EMERGING TECHNOLOGIES AND NATO'S EXPANSION

How can NATO's expansion maximize the benefits of emerging technologies to allied states and to further strengthen transatlantic security? This article reviews the need for deep strategic understanding. It examines theoretical and practical factors affecting emerging technologies and their diffusion inside NATO and in the context of current and future adversaries. Moreover, it highlights specific environments and areas in which new NATO states' experience and domain expertise are likely to contribute to the alliance and explores the role of emerging technologies in defense strategy. Specific recommendations regarding Arctic operations, emerging technologies, and Track II diplomatic efforts are proposed.

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When NATO conducted its first major strategic review, over a decade ago, it was observed that:

Less predictable is the possibility that research breakthroughs will transform the technological battlefield. Allies and partners should be alert for potentially disruptive developments in such dynamic areas as information and communications technology, cognitive and biological sciences, robotics, and nanotechnology [emphasis added] …. The most destructive periods of history tend to be those when the means of aggression have gained the upper hand in the art of waging war.[1]

While the suggestion that such emerging technologies will enable a new class of weapons that will alter the geopolitical landscape remains to be realized, several unresolved security puzzles underlying the emergence of these new technology areas have implications for international security, defense policy, foreign policy, and cooperation among allies. The extent to which these and other newer emerging technologies may exacerbate or mitigate the global security and governance challenges that NATO currently faces and is likely to encounter in the future needs to be further examined.

That short passage from the first strategic concept review conceptually highlights the uncertainty, complexity, and interdependence issues in trying to understand the interactions between emerging technologies and international security. To put it diplomatically, predicting how these innovations and breakthroughs in scientific understanding may be used is a challenge. Looking to history is one valuable past insight. However, one must be careful not to be purely technologically deterministic. That is not to assume that because something is possible, or something potentially may come about, that it is inevitable. History shows us that human ingenuity and use are more often a function of political decisions, regional security threats, and other factors of social, political, historical, economic, and cultural origin.

Previously I co-authored "Emerging Technologies and National Security: Russia, NATO, & the European Theater"[2] with former NATO SACEUR General (ret) Phillip Breedlove for the Hoover Institute's Governance in an Emerging New World project. This paper leverages that work and extends it considering the needs

1) NATO, "Active Engagement, Modern Defence: Strategic Concept for the Defence and Security of the Members of the North Atlantic Treaty Organization," adopted by the Heads of State and Government at the NATO Summit in Lisbon, 19-20 November 2010. http://www.nato.int/strategic-concept/index.html

2) Phillip Breedlove and Margaret E. Kosal, "Emerging Technologies and National Security: Russia, NATO, & the European Theater," Governance in an Emerging New World, Hoover Institute, Stanford University, 25 February 2019. https://www.hoover.org/research/emerging-technologies-and-national-security-russia-nato-european-theater

of NATO expansion.

Finland and Sweden have both been close partner states of NATO as participants in the "Partnership for Peace" program since 1994. Both have trained and exercised with NATO. And both Finland and Sweden contributed military forces to NATO operations and missions in Afghanistan, Bosnia and Herzegovina, Iraq, and Kosovo. The military technology of these two states is largely compatible with NATO militaries. They possess advanced capabilities that have already benefited NATO allies. For example, Sweden is recognized as "one of the [U.S. Department of Defense Foreign Comparative Testing] FCT program's best sources of innovative technologies"[3] Both states are viewed as being substantial contributors to helping "NATO maintain military technology advantage,"[4] especially but not only in the context of Russia's illegal invasion of Ukraine.

"The impact of NATO expansion for technology generally and emerging technologies more specifically, is likely to be significant in two ways. First, in terms of expertise in environments of increasing importance in the context of climate change and great power competition... Second, the expansion of NATO is significant in the context of commitment to NATO's shared values and willingness to act to maintain those shared values, which should contribute to stability in the Baltic region, across Europe, and beyond."

The impact of NATO expansion for technology generally and emerging technologies more specifically, is likely to be significant in two ways. First, in terms of expertise in environments of increasing importance in the context of climate change and great power competition. Finland and Sweden bring expertise in the Arctic and sub-Arctic climates as well as the undersea environments. In testimony to the Senate Foreign Relations Committee in June 2022, U.S. Assistant Secretary of Defense for International Security Affairs, Celeste Wallander noted that "Sweden's 'military expertise in the Arctic and undersea environments would substantially advance alliance capabilities'."[5] Finland's expertise in operations in cold weather

3) Brandi Vincent, "Pentagon exploring new Swedish military technology amid talks of NATO expansion," FedScoop, 9 May 2022, https://fedscoop.com/pentagon-exploring-new-swedish-military-technology-amid-talks-of-nato-expansion/

4) Meredith Roaten, "Pentagon Seeks Out Swedish Tech Partnerships," Defense News, 26 May 2022. https://www.nationaldefensemagazine.org/articles/2022/5/26/pentagon-seeks-out-swedish-tech-partnerships

5) Jim Garamone, "DOD Official Touts Sweden, Finland Joining NATO," DOD News, 22 June 2022.

environments is well-recognized, if not legendary.[6]

Second, the expansion of NATO is significant in the context of commitment to NATO's shared values and willingness to act to maintain those shared values, which should contribute to stability in the Baltic region, across Europe, and beyond. How that may affect emerging technologies may be less direct but is no less critical.

Technology and War – the Scholarly Context

Consideration of challenges to international security and policy-making as a result of scientific and technological advancements is not novel. Anticipating and responding to potential emerging threats to security and understanding disruptive technologies are intrinsic to the security dilemma. Consideration of the relationship between technology and conflict has a substantial and deep history across the social sciences as a determinant of global power.[7] Within security studies, there is rich literature theorizing and empirically exploring the intersection of science, and technology, and understanding the outcomes of armed conflict.[8] In the later 20th century, one predominant political science and international relations model for understanding the conditions under which conflict and cooperation are likely and how technology can contribute to increasing instability in the international system or decrease it was the Offense-Defense model.[9] An advantage of defensive technology over offensive technology lowers the cost/benefit equation of the attacker and, in the words of Clausewitz, "tame(s) the elementary impetuosity of War."[10] Offensive ascendency, conversely, creates a sense of urgency for states to develop more outstanding offensive capabilities and seek out alliances, further increasing tensions. Emerging technologies, like nanotechnologically-enabled meta-materials, biotechnology, artificial intelligence, and neurotechnology, may

https://www.defense.gov/News/News-Stories/Article/Article/3071022/dod-official-touts-sweden-finland-joining-nato/

6) Bair Irincheev, *War of the White Death: Finland Against the Soviet Union, 1939-40* (Mechanicsburg PA: Stackpole Books, 2012).

7) Turner, Ralph. "Technology and Geopolitics," *Military Affairs*, Vol. 7, No. 1 (1943): p. 5-15.

8) Bernard Brodie and Fawn Brodie, *From Crossbow to H-Bomb* (Bloomington: Indiana University Press, 1973); Trevor Dupuy, *The Evolution of Weapons and Warfare* (New York: Bobbs-Merrill, 1980); Steven P. Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca: Cornell University Press, 1991); EB Skolinikoff, *The Elusive Transformation: Science, Technology, and the Evolution of International Politics* (Princeton: Princeton University Press, 1993); Etel Solingen, *Scientists and the State: Domestic Structures and the International Context* (Ann Arbor: University of Michigan Press, 1994); John Arquilla, *Networks and Netwars: The Future of Terror, Crime, and Militancy,* (Santa Monica: RAND Corporation, 2002); Michael E. O'Hanlon, *The Science of War* (Princeton: Princeton University Press, 2009); Warren Chin, "Technology, War and the State: Past, Present and Future," *International Affairs*, Vol. 95, No 4 (July 2019): p. 765-783; Martin van Creveld, *Technology and War: From 2000 B.C. to the Present* (New York: Free Press, 1989); Emily O. Goldman and Leslie C. Eliason, eds, *The Diffusion of Military Technology and Ideas* (Stanford, CA: Stanford University Press, 2003).

9) Robert Jervis, "Cooperation Under the Security Dilemma," *World Politics*, Vol. 30, No. 2 (1978): p. 167-214.

10) Carl von Clausewitz, *On War*, translated by J.J. Graham, 1874, https://www.gutenberg.org/files/1946/1946-h/1946-h.htm

problematize Offense-Defense theory via challenges to distinguishing between offensive and defensive weapons.[11] This work doesn't seek to resolve that issue but notes that emerging technologies may entangle it further. Another major area of scholarly work has considered how emerging technologies may challenge existing laws, including the law of armed conflict, international environmental law, and arms control treaties, and need to govern the introduction, implementation, and use of emerging technologies as a means or method of warfare.[12]

Since WWII, the NATO alliance has seen the nexus between technology and military affairs as not just speculation but a reality that bears directly on the propensity for conflict and outcomes of war, as well as the efficacy of security cooperation and coercive statecraft. It is a critical variable in international security: military outcomes and technological advances are intricately tied.

Technology and NATO Security Environment

In order to understand the changing paradigms for national security in the 21st century and begin to probe its implications for NATO expansion, it is crucial to have an awareness of the factors driving new and emerging capabilities, possesses the ability to analyze the changing nature of technological progress and assess potential impacts on the nature of conflict, and understand the relationships among cutting-edge science, advanced technology, other trends, and international security.

For the U.S. and its allies, dominance in conventional and sophisticated military operations has been enabled by a technological advantage in precision, speed, stealth, tactical intelligence, surveillance, and reconnaissance compared to adversaries.[13] Equally innovative and more revolutionary capabilities will be required in order to ensure dominance and security in the 21st century—when adversaries span from rising and revisionist peer competitor nation-states to disperse insurgencies and lone-wolf non-state actors. Globalization of technology has leveled the playing field internationally to some extent, and NATO faces more complex security challenges than at any time in its past. Additionally, adversaries are increasing their ability to adopt and adapt technology more rapidly than defense

11) Margaret E. Kosal and J. Wes Stayton, "Meta-materials: Threat to the Global Status Quo?" in *Disruptive and Game Changing Technologies in Modern Warfare: Development, Use, and Proliferation*, ed. M.E. Kosal (New York: Springer Academic Publishers, 2019): p. 135-154.

12) Kobi Leins, *New War Technologies and International Law: The Legal Limits to Weaponising Nanomaterials* (Cambridge: Cambridge University Press, 2021); Hitoshi Nasu and Robert McLaughlin (eds), *New Technologies and the Law of Armed Conflict* (Holland TMC Asser, 2014).

13) Defense Science Board, 2006 Summer Study on 21St Century Technology Vectors, February 2007. http://www.acq.osd.mil/dsb/reports/2006-02-Summer_Study_Strategic_Tech_Vectors_Vol_I_Web.pdf & http://www.acq.osd.mil/dsb/reports/2006-02-Summer_Study_Strategic_Tech_Vectors_Vol_II_Web.pdf

establishments can respond. The changing global environment requires NATO and its member states to carefully evaluate new developments in politics and technology, to shape programs in response, and to be willing to take risks.

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What are the roles and significance of emerging technologies, and how should the NATO community respond to the promise and perils of emerging technologies? How will these nascent scientific and technological developments impact local, regional, and international security, stability, and cooperation? What are the most likely sources of technological surprise with the most significant threat capacity and how can the national security community better identify them sooner? Emerging technologies present regional security challenges and may exacerbate (or mitigate) the future geopolitical, military, energy, and economic challenges to a state or region and the potential impacts on state interests and international security. A deep strategic and practical understanding of the significance of emerging technology and its diffusion, as well as extending thinking concerning how science, technology, and inter- and intra-national social relations interact to shape and facilitate the management of the changing global security landscape, is a pressing need for the 21st century.

The author readily acknowledges that there are additional factors beyond technology that will dominate and drive a changing, new strategic environment. These include, but are not limited to, demographics – smaller populations in some states, youth bulges, and increasingly aging populations in other states. Outside of Russia, much of the discussion revolves around megacities and dense urban conflict, which is about people and environments not just structures.

The balance across the acquisitions "iron triangle" of survivability, mobility, and lethality (or firepower) will very soon reach the end of 'era' of physical mass providing protection, even for ground troops. With a near-peer competitor and other operating scenarios, it is likely to be those capabilities that shift the approach to

survivability from protection via mass (which is limiting) to capabilities for active defense and capabilities such as metamaterials that can make objects invisible or ideas like the use of "swarms" by adversaries.[14] Regarding lethality, directed energy weapons are needed; we have to get away from relying solely on traditional explosives and heavy projectiles. New ways to generate, store, and convert power are needed, including at the individual level, such as through harvesting otherwise wasted energy of footsteps striking the ground or other movements.[15] Information and communications technologies (aka cyber-everything) are emerged – not emerging technologies. When the individual is directly connected to the internet or other enhancements are possible, what does that mean for the laws of war? People are likely to learn more quickly by computers hooked into the mind. Do we want to go to that? We may be forced to go to that. The use of augmented reality and man-machine interface portends questions of how such cutting-edge capabilities will affect the balance of power and conflict.[16] The author doesn't claim to project how an adversary will fight – no one's crystal ball has that level of fidelity. However, looking to such emerging technologies offers scenarios to capabilities in which mass is relied upon to protect so it doesn't limit mobility.

Disruptive Technologies & Defense Strategy

Disruptive technology is distinctive because it upsets the established way of doing things. It causes shifts that change the world. Novel technologies are one of the principal means of surprising adversaries or competitors and disrupting established ways of doing things. It is, however, essential to recognize that not all innovative, novel, new or emerging technologies or innovative use of technology are disruptive. Some new technologies and capabilities stay in the laboratory, many start-ups fail when taking the technology to market, and plenty of new and innovative technologies or use of technology never disseminate.

14) Margaret E. Kosal and J. Wes Stayton, "Meta-materials: Threat to the Global Status Quo?" in *Disruptive and Game Changing Technologies in Modern Warfare: Development, Use, and Proliferation*, ed. M.E. Kosal (New York: Springer Academic Publishers, 2019), 135-154.

15) Yong Qin, Xudong Wang & Zhong Lin Wang, "Microfibre–nanowire hybrid structure for energy scavenging," *Nature*, Vol. 451 (2008): p. 809-813, https://www.nature.com/articles/nature06601; Carlos García Núñez, Libu Manjakkal & Ravinder Dahiya, "Energy autonomous electronic skin," npj *Flexible Electronics*, Vol. 3, No. 1 (2019): p. 1-24, https://www.nature.com/articles/s41528-018-0045-x; Minbaek Lee, Chih-Yen Chen, Sihong Wang, Seung Nam Cha, Yong Jun Park, Jong Min Kim, Li-Jen Chou, Zhong Lin Wang, "A Hybrid Piezoelectric Structure for Wearable Nanogenerators," *Advanced Materials*, Vol. 24 (2012).

16) Margaret E. Kosal and Joy Putney, "Neurotechnology and International Security: Predicting Commercial and Military Adoption of Brain-Computer Interface (BCI) in the US and China," *Politics and the Life Sciences*, Vol. 42, No. 1 (Spring 2023): p. 81-103, https://doi:10.1017/pls.2022.2

To be disruptive, technologies do need not be radical or novel from an engineering or technical perspective.[17] In fact, another class of disruptive technology is important to acknowledge: innovative use or misuse of existing technology. Using a combination of existing technologies in novel ways can also result in a disruptive capability.

In defense policy, an offset strategy is a central concept applied to national security involving technological capabilities, specifically targeting disruptive technologies. Offset strategies have used technological innovation to counter the strength of adversaries and deter them. Three offset strategies since WWII are commonly cited. The first offset strategy used a nuclear based deterrence strategy to offset Soviet land forces, proximity to Europe, and conventional superiority in Europe. In order to counter and deter the Soviet adversary, the U.S. and NATO relied on massive retaliation and use of nuclear weapons. The first offset strategy was a success. The second offset began in the 1970s. As the Soviets developed their nuclear arsenal and delivery systems, a new strategy was needed to counter and deter the Warsaw Pact's numerically superior conventional forces and address Soviet advances in strategic nuclear capabilities in the late stages of the Cold War. The second offset strategy invested in developing stealth aircraft, precision-guided munitions, and space-based reconnaissance and navigation capabilities. Second offset capabilities and conventional military superiority were demonstrated during the First Gulf War. The disruptive technology of the second offset has proliferated widely and adversaries (specifically, near-peers) have narrowed the technology gap.

In the case of some states, such as Russia, not only does one need to consider advances in high technology for traditional military applications but also consider innovations and uses below the level of declared war, i.e., what is referred to as hybrid warfare, the grey zone, non-linear war, or war below the line (of the Gerasimov "doctrine"). These terms have been taken to mean the use of subversion, information warfare, and covert activities literally to prepare the battlefield before intervention, or what George Kennan called political war: "the employment of all the means at a nation's command, short of war, to achieve its national objectives,"[18] seeking to undermine influence abroad and in Europe specifically and to weaken the post-WWII rules-based international order. Leveraging all aspects of national power, political warfare spans military, diplomatic, information, and economic arenas and includes both covert and overt activities.

17) National Research Council. *Persistent Forecasting of Disruptive Technology*, Committee on Forecasting Future Disruptive Technologies (Washington DC: The National Academies Press, 2010).

18) A. Ross Johnson, "George F. Kennan on Organizing Political Warfare," History and Public Policy Program Digital Archive, 30 April 1948. https://digitalarchive.wilsoncenter.org/document/114320

Additionally, while the calculus for use in a traditional state-on-state military conflict may not have changed substantially,[19] Russia and its allies are using unconventional weapons, namely chemical agents, in non-traditional ways. Chemical weapons, which once seemed to be nearing status as an artifact of history in the first decade of the 21st century have re-emerged as weapons for targeted assassinations by states like Russia and the DPRK, and these prohibited weapons have been used against insurgents and civilians as part of Syria's civil wars. The long-standing chemical weapons taboo has been shattered, repeatedly.

Concluding Remarks

Emerging technologies present regional security challenges and may exacerbate (or mitigate) the future geopolitical, military, energy, and economic challenges to a state or region and the potential impacts on NATO's interests and security. A deep strategic and practical understanding of the significance of emerging technology and its diffusion as well as extending thinking concerning how science, technology, and inter- and intra-national social relations interact to shape and facilitate management of the changing global security landscape is a pressing need for the 21st century.

In order to transform the current paradigm of incremental and evolutionary improvements of defense acquisition programs and systems, recognition of the need to leap ahead and embrace truly far-sighted concepts as well as foster integrated, multi-disciplinary, and cross-cutting basic research approaches is warranted – such as recent dramatic advances within and at the nexus of nanoscience, materials science, catalysis, supramolecular science, bioinformatics, cellular materials, genomics, proteomics, metabolomics, information sciences, and the cognitive sciences. It's much more important that just funding. It is program management, oversight, and implementation that is risk tolerant. And at a foundational level, it's all about people.

One approach that would benefit NATO is further reinvigorating science diplomacy. The instruments of broader science diplomacy include means like MOUs and other official government-to-government interactions: the classic tools of traditional Track I diplomacy. Science diplomacy has perhaps made the most significant impact in foreign policy as a part of Track II diplomatic efforts: informal diplomacy between individuals who are not officially empowered to act on behalf of the state but are working in accordance with a state's foreign policy goals interact through dialogue, exchanges, cooperative programs, or other means as part of increasing cooperation and transparency or decreasing conflict among states. Track II efforts with nuclear

19) Geoffrey Chapman, Hassan Elbahtimy & Susan B. Martin "The Future of Chemical Weapons: Implications from the Syrian Civil War," *Security Studies*, Vol. 27, No 4 (2018): p. 704-733.

physicists and other scientists during the Cold War are legendary, in the best ways.[20]

In many ways, nuclear diplomacy of the Cold War may be argued as the pinnacle of Track II science diplomacy. Overall, Track II science diplomacy has been an under-utilized tool since then, which may be ironic considering that since the early 1990s, the world has become increasingly technologically dependent and technology has enabled the spread, at an unprecedented rate, of scientific knowledge, capabilities, and materials globally.

In the context of NATO's expansion and emerging threats creating Track II efforts that coordinate with the Arctic Security Forces Roundtable (ASFR) military-to-military efforts, often at the flag-and-general-officer level, is one potential route. Programs like the University of Alaska Fairbanks' Center for Arctic Security and Resilience (CSAR) and the U.S. Naval Postgraduate School's Consortium for Robotics and Unmanned Systems Education and Research (CRUSER) collaborative community of interest represent models that might be emulated with a technological focus or Arctic focus. Such programs might also partner with universities or other organizations from NATO states to focus on bringing together emerging technology to address security needs in the Arctic and Arctic/sub-Arctic undersea environments.

As NATO expands and looks to the future – whether dominated by extremist groups co-opting advanced weapons in the world of globalized non-state actors or states engaged in persistent regional conflicts in areas of strategic interest – new adversaries and new science and technology will emerge. Choices made today that affect science and technology will impact how ably the NATO alliance can and will respond. The changing strategic environment in which security operations are planned and conducted impacts science and technology policy choices made today and affects how science and technology may play a beneficial or harmful role in the future. Some game-changing technologies have received global attention, while others may be less well known; these new technologies and discoveries may significantly alter military capabilities and may generate new threats against military and civilian sectors.

20) Ola Dahlman, Frode Ringdal, Jenifer Mackby, and Svein Mykkeltveit, "The inside story of the Group of Scientific Experts and its key role in developing the CTBT verification regime," *Nonproliferation Review*, Vol. 27, No 1-3 (2020): p. 181-200; John Lewis Gaddis, Philip H. Gordon, Ernest R. May, and Jonathan Rosenberg, eds., *Cold War Statesmen Confront the Bomb: Nuclear Diplomacy since 1945* (Oxford University Press, 1999); Siegfried S. Hecker, ed., *Doomed to Cooperate: How American and Russian Scientists Joined Forces to Avert Some of the Greatest Post-Cold War Nuclear Dangers* (Los Alamos: Bathtub Row Press, 2016).