Correspondence

New Era or New Error? Technology and the Future of Deterrence

Ryan Snyder and Benoît Pelopidas
Keir A. Lieber and Daryl G. Press

To the Editors (Ryan Snyder and Benoît Pelopidas write):

In their recent article, Keir Lieber and Daryl Press argue that enhanced counterforce capabilities are increasingly threatening the survivability of nuclear forces.[1] They do not, however, provide a technically valid basis to support this judgment regarding the United States' strategic submarine (SSBN) force. This omission raises doubts about the emergence of any new counterforce era against the U.S. arsenal.

Lieber and Press base their claim partly on sources that reveal how U.S. antisubmarine warfare (ASW) efforts against Soviet SSBNs during the Cold War benefited from advances in acoustic-gathering and data-processing capabilities (pp. 35–36). They then assume that further advancements within these domains should be expected to aid ASW efforts once again. Not only does this assumption predetermine Lieber and Press's findings, but it ignores fundamental limits that physics places on technology and suggests that an updated review of U.S. SSBN vulnerability is long overdue in the public domain.

Any such review should consider the key parameter that would drive the planning and execution of an ASW strategy to trail and destroy the entire SSBN force using passive acoustics over a considered period: the maximum range at which a U.S. SSBN may be detected. Neither Lieber and Press nor the most comprehensive source they cite attempts this review,[2] but this is the starting point for any serious engagement with the covert trailing threat.

Although precise information about the acoustic signal emitted by a U.S. SSBN that determines this parameter is not available in unclassified sources, a reasonable estimate of 90–110 decibels was made for the Ohio-class SSBN in the 1980s,[3] with physical con-

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Keir A. Lieber is director of the Security Studies Program and associate professor in the Edmund A. Walsh School of Foreign Service and the Department of Government at Georgetown University. Daryl G. Press is associate professor in the Department of Government at Dartmouth College.

1. Keir A. Lieber and Daryl G. Press, "The New Era of Counterforce: Technological Change and the Future of Nuclear Deterrence," *International Security*, Vol. 41, No. 4 (Spring 2017), pp. 9–49, doi.org/10.1162/ISEC_a_00273. Further references to this article appear parenthetically in the text.
2. Bryan Clark, *The Emerging Era in Undersea Warfare* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2015).
3. Tom Stefanick, *Strategic Antisubmarine Warfare and Naval Strategy* (Lexington, Mass.: Lexington Books, 1987), pp. 274–275, fig. A6-5.

International Security, Vol. 43, No. 3 (Winter 2018/19), pp. 190–193, https://doi.org/10.1162/ISEC_c_00338

straints permitting a maximum detection range of 1–2 kilometers in deep ocean channels if a low-frequency SSBN signal is 100 decibels.[4] Even with detection ranges almost certain to be shorter today, further improvements may not offer much gain in military effectiveness; after all, an SSBN signal must be present some practical distance away for acoustic detection to remain meaningful. In any case, with a quieter electric-drive propulsion system and slightly wider hull diameter, the Columbia-class replacement for the current Ohio-class SSBN will shorten this range further.[5]

Regarding processing capabilities, Lieber and Press assume that advancements here could help trailers sift through vast quantities of data to more effectively uncover a submarine signal. But this conflict would depend on already possessing the data to be processed, not on collecting it while an SSBN is changing locations. And there is less time for a trailer to respond to its changing location as the detection range shortens. Today, a U.S. SSBN could travel far beyond its maximum detection range in the time needed to collect enough data for processer speed to provide any benefit.

Maintaining a covert trail also depends on the interaction of the SSBN signal with an array of hydrophone sensors used for detecting sound waves, where the aid provided by foreseeable sensor improvements—either enhanced acoustic sensitivities or higher resolutions of narrow band acoustic tonals—would be of little consequence. Because a single hydrophone cannot adequately separate an SSBN signal from noise, multiple hydrophones are required not only to detect an SSBN but also to determine its directionality to maintain a trail—and launch a weapon in its direction to destroy it. A greater chance of success here depends on the signal of the trailed SSBN maintaining correlation over longer arrays of more hydrophones.[6] Because this can be practically maintained for only a few seconds or less,[7] this again limits whatever advantages unlimited data processing can provide. Any acoustic sensor improvements will then be dominated by the characteristics of the SSBN signal in the ocean environment, the most effective geometry and size of an array that may be practically deployed, and once again, the maximum distance at which an SSBN may be detected.

As for the other technological advancements that Lieber and Press identify (p. 37), their fundamental constraints matter. For example, an SSBN would be aware of any attempt to place it under active trail, with an active signal detected by an SSBN before and from greater distances than a trailer received its reflection. Regardless of the circumstances, however, an SSBN that hears an active signal could eject timed explosive charges at any time to destroy a trailing fleet. Lieber and Press also left unexplored questions about the fundamental limits of autonomous drones—which relate to the covert trailing threat—and nonacoustic means of detection.

Without this assessment, Lieber and Press demonstrate only that enhanced counterforce capabilities have developed against U.S. intercontinental ballistic missiles

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4. See Eugene Miasnikov, "Can Russian Strategic Submarines Survive at Sea? The Fundamental Limits of Passive Acoustics," *Science & Global Security*, Vol. 4, No. 2 (1994), p. 232, doi.org/10.1080/08929889408426401.
5. Ronald O'Rourke, "Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress," report no. R41129 (Washington, D.C.: Congressional Research Service, August 7, 2018), p. 8, https://fas.org/sgp/crs/weapons/R41129.pdf.
6. Stefanick, *Strategic Antisubmarine Warfare and Naval Strategy*, pp. 247–257.
7. Robert J. Urick, *Ambient Noise in the Sea* (Los Altos, Calif.: Peninsula, 1986), pp. 3–18.

(ICBMs) from improved missile accuracy (table 1, p. 26). This merely advances Thomas Schelling's argument from thirty years ago that ICBMs are "an embarrassment" because of their vulnerability to preemptive attack,[8] and raises the question whether Lieber and Press provided an appreciably different analysis now than then of the counterforce threats against the U.S. arsenal. This invites analysis of the possibly foregone nature of the conclusions they reach, with similar definitions, assumptions, and conclusions found in the writings of Herman Kahn, Albert Wohlstetter, and Colin Gray about strategic contexts decades away from today's.

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Keir A. Lieber and Daryl G. Press Reply:

In "The New Era of Counterforce: Technological Change and the Future of Nuclear Deterrence," we argued that dramatic improvements stemming from the computer revolution are rendering nuclear arsenals increasingly vulnerable to attack.[1] Leaps in accuracy have largely negated the strategy of basing nuclear weapons in hardened shelters, and the revolution in remote sensing is eroding the strategy of concealing nuclear forces on land or at sea. Ensuring nuclear retaliation after attack, which is the foundation of robust deterrence, is becoming more difficult.

Ryan Snyder and Benoît Pelopidas criticize our analysis on the grounds that U.S. ballistic missile submarines (SSBNs) are essentially invulnerable. They argue that modern U.S. submarines are extremely quiet, only detectable at short distances, and impossible to track; therefore, they cannot be destroyed.

Snyder and Pelopidas are correct that the U.S. SSBN force is highly survivable, but this observation is beside the point. The revolutions in accuracy and sensing threaten the most powerful country in the world far less than relatively weaker countries. As we wrote, "To be clear, nuclear arsenals around the world are not becoming equally vulnerable to attack. Countries that have considerable resources can buck these trends and keep their forces survivable, albeit with considerable cost and effort. Other countries, however—especially those facing wealthy, technologically advanced adversaries—will find it increasingly difficult to secure their arsenals, as guidance systems, sensors, data processing, communication, artificial intelligence, and a host of other products of the computer revolution continue to improve" (p. 10). In other words, countries such as China, North Korea, Pakistan, and perhaps Russia have far more to worry about than the United States.

8. Thomas C. Schelling, "Abolition of Ballistic Missiles," *International Security*, Vol. 12, No. 1 (Summer 1987), pp. 179–183, doi.org/10.2307/2538923.

1. Keir A. Lieber and Daryl G. Press, The New Era of Counterforce: Technological Change and the Future of Nuclear Deterrence," *International Security*, Vol. 41, No. 4 (Spring 2017), pp. 9–49, doi.org/10.1162/ISEC_a_00273. Further references to this article appear parenthetically in the text.

Although we agree with Snyder and Pelopidas about the current survivability of U.S. SSBNs, we disagree about two fundamental issues. First, their letter suggests that nuclear analysts should view the survivability of U.S. SSBNs as the end of a technological journey: the creation of submarines that are and will remain undetectable. They assert that future breakthroughs in submarine detection will be stymied by "fundamental limits that physics places on technology," and "further improvements may not offer much gain in military effectiveness." If one extends their analysis, presumably other countries' SSBNs will eventually reach the same technological Valhalla, ending the new era of counterforce.

In fact, there is no finish line in military technical competitions. Even the best weapons and sensors face obsolescence with the emergence of new innovations. Physics appears to impose limits—for example, darkness and the curvature of the Earth limit when and how far sensors can "see"—until clever engineers invent devices to work around those constraints (e.g., thermal sights and satellites). The unending nature of technological competition means that countries trying to build survivable submarines must not merely achieve some fixed level of quietness; they must counter the ever-evolving remote sensing capabilities of the best resourced military in the world. For that reason, we expect the new era of counterforce to endure for many years. Furthermore, and critically, the back-and-forth nature of technological competition means that countries—even the United States—should be wary about relying on any single capability (such as the survivability of submarines) in an era of exponential technological change.

Second, Snyder and Pelopidas dismiss the consequences of the accuracy revolution by asserting that hardened targets have been vulnerable for decades. The best technical analyses from the Cold War demonstrate, however, that ICBM fields were survivable.[2] Those analyses were correct at the time, but their conclusions have been overturned by the development of pinpoint accuracy. In fact, continued improvements in accuracy are now making hardened targets vulnerable to even conventional forces—thereby increasing the number of weapons available for disarming strikes and reducing the political hurdles to conducting attacks.

The strategic deterrence community has grown complacent. Almost every aspect of the nuclear deterrence equation has changed since the Cold War. Weapons are now highly accurate; sensors are transforming the target location and tracking mission; and, against the backdrop of these technological changes, target sets are now much smaller. Analysts need to appreciate this new era of counterforce so that they can debate its policy implications and impact on deterrence in the coming decades.

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2. See, for example, John D. Steinbruner and Thomas M. Garwin, "Strategic Vulnerability: The Balance between Prudence and Paranoia," *International Security*, Vol. 1, No. 1 (Summer 1976), pp. 138–181, https://www.jstor.org/stable/2538581. Steinbruner and Garwin identified a set of breakthroughs that would need to occur for hardened targets to become vulnerable. Those breakthroughs—and many more—have now come to pass.