapons resemble enhanced artillery, where they could use an electromagnetic pulse to propel projectiles up a launching rail.
- e. Ballistic missiles traveling at high speeds during their return to the atmosphere.

3. Directed energy weapons: A directed energy weapon (DEW) is a long-range weapon that destroys its target with highly focused energy without a solid projectile, including lasers, microwaves, particle beams and sonic beams. Potential applications of this technology include weapons targeting personnel, missiles and vehicles and optical devices to disable them.[7]

4. Biotechnology: Biological and toxin weapons are either microorganisms like virus, bacteria or fungi, or toxic substances produced by living organisms that are produced and released deliberately to cause disease and death in humans, animals or plants. They are more advanced than conventional biological weapons in terms of spread, speed and effects.[8]

5. Quantum technology: Quantum technology does not fundamentally involve new weapons or standalone military systems, but greatly enhances measurement capability, sensing, precision, computation power and efficiency of current and future military technology.[9]

➡ All of the above indicates that military technology is developing at an accelerated pace, and that the logistic curve[10] is gradually decreasing, which leads to a number of results:

- a. The difficulty of being able to adapt to this rapid pace, both in terms of field experience and material cost, which keeps the gap between developed and underdeveloped countries and prone to widening.

b. The competition between arms production companies is dragging the world towards the possibility of realizing the Frankenstein model by not controlling these different technologies, which may cause an imbalance in all human existence.

Military Technology Orientation Standards

Given the well-established interdependence among the units of the military-industrial compound (political elites, ministries of defense, arms production companies and relevant think tanks) in the great powers of the international system, the criteria that define the orientation of military technology are as follows:

1. The scientific theories that have been proven true in technology laboratories, thus producing what is required by military leaders and strategic planners.
2. Financial capabilities to attain technological achievement.
3. The type of armaments the opposite side has.
4. Taking into account the nature of the geostrategic areas that are most likely to be areas of future wars (topography, climate, population density, etc.).[11]
5. Determining the opposing side in the war. Most conventional wars were direct result of the Westphalia's Peace of 1648, but the number of parties involved in international conflicts has changed to include state and non-state actors. For example, in the drug cartel fights in Mexico in 2019, more than 34 thousand people were killed with no of army or security forces intervention, and in the conflict between two ethnic groups, the Hutus and Tutsis in Rwanda, about a million people were killed in 1994.[12] Or in fighting among groups that emerged in Syria or Iraq during the Arab Spring, not to mention the private security companies that became parties to many wars, including Ukraine.

Central Trends in Military Technology over the Next Decade

Military laboratories work to provide weapons that meet the following conditions as much as possible:

a. Destructive power.

b. Speed in reaching the target.

c. Accuracy in hitting the specified target.

d. They should be of a type that can control the repercussions of their use (their impact does not reach unintended areas or unintended civilian areas, etc.).

Drones have constituted a turning point in weapon technology, as they are less expensive, and they are unmanned. Also, cyber security operations constituted another shift in the difficulty of controlling cyberattacks and even the difficulty of identifying the attacking party, in addition to making it possible to disable ships, reactors, power plants, surveillance cameras, banks, companies, and the archive of documents, and even to monitor individuals.

In addition to the above, there is difficulty in identifying the adversary or enemy that caused damage, due to the huge complexity and overlap in the network of international relations. For example, when the value of a currency, such as the dollar, declines, countries with financial reserves in dollar or linked to the dollar lose great deal of the value of their assets, but the problem is in determining who is responsible for this decline. The responsible may be determined sometimes, but cannot be determined definitively at times. This is applicable when determining the exact parties responsible for pollution, or when discussing the impact of nuclear tests on earthquakes that may destroy entire regions, like the major earthquakes in Syria and Turkey in 2023. As most of these circumstances are related to civil and military technology, we even have not been able to determine the party responsible for the COVID-19 pandemic, to punish it even theoretically, and we do not know the truth about the mission of the Chinese balloon spotted in the US airspace in February 2023.[13]

Despite the importance of the technical aspect, contemporary wars indicate that technology is not always the decisive factor. Otherwise, how do we explain the humiliating defeat of the US in Afghanistan, or the colonial defeats in different regions of the world? Supporters of this idea believe that "war management" is an important part in the technical dimension, that is, how and when the available technology is employed is very important. Comparing the technology possessed by the Saudi forces with that of their opponents in Yemen indicates a large technical difference in

favor of the former; yet, it is still unable to tip the balance in its favor. Consequently, the employment of technology and related experience is as important as its quality.

Studies in this field indicate that military research is moving in the following directions:[14]

- **1. Increased spending on robotics:** Perhaps the most obvious is that robots can assume risks that could potentially lead to human casualties, and have capabilities that humans don't. For example, the ability to stay awake 24/7, the ability to see from all angles, the ability to process information in an instant and bear environmental conditions an ordinary person cannot tolerate, such as submerging in the deep sea or the likes.

- **2. Major advances in hypersonic systems:** Hypersonic describes any object moving at a speed that's five or more times the speed of sound. Basic hypersonic technology has been around for decades, but advanced hypersonic military systems are now being tested and launched. The most remarkable advantage of this new technology is that these hypersonic missiles can fly at low altitudes and maneuver in the air, making them nearly impossible to track. Russia, China and the US are racing to build their own hypersonic weapon systems, focusing both on attack missile systems and defense against foreign attacks systems.

- **3. The growing threat of cyber-warfare:** In today's world, cyber security is a matter of national security. Military personnel classifies cyber warfare in a category called the "gray zone," which is the space between peaceful and routine operations, on one hand, and conventional warfare, on the other hand. Engaging in cyber warfare is not typical warfare, as there is room for deniability, which hinders defense officials in preventing attacks and making quick decisions once the attack is launched. However, cyberattacks, in recent years, have become increasingly war-like, threatening citizens and causing major disruptions, while hackers and cyber terrorists, acting in official capacities for other countries or on their own, have demonstrated the ability to take down critical infrastructures such as nuclear reactors, electric grids, communication systems, factories and financial institutions.

Some scientists expect that by 2025, "cyber attackers will have weaponized operational technology in an effort to harm or kill humans."

- **4. Additive manufacturing, also known as "3D printing,"** offers new opportunities for military applications, as the US Department of Defense issued its first strategy for

additive manufacturing in January 2021. This strategy calls for the army to use 3D printing in order to modernize systems, increase readiness and enhance innovation. The US Army is using 3D printing to manufacture new forms of munitions that have higher velocity and longer range, and it also has plans to use 3D printing to create a military truck exterior in one giant piece.

5. The emergence of DEWs: DEWs use technology that produces a beam of concentrated electromagnetic energy or atomic or subatomic particles, meaning that it converts electrical or chemical energy into concentrated radiated energy, unlike other weapons, that is, without projectiles. Examples include high-energy lasers, high-power microwave devices and particle-beam weapons. The development of these types of weapons initially gained strength in the early 2000s, although they are cumbersome and heavy. However, directed energy weapons have become increasingly smaller and lighter.

These weapons are of great value to the army, as they are silent, and in most cases invisible, and can be used to engage multiple targets simultaneously and fire in an almost completely flat trajectory.

6. Renewed focus on electronic warfare and communications jammers: The US military has been using communications jammers as part of electronic warfare since 2004, but many programs are still shrouded in secrecy. However, from 2020 to 2023, some interesting trends have begun to emerge. One main military communication jammer was first deployed in 2004, which is the Counter Communications System (CCS) was developed for use in electronic warfare. This system operates through space and is able to reversibly block enemy satellite communications. Some studies indicate that the current technology in this system can effectively prevent communications on C, Ku and X-band frequencies. It can also block Ka-band transmissions, i.e. the technology is moving toward disrupting enemy communications by penetrating satellite frequency bands.[15] Various military branches are investing in communications jamming technology. In January 2022, the US Navy contracted with Raytheon Technologies to build five advanced electronic jamming devices carried on

board EA-18G Growler EW aircraft. These devices have the ability to disrupt enemy radars, computer systems and communications.

The Impact of Military Technology Development on the Future of the International System

Barry Buzan's studies on the relationship between the development of military technology and international relations in general constituted the starting point in this respect, especially from the aspects of deterrence, arms race, international polarity and international relations ranging between cooperation and conflict.[16] Yet, the rapid development since Buzan's study re-raised the issue with greater complications. Scientists interested in studying new weapon systems and their impact on the international system tend to embrace several approaches:[17]

1. The behavioral approach: This approach means studying the impact of new weapons technologies on the general public, military and elites. This approach explores "the willingness to use a particular technology on the battlefield in a given scenario, for example, or interest in adopting it for potential usage."

2. Studying new weapons systems and the extent to which current international relations theories can be used, and applying them to limited existing evidence to assess how particular weapons systems are likely to shape international politics. This means that emerging technologies in the military field may affect many of the postulates of the prevailing theories in planning the current reality or the future.

3. Applying game theoretic models to derive predictions about how new weapons will shape politics and then do limited case studies based on available evidence. The central question in this aspect is whether emerging military technology will increase or reduce the odds of war. To answer this question, we will put forward a set of hypotheses, the most important of which are:

   a. The emerging military technology seems more inclined towards patterns that reduce human losses, which makes the tendency for the war decision more seductive for the decision-maker, as long as this technology reduces the social burden on the decision-maker and the society's sense of this burden. The use of

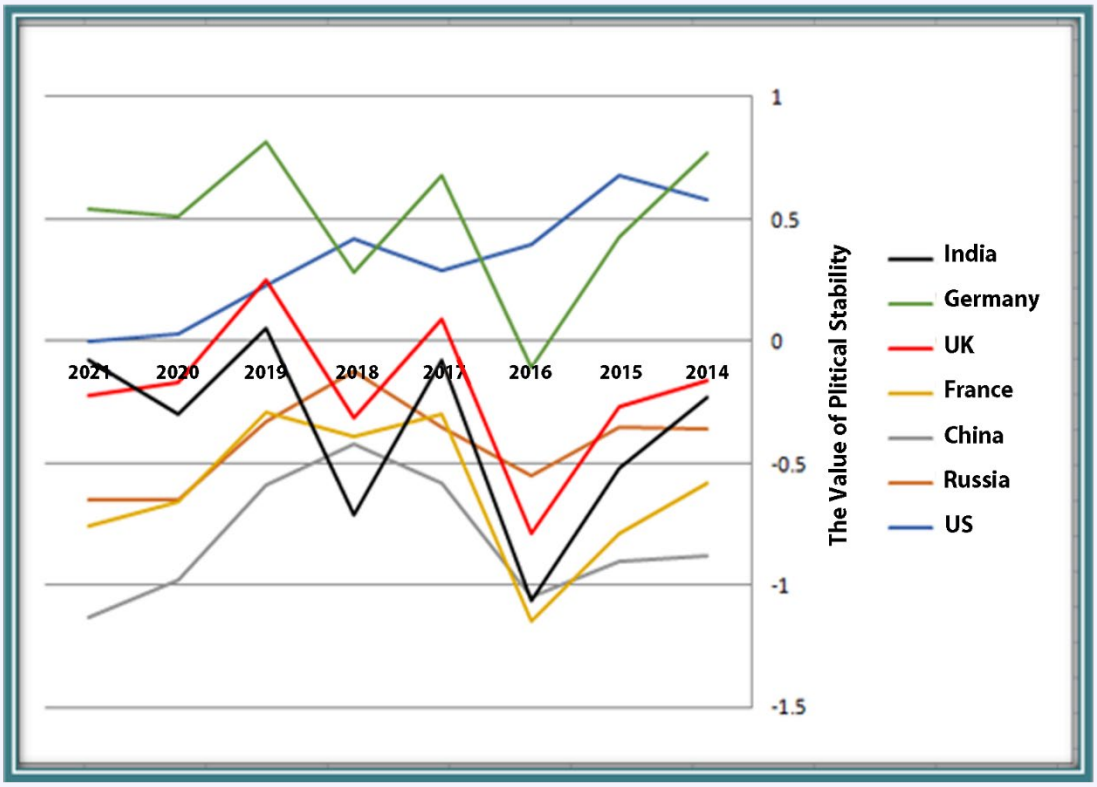
military robots and drones makes human losses much less than wars that depend entirely on the human element.

b. The increasing trend in military technology towards space (satellites, etc.) makes the burdens of wars not greatly affect societies, their locations and infrastructure, which makes ground engagement less and wars for control on land less attractive.

c. The spread of technology and the possibility of transferring expertise from one place to another will open the way for political entities "nonstate actors," such as political or criminal organizations, to employ emerging military technology more widely, especially in the field of cyber warfare, automated military machine wars, cybercrime and espionage. This increases the levels of instability in most countries of the world.

Although specialized estimates believe that development in the field of biological, chemical and nuclear weapons will continue, radiological weapons will remain until 2030 the least accelerated in their development. This means that the international community is moving towards more instability, due to the increasing players, on the one hand, and the acceleration of technology development, on the other hand.[18]

The Value of Political Stability for Major Powers[19]



The Relationship Between the Future of International Political Stability and Military Spending

The R&D sector in the military sphere represents an important aspect of military spending. Studying global military spending indicates that between 2012 and the end of 2021, it increased by 12%, where in 2021, it reached $2.113 trillion compared to $1.859 trillion in 2012. It is noticed that spending in major countries has increased, except for the US, as shown in the following table:

Change in Military Spending and Defence Budget on R&D as a % of Government Budget Allocations for R&D (GBARD) of Major Countries[20]

Country	% Change of Military Spending 2012–2021	Defence Budget on R&D as % of GBARD 2019 [21]
US	-6.1	46
China	+72	20
India	+33	6
Germany	+24	4
France	+13	6
Russia	+11	11.5
UK	+3.7	14

Available data indicate, for example, that military R&D spending increased between 2012 and 2021 by 24% in the US and by 20% in Europe, which means that the development of military technology is clearly increasing.[22]

Conclusion

The above data indicates a number of aspects that have an impact on the future of international stability:

1. The rate of military spending is increasing annually in most countries.
2. Military R&D spending is increasing in most of the major industrialized countries.
3. The increased military spending helps the economic growth in the central industrial countries through production and sales and the absorption of a percentage of unemployment. Suffice it to point out that the share price of major US arms production companies rose between 40% (such as Northrop Grumman) and 37% (Lockheed Martin) during the first ten months of the Ukraine war.[23]

4. The tension in the relations between the central countries in the international system increases military spending and military R&D.

5. Quantitative data indicate that there is a correlation coefficient between political instability and the growth of military industries, hence economic growth would increase. Thus, enhancing the credibility of Nikolai Kondratieff's Long Wave Cycle theory,[24] which links "major" wars to high economic growth to which military spending will contribute. It is necessary to distinguish between this positive correlation in developed industrial countries and the negative one in developing and poor countries. Military spending increases economic hardship in developing countries and thus increases political instability, which is a favorable environment for military industries in industrialized countries, who would supply them with more arms.[25]

6. Military technological development would continue and hence tensions and confrontations at different levels. This means that international instability during 2023–2030 will increase, especially in the midst of the growing conviction among researchers that globally we are heading towards multi-polarity.

7. The possibilities of "non-state" actors possessing weapons of mass destruction are increasing due to the spread of knowledge, which will increase the chances of unrest and extortion strategies against various international powers.

8. The "ambiguous" security attacks from unknown sources will increase, making the decision-making process more complex and increasing errors in estimations.

Endnotes

[1] An expert in futures studies, a former professor in the Department of Political Science at Yarmouk University in Jordan and a holder of Ph.D. in Political Science from Cairo University. He is also a former member of the Board of Trustees of Al-Zaytoonah University of Jordan, Irbid National University, the National Center for Human Rights, the Board of Grievances and the Supreme Council of Media. He has authored 37 books, most of which are focused on future studies in both theoretical and practical terms, and published 120 research papers in peer-reviewed academic journals.

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