The Implications of Hypersonic Weapons Systems for International Stability and Prosperity

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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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Introduction

"Compared to traditional intercontinental ballistic missiles and cruise missiles, hypersonics combine speed exceeding that of intercontinental ballistic missiles, along with the high-end maneuverability of a cruise missile…" (The Rise of Hypersonics, 2020). Consisting of glide vehicles and cruise missiles, hypersonic weapons system is a term used to describe highly maneuverable weapons able to reach speeds exceeding Mach 5 (Borrie et al., 2018) and as per the statement above, the potential of these systems far exceeds that of current counterparts raising concerns about their unpredictable consequences. While this technology has yet to be fully integrated into modern military systems, studies conducted by organizations such as the United Nations and Deloitte, in conjunction with world leaders, have theorized the establishment of these systems could progress into unintended escalation (Borrie et al., 2018), tactical miscalculations, and geopolitical destabilization. In this paper, I aim to explore the diffusion of this technology as it pertains to international conflicts along with global and national stability in terms of welfare and security.

To understand the implications, I will use the technological momentum to learn the extent to which hypersonic weapons could change the scope of military conflicts. This framework claims that technological determinism on societal practices is controlled by the time it takes for diffusion of the technology (Freeman et al., 2021). In addition, I will conduct an actor-network (ANT) analysis to understand the roles of stakeholders who will influence the development of and are affected by establishment of this technology. ANT focuses on how links between all human and non-human actors can shape behavior and influence outcomes on that network (Ritzer, 2004). My STS paper will present evidence on the minimal return on investment offered by hypersonic weapons systems, their potential for adverse effects on strategic stability, and the complexity rising from regulation and execution of hypersonic projects to show that they may be an inhibitor to international stability.

Analysis of stakeholders and regulation

The complexity that goes into the planning and execution of a hypersonic weapons system requires agreement between the customers, engineering firms, and government regulators during all stages of the project. However, this is easier said than done because the motives of each party can have differing economic, social, political, and technical considerations that will require compromises which could potentially limit the extent to which the final product will align with original plan.

To understand the effects of stakeholders on military technology development, I will explore a journal article (Law & Callon, 1988) titled *Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change*. While this study focuses on the development on the British Aircraft Corporation TSR-2, which was designed to be a supersonic military bomber in the late 1950s (BAE Systems, n.d.), the general process through which parties plan, fund, and begin the project aligns very closely with hypersonic systems and has not changed significantly. This article was written by John Law and Michael Callon, sociologists who study technology. While their technical background on the topic is limited, both are some of the first proponents of the Actor-Network theory framework and their roles as professors will have allowed them to develop a sufficient background to speak on technological innovations. In this project, the main actors are the British Aircraft Corporation (BAC), a subdivision of the

British Royal Air Force (RAF), the Treasury, the Ministry of Defense, and all the small contractors involved in the design of various components of the aircraft. With the combination of the Treasury reluctance to increase defense expenditure along with the pressure from the Ministry of Defense to pursue a "missile-oriented" (Law & Callon, 1988, p. 286) defense policy, the Operational Requirements Branch (ORB), a section of the RAF in charge of proposing aircraft needs, was ambushed with several issues even before getting the project under way (Law & Callon, 1988). Nevertheless, certain compromises led to the approval of the TSR-2, but with that came a series of new problems amongst the stakeholders. Particularly, the BAC, the consensus management entity, was not able to sustain its role as the "obligatory point of passage" (Law & Callon, 1988, p. 290) in the negotiation space between the various groups involved, ultimately resulting in long delays and destructive accidents.

The obligatory point of passage (OPP) is part of the problem definition phase of the Actor-Network theory which the actors must be able to move past to move forward in finding a solution (Ryu, 2017). For the TSR-2 project, the OPP is the BAC, which is not a physical point to pass, but rather a middleman to manage and communicate information among the actors. In this case, the job of the OPP would be to maintain the highest level of influence among the actors to minimize disagreements between them that could hinder progress. However, another actor, the Ministry of Supply, tried to impose themselves as the OPP which threw off the balance of the management. This led to duties being spread out among several small committees, increasing the complexity of the project and ultimately ending with its collapse (Law & Callon, 1988).

Applying a similar lens to the current state of hypersonic development in the United States, we will see that the main actors involved could potentially run into issues like those faced by actors of the TSR-2 project. The rise in hypersonic missile capabilities in China has led to several groups engaging in the debate of the necessity of hypersonic weapons, two of which have been especially vocal: U.S. military officials and federal policymakers. The military officials are truly set on increasing expenditure for hypersonic efforts due to the possibility of falling too far behind China and Russia in the arms race. On the other hand, policymakers are more conflicted in deciding whether aggressively pursuit hypersonic weapons or limited proliferation measures will have a more beneficial effect on international stability (Lee, 2022). Both groups have an immense influence in the industry along with the DOD, who is the main source of funding, but who should take on the managerial role in the projects and act as the OPP?

On the surface, it may seem like the military should take on this responsibility because ultimately, they will be the ones in charge of using the weapons and would consequently be the most knowledgeable about the operating conditions. However, their little experience in considering economic and social implications could prove to have an adverse effect on stability resulting in retaliation from other nations. For example, Michael Griffin, a top military official involved in defense research, said "I did not take this job to reach parity with adversaries. I want to make them worry about catching up with us again" (Klare, 2019). It indicates how the military is more concerned about US dominance rather than potential repercussions. The policymakers will be more well-versed in understanding the social implications of hypersonic systems and how to properly allocate resources for the best interest of all the parties involved. This includes several responsibilities, one of which is arms control consisting of risk mitigation of weapon proliferation as seen by the soon to conclude New START Treaty between Russia and US which has contained offensive retaliation between the nations (Slayer, 2023). However, as the legislative branch, policymakers are the ones who will generally endure direct pressure from the executive and judicial branches who may have other agendas that could be financially, legally, or

politically motivated, limiting their effectiveness as an OPP. While both groups have their respective strengths, the limiting factors lead back to the same issue as the TSR-2 where the complexity threatens the possibility of failures. That is not an option because the volatility and immense funding arising from hypersonic development leaves little room for error. On top of this, if gaining the lead in the arms race is the determining factor, hypersonic technology may not be ideal due to its unproven nature. It needs an indefinite amount of time and resources for successful execution.

Minimal return on investment

With the increasing interest in establishing hypersonic weapons arsenals in the United States, investments into the research of this technology have grown rapidly but, the return on this investment has been limited. In the past three years, there has been a 167% increase in the funds allocated to hypersonic research in the Department of Defense Fiscal Year Budget proposals with, $6.6 billion in 2022, $7.2 billion in 2023, and $11 billion in 2024 (Austin, 2023). This rise in investments has come as a reaction to the unknown nature of the weapons and weapons defense systems in the hands of the United States' biggest adversaries: Russia and China (Lee, 2022). With little to no operational defense systems against hypersonic weapons along with their anticipated speed and accuracy, the technology offers a sense of credibility (Lee, 2022) to the deterrence capabilities of a nation, encouraging nations to opt for extensive efforts to pursue these systems. However, limited progress has been made in terms of operational capabilities. The few systems with the ability to deploy right now offer little to no advantages over existing field-tested systems.

ICBMs (Intercontinental Ballistic Missiles) and SLBMs (Submarine Launched Ballistic Missiles) have been around since the late 1950s, remaining a premier weapon in the US nuclear arsenal. Although they technically do have the ability to attain speeds exceeding Mach 5, the lack of maneuverability has barred them from being classified as a hypersonic system. However, several capabilities of these systems have matched or even exceeded those of their hypersonic counterparts, raising the question of the justifiability of allocating so much capital to an unproven technology. To better understand this comparison, let us consider previous systems in these two categories by analyzing attributes including speed, range, and accuracy. The LGM-30G Minuteman is a line of highly tested ICBMs deployed in the mid-20th century able to travel at speeds of 15,000 mph or Mach 23 with a maximum range of over 5,000 nautical miles (U.S. Department of Defense, n.d.). Created almost 50 years later, the Waverider-X51A hypersonic tactical missile by Boeing can fly up to 3,600 mph or Mach 6 for a range less than 500 nautical miles (Air Force, n.d.). Based on these parameters, there is no evidence to suggest the hypersonic system even comes close to the ballistic system in terms of versatility in deploying various attacks. Nonetheless, as mentioned before, speed is a very minimal factor compared to maneuverability when it comes to characterizing hypersonic system capabilities.

Maneuverability, the ability to easily move into various positions, is certainly a vital part of hypersonic systems and serves as one of the main driving forces in heavily pursuing the technology. By allowing the user to control the trajectory of the path, a hypersonic missile will be able to adjust during the flight to avoid detection for a much longer period than the ballistic counterpart which tends to have a fixed path (Slayer, 2023). Consequently, the defending party will generally have more time to react to the ballistic missile, increasing the chances of intercepting the attack. However, this discrepancy in detection times may not be highly

significant when considering a country trying to defend against an attack. Early warning satellites have been estimated to be able to give around a half hour warning for long range ballistic missiles with that approximately being cut in half for hypersonic cruise missiles like that of an intermediate range ballistic missile, while SLBMs can often reach their target within a matter of five minutes (Terry & Cone, 2019). While the relative discrepancy between these systems seems large, considering that the time range is very small with the addition of the fact that communicating information and engaging a defensive procedure could take another several minutes, both the ballistic and hypersonic systems do not offer a clear tactical advantage, further questioning the necessity of the new technology.

To further understand this technology, I will explore the issue through the scope of the technological momentum framework, specifically analyzing historical diffusion of nuclear technologies and drawing parallels to hypersonic systems. In the case of nuclear and hypersonic technologies, growth of their establishment centers around the idea of nuclear deterrence, the idea of preventing armed conflict. At the early onset of nuclear weapons following World War II, the Eisenhower administration emphasized the idea of *massive retaliation*, a term based on "maintaining robust nuclear strategy and force" (Pifer et al., 2010) to deter attacks against the United States. As part of this strategy, the US opted to emphasize affordable nuclear technologies as opposed to conventional massive forces for retaliation to acts of aggression. Technological momentum shows that societal pressures can often influence the rate of technology diffusion (Freeman et al., 2021). For nuclear weapons, this pressure came from high-ranking political leaders forcing the technology to be the backbone of the military strategy. However, the momentum was not widespread as nuclear technologies were contained only in the United States and Soviet Union throughout the Cold War era (Malloryk, 2020). While some nuclear conflicts did arise, having dominant countries like US at the forefront led to improvements in international relations through the establishment of the United Nations in 1945 and economic rebuilding efforts post WWII (Malloryk, 2020). Hypersonic weapons violate the idea of a robust strategy as they are expensive to develop and maintain with added layers of complexity in terms of design, operation, and time of development. In addition, there exists little information about operational defensive systems against this technology. As a result, if a conflict between nations escalates from a threat to an offensive action involving deployment of hypersonic weapons, the brief time to react could instill a "shoot first and ask questions later" (Lee, 2022) mindset in many countries. This escalation could lead to an entire collapse of the international landscape as smaller nations, who are allies to the US, Russia, and China, could get caught in the crossfire, crippling their countries. Like nuclear technologies, societal pressures give hypersonic weapons the potential to gain momentum. However, this pressure will be from the fear and desperation to survive against destructive armed conflicts. As many nations do not have the financial resources to maintain hypersonics, this escalation could prove to be a destabilizing force in international peace and prosperity.

Implications for international and strategic stability

With the technological gap between hypersonic weapons systems compared to their current counterparts, changes in strategic thinking among nations in adapting to new capabilities could prove to have adverse effects on international stability. The concept of international stability is a broad subject open to various interpretations. From a global systemic point of view, stability could refer to survival of affected parties, negligible power shifts, and deterrence of

large-scale wars. From an individual nation perspective, stability would consist of maintaining political independence and territorial integrity without engaging in conflicts that could threaten the welfare of the nation (Deutsch & Singer, 1964). More classical interpretations, such as one by English mathematician Lewis Fry Richardson, simply view stability as the lack of any deviation from the "equilibrium state" (Deutsch & Singer, 1964) of the social, economic, and political landscape. While all these explanations differ slightly, the central idea revolves around avoiding avenues of potential conflict to sustain peace, prosperity, and security.

To understand how the development of hypersonic weapon systems could affect these factors, I will explore a study done by the United Nations Office for Disarmament Affairs (UNODA) and the United Nations Institute for Disarmament Research (UNIDR) titled, *Hypersonic Weapons: A Challenge and Opportunity for Strategic Arms Control*. This study focuses on hypersonic boost-glide systems by analyzing them in a systemic method consisting of a snapshot of the current state of weapon technologies, an analysis of implications on international peace and security, and an examination of effects on future arms control and disarmament efforts (Borrie et al., 2019). My discussion will focus on the peace and security implications by investigating through the lens of technological momentum, an intellectual framework that shows why certain technologies become entrenched in a community due to their proven dependency and effectiveness (Schubert et al., 2013).

On the surface, pursuing hypersonic weapon systems seems to be purely motivated by the need to improve military technological capabilities, but this study brings in other factors behind the motivation: the potential for an arms race and possibility of unintended escalation. To understand how these may arise, I will consider examples between the leading nations. In the early 2000s, the United States began its journey into hypersonic technologies with the establishment of the Conventional Prompt Strike (CPS) program, intended to create high speed long-range weapon systems able to reach targets within an hour (Lockheed Martin Space, 2022). It was established because the US wanted to establish a way to protect overseas military bases with threat of accurate long-range weapons (Congressional Research Service, 2021). Simultaneously, the US withdrew from the Anti-Ballistic Missile Treaty in 2002, which was an agreement between the US and Soviet Union to limit missile proliferation in those nations (The Anti-Ballistic Missile (ABM) Treaty at a Glance | Arms Control Association, 2020). Due to these actions by the US, Russia revived hypersonic projects from the Soviet era and China also began operations in the field closely after, resulting in the creations of the Russian *Avangard* in 2019 and Chinese *DF-ZF* in 2017, both of which are successful flight-tested hypersonic glide vehicles (Borrie et al., 2019). With no imminent military conflict, why did Russia and China follow suit after the US? The fear of falling behind. This notion caused these nations to chase after each other, showing early signs of an arms race, like the Cold War era.

This relates to the idea of technological momentum proposed by Thomas P. Hughes, American historian of technology, which says that technology and society simultaneously influence each other (Freeman et al., 2021). Applying this to the study, we can see that hypersonic technology gained momentum in Russia and China directly because of actions by the US. This is an example of technology influencing society as Russia and China likely considered these actions a threat to their national stability in the case of an armed conflict, ultimately leading them to pursue similar actions to keep pace with the US. On the other hand, the actions by the United States show society influencing technological development as the CPS program came about as a result of the US feeling threatened by the vulnerability of their military personnel in

areas of high risk. As more countries inevitably join this arms race, these effects will be magnified, and the threats of armed conflict could escalate.

As of now, most countries who have hypersonic weapons have not used them offensively, and they serve more as a source of war deterrence. If used, the ambiguity in the capabilities of hypersonic weapons makes their potential effects very unpredictable, and any miscalculation will result in dire repercussions. For example, a defining capability of hypersonic glide vehicles is that they can be armed with conventional warheads, which work by creating explosions based only on size and speed, or nuclear warheads, which have an added component of nuclear radiation, increasing the magnitude of damage caused. Furthermore, the speed of HGVs decreases their visibility to satellites and radars, so it will be difficult to enact defensive countermeasures (Borrie et al., 2019). For this reason, any miscalculation causing a missed target by the weapon could result in unintended civilian casualties and mass destruction in targeted nations. Overall, the issues that have the potential to arise from the increase in hypersonic initiatives throughout the world have important social and political stability implications that could be otherwise avoided.

Conclusion

In conclusion, this paper has delved into the implications of pursuing hypersonic weapons development and how it may be unjustified due to its capability of being the catalyst for international destabilization. From an innovation standpoint, while the new technology offers certain capabilities superior to those of current counterparts, the improvement compared to the immense cost increase has been almost negligible. In terms of effects on strategic stability, possibilities of crisis escalation greatly rise from factors including offensive miscalculation, threat of technological inferiority, and inability to maintain welfare within nations. Finally, the complexity that will arise between stakeholders in the execution of hypersonic weapons syetsm will limit the progression of its innovation and increase the difficulty of regulation.

As seen by this evidence, the current state of hypersonic systems and the anticipated pace of development may not be optimal to maintaining international stability and welfare at this time. However, this does not necessarily mean that the technology will never be ready, as there could come a time when current systems will not be effective enough to deter crisis escalation due to the vast improvement in defensive capabilities. This situation will minimize the influence of dominant nations like the United States, Russia, and China. To ensure that establishment of this technology is successful when time comes, it is important for issues in this paper to be addressed or relations between nations could be worse than ever before.

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