

**The Geopolitical Implications of Hypersonic Weaponry: The Shift in Geopolitical Influence
from Hypersonic Capabilities**

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring 2023

On my honor as a University Student, I have neither given nor received unauthorized aid on this
assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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STS Research Paper

Introduction to Hypersonic Capabilities

With a speed of Mach 5 and above, hypersonic weapons raise a number of unique challenges. Mach number is the ratio of the speed of an aircraft to the speed of sound, and it is used to define categories in which varying flight conditions exist (Hall, 2021). Hypersonic flight only exists at or above Mach 5, roughly 3800 mph at standard atmospheric conditions (“Mach to Miles Per Hour,” 2018). Hypersonics is a relatively new field that has become an important topic in the defense industry. Hypersonic boost-glide missiles are ballistic missiles that enter space and deploy an aircraft known as a glide body that uses the speed it gains from the acceleration of gravity to glide to its target (Swagel, 2023). By using hypersonic technology, glide bodies can fly trajectories that are vastly different from conventional ballistic missiles. Glide bodies are similar to missiles; however, they can be maneuvered much more effectively using flight control surfaces in a non-ballistic trajectory. Adversaries are the enemies of a nation (e.g., China and Russia are the adversaries of the United States). Hypersonic weapons can both shorten the time it takes to eliminate a target and ensure that adversaries are unable to detect or hit such weapons using ground-based defense systems. This is possible due to their depressed trajectories that make detecting hypersonic vehicles challenging. A depressed trajectory is one that is much closer to the ground in which the curvature of the Earth makes detecting such a quick aircraft tremendously difficult (“A Challenge and Opportunity,” 2019). It’s also a result of their increased maneuverability which reduces the likelihood of the missiles being intercepted and destroyed.

Hypersonic vehicles provide the capability of using conventional warheads, rather than their nuclear counterparts. The term conventional refers to a weapon that is non-nuclear. These conventional warheads are able to eliminate a target more accurately. This provides an advantage

for the nations that possess these conventional hypersonic weapons, as they gain an alternative to using nuclear weapons. Thus, nuclear weapons can remain as deterrence while hypersonic missiles can be used to wipe out selected targets without causing civilian casualties. However, nuclear warheads can be used on these glide bodies as well. Thus, uncertainty and worry surround this new technology. The nations that gain these advantages begin to have a new influence on the geopolitical scale.

Background

China, Russia, and the United States have been heavily investing in developing hypersonic missiles. Hypersonic speed is any speed that passes the threshold of five times the speed of sound. All branches of the U.S. military are developing hypersonic weapons for the use of non-nuclear offensive combat. These weapons are sometimes referred to as vehicles as they are quite compact and spend the majority of their flight in the Earth's atmosphere (Kramer, 2023). Their modern-day counterparts are ballistic missiles. The main difference between hypersonic vehicles and ballistic missiles is the trajectory they follow. Ballistic missiles possess a parabolic trajectory that reaches altitudes far beyond the edge of the atmosphere in which they spend most of their flight time in. On the other hand, hypersonic vehicles typically follow a fifty-percent glide phase trajectory that consists of boosting outside of the atmosphere and reentering it, where the vehicle will glide without propulsion for half of the flight time (Kramer, 2023).

Research Question and Methods

The research question is as follows: *How will the geopolitical influence of the United States and its adversaries shift once hypersonic capabilities are fully functional?* The methods that will be used to analyze this question include a literature review and policy analysis.

Secondary sources that have already analyzed the geopolitical implications of hypersonic weaponry are essential pieces of literature that are used for the results and discussion of the research topic. It is also necessary to use policy analysis because the regulation and policies surrounding hypersonic weaponry deployments provide insight into how political power will be handled on a global scale with the possession of these weapons. This has proven to be the case during the 20th century with nuclear weapons and the treaties surrounding them.

Establishing the STS Framework of Technological Momentum and Relevant Social Groups

The STS framework being used is Technological Momentum. This framework is concerned with how the technology in question aligns with a social or political context for it to be an accepted technological system. Hypersonic technology is new in the sense that it has only just recently gained momentum and interest. Hypersonic weapons have not become mature in their development yet. This means that the latter stages of development such as local application, transfer to other locations, development of supportive infrastructure, and becoming standard, accepted systems that cannot be replaced, must be achieved in order for the technology to get passed the technological momentum.

While researching these geopolitical implications of hypersonic capabilities, the relevant social groups include political leaders, global militaries, and civilians. Political and military leaders must be considered as they are ultimately the ones making the decisions on what technologies need to be procured and developed. This STS paper will mainly focus on the world's most powerful countries that are currently the furthest in hypersonic development: the U.S., China, and Russia. Civilians may be facing the consequences of the uncertainties that come with the new era of hypersonic weapons.

Results

Purpose of Hypersonic Weapons

Hypersonic weapons can be viewed to have varying purposes. Some may say that they are used as a form of strategic deterrence regardless of their deployment while others may suggest that there will be unintended consequences from their inevitable use (Borrie & Porras, n.d.). Nations that possess hypersonic capabilities may be displaying a sense of national militaristic competence that many view as politically important. Certain nations may become hesitant to attack the U.S. or its adversaries due to hypersonic capability. This is known as deterrence, and the only strong form of deterrence that is currently used is nuclear deterrence. It can certainly be used as a form of deterrence where warnings can be enough to prevent an adversary from taking a militaristic approach to gain geopolitical power. Critics claim using hypersonic weapons as deterrence is redundant and unnecessary as nuclear weapons already serve this purpose.

Shift in Warfare in the Point of View of the U.S.

The majority of the wars fought by the United States have taken place in the Eastern Hemisphere. Thus, deploying aircraft, personnel, and resources would take months to complete. With hypersonic glide bodies, the U.S. would be able to deliver precision attacks against target areas in an hour or less (Friedman, 2018). The tempo of war can be drastically changed by this capability. The U.S. would be able to quickly and accurately eliminate targets. Known as *fast offense*, the nations being attacked by these hypersonic weapons will not be able to position their military forces nor receive any indicators or warnings before a strike occurs (“The Future of the Battlefield,” 2021). Thus, if the U.S. were the only nation to possess such weapons in high quantity during a time of war, the nation’s enemies would have a significant disadvantage due to the inability to react to offensive attacks.

The Concerns between the U.S., Russia, and China

The United States is most concerned with Russia and China's accelerating efforts to fully develop their hypersonic weapons. Russia has shown its new weapon under development called the Kinzhal which is claimed to be able to reach Mach 10 (Friedman, 2018). China unveiled its rocket-boosted hypersonic glide vehicle called the Dongfeng-17. The U.S. is already at the stage of testing a number of hypersonic weapons that are being developed at a rapid pace. As tensions rise and China makes it clear that it is potentially going to invade Taiwan and take control of the South China Sea, the nation can use hypersonic weapons to destroy U.S. forces in the Pacific Ocean. Thus, hypersonic capabilities can be the sole factor that would enable China to claim Taiwan as part of its country. This is just one example of how a geopolitical shift can occur from the possession of hypersonic weapons. There are countless implications that are yet to be tapped into.

Modern Example of the Geopolitical Advantages that Hypersonic Weapons Provide

In January 2023, Russia's new hypersonic missile named Zircon was armed on one of its patrol ships (Copp, 2023). This missile can travel at hypersonic speeds well above Mach 9. Russia's current president, Vladimir Putin, has specifically acknowledged that the missile's ability to travel at great hypersonic speeds will be useful in penetrating existing anti-missile defense systems. Putin claimed that the Zircon missile that is currently in service has no rival and that it gives Russia a strategic edge. Putin used this hypersonic capability to his advantage when it came to invading Ukraine. The Russian president used the Zircon hypersonic missile as a deterrence, by warning the U.S. and its NATO allies that the Russian military could strike any nation's decision-making centers within minutes if they interfere in a way that is deemed unsuitable to the nation (Copp, 2023). This is a clear example of how the possession of

hypersonic weapons alone can cause a shift in geopolitical power and influence militaristic decisions by other nations.

After analyzing this case, one can conclude that hypersonic weapons can be used as a better deterrence than nuclear weapons in certain situations. Although it is unclear whether Putin's threats are authentic when it comes to his statements of using nuclear weapons on a nation that interferes with its militaristic decisions, it is much more believable and likely that Russia would use hypersonic missiles to accurately strike decision-making centers while reducing civilian casualty to a minimum. Furthermore, if these hypersonic weapons were to strike these locations, new strategies would have to develop to prevent Russia from using more of these hypersonic weapons that are impossible to counter while still making offensive attacks on the nation.

China and the Geopolitical Interest in Taiwan

Conflicts in the South China Sea have led to disputes over territory possession and naval presence. It is clear that China has an interest in claiming Taiwan as part of its territory, while the U.S. has also made it clear that it would protect Taiwan from a Chinese invasion. The U.S. is incentivized to remain involved in the defense of Taiwan's independence as the majority of the world's microchips are developed in the small island nation. China's defenses in the area consist of surface-to-air missiles, SU-30MKK fighter aircraft, DF-21D antiship ballistic missiles, cruise missiles from H-6K bombers, and DF-26 antiship ballistic missiles (Swagel, 2023). All of these defenses can potentially limit the United State's naval presence and air superiority in the South China Sea. Thus, the U.S. may be forced to use an alternative approach to targeting China's sources for all of these defenses. This has the potential to be the first deployment of U.S.

hypersonic weapons and its likelihood may lead to further funding of hypersonic weapon development in the nation.

China revealed the Dong Feng 17 (DF-17) in late 2019 during a military parade. It is a hypersonic glide vehicle that the nation claimed to be ready for combat (Wortzel, 2022). This is similar to how Russia's Zircon missile is also at that stage. On the other hand, the U.S. has had issues with its development of hypersonic weapons. However, the United States military will have a lot more capabilities with a variety of militaristic deployment strategies once all of the hiccups are resolved. The current hypersonic weapon programs that the U.S. is currently public about are the CPS and HALO programs for the Navy, the LRGW program for the U.S. Army, the ARRW and HACM programs for the U.S. Air Force, and the TBG, OpFires, and MOHAWC programs developed by DARPA (Sayler, 2023). With Russia and China already possessing deployable hypersonic vehicles, the U.S. Department of Defense has made it critical that these programs expedite their progress.

Analysis

Global Insecurity

With the world's most powerful nations investing a significant amount of time, money, and resources towards developing and deploying hypersonic weapons with the intent of pursuing national security, there becomes a paradoxical byproduct: global insecurity. There may be an imbalance in the positive and negative consequences of this new arms race. These consequences are associated with security, arms control, and disarmament.

A major challenge that hypersonic weapons have posed to global security is nuclear ambiguity (Kramer, 2023). Hypersonic weapons may confuse the U.S. and its adversaries as to whether an incoming missile was deployed with nuclear intentions. Nuclear ambiguity is the

characteristic of a missile that results in an adversary being incapable of knowing whether such a missile possesses a nuclear or conventional warhead. This is due to the dual capability that most hypersonic weapons have in carrying both types of warheads. Thus, the U.S. is being proactive in attempting to make conventional hypersonic weapons distinguishable from nuclear weapons (Kramer, 2023).

One of the greatest challenges to global insecurity is a hypersonic boost-glide missile's unpredictable path. An adversary may be able to detect that a hypersonic missile has been deployed in the U.S. through the use of infrared instruments aboard satellites in space; however, that nation would not be able to estimate the intended location that the missile will strike due to the incredible speed and maneuverability of a hypersonic weapon (Kramer, 2023). Thus, an adversary may unintentionally respond by attacking the U.S. even though the target of that U.S. hypersonic weapon may be an entirely different country. The lower-altitude flight of a hypersonic vehicle makes it much more difficult to track than a ballistic missile, and its ability to change directions within an instant makes its target highly unpredictable by all adversarial nations. Therefore, the vehicle's intended target is unknown, vastly different from what nations are used to. Most nations would be able to detect whether a ballistic missile is intended to hit them or not. This new difference in predictability could lead to catastrophic global instability with adversaries attacking nations purely due to this lack of certainty.

Policies in Place to Limit Hypersonic Weapon Use

There is currently no defense established against hypersonic weapons. Not a single nation has the capability to intercept a hypersonic vehicle regardless of whether the missile or glide body can be detected and even tracked ("A Challenge and Opportunity," 2019). Although this does not mean it will never be successfully deployed, this capability will not be available during

the initial deployment of hypersonic weapons (Karako, 2022). This means that nations that possess hypersonic capabilities have a significant advantage that cannot be counteracted. This has led certain politicians and defense personnel to discuss limiting or outlawing the so-called “disruptive technology” (Stone, 2020). There are political figures that are calling for a complete ban on hypersonic weapons, yet they acknowledge that this is not possible with the potential advantages that these nations may gain after investing large sums of money in hypersonic development. Thus, discussions must take place on how to regulate hypersonic weapon use. An international conference has been proposed for the UN Office for Disarmament Affairs and the UN Institute for Disarmament Research to research and discuss the security implications that come with hypersonic capabilities (“Discussion Paper for the Convention,” 2019).

Due to the potential threat to strategic stability and inspiration for a new arms race through the possession and use of hypersonic weapons, some experts have argued that the U.S. should limit the expansion of such weapon production. These mitigations come in the form of negotiating arms control agreements with other nations and adding to the New START Treaty. The U.S. and Russia have a strategic offensive arms treaty called the New START Treaty, and Article V of this treaty gives the right to each nation to question a new emerging strategic offensive weapon in the Bilateral Consultative Commission (BCC) (Sayler, 2023). It has been suggested that the most feasible mitigation may be international transparency which consists of exchanging data, collaborating on technical studies, and giving advance test notices.

Although international collaboration was suggested as a method to mitigate strategic instability and global insecurity, it is certainly against the interest of the three major nations involved. A clear example of this comes from a case of suspicion in Russia that has led to multiple arrests. A Russian aerospace engineer by the name of Victor Kudryavtsev and his

colleague were arrested a few months after they participated in a European Union-sponsored project (Stone, 2020). This project was called Transhyberian which had the purpose of analyzing the sudden change in laminar flow to turbulent flow at hypersonic speeds that resulted in findings that could help improve hypersonic vehicle designs. Russia's Federal Security Service determined that they would be arrested on charges of treason for leaking hypersonic secrets to NATO. All of this suggests that international collaboration has been deteriorating, especially surrounding research on hypersonic weapons outside of allied nations. This proves that fear and uncertainty have constantly been surrounding the field of hypersonics and the capabilities it provides for the gain of geopolitical power.

Discussion

Unlike China and Russia, the U.S. is much more focused on developing hypersonic weapons that carry a conventional (non-nuclear) warhead rather than a nuclear one (Sayler, 2023). This results in a much greater challenge for the United States as these weapons would have to be developed with significantly more accuracy. Experts have suggested that a hypersonic weapon with a nuclear warhead would be just as effective as one with a conventional warhead, even if it's less accurate by a magnitude of 10 to 100 (Sayler, 2023). Although this makes developing such weapons increasingly challenging for the U.S., it provides the nation with an advantage over China and Russia as the main focus on conventional warheads provides the U.S. with weaponry alternatives to eliminating targets without leading to major retaliation from the targeted nation and its allies. However, it's important to recognize that China and Russia still have programs that are developing hypersonic weapons that are able to use conventional warheads.

Hypersonic boost-glide missiles and hypersonic cruise missiles are not a part of the current arsenal of the United States. The U.S. is currently developing and testing hypersonic weapons to later mature hypersonic technology and include these weapons with the intercontinental ballistic missiles and subsonic cruise missiles that are already a part of the U.S. military weaponry resources (Swagel, 2023). Supersonic missiles that range between Mach 1 and 5 have already been challenging enough, so creating a glide body that is capable of gaining substantial speed only through the use of gravitational potential energy and eliminating a target using kinetic energy is a truly difficult task. Hypersonic technology has not matured enough for nations to have a significant number of hypersonic weapons as a part of their arsenal. That is why the STS Framework of Technological Momentum has been used throughout this paper.

Although there is currently no option to intercept and destroy incoming hypersonic weapons, potential solutions to this problem have been analyzed. This defense system comprises space sensors and a glide-phase interceptor (Karako, 2022). A group of satellite sensors that are able to observe, classify, and track hypersonic weapons in space during their climbing phase is crucial for maintaining sight of an incoming hypersonic weapon. This is necessary to enable a birth-to-death tracking capacity which is the ability to track such weapons along their entire trajectory, even at the immense speeds that hypersonic vehicles travel at.

Once these weapons are able to be tracked with precise coordinates in the atmosphere, a defense weapon capable of intercepting them is needed. This intercepting weapon is known as a glide-phase interceptor (GPI). A GPI would either use a hit-to-kill weapon method or an alternative mechanism, such as a blast-fragment warhead which would alter the course of the hypersonic weapon (Karako, 2022). The hit-to-kill weapon would intercept the hypersonic missile or glide body at an exact position in the detected trajectory to instantly eliminate it. On

the other hand, if this is too complex to achieve, a similarly effective yet less desirable method would be to throw the hypersonic weapon off course using a large area of shrapnel that does not require the same accuracy as the hit-to-kill method. Thus, even with the correction of guidance and control systems, reaching the exact target with the intended kinetic energy would not be as easy to achieve by a hypersonic glide body.

However, the performance and effectiveness of these systems are still far from being proven and fully developed. These are purely theoretical solutions to what seems to be a significant challenge for engineers and other professionals to solve. This means that intercepting and destroying hypersonic weapons will most likely not be the first defense strategy used to counter these advanced weapons. It is important to synthesize the new era of hypersonic weapons with that of the nuclear weapons developed during the 20th century. The fear and uncertainty that surrounded nuclear weapons during the cold war are certainly not being emulated by society today. If nuclear ambiguity and target uncertainty begin to occur due to the increased use of hypersonic weapons in the future, this may bring light to the instability that these weapons bring. Thus, society may begin to fear this uncertainty the same way nuclear weapons were feared in the past. However, since conventional warheads are expected to be the primary lethal method of eliminating targets using hypersonic weapons, there should be some reassurance knowing that these weapons are intentionally designed to avoid civilian casualties.

Conclusion

Hypersonic weapons provide enhanced militaristic capabilities when it comes to national defense and international combat. However, these new capabilities come with a new set of concerns that revolve around international stability. Many uncertainties remain unresolved, such as nuclear ambiguity, major advantages in combat, and the inability to intercept hypersonic

weapons. The U.S., China, and Russia may have difficulty predicting hypersonic weapon trajectories, face short timelines to make forced decisions, and are currently spending excessive amounts of money on developing these capabilities. Most nations will not have a say in what policies will be formed to control hypersonic weapon use. Those are the same nations that may be vulnerable targets to this new advanced weaponry. It is crucial to recognize how hypersonic capabilities could threaten global stability and security, yet it is also important to understand its advantages and inevitability.

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