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# Revolutions In Military Affairs: A Theory On First-Mover Advantage

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**Abstract**
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**Keywords**
Revolution In Military Affairs, First-Mover Advantage, Military Innovation, War, Strategic Studies, International Security, Social Sciences, Political Science, Michael C. Horowitz, Horowitz, Michael C.

**Disciplines**
Political Science

# REVOLUTIONS IN MILITARY AFFAIRS:

# A THEORY ON FIRST-MOVER ADVANTAGE

by

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## I. INTRODUCTION

With nothing more than a bow, a horse, and a vicious intensity, Genghis Khan and the Mongolians set out to conquer the world. Beginning in the Central Asian steppes and spreading from Eastern Europe to the Sea of Japan, Genghis Khan's nomadic warriors united the largest contiguous land empire in the history of the world. In the 13th century, they aspired for *Pax Mongolica*, or "Mongol Peace," named after the unification of the Roman Empire. But the Mongolian conquest was anything but peaceful.

At that point in history, the Mongolian invasions were the most violent military operations Europe or Asia had experienced. Arriving on horseback, they "swallowed whole nations at a stride," writes Vic Hurley. They were not merely looters and raiders, but "had come to impose permanent rule upon Europe" (2011, 150). The Mongolians mastered military logistics, weaponry, tactics, and physical stamina (149-150). In turn, small towns and big cities experienced the deadly wrath of Genghis Khan. Across all of Eurasia, people heard about the Mongolians. Relying on psychological fear tactics, the Mongolian cavalry rode as far as they could see.

Genghis Khan's conquest was possible because of innovative military technology and strategy. Among the troops, the Mongolians were skilled and professional. "Khan inflicted a dreadful iron discipline on his troops" and employed severe penalties. Their physical strength was extraordinary, for "if food was not available, the Mongols simply abstained from food" (150). The Mongolian army's "speed, stamina, and horsemanship" surpassed that of any other military. In terms of organizational innovation, Genghis Khan set up task forces for arms and equipment supply, information, communications, and tactical and strategic planning (151).

Most impactful, however, was the uniquely Mongolian recurved composite bow. Each a product of excellent workmanship, the improved bow increased the pull potential up to 160 pounds and could kill at the extreme range of 300 yards (151). The Mongolians perfected their lethal and precise archery on horseback. As Stephen Turnbull writes of one conquest, the Mongolians used a "different archery technique, whereby arrows were shot in huge clouds, rather than being used in long-range individual combat. Dense showers of arrows, some tipped with poison, were poured into the [adversary's] lines" (Turnbull 2003, 19).

Alone in their quest, the Mongolians demonstrated that "a single state can initiate revolution by recognizing how to effectively combine various evolutionary developments, new ideas, and technology" (Metz and Kievit 1995, 13). The nomads marched through civilized cities and fought off armies, but "even the Great Wall of China was ineffective in stopping" the Mongolians (McNeill 1982, 17). With innovative technology and novel thinking, Genghis Khan conquered the largest empire in history.

As in the conquests of Genghis Khan, the character of every war is marked by the technology employed. The type of weapon systems used in war dictates the disposition of the conflict—the bayonet in the American Civil War, tear and mustard gas in World War I, the atomic bomb in World War II. Military technology not only changes the way we fight, but it also transforms the way we even think about war. As weaponry has evolved from the spear to the nuclear weapon, it is clear that the arrival of a new technology can lead to dramatic implications for how a war is fought.

Military innovation profoundly impacts the state of international politics. A technological advantage in war can likely decide the victor. To put it in economics

terminology, comparative advantage is essential in dictating the outcome. A military will remain unbeatable so long as it is able to hold a strategic technological and bureaucratic edge over its adversaries. When a technology is introduced, the actor who first possesses the technology has a benefit over its competitors. This is a powerful boon for any organization—be it the local take-out restaurant or the United States Armed Forces. In fact, debut of a technology by the first mover can shift the entire market. The next actors to pursue this innovation will then attempt to mitigate the first mover's benefit. This is a common occurrence in both business and war. The purpose of this study is to understand how innovations spread between actors in general and the length of first-mover advantage in particular.

However, as innovations diffuse, they do not all have the same impact. In adopting revolutions in military affairs, some actors benefit from a lengthy first-mover advantage; some actors suffer from a brief first-mover advantage. Why does this disparity occur? Understanding this central puzzle has consequences for international security. A military able to exploit first-mover advantage increases its relative geopolitical power; a military unable to do so may undermine its relative power (Hundley 1999, 13).

Within the field of military innovation, this study aims to contribute to specific debates as well as shed light on grander philosophical military theory. In particular, this study aims to answer an ostensibly simple question: what are the determinants of first-mover advantage? But this is part of a larger, more philosophical discussion. Of course, the classical military theorists like Sun Tzu and Carl von Clausewitz desired to understand the fundamental debates on war and its virtue. The grand philosophical debate to which I hope

to contribute is more defined; that is, why does first-mover advantage even occur in the first place, or is this just another inevitable phenomenon in warfare?

In this paper, I will present a theory to explain the length of first-mover advantage in military technology. For the purposes of argument and convenience, I will refer to the presented theory as the "FMA Theory." The FMA Theory will argue that two factors, leadership and doctrinal congruence, relate to the two relevant actors, the first mover and secondary actor, to explain the length of a first mover's strategic edge. Under certain conditions, an actor either increases or decreases the length of its advantage. Then, the FMA Theory will be tested on three case studies—the aircraft carrier, the submarine, and the intercontinental ballistic missile.

I find that the FMA Theory properly explains the length of FMA, as evidenced by the three case studies. In the adoption of the aircraft carrier, the United States Navy achieved a lengthy advantage while the British Royal Navy and Japanese Imperial Navy suffered from a brief advantage. For the submarine, the German Imperial Navy experienced a brief advantage in the First World War. The intercontinental ballistic missile presents a brief FMA as both the Soviet Union and United States simultaneously innovated in the 1950s.

## II. A THEORY OF FIRST-MOVER ADVANTAGE

### A. Key Definitions

Before the study is furthered, I will define relevant terms.[1] The following are essential terminology for the FMA Theory.

**Military innovation** is the field of research within international security studies that examines the process of change in conflict. In particular, this paper scrutinizes change within military organizations. Like any organization, militaries alter their ways in order to adapt to changing norms, environments, and needs. This process is known as military innovation. As defined by Harvard Professor Stephen Peter Rosen, military innovation is:

> "a change that forces one of the primary combat arms of a service to change its concepts of operation and its relation to other combat arms, and to abandon or downgrade traditional missions. Such innovations involve a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas. They involve changes in the critical military tasks, the tasks around which war plans revolve" (1988, 134).

**Weapon system innovation** is "the process of accommodation between" alien systems and preexisting doctrine. If "military innovation" is the research umbrella, then "weapon system innovation" is the evidence. The novel, or alien, platform is called an innovative weapon system. An **innovative weapon system** is defined as a "potential leap in combat power over traditional means while challenging and requiring the

[1] Definitions will also be dispersed throughout the study.

transformation of essential tasks, organizational power structures, or key roles" (Ehrhard 2000, 6).

**Revolution in Military Affairs (RMA)** is an innovative weapon system or doctrine that fundamentally changes the essence of war. An RMA is a game-changer in war. It is best defined by Andrew Marshall, Director of the Office of Net Assessment in the United States Defense Department as,

> "a major change in the nature of warfare brought about by the innovative application of new technologies which, combined with dramatic changes in military doctrine and operational and organizational concepts, fundamentally alters the character and conduct of military operations" (McKitrick 1995).

In citing Marshall, Dima Adamsky notes "the term 'revolution' does not mean that change will be rapid but implies that it will be profound, making new methods of warfare more powerful than the old" (2010, 1; Marshall 1995). Richard Hundley similarly defines an RMA:

> "An RMA involves a paradigm shift in the nature and conduct of military operations which either renders obsolete or irrelevant one or more core competencies of a dominant player, and/or creates one or more new core competencies, in some new dimension of warfare" (1999, 9).

The idea of an RMA is perhaps best illustrated through historical examples, as shown in Figure 1.

**Figure 1.** List of Revolutions in Military Affairs[2]

| | | |
|---|---|---|
| Armored/Tank Warfare | Transport Aircraft | Strategic Defense Initiative |
| Bomber Warfare | Strategic Guerrilla Warfare | Anti-ballistic Missile |
| Intercontinental Ballistic Missile | Submarine Warfare | Nuclear Warfare |
| Flamethrower | Machine Gun | Manned Aircraft |
| Radar | Blitzkrieg | Total Warfare |
| Aircraft Carrier | Macroelectronics | Information Warfare |

A schism exists with regards to the nature of an RMA. Some RMAs are technology-driven while others are doctrine-driven. For instance, the submarine and nuclear warfare are based on technological advances, while German blitzkrieg and Maoist strategic guerrilla warfare are based on innovations in military doctrine. Consider the combat strategies in the American Revolutionary War that employ doctrinal innovation. When the Americans "engaged the opponent from behind cover rather than in formation out in the open" and targeted officers, they did so against standard warfare practices of the day (Hundley 1999, 14). Solely for the purposes of comparison, this study will only deal with technology-driven RMAs.[3]

**First-mover advantage (FMA)** is the gain due to a player's status as the first to utilize an RMA. An RMA "frequently bestows an enormous and immediate advantage on this first actor to exploit [the RMA] in combat" (13). The purpose of this study is the length at which the first mover keeps this strategic benefit.

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[2] Based off the list provided by Hundley 1999, 1; Horowitz 2010, 61. This is a well-accepted, non-exhaustive list of RMAs since 1800 in no particular order.

[3] While the FMA Theory ought to vaguely apply to doctrine-driven RMAs, the degree to which I am able to extrapolate is uncertain. I recommend this as a follow-up study.

**First mover** is an international actor that first uses an innovative weapon system. For this study, the first mover is the actor that not only introduces the weapon system, but also adopts it. As the only actor using the RMA, the first mover has the opportunity to benefit from it. In order to do so, the actor will seek to both integrate the innovative weapon system in its defense bureaucracy and protect it from competing actors.

**Secondary actors** are international players that follow the first mover. In response to the introduction of an RMA, the secondary actor will act to "catch up" to the first mover. The degree to which the secondary actor succeeds partly determines FMA length.

**Major power** is an international actor that holds military power over other actors. It is considered with regards to its international influence, its budgetary might, and its capital force. A player is labeled a major power for both its absolute and relative power. Major powers tend to be the first movers. While RMAs are not always brought about by hegemonic players, they are seldom used to the advantage of a low-level actor.

**B. Literature Review on Military Innovation**

With war comes tragedy. This is a well-established truth. War brings death, and a lot of it. Any theory on warfare must first begin by mentioning the honorable sacrifices made during it and horrendous casualties that result from it. In fact, war has no intrinsic value, but is instead a means of achieving a political goal, argued Carl Von Clausewitz in his famous treatise On War. States pursue conflict to achieve societal objectives; whether that pursuit translates into justice is a grander debate. The tragic reality of war sometimes renders virtue: pushing the natural bounds of human bravery, genuine togetherness among peers, and societal commitment to innovation and progress.

Technology is constantly changing—be it military or civilian. Military innovation has applications for the business community. Today, it is common for business leaders to explore war studies.[4] The military innovation process is not dissimilar to that of a private firm. Innovative technology can similarly shift an entire market. Technology-intensive companies are constantly seeking the next "revolution in non-military affairs." Within a firm, advances in *either* technological change or managerial change will increase productivity; a business that embraces *both* technological and managerial innovation add an even greater increase in productivity (Horowitz 2010, 6).

In many ways, a military behaves like any other human organization. Organizations function to maximize efficiency and promote a common goal. In a competitive marketplace, innovation is necessary for survival. According to MIT Professor Barry R. Posen, "warfare is an extremely competitive endeavor. Its most successful practitioners strive for even the smallest advantages" (Posen 1984, 48). This is why bureaucratic organizations must constantly implement change. However, while the newest cell phone's specifications may improve efficiency in civilian tasks, new technologies in large bureaucracies can achieve the opposite effect. In a business organization, new technological or managerial processes are costly.[5] In a military organization, innovation is similarly disruptive. For that reason, explains Harvard Political Scientist Graham Allison, "bureaucratic functionalists emphasize the inherently conservative nature of large organizations" (1971, 78-94).[6]

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[4] For this reason, many of my classmates who study business are assigned Sun Tzu's *The Art Of War* in management courses.

[5] For more on disruption due to innovation, see Harvard Professor Clayton M. Christensen, *The Innovator's Dilemma* (1997).

[6] "Conservative" connotes less willing to innovate in a particular RMA, not overarching political outlook.

Military bureaucracies are not just any organization, however. Change occurs within a military in order to foster an advantage in war. As Sun Tzu writes, “To not prepare is the greatest of crimes; to be prepared beforehand for any contingency is the greatest of virtues.” This piece of wisdom is as true today as it was in the ancient Chinese civilization. Preparation can transpire by means of innovative weapon systems.

Talk is cheap when it comes to innovation. A firm’s executives never admit that they will forgo innovation while its competitors vigorously invest in the most cutting-edge technology. Military organizations act similarly. Established militaries continuously assert their intention to integrate each novel weapon that arises. One needs to look no further than heightened rhetoric from military and political leadership on innovation over the centuries. Accordingly, understanding innovation requires one to distinguish between genuine action and mere rhetoric; this study focuses on the former and ignores the latter.

War impacts economics, social society, and technology, explains University of Chicago historian William H. McNeill. For economics, there is a strong relationship between market growth and capacity for military development (1982, 362). Economics impact war —economically powerful states tend to pursue military power. All military leaders understand that their organization benefits in the long-term from a well-fed and well-equipped fighting force. His examples stand the test of time. For example, Xerxes the Great of Persia found strength against the Greeks from efficient supply lines. Military victory is commonly a result of relative economic advantage (3-16). The relationship goes both ways; just as economic power influences military power, military power influences economic power. War prompts industrial growth, domestic production, and increased market coordination (262). Similarly, war is a deeply social occurrence. A military is a public entity

that serves domestic interest and impacts foreign culture. It is comprised of people from the community, yet influences culture abroad in wartime service. Thus, innovation demonstrates a society's capacity to change.

Most relevantly, McNeill writes that war impacts technology, and vise versa. On one hand, for strategic necessity, war pressures a society to innovate. On the other, new technologies frequently upset balances of power throughout history. He cites examples of RMAs, such as the introduction of gunpowder in the 14th and 15th centuries and the steamship and railroad in the 19th century (80-81).

If one is to accept that a military innovates, the next curiosity regards its timing. When is the best time for a military to innovate? Will a military innovate due to necessity during the chaos of war or will it innovate during the complacency of peace?

Wartime innovation is determined by successes and failures in combat. An innovative weapon system's successful debut can lead to an auspicious future for the system. In this case, innovation occurs "because an inappropriate strategic goal is being pursued, or because the relationship between military operations and that goal has been misunderstood" (Rosen 1991, 35). Or, in other words, innovation transpires when a war is not being won regardless of how well the traditional methods are being used. If stress on an organization can highlight a domain worthy of reform, war is appropriately a stressor.

The convention wisdom is that militaries tend to innovate following a war.[7] Lessons ought to be learned from experience. As in life, this is not always the case. Defeat in war is

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[7] This aligns with the notion that power transition increases the likelihood of conflict. According to the dynamic differentials theory, major war occurs when strong military powers fear significant decline in their relative power. Consequently, the strong state may see militarized conflict as a strategic tool for self-preservation, especially if it faces only one challenger rather than many challengers. For instance, strategic worries led to the Cold War between the United States and Soviet Union. This strategic insecurity can drive innovation as well. For more, see Dale Copeland, *The Origins Of Major War* (2000).

not “sufficient to produce innovation” following a conflict. Contrary to prevailing notions, “defeat by itself” will not produce change in subsequent peacetime. Change in personnel or practices are not immediate following a failure (9). Consider the United States Army’s lack of innovation following the Vietnam War. The conflict failed to yield innovative strategies in counterinsurgency (Lovell 1987, 121-154).

Instead, militaries learn lessons from previous wars in order to apply them to future scenarios. Dependency on lessons learned from the last war is not the most efficient way to innovate. When a military innovates solely based on preexisting notions, it fails to consider future challenges. Avant-garde thinking is required in innovation, because struggles from the most recent war may not remain in the next war. Tactics and technology change the nature of war on a linear time basis; innovation relates to the future, not just the past. Posen asserts that the British Royal Air Force as well as the French and German armies did not innovate in the time between first and second world wars (1984 , 223). This does not suggest militaries are innately anti-innovation; they still incrementally innovate based on their preexisting philosophies. Rather, it means militaries tend to not be efficient in doing so.

Innovation is possible during peacetime, though it is a slow process. Some argue that a military’s intelligence estimates on enemy weapon systems influence its own weapon system investments. However, Rosen makes the argument that American military development in technology from 1930 to 1955 occurred without much influence from the activities of potential enemies. Rosen argues that this was a “self-contained process,” determined by the actions and actors within the military establishment and unaffected by external actors (1991, 250). Peacetime military innovation occurs “remarkably

independent of intelligence about foreign military powers" (57). Potential adversaries fail to effectuate change within a military bureaucracy.

**C. Literature Review on Revolutions In Military Affairs**

How do RMAs occur? History illustrates that a military will only innovate under certain conditions. On a micro-level, a successful weapon system innovation is achieved through three steps: development, adoption, and integration (Ehrhard 2000, 10).

First, weapon system development is the process of creating a functional platform. This is accomplished through an incubation period of research and development.[8] In order for this to occur, defense organizations invest in the innovative weapon system. Innovation-friendly militaries have institutional mechanisms for experimentation (Hundley 1999, 66). Military technology research and development occurs through the private industry or state-driven public sector.

A technology-driven RMA is typically a result of combinations of "enabling technologies," rather than just an individual introduction. Multifaceted stages of new technology development "culminate in a new military reality" (61). For examples of enabling technologies, see Figure 2.

Military organizations will continuously invest in developing new systems and adopt them through a trial and error process. Then, if both development and adoption are successful, the organization will integrate the system into its bureaucracy.

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[8] It is also important to note the inverse; that is, failed RMAs. The purpose of the study is of course to understand successful RMAs, but for every successful RMA there are probably far more failed RMAs (Hundley 1999, 15). Much can be learned about military affairs from a failed RMA.

**Figure 2.** An RMA Requires an Enabling Technology[9]

| RMA | Period of Development | Enabling Technology | Years of Emergence |
|---|---|---|---|
| ICBM | 1995-1965 | Fusion weapons | 1950-1955 |
| | | Multistage rockets | 1945-1955 |
| | | Inertial guidance | 1950-1955 |
| Atomic bomb | 1941-1945 | Nuclear fission | 1938 |
| Carrier warfare | 1921-1939 | Aviation | 1900-1915 |
| | | Radio communications | 1900-1915 |
| Blitzkrieg | 1921-1939 | Tanks | 1915-1918 |
| | | Radio communications | 1900-1915 |
| | | Dive bombing | 1921-1926 |

Second, in weapon system introduction, the platform first experiences operational realities. In this stage, the innovative weapon system is tested and acquisitioned into the military bureaucracy (22). It is then debuted in its "demonstration point," the moment at which it is proved effective. The only way a weapon system proves to be worthy of full system integration is by means of actual experience. This is the innovative weapon system's critical demonstration point; or, the pivotal moment "when the relevant community has sufficient information to reasonably understand the significance of an innovation" (Horowitz 2010, 8).

Third, weapon system integration is the point at which the platform is a functional and viable means of action within the military bureaucracy and doctrine. Integration

[9] Adapted from the chart found in Richard O. Hundley, *Past Revolutions, Future Transformations: What Can The History Of Revolutions In Military Affairs Tell Us About Transforming The US Military?* (1999, 61). The requirement is for technology-driven RMAs.

requires a military to have its own demonstration point. An innovative weapon system will only receive investment if it seems auspicious. It is likely that a demonstration point typically occurs during warfare, because a conflict will display either the boons or deficiencies of a weapon system. In some instances, peacetime demonstration points may occur. And, if the demonstration point is remarkable enough for the technology's mass diffusion, it may not need operational experience. For example, the diffusion of the nuclear weapons has been sufficient to be integrated into plenty of countries' military doctrines without them using it. It also explains the diffusion of the technology to other actors. A demonstration point for one actor may provide justification for many countries adopting the system. Only when the technology has been developed and initially adopted can it be fully integrated into a military bureaucracy.

Integration requires the military to have its own operational concept, or "the manner in which the new system is employed in some type of military situation, accomplishing some military task either dramatically better or dramatically differently than it had been accomplished before, or performing a new task that did not exist previously" (Hundley 1999, 24). An RMA is the result of the union of a technological device and an employment concept. It is more than solely the culmination of hitherto unavailable enabling technologies. As military historian Max Boot writes in a history of military innovation since 1500,

> "Technology only sets the parameters of the possible and creates the potential for military revolution. What indeed produces an actual innovation is the extent to which militaries recognize and exploit the opportunities inherent in new tools of

war, through organizational structures and deployment of force. It was how people responded to technology that produced seismic shifts in warfare" (2006, 10).[10] Militaries must focus to invest in both the technical and doctrinal areas. Consider the examples of innovative systems and their required employment concepts in Figure 3.

**Figure 3.** An RMA Requires an Employment Concept[11]

| RMA | Device/System | Employment Concept |
|---|---|---|
| ICBM | Long-range ballistic missile with fusion warhead and inertial guidance | Bombardment of strategic, fixed targets |
| Carrier warfare | Wheeled planes operated from fast, flat-desk ships | Airborne attack of naval surface targets |
| Blitzkrieg | Tanks, two-way radios, and dive bombers | Mobile maneuver warfare |
| Machine Gun | Rapid fire, anti-personnel gun | Direct-fire weapon against massed infantry formations |

*C1. Leadership In Revolutions In Military Affairs*

Innovation is difficult, for change disrupts norms. Leadership is needed to break through the natural resistance to change. For the FMA Theory, leadership will be considered in four regards: organizational culture, administrative support, bureaucratic competition, and information safeguards.

Organizational culture is how the military's bureaucratic norms relate to the innovation process. Dr. Rosen notes the innate resistance to change in bureaucracies. Citing political theorist Max Weber, Rosen says, "Almost everything we know in theory about large

[10] Quoted from Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the US, and Israel* (2010, 1).

[11] Adapted from the chart found in Richard O. Hundley, *Past Revolutions, Future Transformations: What Can The History Of Revolutions In Military Affairs Tell Us About Transforming The US Military?* (1999).

bureaucracies suggests not only that they are hard to change, but that they are designed not to change" (Rosen 1991, 2). Sociologist Tom Burns and psychologist George MacPherson Stalker argue that bureaucratic organizations value consistency and repetition; efficient management is derived from retaining the status quo (1961).

There is an inherent paradox when it comes to military change. The commonplace assumption is that militaries are "seen as traditional in nature and therefore as being strongly disinclined to undertake major change." This is because "militaries prefer to preserve tried and tested strategies and structures." A military operationally assumes practices and holds fastidiously to its consistent traditions. Notwithstanding, a military must "make major changes in terms of…how they prepare to fight" (Farrell and Terriff 1991, 4). While a military must be operationally consistent, a strategic edge only occurs when it has the most advanced systems.

Rosen argues that military organizations tend to resist outside intervention. If regular bureaucracies are "not supposed to innovate," then certainly "military bureaucracies…are especially resistant to change" (1991, 2). Likewise, Posen says a military endeavors to "reduce both internal and external sources of uncertainty," which is achieved by relying on dependable routines. Like Farrell and Terriff, Posen writes that there is a bias against innovation within a military organization, for it is easier to repeat standard operating procedures (SOPs) than to introduce disruptive innovative weapon systems (1984, 44). Farrell and Terriff cite the "prolonged and painful birth of battlefield mechanization" as exemplifying the instinctive partiality toward SOPs (2002, 4).

Uncertainty is not the only reason behind this innate "inflexibility of military institutions." Traditionalism is deeply rooted in a military's culture. Rosen recites a fitting quote by Colonel John Mitchell of the British Army in 1839:

> "Officers enter the army at an age when they are more likely to take up existing opinions than to form their own. They grow up carrying into effect orders and regulations founded on those received opinions; they become, in some measure identified with existing views, till, in the course of years, the ideas thus gradually imbibed get too firmly rooted to either shaken or eradicated by the force of argument or reflection. In no profession is the dread of innovation so great as in the army" (1991, 2).

The long-standing traditions of a military organization are ingrained in a culture that vehemently resists change. The source of a military's consistent operational routines is the same source that disallows drastic innovation. Like most human organizations, a military does not maintain a culture that incentivizes innovation.

An innovation-friendly organization will maintain a culture of "productive paranoia,"[12] or a mindset receptive to change. A military with productive paranoia will look for unmet strategic challenges and value those who do so. An organization with a culture of productive paranoia will be able to focus on a definite thing or short list of things (Hundley 1999). This emphasis on novel concepts are a result of trial and error in the development stage.

Due to the nature of an RMA, military organizations sometimes face a challenge to its core competency. Hundley defines a core competency as "a fundamental ability that

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[12] A term coined by Hundley (1999, xix) and adapted from former CEO of Intel Andrew Grove, *Only the Paranoid Survive* (1999).

provides the foundation for a set of military capabilities" (Hundley 1999, 9). In other words, it is what the military is excellent at doing. Thus, challenging the virtue of one's core competency is very difficult. By challenging a weapon system that is one's core competency, one risks undermining the program. This is very difficult when the actor is especially skillful at the program. The process of considering a change in a core competency includes doctrinal changes, acquisition programs, force structure modifications (Posen 1984, 53; Hundley 1999, 24).

When one actor innovates, other actors will attempt to catch up. Cultural and psychological factors impact an actor's ability to respond. In his study of military-technical revolutions in the Soviet, American, and Israeli militaries, Adamsky discusses the cultural factors necessary for an RMA. Despite the assumed belief that technologically-established militaries would be more likely to be a first mover, the degree to which an organizational culture favors innovation matters just as much (2010).

Like other types of organizations, bureaucratic politics play a role in determining decisions for a military. If an actor faces obstacles to responsiveness, adoption can be more challenging. As Allison and Halperin explain,

> "the 'maker' of government policy is not one calculating decision-maker, but rather a conglomerate of large organizations and political actors who differ substantially about what their government should do on any particular issue and who compete in attempting to affect both governmental decisions and the actions of their government" (1972, 42).

A mission-oriented organization will "attempt to maintain or further their autonomy, organizational morale, organizational essence, and their roles and missions," writes Halperin (1971, 76; Beard 1976, 229).

Nonetheless, an actor can override "obstacles to responsiveness," or factors that will slow down the innovation process, by overcoming denial of the RMA's importance, avoiding diversion from adopting the RMA, and achieving acceptance of the RMA and implementing the pertinent action (Hundley 1999, 50-53). When one's core competency is challenged, the obstacles to responsiveness are even higher. Hundley reasons, "Established military organizations more often than not fail to respond adequately to emerging RMAs threatening their core competencies, even ones of which they are aware, primarily because of inherent obstacles to the changes necessary to cope with an RMA" (49).

Strong administrative support is necessary for the integration of an innovative weapon system. There are a few characteristics of a fully integrated weapon system. The platform will receive a "system-unique unit" within the organization; a division solely for the purposes of implementing that innovative weapon system. Also, it will obtain "an officer specialty for system operators;" that is, the individual operating the platform will be given a credentialed position. When an organization holds the weapon system in high regard, the cap on officer rankings will be higher. Subsequently, these system operators will become "a politically active, powerful constituency" within the bureaucracy. The platform will find support within the government and legislative bodies as well as the defense industry (Ehrhard 2000, 49).

In Rosen's study on whether endogenous or exogenous elements are mostly responsible for weapon system innovation, he found that peacetime innovation occurs due

to the influence of senior military officers. A respected high-ranking military officer, or "maverick," will value the innovative weapon system and push for its adoption (1991, 18). Career promotion is the internal source of power in a military. Senior officers will pioneer new promotion patterns or even "create new career paths" for younger, junior officers in specialty roles (76). When a high-ranking military officer can provide "both intellectual and organizational components" to an innovative weapon system, the military can consider adoption and implementation (21). This is most effective when the innovation originates from a maverick within a subgroup whose norms would be challenged by the innovation.[13]

Innovation created by personnel changes often lag by one generation. This inevitable one-generation time lag is sufficient for young officers who use the new technologies to become senior officers (76). Surely, British Colonel Mitchell's quotation holds value; younger officers accept the majority of practices from their superior officers. But gradual change does occur by these young officers adopting innovative technologies and strategies, and eventually passing on the improved doctrine to posterity.

Civilian actors can affect peacetime innovation too. A civilian political leader who is supportive of a particular platform can be instrumental in perpetuating a particular innovative weapon system. A politician will provide protective cover for the military maverick and the technology. Support for the technology's adoption is achieved through budgetary support for the program and public statements of approval of the innovation.

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[13] For example, United States Air Force General Bernard Schriever, a nuclear bomber pilot, was instrumental in the integration of the ICBM into the Air Force. For more, see the chapter on the ICBM.

Support for the military maverick is achieved through recommending promotion of the individual (14).[14]

Nonetheless, civilian political leaders are less instrumental to weapon system innovation than one would expect. Barnard College Professor Kimberly Marten Zisk argues that civilian intervention in military innovation is not always required. In Zisk's study of the Soviet Union's military bureaucracy, lack of civilian intervention permitted innovation. Interestingly, the Soviet military was "not as tied to the status quo as many believed." Based on evidence from declassified Soviet military journals, Gorbachev's leadership incentivized enough military innovation so to not produce a "civil-military conflict" (1993, 121). Innovation in the Soviet Union occurred because civilian leadership did not interfere.

Oftentimes, a political leader's benefit is only his or her support for the key military mavericks who have innovative ideas. In the United States, civilian leaders seldom "push the American military to develop capabilities it otherwise would have neglected" (Rosen 1991, 256). Budgetary support for a weapon system is needed, but Rosen warns that "it is wrong to focus on budgets when trying to understand or promote innovation." This is because "talented military personnel, time, and information" are purportedly the "key resources for innovation" during peacetime (252).

Posen contends that civilian political leaders invest their time on military oversight depending on the threat level. Civilians tend be more involved in a military organization's strategies in "periods of crisis" than in "periods of low threat." During low threat intervals, civilian elites do not spend their time on military oversight, but instead on other public policy matters. Meanwhile, military organizations tend to be unconfined in their

[14] Civilian support for a military maverick can sometimes even be more impactful than budgetary support.

bureaucratic planning. Civilian intervention peaks in high threat, or "crisis" moments. When this occurs, civilian assessments are made on "realpolitik" considerations, which are inclined to "trump organizational proclivities" (1984, 34-35). Hence, innovations made during crisis are based on political objectives instead of organizational needs.

Moreover, interservice bureaucratic competition can serve to promote or hinder an innovative weapon system. Integration must occur within each branch of a military. When one branch "fails to integrate it into its standard combat scheme…that particular innovative system is stifled" (Ehrhard 2000, 49). Relevant branches must interact appropriately in order to foster operational coordination and continued innovation. Each branch must work with the others in order to satisfy operational and management needs.

Alternatively, competition between branches is necessary for innovation. Each branch will strive to out-compete the other in terms of integration. Political scientist Samuel Huntington writes that "conventional wisdom holds that interservice competition necessarily undermines economy, efficiency, and effective central control in the military establishment." Rivalry occurs due to the impacts of jurisdiction, budgetary needs, operational sovereignty, and promotion potentials. For example, interservice competition in the United States is "the competition between military services (Army, Navy, Air Force, and Marines) for prestige, funding, and influence, particularly in the Congress." ("Interservice rivalry", 2001). Nonetheless, Huntington argues that in analyzing "American military politics and interservice rivalry since World War II...conventional wisdom may err" (Huntington 1961, 40).

Institutional safeguards protect proprietary information. A culture favoring innovation also seeks to protect its development, adoption, and integration methods from

other actors. Such militaries will take meaningful steps to avoid sharing its precious technological or organizational secrets regarding an RMA. For strategic and security reasons, a military will attempt to collect and assess an adversary's weaponry (Hundley 1999, 41). Information, both open-source and clandestine, is instrumental to the ability to develop, adopt, and integrate an innovative weapon system (39).

*C2. Doctrine In Revolutions In Military Affairs*

Like leadership, doctrine is fundamental to military innovation. Every military maintains a specific doctrine. Doctrine dictates an actor's commitment to certain goals, such as value among competing innovative weapon systems. When an weapon system aligns with a military's doctrine, the military will hold it in higher value. Reliance on the platform, or speculation that future scenarios will require reliance on the platform, causes an organization to commit to the platform. For the purposes of this study, doctrine will be considered through compatibility and resource allocation.

An innovative weapon system must be "compatible with valued local patterns" within the organization (Rogers, 14-16). A military will be far more willing to develop, adopt, and integrate an innovative weapon system if it aligns with its overall goals. Military organizations are inherently "risk-averse," explains political scientist Emily Goldman. Thus, militaries seek to "adopt technologies and strategies that support existing goals, defined in terms of protecting resources, autonomy (jurisdiction and independence), and organizational essence (the views on missions and capabilities held by the dominant group in the organization)" (Goldman, 267).

Compatibility relates to the offensive versus defensive strategic thinking. Militaries tend to hold a consistent position in bureaucratic strategy: an offensive bias. If militaries

were “left to their own devices,” which Posen says happens “frequently,” they would favor offensive strategies. This offensive bias is commonplace among all “large, functionally specialized bureaucracies” (1984, 34-45). In a military, this bias translates into larger budgets and greater resources, both of which “reduce uncertainty.” Offensive doctrines, as exemplified in the German Army and Air Force in the interwar period, limit civilian influence and therefore promote more autonomy (222).

Posen claims that a military’s offensive bias is intensified by an apparent information asymmetry. Military officers naturally understand more than their civilian overseers. Accordingly, military actors utilize this asymmetrical knowledge base in order to push for offensive strategies (69).

However, the availability of alternative platforms impacts the likelihood of pursuing an innovative weapon system. If a military can invest in a cheaper offsetting weapon system, then the innovative weapon system is less urgently needed. Many weapon systems are responded with a less costly defensive alternative.[15] The pursuit of that defensive alternative impacts the trajectory of the original system.

Similarly, the ability to bandwagon affects a military’s doctrine. If possible, a country will form alliances with a first mover in order to avoid the cost of the innovative weapon system. If a country is not able or not willing to coordinate with the first mover, then it may seek out other potential adopters to balance against the first mover (Elman; Horowitz 2010, 79).

Resource allocation shows commitment to an innovative weapon system. Internal value is determined via resources. A valued weapon system receives adequate funding and

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[15] Costliness is considered in terms of technological expense and organizational requirements.

support; an undervalued weapon system struggles to find budgetary support. A platform is protected and furthered through research and development and adoption measures, both of which require resources.

A modernizing military is more flexible in its resource allocation than an well-established military. For a modernizing military, free resource mobilization can be a boon for an innovative weapon system.

**D. Defining The Scope Of First-Mover Advantage**

The purpose of this study is to explain the length of FMA. For any study in the social sciences assumptions must be considered.

Length is divided into two categories: "lengthy" and "brief." But what does this really mean? How long is "lengthy" and how long is "brief"? Length, it must be assumed, is not necessarily measured in years. Instead, length must be relative to the circumstance of the RMA. Length measurement is deemed lengthy or brief relative to the era in which the RMA occurred. For example, consider the length of an RMA introduced during the Second World War compared to an RMA introduced during the Thirty Years' War. In absolute terms, the spread of an innovative weapon system may have taken longer before communication technology and advancements in defense organizations. For the purposes of this study, we must hold for such factors among the case studies.

In addition, an assumption must be held regarding the barriers of entry of an RMA. In order to be considered for this study, an RMA must be of sufficient difficulty for integration. As previously discussed at length, innovation adoption can be costly. According to University of Pennsylvania Professor Michael C. Horowitz, a military can only adopt an

innovative practice or technology if it meets the requisite "level of financial intensity" and "organizational capital" (2010).

Horowitz's Adoption-Capacity Theory explains when a military bureaucracy is capable of adopting an innovative weapon system, which occurs only under certain conditions. First, for a military to adopt a new system, it must be able to financially support it. This "financial intensity required to adopt innovation," measured in the cost per unit of technology, can deter a military from adopting an innovative weapon system. As the "cost per unit of the technological component" increases, fewer militaries are qualified to adopt the platform. In fact, the costlier the innovation, the more likely a military will resort to alternative means, such as offsetting technologies, bandwagoning, and alliances (2010).

Second, Horowitz states that in order for the diffusion of an innovative weapon system across militaries, each must also have the requisite organizational capital. In particular, a military organization must have the institutional ability to accept change. The Adoption-Capacity Theory states that effective innovation goes further than mere adoption. "There is a big difference between the introduction of a technology onto the battlefield and the full integration of that technology into national strategy," he writes. In fact, the "difference" can dictate the victor and loser in war (2010, 2-3). This is a costly process for large military bureaucracies with well-established SOPs.

But all innovations are "not created equal when it comes to the ease of adoption." Some innovative weapon systems are adopted and integrated with ease, while others are more costly. This can depend on the particular military actor. Horowitz posits that when an innovation demands high financial requirements, a preexisting wealthy and powerful state will benefit. When an innovation requires a higher organizational change, smaller actors

will benefit, which can "upset the balance of power toward newer and more nimble actors" (4-8).[16]

**E. Lengthy First-Mover Advantage**

The FMA Theory seeks to explain the success stories. Lengthy FMA is a pattern for which military leaders strive. It occurs when a first mover receives an advantage over an innovative weapon system and holds on to it for an extended period of time. The first mover introduces and integrates the technology. And, very importantly, a secondary actor is not able to do the same. FMA is determined by two variables, internal conditions and external conditions. With all other things being equal, the interaction between internal and external conditions either increases or decreases the length of FMA. Internal conditions explain the first mover's capacities; external conditions explain the second mover's conditions.[17] Both highlight an important part in the FMA process. Lengthy FMA is a result of a first mover developing, adopting, and integrating an RMA; the first mover holding on to that RMA; and the secondary actor failing in that same regard.[18]

*E1. Internal Conditions: Lengthy First-Mover Advantage*

Internal conditions explain phenomena within the actor's own bureaucracy. The process of FMA is simple. First, the military must develop the RMA. Second, the military must adopt and then integrate the RMA. Internal conditions that allow for greater ease in the innovation process lead to lengthier FMA. This is because constant innovations create

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[16] For example, nuclear weapons are seen only in larger military bureaucracies. Nuclear weapons have a very high per unit cost, yet they are an organizationally inexpensive weapon system (Horowitz 2010, 4-8).

[17] For simplicity, this paper takes the perspective of the first mover. Accordingly, "internal" factors belong to the first mover while "external" factors belong to a secondary actor; the "adversary" represents a secondary actor.

[18] See Figure 4, FMA Theory: Lengthy First-Mover Advantage (33).

greater likelihood of FMA. In essence, in order for lengthy first-mover advantage, a military needs to first become a first mover. Third, once the RMA is set within the first mover's bureaucracy, the first mover must protect the RMA from a secondary actor.

Internal conditions are divided into two categories: strong leadership and doctrinal congruence. Leadership within a bureaucracy has telling effects on FMA. A military with leadership conducive to innovation and protection, known as "strong leadership," elicits a lengthy FMA. Strong leadership includes the following: liberal organizational culture, strong administrative support, bureaucratic competition that enhances innovation, and strong information safeguards.[19]

A liberal organizational culture favors constant innovation, accepts criticism, questions its own core-competencies, and maintains institutions within it that aim to identify areas in which innovation is needed.[20] "Liberal" is not necessarily a political distinction, though politically liberal militaries tend to be organizationally liberal. Rather, liberal is synonymous with "innovation-friendly."

Strong administrative support is achieved by individuals standing up for an RMA. Senior military mavericks promote and protect innovative weapon systems, and their civilian political counterparts promote and protect them. Administrative support also includes how decisions are made. Adoption and integration of novel technologies flourishes with less hesitation from the leadership. With more central leadership, quick changes in

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[19] It is important not to confuse the factors within leadership. Information protection can be valued regardless of the extent of its liberalism. Whether or not the bureaucracy is open to new ideas, or even the military is one of a liberal state, has little to do with its commitment to keeping its innovative weapon systems from competing actors.

[20] Liberal versus rigid is measured with respect to each RMA. Conceivably, there could be a military with a notably rigid organizational culture but, for whatever reason, is willing to be liberal for a specific RMA. In this hypothetical, the culture is deemed "liberal" for this particular RMA, even though the label may seem undeserved.

planning are possible. Policy-making processes are swifter with fewer actors involved, which occurs in less inclusive institutions.[21]

Strong leadership indicates bureaucratic competition is healthy and does not stifle growth. Inter-branch competition over operational roles and weapon system programs can drive development, adoption, and integration, so long as rivalry does not undermine the program.[22]

Information protection decreases the likelihood that a technology is adopted by a secondary actor in the short-term. Military organizations keep their clandestine innovations from other actors. A first mover with institutional information safeguards is more likely to halt the diffusion of the RMA.

The extent to which an RMA is congruent with one's doctrine determines the length of FMA. A weapon system that is "doctrinally congruent" aligns with the organization's goals and increases the length of FMA. Doctrinal congruence is determined through compatibility and resource allocation. When a weapon system is compatible with a military's own grand strategy, it seeks to protect it. Resource allocation reflects a military organization's value on a weapon system. Favorable resource allocation increases FMA length. When an RMA aligns with a military's vision for the future, the military attempts to keep its advantage through budgetary support.

*E2. External Conditions: Lengthy First-Mover Advantage*

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[21] There exists a trade-off between liberal culture and central planning. Central planning, which increases the length of FMA, is usually associated with a rigid organizational culture, which decreases the length of FMA. In order for Lengthy FMA, the central planning must not inhibit the organizational culture. There is much theory dedicated to the virtues of central planning versus dispersed governance, which will not being examined.

[22] This is mostly critical in innovative weapon systems that bridge two or more branches of a military.

External conditions explain phenomena within the secondary actor that relate to the innovation process. The factors that contribute to the first mover's success must not be present for the secondary actor. The secondary actor is understood through "external conditions." By definition, external conditions should demonstrate the antithesis of internal conditions. In order for a condition to prompt lengthy FMA for the first mover, the opposite of that same condition is present in the adversary's military. External conditions are expressed via weak leadership and incongruence to adversary doctrine.[23]

First, for lengthy FMA, the secondary actor must exhibit weak leadership. Weak leadership hinders innovation and disallows catch-up to the first mover. Weak leadership is demonstrated through rigid organizational culture, weak administrative support, bureaucratic competition that stifles innovation, and weak information safeguards. A rigid organizational culture is not open to criticism, does not question its core-competencies, and does not have institutions that aim to identify areas in which innovation is needed. Weak administrative support creates dispersed and indecisive decisions, rather than centrally-planned and decisive ones. Military mavericks and civilian leaders do not support innovative weapon systems; or they are unwilling or unable to do so. In weak leadership, bureaucratic rivalry over competing resources and programs stifles the growth of these very resources and programs. And information protection is not institutionalized, thus other militaries can consider the potential for catch-up.

Second, lengthy FMA occurs when the RMA is incongruent with the secondary actor's doctrine, evidenced by incompatibility and unfavorable resource allocation. For

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[23] For a comparison between strong leadership and weak leadership, see Figure 7, FMA Theory: Leadership (34). For a comparison between doctrinal congruence and doctrinal incongruence, see Figure 8, FMA Theory: Doctrinal Congruence (34).

incompatibility, a military is less likely to pursue a technology if it does not serve an integral function to its organizational goals. The secondary actor continues to pursue other weapon systems, while the first mover values the RMA and take steps to protect it. Unfavorable resource allocation for the secondary actor indicates that the RMA is not valued as a vital necessity for war planning.

**Figure 4.** FMA Theory: Lengthy First-Mover Advantage

| | | Conditions | |
|---|---|---|---|
| | | Leadership | Congruence |
| Internal vs. External Explanations | Internal (First Mover) | *Strong* | *Congruent* |
| | External (Secondary Actor) | *Weak* | *Incongruent* |

**Figure 5.** FMA Theory: Brief First-Mover Advantage

| | | Conditions | |
|---|---|---|---|
| | | Leadership | Congruence |
| Internal vs. External Explanations | Internal (First Mover) | *Weak* | *Incongruent* |
| | External (Secondary Actor) | *Strong* | *Congruent* |

**Figure 6.** FMA Theory: Brief First-Mover Advantage: Simultaneous Innovation

| | | Conditions | |
|---|---|---|---|
| | | Leadership | Congruence |
| Internal vs. External Explanations | Internal (First Mover) | *Strong* | *Congruent* |
| | External (Secondary Actor) | *Strong* | *Congruent* |

**Figure 7.** FMA Theory: Leadership

| | | | | |
|---|---|---|---|---|
| Strong Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Enhances Innovation* | *Strong Information Safeguards* |
| Weak Leadership | *Rigid Organizational Culture* | *Weak Administrative Support* | *Bureaucratic Competition Stifles Innovation* | *Weak Information Safeguards* |

**Figure 8.** FMA Theory: Doctrinal Congruence

| | | |
|---|---|---|
| Congruent | *Compatible (Offensive versus Defensive Doctrine)* | *Favorable Resource Allocation* |
| Incongruent | *Incompatible (Offensive versus Defensive Doctrine)* | *Unfavorable Resource Allocation* |

**F. Brief First-Mover Advantage**

Brief first-mover advantage occurs when a first mover receives an advantage over an innovative weapon system, yet it does not last. The first mover introduces and integrates the technology, but a secondary actor soon is able to do the same. By definition, brief FMA stands opposite to lengthy FMA. The converses of the conditions that explain lengthy FMA are those that explain brief FMA. The argument for brief FMA follows that of lengthy FMA, only in its antithetical.[24] Like lengthy FMA, brief FMA is determined by two variables: internal conditions and external conditions. Internal conditions explain one's own capacities; external conditions explain the adversary's conditions.

*F1. Internal Conditions: Brief First-Mover Advantage*

Some first movers fail to keep a first-mover advantage. The internal conditions of the first mover that lead to brief FMA include capacities that neither prompt constant innovation nor protect it from a secondary actor. These are similar conditions as the external conditions that disallow a secondary actor to catch up in lengthy FMA. The internal conditions include weak leadership and doctrinal incongruence.

A first mover's weak leadership decreases the length of FMA. If a first mover has a rigid organizational culture, weak administrative support, bureaucratic competition that stifles innovation, and weak information safeguards, secondary actors are capable of exploiting the opportunity, resulting in a brief FMA. The innovative weapon system's incongruence with the first mover's doctrine will lead to short FMA. When the weapon system is incompatible with one's own grand strategy, a military does not have the incentive for resource allocation and protection of the system. Although the first mover

[24] See Figure 5, FMA Theory: Brief First-Mover Advantage (33).

holds an advantage, it does not view the RMA as vital to its security and doctrinal future and will not take steps to protect it.

*F2. External Conditions: Brief First-Mover Advantage*

A secondary actor can quickly catch up, if the conditions are correct. These are similar conditions as those that contribute to a first mover's success in lengthy FMA. In particular, the secondary actor's catch up is accomplished through strong leadership and doctrinal congruency. For leadership, the secondary actor has a liberal organizational culture, strong administrative support, bureaucratic competition that enhances innovation, and strong information safeguards. For congruence, the weapon system is compatible with its doctrine and receives favorable resource allocation.

*F3. External Conditions: Brief First-Mover Advantage (Simultaneous Innovation)*

There is another explanation for brief FMA, called "simultaneous innovation." Simultaneous innovation occurs when both the first mover and secondary actors measure well on the leadership and doctrine metrics. Consider two actors pursuing a technology-intensive RMA at the same time. If one actor (the first mover) achieves the RMA first, the other actor (the secondary actor) will shortly follow. The secondary actor's ability to catch up is not attributed to a transgression of the first mover.[25] For simultaneous innovation, internal conditions include strong leadership and congruent doctrine; likewise, external conditions present strong leadership and congruent doctrine.

**G. Research Design**

The research design chosen for this study is strictly qualitative. The research presented in this study is predominantly a synthesis of secondary sources, though primary

[25] See Figure 6, FMA Theory: Brief First-Mover Advantage: Simultaneous Innovation (33).

sources are considered. Much theory and study has been advanced in this field. Our current understanding of military affairs is an amalgamation of great military leaders and academics producing theory generation after generation. In turn, the FMA Theory and the subsequent three case studies stand on the shoulders of military and academic giants.

Given the large universe of RMA cases, the three selected—the aircraft carrier, the submarine, and the intercontinental ballistic missile—test both lengthy and brief FMA. They were chosen for generalizability. The RMAs are contemporary historical examples that encompass the pre-nuclear, major-war period and the post-nuclear Cold War era. The selected case studies are all used in the present day.[26] Confirming the hypotheses tested in this paper would demonstrate important implications of the FMA Theory for today's actors. Predicting the next RMA is the topic of many other papers, but the FMA Theory explains the length at which the first mover maintains a strategic advantage over the RMA. The secrets behind how war is won is indeed a subject of critical importance.

[26] The FMA Theory ought to hold for RMAs introduced before the 20th century, though the selected case studies do not afford such an extrapolation.

**III. CASE STUDY: THE AIRCRAFT CARRIER**

Any discussion on the projection of naval power ought to begin with the aircraft carrier. The aircraft carrier has become a symbol of military superiority. Today the United States is the overwhelming major naval power because of its aircraft carrier capabilities. The United States Navy operates 11 carrier fleets while no other country operates more than one carrier fleet. Only 14 actors have ever possessed aircraft carriers; no actor other than Great Britain operates more than one carrier of any type (Verma 2011, 6).

What is carrier warfare? As defined by Horowitz, it is "the combined use of fleet aircraft carriers and an array of logistical ships for the purpose of conducting strikes against enemy naval assets and establishing sea control" (2010, 67). At its basics, an aircraft carrier is a sea-going warship designed for both deploying and retrieving aircraft. The stakes are high when it comes to carrier warfare. Within a single generation, the aircraft carrier "replaced the battleship as a beating heart of successful naval organizations." The carrier became a "mobile airfield, abandoning reliance on gunfire," which had been a staple of navies for a few centuries (67-68). The beauty of the carrier is that it "represents a diverse set of capabilities that transcend the narrow confines of just 'sea power'" (Verma 2011, 3). The aircraft carrier combines air and sea platforms into a revolutionary weapon system, the ideal platform for the pursuit of naval aviation.

A self-contained system, the aircraft carrier allows navies to conduct "operations with far-reaching effects at the strategic, operational, and tactical levels" (4). They greatly maximize distance covered—projecting naval power from the sea over hundreds of miles. This RMA is part of a larger trend in military innovation: the increase of distance in battle. Hand-to-hand combat at short range developed to line-of-sight combat at a greater range.

Then, the aircraft carrier expanded the distance of reach even farther (Fontenoy 2006, vii; Verma 2011, 4).

The history of the aircraft carrier begins in the First World War and continues today. It is the story of how three prominent navies—the United States Navy, the British Royal Navy, and the Imperial Japanese Navy—fought to keep their relative advantages.[27] In World War I, the British Royal Navy was the first to introduce the aircraft carrier with the HMS *Furious*. In the interwar period, the Japanese Imperial Navy was the first to adopt the aircraft carrier. Carrier warfare largely dictated the outcome of many sea battles during the Second World War. Following World War II, the United States Navy fully integrated the aircraft carrier and reorganized its organization around carriers, presenting a dominance that continues today. Since the Second World War, the aircraft carrier has been used in various types of missions other than traditional combat, including humanitarian assistance and disaster relief operations, peacekeeping, support of low-intensity operations, and for power projection (Verma 2011, 4).

The history of the aircraft carrier raises a two critical questions. First, why were the British or Japanese not able to keep their FMA? Second, why has no other actor been able to challenge the United States Navy in carrier warfare in the post-war era? In the following chapter, I will outline the development, adoption, and integration of the aircraft carrier, explain the two FMAs, and test carrier warfare with the FMA Theory. I find that the FMA Theory indicates strong leadership and congruent doctrine by United States Navy and weak

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[27] Other navies have adopted the aircraft carrier but are not of relevance to the study on FMA. Other less prominent, perhaps "tertiary," countries that experimented with the aircraft carrier include Germany, Italy, France, and the Soviet Union. Only the United States, Japan, Great Britain, and possibly France have ever had the operational capacity to establish a carrier-centric fleet (Horowitz 2010, 77).

leadership and incongruent doctrine by the British Royal Navy and the Imperial Japanese Navy. Depending on how first-mover status is determined, which in this case is contentious, the FMA Theory explains both lengthy and brief FMA.

**A. Development And Adoption**

The First World War set the aircraft carrier in motion. Prior to the war, the British Royal Navy was a hegemonic force, but the actuality of naval aviation was limited to a great theoretical promise (Horowitz 2010, 66). In the second half of the 19th century, warship design was enhanced by steam power and advances in artillery (Fontenoy 2006, 1). Then, as all the great powers met in conflict, the idea of naval aviation became tangible.

The British Royal Navy and the Japanese Imperial Navy first introduced the aircraft carrier in World War I. The British began with the HMS *Furious*, debuting the world's first aircraft carrier. The United States used the *Furious* as a basis for their first carriers due to the influential writings of British naval constructor S. V. Goodall on their carrier experience (Friedman 1983, 33). The United States briefly deployed two aircraft on the battleship *Mississippi* in April 1914. However, the United States Navy did not undertake serious efforts until after the war (Fontenoy 2006, 11-12). Simultaneously, the Japanese launched the earliest carrier-based aircraft in September 1914. The Imperial Japanese Navy used the seaplane carrier *Wakamiya Maru* for a reconnaissance mission over the German fortress city of Tsingtao (14).

By the conclusion of the First World War, naval aviation had "secured for itself an important place in operations." While the vast majority of carriers remained shore-based, the *Furious* demonstration point "confirmed the potential of carrier-based aviation," despite its technological and organizational infancy (Fontenoy 2006, 21). Before the war, carriers

were expected only to be useful in reconnaissance roles; during the war, however, they proved to be effective in offensive missions and fleet defense (13).

While World War I provided the introduction, the interwar period served as the incubation period for aircraft carrier experimentation. Following the end of World War I and the decline of the German and Austro-Hungarian navies, three prominent naval powers remained: Great Britain, the United States, and the Empire of Japan. And in the 1920s and 1930s, these three navies experimented with carrier warfare (23). United States Navy Admiral William Sims designed tabletop exercises featuring carriers at the Naval War College in the early 1920s. The commitment to carrier experimentation in this era later "made it easier for the United States Navy to make the final jump to adopt carrier warfare" in World War II (Hone, Friedman, and Mandeles, 1999). The British Royal Navy ordered the *Hermes*, the first vessel designed specifically for carrier operations in July 1917. Then in 1924, the British converted the battleship *Almirante Cochrane*, an incomplete battleship bought from the Chileans, into the carrier HMS *Eagle* (Fontenoy 2006, 24).

**B. Integration And First-Mover Advantage**

For the aircraft carrier, the FMA was established in the Second World War. Following the war, the fall of the Imperial Japanese Navy and the end of the hegemonic British Navy led the United States Navy to launch ahead as the leader in aircraft carrier warfare. However, while the final outcome of the war impacted the trajectory of the carrier, actions taken during World War II prompted the lengthy American advantage and brief Japanese and British advantages.

Carrier warfare in World War II can be explained through three demonstration points. First, the British attack on the Taranto Italian harbor on November 12, 1940 "hinted

at the potential of the carrier as an offensive strike element" (Goldman 2003, 267). Still, the British degraded the carrier to a defensive role in the war. As a result, World War II became a period of British carrier stagnation, characterized by an unwillingness to completely adoption. Late in the war, the British Pacific Fleet began adopting American management operations for carrier task forces in the joint Okinawa campaign of 1945 (2003, 277; Friedman 1989).

Second, the use of carriers in the Japanese attack on Pearl Harbor on December 7, 1941 illustrated an internal value placed on carrier-based strikes. While the British lost their edge, the Japanese and Americans saw the value of carrier warfare as an offensive weapon and took first-mover steps to integrate (Goldman 2003, 267-277). By the mid 1930s, the Imperial Navy had overtaken the Royal Navy in naval aviation. This was evidenced by the attack on Pearl Harbor as well as the sinking of the British HMS *Prince of Wales* by Japanese naval air three days later. Also, in July 1942 the Japanese naval fleet officially reorganized around carrier task forces (Horowitz 2010, 69-70).

Third, for both the Japanese and Americans, the Battle of Midway on June 4 to 7, 1942 served as a demonstration point for carrier warfare (Stulberg 2005, 510). Midway indicated the necessity of carriers in Japanese and American war planning, such as "decisions concerning the fleet compositions by both [United States Navy Fleet Admiral] Chester Nimitz and [Japanese Marshall Admiral] Isoroku Yamamoto," as well as realtime response (Fuquea 1997, 710). The battle "signified a conceptual shift, as the aircraft carrier came to be seen as the primary capital ship in Britain, the United States, and Japan" (Goldman 2003, 267). The Americans brought its carriers, not its battleships, to Midway. According to Admiral Nimitz's report, long-range air strikes became a decisive

element in the naval battle (Horowitz 2010, 69; Nimitz 1942). Following Midway, naval aviation secured its place as "the principal offensive element" of the two navies. And both navies "changed their force structures to task forces centered on [aircraft carrier] employment in combination with screening and logistical ships (Horowitz 2010, 69-70). Goldman writes, "Collectively, Taranto, Pearl Harbor, and Midway compelled naval leaders to revise how they viewed the relationship between battleship, battle line, and aircraft carrier." In turn, the carrier was viewed in a vital independent role (Goldman 2003, 273).

The post-war period solidified American supremacy over the aircraft carrier. The American carrier program is so central to its navy that "whenever the United States gets involved in a foreign crisis, one of the first questions the White House asks the Pentagon is 'Where are the carriers?'" (Gardiner 1993, 14).[28] Through different conflicts—the Korean War, Vietnam War, Gulf War, Iraq War, and Afghanistan War, not to mention the Cold War with the Soviet Union—the United States has relied on carrier warfare as both an offensive strike weapon and a defensive stronghold (Goldman 2003, 267). Since 1945, carrier modernization has been a priority of the United States Navy.

Innovation within the RMA has flourished, both technically and operationally. Carrier warfare has changed from propeller-driven aircraft to jet aircraft, from hydraulic catapult to the steam catapult, and from flat decks to angled decks. Carriers can now be nuclear-powered and permit vertical and short take-off landing (V/STOL) aircraft (Gardiner 1993, 23).

While the United States has invested heavily in carrier warfare since World War II, no secondary actors have yet been able to adopt the RMA. Since 1945, the aircraft carrier

[28] For security purposes, the answer to the aforementioned question is that the carrier fleets are strategically placed so as to always have one in close proximity to a conflict.

has failed to diffuse. The post-war period is only relevant to the FMA Theory in that American dominance persisted while other actors have mainly been unable to integrate (Horowitz 2010, 67). After World War II, Great Britain is the only other country to integrate the carrier, and that was only due to their lasting alliance with the United States.

Instead of adopting the RMA, other actors have pursued alternative response strategies (67). The most likely secondary actor in the post-war era would have been the Soviet Union. Despite a commitment to military buildup in the Cold War, the Soviet Union "disdained the acquisition of carriers." In turn, the Soviet Union's naval doctrine became "dictated by the Western carrier task forces, and the need to guard against them" (Gardiner 1993, 14). The Soviets were "late adopters" by forming a relatively unsuccessful program toward the end of the Cold War. Instead, the Soviets invested in alternative platforms—namely, the submarine and missile technologies—in order to offset the carrier (Fontenoy 2006, 133-136).[29]

Recently, the People's Liberation Army Navy of China shows signs of becoming an adopter of carrier warfare. As a growing regional and global military actor, the People's Republic of China has demonstrated their interest in carrier development by buying the *Varyag*, a failed Soviet carrier, and commissioning it into *Liaoning* (Chang 2012).

**C. Analysis**

It is possible to argue that there were two FMAs—not only the obvious lengthy American FMA from World War II and continuing to this day, but also the brief British and Japanese FMAs from World War I to the interwar period. Which FMA matters depends only on how one interprets who the first mover is. If first-mover status begins at weapon system

[29] For more on the Soviet pursuit of offsetting weapon systems, see the following chapters on the submarine and intercontinental ballistic missile.

introduction, the British Royal Navy held a brief FMA; if it begins at weapon system adoption, the Japanese Imperial Navy held a brief FMA; and if it begins at weapon system integration, the United States Navy held a lengthy FMA. For an overview of how the FMA Theory holds either way, see Figure 9. For the British and Japanese carrier programs, brief FMA occurred because of internal weak leadership and doctrinal incongruence as well as the external American strong leadership and doctrinal congruence. For the American carrier program, lengthy FMA is attributed to internal strong leadership and doctrinal congruence as well as weak leadership and doctrinal incongruence by any adversaries.

**Figure 9.** Aircraft Carrier Results

| | Leadership | Congruence |
|---|---|---|
| United States Navy | *Strong* | *Congruent* |
| Japanese Imperial Navy | *Weak* | *Incongruent* |
| British Royal Navy | *Weak* | *Incongruent* |

It must first be argued that the aircraft carrier passes the requisite assumptions; that is, that the RMA, according to Horowitz's Adoption-Capacity Theory, has sufficiently high barriers to entry. Organizationally, the carrier warfare RMA necessitates vital changes in doctrine. Organizational requirements include extensive training of a tremendous quantity of personnel in order to integrate both traditional naval functions with air power functions. The multiplicity of independent tasks serves as a severe challenge for any military actor to adopt (Horowitz 2010, 72). High organizational barriers are demonstrated by the fact that only three navies—the United States Navy, British Royal Navy, and WWII-

era Imperial Japanese Navy—have ever been capable of the "core organizational practices associated with carrier strike operations" (65). Unlike other highly technical RMAs, such as the atomic bomb, the carrier technology by itself, without the organizational expertise, is useless for international security (71). Technologically, the aircraft carrier is extremely costly. The carrier warfare RMA requires the carrier itself, a weapon platform of extreme financial cost. Consider the expense of the *USS George H.W. Bush*, the final United States Nimitz-class aircraft carrier: 6.35 billion dollars in total procurement cost (O'Rourke 2005).[30] Horowitz explains the technological barrier to entry:

> "Investing a little bit every year would not culminate in a modern and competitive carrier warfare force. Today, decades after the introduction of the innovation, even if a state purchases a prebuilt carrier and avoids developmental costs, the maintenance costs of running an aircraft carrier are still on the order of hundreds of millions of dollars a year" (2010, 71).

In addition, because of the dual sea-air functionality, carrier warfare requires "the integration of technological advancements also utilized in other military areas" (2010, 68).

The introduction of the aircraft carrier RMA was the result of two enabling technologies, radio communications and aviation. From 1900 to 1915, aviation and radio became feasible technologies with military applications (Hundley 1999, 61).[31]

It must next be demonstrated how the Japanese, British, and American navies fit into the FMA Theory model—via leadership and congruence. The model will explain why the British swiftly squandered their innovation edge during the interwar period and why the

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[30] The *USS George H.W. Bush* was more costly than the average Nimitz-class carrier, but the central point of high "financial intensity" remains.

[31] See Figure 2, An RMA Requires an Enabling Technology (14).

Americans became the dominant actor over the Japanese in World War II and over other adversaries in the post-war era.

*C1. The Aircraft Carrier: Doctrinal Congruence*

How did the aircraft carrier fit into the navies' doctrines? First, doctrine consists of the internal compatibility of the weapon system with its overall offensive or defensive bias. While the overall assumed doctrine in the interwar period was that carriers would be "supporting elements, providing reconnaissance, scouting, and protecting battleships from enemy planes," this was not sustained in World War II (Horowitz 2010, 73). For the United States Navy, carrier warfare was considered an offensive platform, which was compatible with its offensive bias. With a big ship-big gun orthodoxy, the American carrier was adopted in "moderate/high capacity," as defined by Goldman (2003, 299-302). The Navy needed "offensive power projection across vast ocean expanses, a mission for which the carrier was ideally suited."

The British Royal Navy viewed carrier warfare as a defensive platform, conflicting with its gunnery naval bias. They intended to use carriers in conjunction with battleships for protection, not "autonomous offensive or defensive missions" (Rosen 1991, 97-98; Till 1977, 112). Offensive carrier warfare had the potential to flourish in the Mediterranean, but the offensive strike doctrine did not come from the British until late in the war against the Germans in Norwegian waters (Goldman 2003, 270). The British carrier was adopted in "very low adoption capacity" (299-302).

The Imperial Japanese Navy considered naval aviation a defensive means of supporting other operations, which directly contradicted its offensive war bias. Kings College London Professor George Till cites one of the first Japanese aviators, "The strategic

concept of the Japanese Navy was undoubtedly based upon the doctrine of annihilating the enemy in decisive battle, with battleships the backbone of the Japanese Fleet" (Till 1996, 220). While Japanese carriers shifted to an offensive carrier role in 1932, the Naval General Staff always valued traditional battleship engagement more than carrier warfare (Horowitz 2010, 73). The Japanese carrier program was adopted in "moderate/low capacity," as defined by Goldman (2003, 299-302).

Also relevant to doctrinal congruence is the actor's expectations regarding its adversary. On one hand, a potential threat can spur innovation. In the interwar period, both the United States and Japan regarded each other as threats, prompting war planning in favor of naval aviation. Unlike the European theater, significant geographic distance between these two powers meant that far-reaching power projection was vital. Because of the limited range of land-based aircraft, naval aviation became a critical goal for both sides (Horowitz 2010, 74). Braisted writes on the American pre-war expectations:

> "On the assumption that Japan, not Britain was the most likely antagonist, the planners in Operations drew up a building program that gave first priority to preparations against the more immediately dangerous Asian rival. The recommendations of the Plans Division were based on a scheme for a three-phase Pacific war. During the first, the Navy would concentrate its main battle forces in the Eastern Pacific. This would prepare for phase two, the advance to the Western Pacific, during which the United States would occupy points in the Japanese mandates and recapture Guam. The third phase would be aimed toward bringing decisive pressure on Japan through close blockage and occupation of her territories...Since completion of the 1916 program would guarantee the United

> States decisive superiority over Japan in capital ships through 1924, the Plans Division favored laying down during the coming year other types in which the Navy was seriously deficient: four airplane carrier...and six submarines" (1971, 472).

On the other hand, an adversary hinders weapon system integration when the threat does not align with its doctrine. During World War II, the British viewed Nazi Germany and Fascist Italy as its most urgent threats, and neither possessed aircraft carriers. Therefore, as the British valued a "Germany-first" strategy, resources were allocated to the Royal Air Force and its land-based air attacks, not the aircraft carrier (Goldman 2003, 276-277).

Similarly, in the post-1945 period, the Soviet's inaction actually furthered the American carrier doctrine. Japan served as the primary naval threat in the Second World War, so the subsequent weak Soviet surface challenge was to the American boon. American naval planners used carriers as a forward deterrent weapon. United States Navy carriers mitigated the threat of the Soviet Union "overrunning forward land bases." So, the United States Navy valued carriers as "a major means of striking back at Soviet forces" (Gardiner 1993, 18).

Availability of alternatives to the weapon system can impact its doctrinal congruence, as evidenced by the lengthy American FMA after 1945. "Other states interested in pursuing naval capabilities, but lacking the financial and organizational capabilities to adopt or the willingness to ally with an adopter, have chosen to develop alternative naval capabilities, especially submarines and anti-ship missiles." Instead of its own carrier program, the Soviet Union invested in offsetting technologies like submarines with advanced torpedoes and anti-ship missiles technologies (Horowitz 2010, 82). Hitherto, the Chinese have followed likewise, integrating alternative weapon systems rather than

adopting Chinese carriers (O'Rourke, 2005). Since the 1970s reform era, Chinese officials have expressed interest in the aircraft carrier as a program vital to naval modernization. They acquired retired carriers for the purposes of information gathering. On September 25, 2012, the Chinese commissioned the *Liaoning*, the People's Liberation Army Navy first aircraft carrier. The *Liaoning* is remodeled from the *Kuznetsov*-class *Varyag* aircraft carrier (Office of the Secretary of Defense 2012, 7).

Second, for the evaluation of doctrine, the American carrier program had favorable resource allocation while the Japanese and British programs did not.[32] While the United States passed the 1938 Naval Expansion Act, providing budgetary support for the aircraft carrier. Contrastingly, British and Japanese faced fiscal constraints following the First World War. Lack of domestic support for defense spending in the interwar period translated into a weaker budget. More so, following the war the Allied occupation of Japan led to a new constitution forbidding a military.

In summation, with regards to doctrinal congruence, the FMA Theory holds for lengthy FMA for the United States Navy as the first mover. Internally, the American military exhibited doctrinal congruence with a compatible doctrine and favorable resource allocation. Externally, American adversaries displayed doctrinal incongruence with incompatible doctrine and unfavorable resource allocation. Moreover, the FMA Theory holds for brief FMA for the British Royal Navy or the Japanese Imperial Navy as the first

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[32] The 1922 Washington Naval Conference imposed further fiscal constraints. The conference elicited the Five-Power Naval Limitation Treaty, which limited the overall development of naval warships among prominent actors. It created the tonnage ratio for battleships, battle cruisers, and aircraft carriers of 5/5/3/1.67/1.67 for the United States, British, Japanese, French and Italian navies, respectively (Horowitz 2010, 76; Fontenoy 2006, 23).

mover. Internally, the British and Japanese both exhibited doctrinal incongruence while the United States Navy, the secondary actor in this case, maintained a doctrinal congruence.

**Figure 10.** Aircraft Carrier Doctrinal Congruence

| | | |
|---|---|---|
| American Congruent Doctrine | *Compatible (Offensive versus Defensive Doctrine)* | *Favorable Resource Allocation* |
| Japanese Incongruent Doctrine | *Incompatible (Offensive versus Defensive Doctrine)* | *Unfavorable Resource Allocation* |
| British Incongruent Doctrine | *Incompatible (Offensive versus Defensive Doctrine)* | *Unfavorable Resource Allocation* |

*C2. The Aircraft Carrier: Leadership*

How did the aircraft carrier fit into the navies' leadership? First, liberal and rigid organizational culture must be assigned to the three navies. The British held the most rigid organizational culture. Due to its recent hegemonic status, the British Royal Navy was unwilling to challenge its core competencies. The United States and Japanese navies were relatively young and both began naval modernization by World War I. The Imperial Navy modernized after the Meiji Restoration in 1868, and the United States Navy modernized a bit afterwards. The lasting British naval superiority undercut its carrier platform. Geoffrey Till argues that the United States and Japanese navies became first movers in carrier warfare because of their organizational age. "In contrast to the British policy," Till writes, "the Japanese and American, being newer in the business were willing to make bolder departures" (1996, 198). The United States Navy produced a culture productive paranoia, or a "healthy skepticism," regarding a naval revolution that included aviators (Goldman

2003, 301). Nonetheless, the Japanese initiated a "more receptive organizational environment for developing offensive carrier doctrine" (285). Although the organizational culture favors the Japanese over the Americans, it is only a slight edge, for military mavericks publicly backed the carrier RMA since its infancy.

Second, strong administrative support can further a weapon system adoption and weak administrative support can hinder it. The Royal Navy had the weakest administrative support among the three navies. British attempts at naval reforms failed to secure high-level political or military support. The planners in favor of carrier warfare had low administrative authority. Unlike the British, the Americans and Japanese both enacted "administrative changes early on that paved the way for an air-centered vision of naval operations." President of the United States Franklin D. Roosevelt was an avid supporter of carrier development, but American central authority was slightly weaker than that of the Japanese. Compared to the Japanese, American carrier forces were less organized in the Pacific theater. By August 1939, Admiral Yamamoto single-handedly directed naval strategy with highly central administrative authority. As a result, the Japanese Naval Air Service progressed swiftly (285-286).

Third, bureaucratic rivalry can either enhance or stifle innovation. This is particularly the case with the aircraft carrier, for naval aviation combines distinct air and sea functions. The degree to which a military was able to unify its naval and air departments decided the success of the program. Under divided control of the Fleet Air Arm, the aircraft carrier was undermined by the British Royal Air Force and the British Royal Navy. Inter-branch competition turned to rivalry for the Japanese too. A separate Naval Air Service was formed in 1912, an early and auspicious indicator for integration

(299-301). However, the Imperial Army dictated policy-making in the Japanese defense bureaucracy, and the inferior status of the Navy caused budget setbacks for the aircraft carrier (285). For the United States carrier program, the Navy retained autonomous control over aviation, causing the innovation process to go uninterrupted (301).

Fourth, there is no conclusive evidence on the impact of information safeguards being a factor on the diffusion of the carrier. This is because of the alliance between the United States and Great Britain and their joint carrier operations by the end of the Second World War.

**Figure 11.** Aircraft Carrier Leadership

| | | | | |
|---|---|---|---|---|
| United States Strong Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Enhances Innovation* | *Information Safeguards Not A Factor* |
| Japanese Weak Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Stifles Innovation* | *Information Safeguards Not A Factor* |
| British Weak Leadership | *Rigid Organizational Culture* | *Weak Administrative Support* | *Bureaucratic Competition Stifles Innovation* | *Information Safeguards Not A Factor* |

In summation, with regards to leadership, the FMA Theory holds for lengthy FMA for the United States Navy as the first mover. Internally, strong leadership with a liberal organizational culture, strong administrative support, bureaucratic competition that enhances innovation, and strong information safeguards explains the lengthy FMA. Externally, the adversaries' weaker leadership with bureaucratic competition that stifles innovation explains lengthy American FMA. Not all factors in the FMA Theory model are

always weighted equally. For the aircraft carrier, the Japanese bureaucratic rivalries were more instrumental in weakening leadership than their relative advantage in organizational culture and administrative support.

Moreover, the FMA Theory holds for brief FMA for the British Royal Navy and as the first mover. Internally, the British exhibited weak leadership while the United States Navy and Imperial Japanese Navy, as the secondary actors, simultaneously maintained strong leadership.

Ergo, the FMA Theory explains the length of FMA for the aircraft carrier revolution.

## IV. CASE STUDY: THE SUBMARINE

When the submarine was first introduced, military leaders denounced it as an unfair weapon. The story of submarine warfare is one of stealth and surprise, one of men with marrow-deep courage and extraordinary gumption, one of philosophical controversy, and one of critical importance to 21st century international politics.

A submarine is a weapon system that is submersible and can independently function underwater. The submarines discussed in this study are not those used today.[33] With "limited underwater performance and endurance," it was "essentially a surface ship that could submerge to hide" (Friedman 1995, 1). Over time, it became sustainable underwater. The RMA in question is unrestricted submarine warfare. In particular, unrestricted submarine warfare, used in both World War I and World War II, is the use of submarines to attack both merchant ships in raiding commerce and adversarial warships.

In the following chapter, I will delineate the history of the submarine—its development, adoption, and integration, explain the first-mover advantage of unrestricted submarine warfare, and test the FMA Theory. I find that the Germans experienced a first-mover advantage, albeit an ephemeral one as its British Royal Navy and United States Navy adversaries promptly responded. The FMA Theory shows the Imperial German Navy's weak leadership and incongruent doctrine and British and American navies' strong leadership and congruent doctrine. The FMA Theory explains the brief submarine FMA.

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[33] In 1945, there was a technological shift in the submarine. While Cold War innovation with regards to submarine and antisubmarine warfare is not being considered here, it would certainly be a worthy study. After 1945, technological changes included nuclear propulsion, ballistic missile launching capabilities, advanced ASW radar and sonar, and much more (Friedman 1994). By the end of the Cold War in 1990, the United States Navy had 100 submarines available for ASW operations alone (McKitrick 2003). For more on Cold War submarine warfare, see Owen R. Cote Jr., *The Third Battle: Innovation in the U.S. Navy's Silent Cold War Struggle with Soviet Submarines, Newport Paper Number 16* (2003).

**A. Development And Adoption**

The development of the submarine is dominated by private risk-takers and constant experimentation. Individual inventors designed submersibles "despite the lack of any perceived need for their development." Unlike the aircraft carrier, "whose features and evolution invariably reflect official concepts and requirements," the submarine developed because of man's love for exploration (Fontenoy 2007, 1). As military historian Thomas Parrish writes,

> "Something about the surface of the earth has always made us try to leave it. Our ancestors scanned the heavens and sought to break way, flying toward the sun, into a new and temptingly close upper dimension, and they also cherished the dream of escaping the familiar surface by diving beneath it, into the depths of the sea" (2004, 9).

Due to the nature of the platform, experimentation of the submarine illustrated "sheer courage, [for] each and every one that let the waters close darkly over him was perfectly aware that he might never see the light of day again" (Compton-Hall 1999, ix).

The development stage of the submarine begins in antiquity and ends at its demonstration point in the First World War. In its early history, exploration of the subsurface started with divers. According to Thucydides' History of the Peloponnesian War, the first military use of divers was in the siege of Syracuse in 413 BCE. According to Aristotle, Alexander the Great used diving boats at the siege of Tyre in 332 BCE. In 12th century Alexandria, primitive submersibles were said have been used in reconnaissance missions (Fontenoy 2007, 1).[34]

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[34] Supporting evidence of these phenomena are mixed.

Diving mechanisms prompted submersible vehicles. In 1623, a Dutch inventor for King James I named Cornelius Drebbel traveled along the River Thames at London. In 1648, Bishop John Wilkins of Chester wrote the theoretical military benefit of the submarine. Wilkins noted the strategic privacy ("a man may thus go to any coast in the world invisibly") and potential safety ("from the uncertainty of tides, pirates and robbers, ice and great frost").

Submersible development flourished in the 18th and 19th centuries. In Russia, Czar Peter I supported a prototype in June 1720, but "leaking problems and Peter's death led to the death of the project." In 1834, Engineer-General Karl Andreyevich Shilder experimented with iron submersibles and armed them with six Congreve rockets. (Fontenoy 2007, 1; Compton-Hall 1999, 61-62). Then, the Crimean War of 1853 to 1856 prompted Russian submersible projects at the initiative of several naval officers, though none were ever built (Fontenoy 2007, 1).

In the United States, submarine development began with the one-person *Turtle* in 1776, "a hand-powered, egg-shaped device." Designed by David Bushnell, it was the first verified submersible to independently operate and move underwater. In the Revolutionary War, the *Turtle* attempted and failed to sink the HMS *Eagle*, the British warship blockading New York Harbor (Fontenoy 2007, 3-4; Friedman 1995, 11; Parrish 2004, 11). In 1800, American Robert Fulton built the *Nautilus*, the first dual-propulsion submarine, and offered it to France (Fontenoy 2007, 3-4; Compton-Hall 1999, 42-46). During the War of 1812, Silas Halsey died during a failed submarine operation on a British warship in New London harbor. In the American Civil War, the French-designed *Alligator* was the first to utilize compressed air and an air filtration system. The *Alligator* was built by the United States

Navy by the Philadelphia Navy Yard, but it got lost in a storm off the North Carolina Outer Banks on its first combat deployment (Fontenoy 2007, 4; Friedman 1995, 11-13). In the late 1800s, the American Submarine Company built the *Intelligent Whale*, but the United States Navy rejected it (Fontenoy 2007, 5-6; Parrish 2004, 23). With John Holland's *Holland I*, the Navy finally accepted its first submarine in the 1880s (Friedman 1995, 19-31; Compton-Hall 1999, 132-133).

In Europe, France became a first mover in submarine development. Jules Verne published Twenty Thousand Leagues Under The Sea, a science fiction classic in 1870, which featured an advanced submarine and inspired inventors. France interpreted the submarine as a potential challenge to British naval supremacy. While the British failed to develop submarines until World War I, the French took significant interest in the innovative weapon system early on. "Believing that they could never rival their traditional British enemy on the surface of the sea, younger officers saw some years before 1900 that this new weapon might bring them an effective new way of commerce raiding—attacking enemy cargo vessels" (Parrish 2004, 38-39).

The French Navy is the official first mover in development. From 1850 to 1880, France invested efforts to develop the first mechanically powered submarine, launching the *Plongeur* in 1863 (Fontenoy 2007, 5-6). In response, the British Royal Navy and the Imperial German Navy are secondary actors in development, both of which quickly surpass the French in submarine capabilities. In fact, Horowitz cites French naval analyst Herbert C. Fyfe's frustration on the matter: "We [the French Navy] have been only the humble artisans working for [the British Royal Navy] to establish their superiority" (2010, 2; Fyfe 1902, 281).

The submarine is characterized by internal French weak leadership and incongruent doctrine as well as external British strong leadership and congruent doctrine.[35] The French submarine aligned with doctrinal priorities, because the submarine could act as a counter to the superior British battleships. Contrastingly, the British were doctrinally committed to their advantage in big gunnery vessels and battleship fleets (Horowitz 2010, 1). However, in terms of resource allocation, the French did not commit enough resources to the program, especially compared to the superior British industrial production capabilities. Following a successful campaign in 1869, French liberals controlled a larger part of government. Against the interest of Napoleon III, they demanded a reduction in naval expenditures (Ropp 1987, 10). Meanwhile, the British maintained a well-funded navy.

While the doctrine is ostensibly split between the two actors, the French lacked leadership. In organizational culture, the French could not "institutionalize their advantage...[as] crippling organizational debates prevented the integration" of the RMA (Horowitz 2010, 1). The French had not attempted any reform of their naval administration since the old monarchy while trying to integrate industrial, Napoleonic-era weapon systems (Ropp 1987, 10). It is difficult to assess actual administrative support by either actors at this infancy level. The French set up organizations for technical education for shipbuilders, while the English merely relied on French designs. In information safeguards, the British exploited France's technological boon. Historically, English naval architects modeled their designs on ships captured from France. By 1850, over one-third of British vessels were based on French design models (8). In consequence, although the French possessed avant-

[35] While German doctrine and leadership will be described as incongruent and weak, this is relative to the British and American navies in World War I. In relation to the French submarine program, the Germans exhibit strong leadership and congruent doctrine. The specifics of the German submarine program will be described later.

garde thinking and technological ingenuity, their poor leadership disallowed their first-mover status to transform into a first-mover advantage.[36]

The introduction and adoption of the RMA occurred in World War I with the German unrestricted submarine campaign and the Allied response (Herwig 1996, 228). The German Navy was the first to conduct unrestricted submarine warfare; that is, a commerce-raiding strategy against Britain using "submarines to attack and sink without warning all British shipping and neutral vessels trading with the United Kingdom" (Fontenoy 2007, 15). They accomplished this by means of their "Unterseeboot," also known as U-boat submarine. It began in response to the British blockade of Germany; a "counter-blockade" against Allied commerce. While German and Austria-Hungarian forces possessed small but relatively up-to-date fleets of submarines, neither the Allied nor Central powers had doctrines for submarine use until the Germans began the counter-blockade (14-15).

World War I German submarine warfare gained enough momentum to be considered a demonstration point. On September 22, 1914, a German U-9 torpedoed three British armored cruisers within an hour off the Dutch coast (14-15). In a short period of time, the British Royal Navy realized the threat of the submarine to its naval superiority. The campaign began with limited resources, but sank a significant number of merchant vessels (Herwig 1980, 163-164). What was even more significant was the German sinking

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[36] The French submarine experience is not being tested with the FMA Theory because it fails the required assumptions. It is true that the French submarine meets both technological and organizational barriers to entry in accordance to the Adoption-Capacity Theory. (For evidence of sufficient organizational and technological barriers to entry, see the study of German submarine FMA.) However, there is a difference between being a first mover and experiencing a first-mover advantage. The French first-mover status occurred in the RMA's infancy period. The French never had an advantage, because the submarine was never really adopted. Therefore, while France as the first advanced developer acts as a first mover, their first-mover advantage does not exist. Instead, Germany introduced and adopted unrestricted submarine warfare in the First World War, so they express the actual first-mover advantage.

of the *RMS Lusitania*, a British boat, which enraged the United States. On board were 1,959 people, 159 of whom were American. The subsequent crisis between the United States and Germany led to a brief hiatus of German U-boat operations. President Wilson threatened Germany with diplomatic severance, so German Admiral Henning von Holtzendorff reinstated his order to follow the Prize Regulations of the Declaration of London in 1909 (Fontenoy 2007, 17; Tucker 2005, 1125-1126).

In June 1916, the Germans lost the Battle of Jutland to the Royal British Navy. As a result, the Germans recognized that their surface fleet alone would not be able to beat the British. On January 9, 1917, the Germans announced the reinstatement of the commerce raiding campaign. The unrestricted submarine warfare was a matter of necessity. For this reason, Jutland was the largest naval battle of the war, and the only one in which fleet battleships combated. Among the Allies, British and French navies each began World War I with more than double as many submarines as the German Fleet. However, unlike the Germans, they lacked a methodology for effectively using the innovative weapon system. Wartime response of antisubmarine warfare (ASW) became their doctrine.

Following heavy losses on shipping, the British Admiralty sought an aggressive strategy to seek out and destroy the U-boats (Herwig 1996, 229). The ASW campaign began in 1915 and served as the primary mission of British submarine operations. They succeeded in sinking only 13 of 290 sighted U-boats that year (Fontenoy 2007, 14). The United States Navy joined ASW in March 1918. Over the course of the war, 320 German U-boats were sortied, 178 U-boats were lost, including 134 from antisubmarine operations (Herwig 1996, 231). While at first the British refused to introduce convoys for preventative means, convoys eventually reduced the ability to attack merchants (230).

For the offensive British submarine program, the 8th Submarine Flotilla primarily functioned for patrol and reconnaissance off the German coast (11). Missions included patrolling the Heligoland Bight, but none of the attempts at destroying the High Seas Fleet of the German Imperial Navy succeeded (Parrish 2004, 69).

Like the British, French and Russian submarines experienced limited success in the First World War. French submarines were deployed in the Adriatic for defensive operations. Eight Russian submarines were deployed in the Baltic for short-range operations (Fontenoy 2007, 12-13).

For the United States, World War I surprised submariners. While their surface fleet was inferior to the British in gunnery, they wrongly believed their submarine was up-to-date when they entered the war in April 1917. Pre-war American naval planners had undervalued submarines. The Navy's civilian leadership disdained submersibles, arguing that they violated international law (Herwig 1996, 253). In 1911, the General Board divided submarine functions as either "coastal protection (defensive) [or] fleet operations (offensive)," though they only utilized the former during the war (253). The war "confirmed submariners' prewar suspicions that American submarines were far too small" (Friedman 1995, 149-150). By the end of the war, the United States Navy considered submarine operations of far higher value than for support and reconnaissance (150).

**B. Integration And First-Mover Advantage**

The interwar period between World War I and World War II featured submarine integration, especially in the United States Navy. By the time World War II began, the United States Navy and Nazi Germany *Kriegsmarine* were prepared to face their respective Japanese Imperial Navy and British Royal Navy adversaries in submarine warfare. The

effectiveness of the Imperial German Navy's U-boat sparked interest from the victors of the First World War. With the "impeding emergence of superior detection equipment," the relevant interwar powers tried to "produce faster, stronger, more powerfully armed, and longer-ranged boats" (Fontenoy 2007, 23). By design, these vessels were still submersibles, best operated on the surface yet could rapidly dive for stealth (23-24). In terms of doctrine, they were used for scouting, minelaying, and operations against adversarial heavy warships (Herwig 1996, 262). The Second World War featured very matured submarine warfare by the Americans and Germans, and to a lesser degree by the Japanese and British.

Under Article 191 of the Treaty of Versailles, the interwar German military was officially unable to build or innovate. In 1919, the Germans surrendered 176 boats to the British. But they innovated clandestinely by building for foreign navies. Although interwar Germany faced fiscal hardship, financing submarine development occurred anyway. In 1935, only five weeks after the repudiation of the Versailles Treaty, the Germans were able to produce their first new submarine, the *U-1* (Herwig 1996, 231; Fontenoy 2007, 26-27). The German U-boat was a major factor in the Second World War. Due to its success in the Battle of the Atlantic, the Germans built 1,162 U-boats, of which 784 were destroyed (Herwig 1996, 231).

While the Germans were persistent in attempting to continue submarine adoption, the British spent the interwar period undervaluing the RMA, a move that later proved very costly. The British believed that the impact of Germany's World War I unrestricted submarine warfare had been overestimated. "Ignorance and indifference led to a general failure to think through the lessons of the last war. Success is not always a good teacher, and the Royal Navy had, after all, accomplished its major objectives during WWI." Although the

British officially proposed a ban on submarines at Versailles in 1919 and the London Conferences of 1935 and 1936, they actually retained a very limited budget for submarines. Instead of investing in submarines, the British continued their "traditional service beliefs...wedded to its obsession with battleships and major fleet engagements" (241-244). Submarines remained in the prewar patrol roles for the first year of the war. In September 1940, the British ended their prohibition on attacking enemy trade, though their campaign against German and Italian merchants had mixed results (Fontenoy 2007, 31-32).

For the Americans, the interwar period prompted submarine adoption that was impactful in the World War II Pacific campaign against the Japanese. The United States Navy standardized a single "fleet boat" design; the 38 *Porpoise*, and subsequently *Gato* class, archetype submarines that were hardly changed throughout the entire Second World War (25). Among the Allies, the United States Navy was the most successful submarine force in the Second World War. In the Pacific, the Navy's campaign on merchant shipping and Japanese warships proved to be highly effective. Among merchant ships, the American submarines inflicted a cost of about 4.8 million tons of Japanese goods and accounted for one-third of its warship casualties (34). Technologically and organizationally, the American submarines became dominant. The Pacific war demonstrated the importance of submarine warfare. The Americans faced some challenges, including unreliability of torpedo strikes and a mediocre start due to long dispatches from bases in Hawaii and Australia. In addition, the Japanese ASW was effective, taking out 50 submarines. The American casualties include 3,500 crewmen, over one-fifth of their operational submariners (33-34).

The Imperial Japanese Navy also utilized peacetime to standardized three submarine types for a wartime fleet. The first was a headquarters submarine for command

facilities, which highlighted communications. Second was an attack submarine with torpedo capabilities. In particular, with German assistance, the Japanese constructed very large cruiser submarines called *junsen* as well as two-man "midget submarines" for stealthy attacks on ports. Third was a small reconnaissance submarine used primarily for scouting (26). While the Japanese experienced success in ASW, their own submarine warfare was unproductive. The Japanese Imperial Navy sunk 20 warships and just over 100 merchant vessels throughout the war, while suffering crippling losses (38).

Throughout the multifaceted, seemingly disorganized history of submarine warfare, the Imperial German Navy served as a first mover in the First World War, losing their submarine advantage to the United States and Britain during the war as well as in the interwar and Second World War periods. The FMA Theory will explain the brief German FMA.

**C. Analysis**

The brief unrestricted submarine warfare FMA by the Imperial Germany Navy is characterized by internal weak leadership and incongruent doctrine as well as external strong leadership and congruent doctrine. The Germans shocked the world by unveiling "excellent weapons," especially the U-boat, and "trained their forces within an ingenious tactical framework" in World War I. But they failed to remain the only actor with the RMA because they lacked "operational endurance" (Herwig 1996, 241). And soon enough, the Americans and British were able to reduce the submarine warfare advantage.

**Figure 12.** Submarine Results

| | Leadership | Congruence |
|---|---|---|
| Imperial German Navy | *Weak* | *Incongruent* |
| United States Navy | *Strong* | *Congruent* |
| British Royal Navy | *Strong* | *Congruent* |

The submarine clearly fits into the RMA template. As per the requisite assumptions, submarine warfare beginning in the First World War held high barriers to entry. Technologically, submarines were costly.[37] At the time, each German U-139 submarine cost approximately 8.7 million marks (Williamson 2002, 16).[38] The history of submarine warfare shows that "those forces that fell behind in the technological battle suffered disproportionately heavily in combat" (Fontenoy 2007, 38). For example, most actors experienced problems with torpedoes in the First World War, limiting their use among most actors. In addition, as the submarine matured in the interwar era, detection technology like sonar and radar reduced the ease of submarine use. Detection devices are important enabling technologies that impacted the FMA. Not only did detection devices help with offensive submarine warfare, but they also inspired countermeasures like antisubmarine warfare. "After the submarines' enemies received their own radars, the surface was no longer safe, day or night" (Friedman 1995, 1). Other instrumental

[37] Even though the submarine has acted as a more cost effective response to the aircraft carrier and warships, its own cost is sufficiently high to deter actors from integration.

[38] The actual development cost per submarine does not matter; only that cost is a barrier to entry.

technologies include stealth measures, including wakeless electric torpedoes and anti-escort homing torpedoes.

Organizationally, the submarine is a very complex system. Navies have had difficulty "integrating submarines into existing force structures" (Herwig 1996, 228). Like any RMA, submarine warfare prompts new strategies and operational concepts for use of force. In terms of personnel, it requires arduous training and faces challenges in recruitment of daring individuals. The RMA "represented a disruptive change. A shift in naval power away from the gun and capital ship, and toward the torpedo and submarine, contradicted centuries of thinking about the production of naval power" (Horowitz 2010, 32-33). Because the submarine is an "organizationally disruptive change," powerful naval forces like Great Britain were on the defensive relative to "newer and more nimble naval powers" like Germany (Horowitz 2008). This organizational disruption allowed the FMA to occur. Moreover, what must also be noted in the assumptions is the timespan of the FMA. For the purposes of this study, German submarine warfare spans from the beginning of World War I in 1914 through the interwar period. Factors pertaining to submarine warfare use in the wartime and interwar periods will be scrutinized.[39]

*C1. The Submarine: Doctrinal Congruence*

Brief FMA is explained by Germany's doctrinal incongruence (incompatibility and unfavorable resource allocation) and its adversary's doctrinal congruence (compatibility and favorable resource allocation).

Submarine compatibility favors the British and Americans. Compatibility to doctrine is exceptional for the submarine in three regards. First, the submarine experienced a

[39] World War II submarine warfare will also be noted at some points, particularly the American Pacific campaign.

challenge in finding an operational role. "Competing wartime demands on submarines often preclude their achieving full potential." Submarine warfare often leads to "class wars of attrition...[which] extend over entire oceans and requires prolonged effort to be effective" (Herwig 1996, 228).

Second, once the operational mission is set, willingness to attack merchant vessels prompted a philosophical debate among naval leaders. Is it permissible to launch an offensive on adversarial commerce?[40] In none of the wars in featuring submarine warfare did actors plan on targeting merchants; each would have preferred offensive units of large surface warships. Instead, unrestricted attacks "appeared as an ad hoc child born out of necessity" (228).

Third, the submarine is interesting in terms of compatibility because of its association with alternative platforms. The submarine both acted as an alternative platform to the aircraft carrier and faced an alternative platform from convoys and antisubmarine warfare. Part of compatibility is the response. Submarines were a reaction to carrier warfare; submarine warfare is a cheaper, offsetting technology for navies attempting to deal with carriers." (Horowitz 2010, 82). In turn, consider that today approximately 40 countries operate submarines, compared to the 10 that have aircraft carriers (McKitrick 2003).[41] And submarines faced a defensive response: ASW and convoys. Antisubmarine warfare is the defensive use of surface ships, air power, and submarines to find and attack offensive

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[40] In an analysis of the Battle of Midway, Craig L. Symonds says of the change over time in submarine doctrinal norms, "It is a measure of how much the world had changed in 25 years that although the United States had professed horror at the German use of unrestricted submarine warfare in 1917, the first United States Navy operational order of the Second World War was to 'begin unrestricted submarine warfare against Japan'" (2005, 208).

[41] Only six actors have ballistic missile submarines: the United States, China, France, Russia, India, and the United Kingdom.

enemy submarines. A convoy is the defensive use of grouping vessels for mutual support. Armed with support submarines, air power, and surface ships, the convoy acts to protect merchants from offensive enemy submarines (Owen 2007).

While the Germans were first movers, their naval doctrine was most compatible with a Mahanian surface fleet.[42] In additional to technical problems, "naval doctrinal issues were more important brakes on the submarine development, as the German example demonstrates" (Millet 1996, 365). "If German submarine development had an Achilles' heel, it lay in its doctrinal conceptions," write Holger H. Herwig. Instead of forming U-boat compatibility, German naval planners "stressed the need for destroyers" (Herwig 1996, 237). The German *Kleinkrieg* (little war, or small engagements) strategy argued for drawing the British into geographically and numerically disadvantageous positions (Tucker 2005, 1125). Submarines did not necessarily further this strategic goal. German commitment to submarines was undermined when sinking merchant vessels led to a crisis with the Americans and "exacerbated concerns of the German Army's general staff about increased complications with neutral nations" (Fontenoy 2007, 16). In turn, the Germans halted unrestricted U-boat operations, "but for the next year and half its navy waged an increasingly effective political campaign at home to resume unrestricted U-boat warfare" (Herwig 1996, 229).

Later, in the interwar period, the Germans considered submarine warfare in their war-gaming—not in their ability to attack enemy shipping, but instead only in attacking

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[42] Captain Alfred Thayer Mahan, the 19th century United States Navy strategist and historian, argued that navies must obtain relative sea power in order to project superiority. With the introduction of the submarine, a "Mahanian navy" meant a big-ship surface battlefleet. Mahan's views were as extensive as his impact was pervasive, Livezey writes (1981). The American Historical Association resolved in 1914: "The profundity of his views and the lucidity of his reasoning attracted the attention of the statesmen of all nations; and more than any American scholar of his day, he as affected the course of world politics" (1916, 53; Livezey 1981, 35).

enemy warships, in laying mines, and in scouting. This strategy was only furthered by Konteradmiral Arno Spindler's "Handbook for U-boat Commanders," which argued for 'warfare against merchantmen only on the 'stop, search, and seize'" basis. Similarly, Grand Admiral Erich Raeder argued that the submarine was "one of the best *defensive* means of the weaker" navies (237).

The submarine should have been compatible with the German war doctrine. The submarine was a strategic advantage held over the British adversary. It directly challenged the core-competency of the enemy. However, because of the novelty, the doctrine was not operated to the fullest. Overall, Germany's inner perception of the RMA led to a weak compatibility.

Like the Germans' incompatibility, the Allied navies had similarly poor compatibility in offensive submarine war. Like German compatibility, the Allied were committed to the Mahanian strategic culture. This continued through the First World War and through the interwar period, even favoring naval aviation over submarine (Herwig 1996, 254). The submarines themselves were an adverse factor. World War I submarines were "small, cramped and unseaworthy." In turn, submarines "had insufficient room to take on crews of captured vessels." In fact, their successors, the American S-class and the V-fleet, were unsuitable for their commissioned needs (254-255).[43]

In terms of naval philosophy, the Allied forces were no better on submarines than their German adversaries. American public opinion did not permit unrestricted warfare against merchants (Herwig 1996, 255; Bemis, 13). Likewise, British Admiral Arthur K. Wilson's denounced the submarine in 1902 as "underhanded, unfair, and damned

[43] World War II-era American submarine technology, however, improved these problems, rendering them successful against Japanese merchant and warship vessels.

unEnglish," a notion that lasted through World War I (Herwig 1996, 247; Herwig 1980, 86). Allied political naval philosophy created complacency for offensive submarines in the First World War (Herwig 1996, 249).[44] While the British understood submarine technology, they struggled in adopting a fitting operational concept. The British used the submarine for defensive purposes, but did not find the German commerce-raiding strategy acceptable.

More importantly, however, is the notably effective Allied response in the war. As a secondary actor, the British and American navies implemented alternatives to limit FMA because such alternatives were doctrinally congruent. In April 1917, the Central Powers were close to a submarine warfare triumph against merchant shipping. Following the introduction of the convoy system, the Allied efforts undermined the submarine advantage. At first, the British were hesitant to use convoys because they "feared the detrimental effect that convoys could have on the efficient employment of shipping (Fontenoy 2007, 35). This was soon reversed. By 1918, while German and Austrian submarines sank 600,000 tons of shipping, their losses rose to 10 submarines, double that of their total losses for the previous three years. By the end of the war, they sank less than 250,000 tons of shipping and lost an additional four submarines. (21).[45] While unrestricted submarine warfare was incompatible with neither the British nor the American naval thinking, it was not needed. Instead, what was even more important than having compatible submarine warfare was being able to effectively implement antisubmarine warfare.

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[44] Among the Allied Powers, theoretical support for offensive submarine warfare began in the interwar years and culminated in the World War II American campaign in the Pacific. Despite the Japanese and German technological superiority, American submarine warfare flourished because of their need for a stealth offensive weapon system (Millett 1996, 347).

[45] In the interwar period, ASW was furthered by the British ASDIC (Anti-Submarine Detection Investigation Committee) sonar. The ASDIC ultrasonic sound-wave technology was first introduced by the British in 1917 to locate submarines at ranges of up to 1,000 meters. Along with ASDIC, radar was developed in this period. Naval planners considered both technologies "as *the* critical deterrent to another U-boat campaign" (Herwig 1996, 245).

Furthermore, because the submarine both served as a cheaper alternative weapon system and faced a cheaper alternative weapon system, allocation of resources for the submarine warfare was less impactful. Nonetheless, the Imperial German Navy allocated resources less favorably for the submarine than their Allied counterparts. As discussed previously, both British and French navies began the war with more than double as many submarines as the German Fleet. As the RMA was introduced, their hesitation translated into financial hesitation, especially relative to their adversaries. In the interwar period represents the ultimate unfavorable resource allocation, because after Versailles the Germans were forced to surrender their military. Germany was officially "forbidden to build either capital ships or submarines and had to undertake clandestine research and development cautiously and in modest proportions" (Herwig 1996, 262). The Allied navies faced financial constraints in the interwar era too. The British budgeting until 1939 "discouraged nearly all innovation" (252). Overall, the British and American defense budgets were more favorable than that of the Germans.

**Figure 13.** Submarine Doctrinal Congruence

| | | |
|---|---|---|
| German Incongruent Doctrine | *Incompatible* | *Unfavorable Resource Allocation* |
| American Congruent Doctrine | *Compatible* | *Favorable Resource Allocation* |
| British Congruent Doctrine | *Compatible* | *Favorable Resource Allocation* |

In summation, with regards to doctrinal congruence, the FMA Theory holds for brief FMA for the Imperial German Navy as the first mover. In terms of compatibility, while no

World War power viewed the submarine as the ideal weapon, the Allied response demonstrated the compatibility of alternatives. With regards to resource allocation, it is clear that Allied submarine resources were superior to German resources.

*C2. The Submarine: Leadership*

According to the FMA Theory, leadership is composed of four categories: organizational culture, administrative support, bureaucratic competition, and information safeguards. However, due to the nature of the submarine RMA, bureaucratic competition is a non-factor.[46] On all three relevant categories, the Allied naval forces excel in leadership over the Imperial German Navy.

First, regarding organizational culture, certainly every military is wary of an innovative weapon system. But the German Navy's rigid culture was not open to the submarine, a weapon system requiring serious organizational capacity. The German naval culture did not "game" possible problems of submarine warfare. By not gaming how the adversary would respond, their lack of preparation undermined their advantage. In turn, they "floundered from one battle in the Atlantic to the next with no clear direction" (240-241). Also consider, for instance, the work of Rear Admiral Arno Spindler, a U-boat specialist yet Mahanian traditionalist, who was ignorant of the utility of the submarine for commerce raiding. In writing an official history of unrestricted submarine warfare, Spindler attempted to "misuse history to prove particular lessons," a move that represents rigid organizational culture (233-234).

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[46] For submarine warfare, interservice competition is non-existent; for every actor, it neither fosters nor hinders growth. This is because the submarine clearly resides in any military's naval force and does not initiate any interservice competition. Contrast that with the aircraft carrier; naval aviation, by nature, relates to naval and air divisions.

At first, Allied organizational culture did not favor innovation either. The United States Navy had an organizational problem with recruitment of submarine commanders willing to take risks in a war that very much depended on the decisiveness of the commander on the spot (259). Britain's rigid organizational culture seemed to be ubiquitous. Mahanian policy-makers did not want to challenge the core competency that "had defined British naval supremacy: gun battles between capital ships" (Horowitz 2010, 32-33). "The culture of the officer corps discouraged serious examination of disturbing challenges to the status quo" (Herwig 1996, 252). However, despite deleterious hesitation, the Allies' ability to effectively disperse a counterattack demonstrates relative organizational strength. That submarine warfare did not defeat Allied shipping in the long-run shows that they had a strong organizational set.[47]

Second, weak administrative support among German military and civilian leaders elicited a brief FMA. Submarine forces were able to "divide politicians and admirals on the issue of wartime roles" (Millet 1996, 364). Both Admirals Alfred von Tirpitz and Erich Raeder stood in opposition to submarine warfare. Only reluctantly did they realized it was their only available weapon (Herwig 1996, 231). Overall, German naval planners "remained wedded to the stolid belief that only a symmetrical Mahanian surface fleet—not U-boats—constituted sea power" (241) In the interwar period, Rear Admiral Arno Spindler was instrumental in collecting accounts of wartime experiences, especially from U-boat commanders. This advanced German thinking about submarines in the 1920s. His research

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[47] Interwar organizational culture among the British was even worse. Their defense bureaucracy "suffered from a sterile anti-intellectualism...that prevented a thorough study of the 'lessons' of 1914-1918." The general sentiment was that war seemed unlikely in the foreseeable future, especially with the League of Nations serving "as an umbrella to ward off future wars of aggression." When the Second World War began, their "decision to ignore history proved costly" (Herwig 1996, 249-250).

"served to keep alive U-boat traditions, attacked the prevalent view that the U-boats had little significance, and established small but enthusiastic band of submariners" (234).[48]

On the Allied side, British Royal Navy Admiral John Fisher represents a maverick. His efforts to transition the Navy away from a solely Mahanian surface fleet toward submarine and torpedo vessels, while ambitious and unrealistic, were impactful for protecting targeted commerce (Horowitz 2010, 141-142). For the Americans, Admiral William Sims was the maverick who advocated for flotilla defense via the convoy system. Recently promoted to Rear Admiral, Sims was supervised "American naval shipping operating from Britain." In that role, he conflicted with his superiors like Secretary of the Navy Josephus Daniels and Chief of Naval Operations William Benson in order to bring about the convoy system. He brought in Atlantic commander Frank Mayo for administering anti-submarine forces. Sims was an early, resolute, and vocal supporter of the convoy system (Bowling).[49]

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[48] In the Second World War, the debate among German admirals became lively. Admiral Karl Dönitz and Admiral Erich Raeder faced off regarding the impact of submarine warfare versus the impact of warships. After the war, Dönitz argued that the German submarine could have won the war, but failed because of lacking administrative support (Herwig 1996, 239). Dönitz's support for unrestricted submarine warfare was partly the subject of his Nuremberg trial. He was found not guilty for actions against merchant vessels because the Allies committed similar actions. Dönitz was guilty on other charges. For more, see De Vabres, "Judgement: Doenitz."

[49] The United States did not start its own offensive, commerce-raiding submarine campaign until 1941. Chester Nimitz, five-star Fleet Admiral of the United States Navy, served as a military maverick. Coming from the submarine community himself, Nimitz "immediately sent out the handful of submarines to conduct offensive operations" after Pearl Harbor (Symonds 2005, 208). With the political support of Charles Evans Hughes and President Franklin Delano Roosevelt, the unrestricted submarine warfare flourished (Millett 1996, 364). Specifically, Roosevelt endorsed Admiral Harold R. Stark's proposal following the attack on Pearl Harbor. Stark had already ordered Admiral Thomas C. Hart, commander-in-chief of the Asiatic Fleet, to prepare "economic starvation" of Japan in November 1940. Roosevelt told Congressional leaders that the move would amount to a "strangulation of Japan—strangulation altogether" (Herwig 1996, 252-253; Bemis, 34). Admiral Nimitz attributed the triumph in the Pacific to the submarine: "It was to the Submarine Force that I looked to carry the load until our great industrial activity could produce the weapons we so sorely needed to carry the war to the enemy. It is to the everlasting honor and glory of our submarine personnel that they never failed us in our days of peril" (Roscoe 1949, v). "Doctrinal development thus came in line with more realistic national objectives" (Herwig 1996, 256).

Third, the Germans were unable to keep submarine information away from their adversaries. Although the Allied naval forces were unable to use information for their own unrestricted submarine forces, the German U-boat strategy was not a mystery to the Americans and British. In turn, the Allies were capable of implementing antisubmarine and convoy response campaigns.[50] The German information protection did not prevent the Allied response.[51]

**Figure 14.** Submarine Leadership

| | | | | |
|---|---|---|---|---|
| German Weak Leadership | *Rigid Organizational Culture* | *Weak Administrative Support* | *Bureaucratic Competition Not A Factor* | *Weak Information Safeguards* |
| American Strong Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Not A Factor* | *Strong Information Safeguards* |
| British Strong Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Not A Factor* | *Strong Information Safeguards* |

In summation, with regards to leadership, the FMA Theory holds for brief FMA for Germany as the first mover. Internally, brief FMA is explained by weak leadership with a rigid organizational culture, weak administrative support, and weak information safeguards. Externally, brief French FMA is explained by the adversaries' strong leadership with liberal organizational culture, strong administrative support, and strong information

[50] It is important to note that the Allied convoys and antisubmarine response was also not protected. The Germans' inability to counter their response was not due to any information asymmetry.

[51] It may be that such a safeguard is not possible. Submarine development occurred before the war and improved little during the war. Ultimately, the Allied response utilized ASW and convoys, which are different weapon systems that did not rely on gathering information from the German adversary.

safeguards. Ergo, the FMA Theory explains the length of FMA for the submarine warfare revolution.

**V. CASE STUDY: THE INTERCONTINENTAL BALLISTIC MISSILE**

When President Harry S. Truman ordered the use of the atomic bomb on Hiroshima and Nagasaki in August 1945, he achieved two feats. First, the nuclear obliteration of the Japanese cities sealed the fate of the war. The United States had been invading the Japan homeland, resulting in tremendous casualties for both sides. Iwo Jima sustained over 19,000 American casualties; Okinawa sustained over 80,000 American casualties (Isaacson). A triumphant invasion of Japan was estimated to last 18 months and cause 500,000 American casualties. Japan was readying the deployment of 2 million soldiers, as well as millions of auxiliaries, all of which were prepared to die for the Empire of Japan. Between Hiroshima and Nagasaki, up to 250,000 Japanese casualties were incurred. Truman believed that, on balance, the Bomb saved lives. Second, through Hiroshima and Nagasaki, Truman signaled to Joseph Stalin and the Soviet Union, an uncomplimentary World War II ally, his willingness to use the weapon system (Wainstock, 2011 96-97; Craig and Radchenko 2008). The latter represents the beginning of a cold war that lasted over four decades.[52]

The method by which the Americans used strategic bombing was manned aerial bombers. They used the B-29 *Enola Gay* and *Bockscar* bombers in Hiroshima and Nagasaki, respectively.

Following World War II, the 20th century was marked by the feud between two global superpowers—the United States and the Soviet Union. The introduction of nuclear weaponry spurred a perilous arms race, or the escalation in weaponry between the two powers, especially in terms of nuclear weapons. Julius Robert Oppenheimer, dubbed the

[52] For a thorough report on the use of the atomic bomb and its role in the Cold War, see Campbell Craig and Sergey Radchenko, *The Atomic Bomb and the Origins of the Cold War* (2008).

"father of the atomic bomb" for his work in the Manhattan Project, became an outspoken advocate for international nuclear power control.[53]

Advances in missile technology led to a delivery system RMA, the intercontinental ballistic missile.[54] A ballistic missile is defined as "any unmanned, actively guided, rocket-propelled vehicle that can be fired ground-to-ground along a ballistic (or parabolic) trajectory" (Karp 1996, 4). "Intercontinental" signifies that the ballistic missile is capable of destroying targets at great lengths[55] and almost always of nuclear disposition.[56] After the impressive debut of Nazi Germany's V-2 rocket in the last year of World War II, the Soviets and the Americans both pursued short-range ballistic missiles (SRBM), medium-range ballistic missile (MRBM), intermediate-range ballistic missile (IRBM), and intercontinental ballistic missiles. While the Soviets were the first to achieve ICBM capabilities with the Semyorka R-7 in August 1957, the Americans countered with their own ICBM, the SM-65 Atlas, in December 1958.

In the following chapter, I will delineate the history of the ICBM—its development, adoption, and integration, explain the first-mover advantage, and test the FMA Theory. The ICBM demonstrates brief FMA due to simultaneous invention. As a first mover, the Soviet Union experienced a brief advantage, though not because of its own faults. The FMA Theory shows strong leadership and congruent doctrine by both the Soviet Union and the United

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[53] Many of the scientists and intellectuals who assembled fusion technology became vociferous advocates against the use of nuclear weapons. Oppenheimer later remarked at his 1954 security hearings, "When you see something that is technically sweet, you go ahead and do it and you argue about what to do about it only after you have had your technical success. That is the way it was with the atomic bomb." Likewise, following his work on the Manhattan Project, Albert Einstein co-signed the Russell–Einstein Manifesto, which decries the perilousness of nuclear escalation.

[54] Hereafter referred to as ICBM.

[55] What began as a short-range ballistic missile that could travel 200 kilometers, the ICBM "may be launched from any place on earth and hit a target at any other location on earth" (Stine 1991, 2).

[56] Because an ICBM threat incites a nuclear response, there exists no military reason for non-nuclear ICBMs.

States. Because the United States was a simultaneous adopter, they followed quickly after the Soviets. The FMA Theory explains the brief ICBM FMA.

**A. Development And Adoption**

The early history of the ICBM begins in Nazi Germany. Of the eight conflicts in which a ballistic missile has been used, the most important was the German V-2 ballistic rocket. Today, the V-2 "remains the leading example of the use of ballistic missiles in warfare. Not only was it the first successful long-range rocket, and the first fired in anger, but it was also built and used in greater numbers than any other large rocket" (Karp 1996, 37).

In 1929, a group of amateur scientists began working on a rocket. A year later, Captain Walter Dornberger began the official development of short-range liquid-fuel ballistic missiles (Stine 1991, 14-21). In 1932, the *Heer*, Nazi Germany's army, sponsored the project called A-1, under the leadership of German rocket scientist Wernher von Braun (Stine 1991, 22-26; Karp 1996, 38). Between Dornberger and von Braun and their Kummersdorf team, the V-1 and the V-2 missiles were created.[57] The V-2, first reaching Paris on September 6, 1944, was widely employed during the last year of World War II. Hitler and Nazi officials decided to mass produce the V-2 because of its low cost (Karp 1996, 38-40; Beard 1976, 46).[58] In turn, over 5,700 V-2 rockets were produced. It caused considerable damage to British and Belgian cities, delivering approximately 2,400 tonnes of high explosive and killed about 7,000 people (Karp 1996, 40; Beard 1976, 5). Although the German V-2 missile's range was only a few hundred miles, "it was a clear harbinger of the future" (Zaloga 2002, 35).

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[57] For a more specific account of V-2 missile development, see George Harry Stine, *ICBM: The Making Of The Weapon That Changed The World* (Stine 1991, 27-80).

[58] While the operating costs were low relative to the devastation it created, research and development investment constituted 60 percent of the program's total cost (Karp 1996, 38-40).

In the immediate post-war era, the Soviet Union began focusing efforts on missile development. Despite the war ending with the Red Army at its zenith as the largest army in the world, the August 1945 atomic bomb shifted the balance of power away from the Soviets. Joseph Stalin realized the implications of the atomic bomb, contrary to his public pronouncements saying otherwise. Accordingly, Stalin authorized an expensive crash program for missile development (1-3). In May 1946, Stalin formed Special Committee Number Two, tasked with overseeing the development of new strategic offensive weapons (36). The Soviets attempted to learn from German scientists. They attempted to recover lost documentation and study captured manufacturing plants.[59] Soviet rocket scientist Sergey Pavlovich Korolyov led the Scientific-Research Institute Number 88, a secured and independent bureau for missile research and development. In 1947, Korolyov went to the Kremlin to meet with Stalin regarding the R-1 (Stine 1991, 125). Both the R-1 and R-2 ICBMs were not armed with nuclear warheads, but instead only high-explosive warheads. This was because of low reliability, heaviness of early nuclear systems, and the relatively small number of warheads available (Zaloga 2002, 39). The R-2 exhibited range that was twice that of the German V-2. Then, the R-5M gave the Soviet Union nuclear strike capability up to 750 miles, though it still could not reliability reach American bomber bases in the United Kingdom, Japan, or the Pacific (42).

Prior to the unveiling of the R-7, the hydrogen bomb was introduced. The Americans demonstrated the hydrogen bomb in the Pacific on November 1, 1952. In response, the Soviets tested their first hydrogen bomb in 1953. The Soviet thermonuclear weapon, developed by Andrei Sakharov and 1,000 times the magnitude of the atomic bomb, was

[59] Nonetheless, the eventual Soviet R-7 product was notably unique from the German V-2 experience.

demonstrated at the Semipalatinsk test site in northern Kazakhstan (Evangelista 1988, 168-169).[60]

The Soviet R-7 was finally introduced in August 1957, but it was a decade-long project. At this point, the Soviet ICBMs were "not readily producible and were not good strategic weapons." Regardless, the Soviets "had indeed 'beaten' the United States to a vital weapon." As Warner R. Schilling writes, "Beyond a doubt, the Soviet ICBM of 1957 both preceded in time and was of superior performance to its 1958 American counterpart" (Beard 1976, 4).[61]

Far more public and impactful, however, was the Soviet launch of Sputnik I, the first earth satellite, on October 4, 1957. One month later, the Soviets launched Sputnik II, a much larger satellite. Sputnik was an empty satellite—void of any cameras, devices, or research tools. Sputnik "caused an enormous shock in the United States," and undermined presumed American technological superiority. It was of "enormous symbolic importance, [as] American international prestige and American domestic self-perception and self-confidence were strongly shaken" (1). With "the entire world turning its eyes skyward," Sputnik was a transformative moment for the Cold War. It "left Americans feeling vulnerable, behind, and scandalized." In response, Senate Majority Leader Lyndon B. Johnson led hearings and voiced national outrage. Johnson spoke what was on everyone's mind: the likelihood of the Soviets "dropping bombs on us from space like kids dropping rocks onto cars from freeway overpasses" (Heefner 2012, 27). Among American leadership, only one question was looming: how did we fall behind the Soviets?

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[60] Oppenheimer opposed the development of the hydrogen bomb because he rightly feared it would lead to an arms race between the Soviet Union and the United States (Evangelista 1988, 106-108).
[61] Quoted in Warner R. Schilling, *The Politics of National Defense: Fiscal 1950* (1962, 39).

The United States emerged from the Second World War as a global superpower. With a monopoly on atomic weapons and the largest Air Force, the United States was rivaled only by the Soviet Union (Bottome 1971, 15). Concerned about the perceived Communist expansion, the United States adopted a policy of containment in 1948. Containment policy "was the evolving concept of deterrence. According to this idea, the decisive task of the military leaders was no longer to vanquish in war, but to deter the enemy from precipitating an attack" (16). The American hydrogen bomb, showcased in 1952, was a "crucial weapon in the emergence...in the policy of strategic deterrence" (17).

From the onset of early German missile use, the American defense community was interested in developing a similar weapon. When the first German missiles exploded in London in September 1944, the United States Air Technical Service Command requested a similar weapon. In the fall of 1945, the Air Staff expanded the guided missiles program within the United States Air Force (Beard 1976, 46).

Following the war, the United States forced German scientists relocation to the United States via Operation Paperclip in order to learn more about the German V-2 missile program. Slow, yet meaningful development occurred in the late 1940s. Research and development was at an all-time high. Between presidential support for development and thorough assessment of German rocket technology, guided missile development had the means to flourish (46). However, some budgetary setbacks hindered the program, such as a 7 million dollars cut that cancelled 11 of the planned 28 guided missile projects in 1947 (53). Looking back on history, it is clear that American missile development between the end of the war and Sputnik was slow. As Edmund Beard writes, "the story of the American

ICBM through a long pattern of disbelief, neglect, and delay—some of it apparently justified in the clear light of hindsight, some of it not" (5).

In the next decade, the American missile program developed through fear. American resources began to be redirected toward accelerate ballistic missile development only in 1954, seven years after the Soviets had done so (12). Especially after Sputnik, the American ICBM program progressed remarkably quickly.[62] Although the Eisenhower administration tried to quell public fear, the overwhelming assumption was that the Soviets were dangerously ahead in missile development (2). In particular, the concern regarded a supposed "missile gap" scare—that the "USSR might be able, by taking advantage of its development lead, to gain a first-strike capability against the United States which could not be effectively answered"—a highly debated topic in the 1950s (7). Edgar M. Bottome, who argues that the missile gap was a myth, explains:

> "The distinction is made between a possible 'missile lag' which would not have endangered the security of the United States, and a possible "deterrent gap" which could have threatened American security. A missile lag would have meant simply that the Soviet Union had more missiles than the United States. A deterrent gap would have meant that the Soviet Union possessed the ability to destroy United States retaliatory installations in a first strike, and thereby effectively remove the American ability to deter" (Bottome 1971, 9).

In 1958, the year after the launch of Sputnik and the R-7 demonstration point, the United States revealed the Atlas, its first ICBM (Stine 1991, 189-202).

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[62] See Figure 15, United States Expenditures on Missile Systems, FY 1946-1960 (87).

Before analyzing how the mutual timing of the ICBM by the Soviets and Americans created a brief FMA, the development gap must first be explained in terms of weak American leadership and incongruent American doctrine between 1948 to 1953.[63,64]

For leadership, the United States exhibited "not a short-term struggle between competing interests over a specific decision, but rather a decade-long pattern of non-decisions, characterized by inaction, procrastination, selective ignorance, and an unwillingness to recognize new facts" (Beard 1976, 216). The United States organizational culture hindered ICBM development, because it challenged the Air Force's manned bomber core competency. In fact, not uncommon to other challenges to a core competency, the organization faced a paradox:

> "Ballistic missiles obviously were among the most important Air Force functions. Were they to go to another service, the Air Force's autonomy, and indeed its purpose, would be threatened. However, the missiles also challenged the organizational essence and thus the Air Force's morale. The result was the ambivalent approach of the Air Force followed until, and even after, the dictates of the [Strategic Missiles Evaluation Committee]. On one hand, missiles were dismissed or derided, while on the other, they were consistently claimed as *Air Force* weapons and missile efforts by the other services were strongly resisted" (229).

Instead of developing the ICBM, the Air Force believed the next war "would be fought and won by attacking the enemy from the air and destroying his cities and industrial

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[63] This is not an explanation of the FMA. Rather, it aims to explain why the United States lagged in development. This explores the period *prior* to the Soviet introduction, while the FMA explores the period *after* the Soviet introduction.

[64] After 1953, the United States changed to strong leadership and congruent doctrine, like the Soviet Union had been maintaining, which will be explained in Analysis.

potential" (Bottome 1971, 18). On an individual level, "Men who had always flown and relied upon bombers found it hard, indeed almost impossible, to sense the revolutionary implications of ballistic missiles" (Beard 1976, 8). Thus, they developed the B-36 bomber, a weapon system that aligned with their core competency.

Moreover, lack of mavericks within the defense community lead to a delayed start for the Americans. After the war, Air Force Chief of Staff General Henry Arnold noted that the long-range ballistic missile was feasible, yet not in the near future (5).

Institutional support for missile development was in minority. Following General Arnold's retirement in 1946, "no powerful figure or group within the Air Force gave much consideration to long-range ballistic missile potentials" (12). Although the Air Research and Development Command viewed the missile favorably, the agency was only created in 1951. In turn, the agency was less able to lobby than its peer agencies (8-9, 107-110). Instead, the Air Force concentrated on manned aircraft development, namely the jet-engined Snark and Navaho. According to a June 1947 Air Force report, long-range, surface-to-surface missiles ranked fourth in terms of development priority (5).

In terms of doctrine, resource allocation did not favor the ICBM program until the late 1950s. It was argued that with missile development came much technological uncertainty. However, this uncertainty was caused by "insufficient funds (and for some time no funds at all) allocated to their solution" (9). Militaries typically operate under the principle of least harm. Yet, the United States Armed Forces failed to conduct a sufficient research and development in order to prevent deleterious surprises. Even despite the defense spending increases during the Korean War, the ICBM "was kept on a sputtering back burner until outside civilian dictate caused a reversal" (9). For a breakdown on

expenditures on missile technology, see Figure 15. Note the extreme lack of ICBM funding before 1954.

**Figure 15.** United States Expenditures on Missile Systems, FY 1946 - 1960[65]

| Fiscal Year | IR/ICBM Programs | Other Surface-to-Surface Missile Programs | All Other Missile Programs | Grand Total, All Missile Programs |
|---|---|---|---|---|
| 1946 & Prior | 2 | 19 | 51 | 72 |
| 1947 | — | 20 | 38 | 58 |
| 1948 | 0.3 | 36 | 45 | 81 |
| 1949 | 0.1 | 45 | 53 | 98 |
| 1950 | — | 65 | 69 | 134 |
| 1951 | 0.5 | 185 | 598 | 784 |
| 1952 | 0.8 | 239 | 818 | 1,058 |
| 1953 | 3 | 403 | 760 | 1,166 |
| 1954 | 14 | 336 | 717 | 1,067 |
| 1955 | 159 | 398 | 911 | 1,468 |
| 1956 | 526 | 387 | 1,368 | 2,281 |
| 1957 | 1,401 | 603 | 2,502 | 4,506 |
| 1958 | 2,150 | 639 | 2,391 | 5,180 |
| 1959 | 2,946 | 685 | 3,269 | 6,900 |
| 1960 | 3,303 | 509 | 3,173 | 6,985 |

[65] Measured in millions of dollars. Adapted from the chart found in "*Hearings: Missiles, Space, and Other Major Defense Matters*." United States Senate, Committee on Armed Services, Preparedness Investigating Subcommittee, 86th Congress, 2nd Session, 1960, 509. In Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (1976, 206).

While the development phases were varied and lengthy, the adoption phase of the ICBM occurred nearly simultaneously and quickly. Due to the nature of nuclear weaponry and ICBM reach, possession of the weapon system matters only as much as operational capability to use it. Therefore, adoption is a quick follow-up to introduction.

For both the Soviets and Americans, ICBM adoption occurred in the late 1950s and early 1960s. Strategic force structures were being institutionalized. Both the R-7 and Atlas ICBMs were "by no means mature weapon systems, but they held out the hope for a reasonably robust nuclear delivery system that had a high probability of being able to carry out their mission in the face of existing [adversary] defenses. (Zaloga 2002, 57). The Soviet program, officially deployed in 1961, "proved so poorly suited to the rapidly changing strategic environment that the program had to be curtailed" (60).[66]

Once the United States committed to the ICBM development, they achieved their goal quickly. As shown in Figure 16, Atlas development was quick, relative to bomber programs. Following the lag in development, the Americans felt an obligation to "race ahead" both in the weapon systems actual adoption and publicity of its adoption (60-61). For instance, advancement in Weapon System Q, commonly known as Minuteman, showed the American adoption of ICBMs. Public promotion of the platform was ubiquitous. Its very name was unique—unlike the previous mythological names (Thor, Jupiter, Titan, Atlas, Nike, and Zeus), "Minuteman" prompted American imagery (Heefner 2012, 30). Between local and national newspaper coverage, a public unveiling, a film on the Air Force narrated by Walter Cronkite, and Roy Neal's Ace In The Hole, the public was well aware of the ICBM program (34).

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[66] In fact, this led to a Soviet "missile gap," which is credited with being an underlying and overlooked reason for the Cuban Missile Crisis (Zaloga 2002, 60).

**Figure 16.** United States Development Pace Among Air Weapon Systems[67]

| Program | Years to First Unit Deployment |
|---|---|
| B-47 | 7.6 |
| B-52 | 9.4 |
| B-58 | 11.2 |
| Snark | 13.4 |
| Navaho | Cancelled After 9.5 Years of R&D Testing |
| Thor | 3.3 First Squadron Complete |
| Atlas | 4.9 First Complex |
| | 5.2 First Squadron Complete |

**B. Integration And First-Mover Advantage**

For the ICBM, integration occurred in the 1960s. With the arms race underway, both the United States and the Soviet Union fully integrated the ICBM into their bureaucracies. By 1961, the missile gap no longer existed, because each had a sufficient amount of ICBMs to deter the other. By 1967, the Soviet Union had a over 700 ICBMs, and the United States was capable of delivering 1,054 warheads from its ICBMs (Beard 1976, 213; Dumbrell 2004, 62). In essence, the critics of missile escalation and strategic deterrence were unsuccessful (Zaloga 2002, 60-61).

Other methods of using ICBMs were integral to its integration. Ballistic missile submarines featuring ICBMs, or submarine-launched ballistic missiles (SLBMs), only furthers the deterrence strategy. In the United States, the *USS George Washingto*n debuted

[67] Adapted from the chart found in Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (1976, 201).

its first submerged missile launch in July 1960, and eventually carried 16 Polaris missiles on board. In September 1960, the Soviet Union's first SLBM was achieved through Project 611 (Stine 1991, 204-211). By operating in stealth environments, submarines are capable of launching a devastating retaliatory strike, after a first strike occurs. The incorporation of ICBMs into the Soviet and American navies demonstrates the interservice integration during the 1960s.

Moreover, the FMA must be clearly defined in this case. Following the introduction of the Soviet R-7 ICBM in August 1957, the United States was quickly able to catch up, and in December of the next year, the Americans launched Atlas. Thus, the Soviets had a brief FMA over the ICBM weapon system.

Specifically, the brief FMA is due to simultaneous innovation. Following a dramatic shift to strong leadership and congruent doctrine in 1954, the United States was able to adopt the ICBM. Meanwhile, the Soviets had a static strong leadership and congruent doctrine.

In addition, the ICBM FMA is unique in two regards. First, like possessing a nuclear weapon, the advantage is not in actual deployment of the weapon system. Had either the United States or Soviet Union actually used their ICBM arsenals in combat, it would have likely caused extreme devastation. Achievement of just one ICBM is enough to shift the power distribution; ICBM capability is of inherent value. Second, the measurement of nuclear weapons or ICBMs is not in the absolute quantity, but the quantity relative to the adversary, evidenced by the American fear of a missile deterrence gap in the late 1950s.

**C. Analysis**

The ICBM FMA explains the period from 1954 to 1960—the period in which the United States realizes it is behind in missile development, receives a surprise with the Sputnik launch, and successfully acts to catch up to the Soviets. The brief ICBM FMA by the Soviet Union is characterized by internal strong leadership and congruent doctrine as well as external strong leadership and congruent doctrine. The ICBM FMA is an example of simultaneous innovation.

**Figure 17.** Intercontinental Ballistic Missile Results

| | Leadership | Congruence |
|---|---|---|
| Soviet Union | *Strong* | *Congruent* |
| United States | *Strong* | *Congruent* |

As per the requisite assumptions, the ICBM has high organizational and technological barriers to entry. When it comes to the ICBM, there is no room for error in technology or organization; miscalculation or oversight would prompt catastrophe. Technologically, missile technology requires an extensive research and development phase. Long-range missiles were ostensibly impossible in the World War II. The ICBM only became feasible because of three enabling technologies: fusion weapons (developed from 1950 to 1955), multistage rockets (developed from 1945 to 1955), and inertial guidance (developed from 1950 to 1955).[68] Organizationally, the ICBM also faces high barriers to entry. By nature of the weapon system, the ICBM does not easily fit in one branch of the military. It requires deliberate planning and careful shielding from adversaries.

[68] See Figure 2, An RMA Requires an Enabling Technology (14).

*C1. The Intercontinental Ballistic Missile: Doctrinal Congruence*

After 1954, the Soviet Union and the United States militaries both demonstrate congruence through doctrinal compatibility and favorable resource allocation.

First, the ICBM was compatible with both the American and Soviet military needs. In terms of deterrence, the long-range missile promoted the notion of mutually-assured destruction (MAD) and massive retaliation, effectively thwarting either side from reverting to nuclear warfare. MAD is the military policy in which one state's use of a nuclear weapon will prompt a full-scale nuclear holocaust to both parties. Massive retaliation, a term coined by Secretary of State John Foster Dulles which commits a state to respond to an attack with overwhelming greater force, renders the first act of aggression unattractive. Assuming that rational actors are not willing to suffer from a nuclear bombardment, MAD is a form of Nash equilibrium that disincentivizes the use of nuclear weapons. Thus, neither side will incur the costs of a first strike (Bettes 1981, 289-290). As a strategic alternative to bombers, the ICBM made a devastating retaliation automatic, and thereby a first strike less acceptable.

The ICBM did not have a cheap alternative. Anti-ballistic missile and missile defense systems were not plausible in the 1950s or 1960s. It did not affect the trajectory of the ICBM adoption.

For the Soviets, the ICBM seemed like the perfect system to challenge the American nuclear superiority that resulted from the World War II bombing of Hiroshima and Nagasaki. For the same strategic necessities the Americans faced, the Soviets believed ICBMs were compatible with their defense goals. For the Americans, the ICBM adoption aligned with defense fears. Because of the missile gap threat, the Americans felt obligated to

deter a Soviet first strike. After 1954, the Atlas was deemed a necessary project to promote. The pace of adoption was only quickened following American embarrassment and public fear over Sputnik (Beard 1976, 7).

Second, both the American and Soviet ICBM programs received favorable resource allocation after 1954. In fact, for the Soviets, constant resources were devoted to the program since Stalin's observation of the 1945 American atomic bomb (Zaloga 2002, 2). For the United States, the Atlas was well-funded, despite overall defense budget cuts. Sudden enlargement in ICBM funding occurred after 1954.[69] The Gillette Proposals, which aimed to quicken the budgetary process for ICBMs, "permitted the bypassing of much of the normal Air Force review system" (Beard 1976, 216-217). Implementation of the Gillette Proposals eliminated the previous "problems and delays that heretofore beset the ICBM program" (Beard 1974, 193-194).

**Figure 18.** Intercontinental Ballistic Missile Doctrinal Congruence

| | | |
|---|---|---|
| Soviet Union | *Compatible* | *Favorable Resource Allocation* |
| United States | *Compatible* | *Favorable Resource Allocation* |

In summation, with regards to doctrinal congruence, the theory holds for brief FMA for the Soviet Union and the United States as simultaneous innovators. As a first mover, the Soviet Union internally possesses doctrinal congruence with a compatible doctrine and favorable resource allocation. As a secondary actor, the United States also possesses doctrinal congruence with compatible doctrine and favorable resource allocation.

[69] See Figure 15, United States Expenditures on Missile Systems, FY 1946-1960 (87).

*C2. The Intercontinental Ballistic Missile: Leadership*

After 1954, both the United States and Soviet Union possess strong leadership characteristics—liberal organizational cultures, strong administrative support, bureaucratic competition that enhances innovation, and strong information safeguards.

First, the two actors express very different organizational cultures, and neither culture was better suited to adopt the ICBM. The United States was a maritime power. Navies tend to have a global outlook, and the Air Force adopted this perspective. The Soviet Union was a more traditional continental power. With an army-dominated culture, the Soviet Union acted to emphasize ground-based weapon systems. Decision-making the Soviet Union was very centralized, allowing for swift changes to doctrine.[70] Although the Soviet organizational culture is identified as "liberal," it must again be noted that "liberal" means open to innovation and not bureaucratically closed off to the RMA. In general, the Soviet Union was very much not politically liberal. Relative to the American organizational culture, Soviet bureaucratic politics played a lesser role in undermining the ICBM (Zaloga 2002, 2-3). For the ICBM adoption alone, the Soviet culture was liberal, and thereby willing to consider the RMA.

Second, administrative support allowed the rapid development and adoption of the ICBM. For the Soviet Union, Joseph Stalin and Nikita Khrushchev each single-handedly ensured ICBM success. Stalin ordered the establishment of three special organizations: the Special Committee Number One under Lavrenty Beria for the development of nuclear weapons, the Special Committee Number Two under Georgy Malenkov for the development of missiles, and the Special Committee Number Three under Maksim Saburov for strategic

[70] Broadly speaking, the Soviet army culture was similar to that of Nazi Germany and the American naval culture was similar to Great Britain (Zaloga 2002, 2-3).

air defense (4). The success of Sputnik "persuaded Soviet military and political leaders of the rocket's potential as a weapon when it was joined with a thermonuclear warhead" (Evangelista 1988, 200). In December 1959, Khrushchev ordered the Strategic Missile Force, a combat arm for ICBMs (Zaloga 2002, 22-23).

For the United States, political urgency accelerated the path of the ICBM. Among civilian leadership, public fear after Sputnik and concern over a deterrent gap forced Eisenhower to "reconsider his defense ceilings, loosening the constraints he had imposed on military spending" (Heefner 2012, 27). ICBM development leaders were "were assured of direct access to the highest civilian authorities whenever necessary" (Beard 1974, 194).

Congressional concern also spurred missile development. In April 1956, Senator Stuart Symington, Chairman of the Subcommittee on the Air Force of the Senate Armed Services Committee who previously served as the first Secretary of the Air Force, conducted hearings to investigate the inadequacy of the United States strategic missile program (198).

In a move that is telling of organizational leadership, the ICBM program was infused with non-Air Force personnel in 1953 and 1954. They were tasked with providing development ideas "outside of the prevailing cultural perspectives" (Beard 1976, 6). As a result, the administration changed the line of command for the ICBM in order to mitigate the "delays, obstruction, and funding scarcity that had plagued the program in its early years" (194).

The ICBM demonstrated the American defense organization's capacity to change under pressure. As Beard writes,

> "American national security policy clearly requires organizations capable of necessary change, innovation, and open-minded planning. If bureaucratic structures,

> organizational inertia, and individual bias or misperception affect the output and implementation of American defense policy, such influence should be recognized and, where possible, remedied" (10).

In 1955, Secretary of Defense Wilson responded to the urgent call for ICBMs by establishing the Office of the Secretary of Defense Ballistic Missile Committee. One week later, Secretary of the Air Force Donald Quarles formed the Air Force Ballistic Missile Committee (196).

Nonetheless, military mavericks still promoted the program. United States Air Force General Bernard Schriever played an instrumental role in implementing the crash ICBM development program (141). As a nuclear bomber pilot, Schriever "dismantled the hegemony of the nuclear bomber pilots in the Air Force." "Despite the clear threat poised" by this novel weapon to the "way of life and core mission" of bomber pilots, General Schriever advocated for ICBM advancement (Ehrhard 2010, 45). Due to his personal bomber pilot role within the Air Force, he was successful in altering prevailing bureaucratic notions and advocated for this technological advancement. Indeed, Schriever was not alone in his quest. Secretary of Defense Wilson penned a memo to the Air Force Secretary in November 1955, assigning missile development the highest priority. It read, "attainment of the earliest possible operational capability with this weapon [is] of utmost importance to national security" (Beard 1974, 197). Following 1954, the military, political, and civilian leaders in United States were committed to missile development.

Third, interservice rivalry ceased undermining ICBM development after 1954. At first, the ICBM was problematic for the Soviet General Staff, the policy-making force of the military. Due to the organizational culture, General Staff is predominantly controlled by the Soviet Army and Ground Forces, which was more inclined to invest in bombers (Zaloga

2002, 43). However, Sputnik "convinced Khrushchev that future Soviet military power would be based on the nuclear missile" (22-23). In the United States, the Air Force provided the Atlas with "a revolutionary management structure was implemented to speed the project" (Beard 1976, 216-217). It was given unique development channels that differed from regular procedure, an auspicious result from strong administrative support.

Fourth, proprietary information played a role in ICBM FMA. Both sides engaged in espionage while both maintained institutional safeguards. Both utilized German scientists, though they were less helpful than each side had hoped. Regardless of the flow of information, what is most important is that neither side received an edge.

**Figure 19.** Intercontinental Ballistic Missile Leadership

| | | | | |
|---|---|---|---|---|
| Soviet Union Strong Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Enhances Innovation* | *Strong Information Safeguards* |
| United States Strong Leadership | *Liberal Organizational Culture* | *Strong Administrative Support* | *Bureaucratic Competition Enhances Innovation* | *Strong Information Safeguards* |

In summation, with regards to leadership, the theory holds for brief FMA for the Soviet Union and the United States as simultaneous innovators. Both the first mover, the Soviet Union and the second mover, the United States, possessed strong leadership with a liberal organizational culture, strong administrative support, bureaucratic competition that enhances innovation, and strong information safeguards.

Simultaneous innovation leads to a brief FMA. Ergo, the FMA Theory explains the length of FMA for the intercontinental ballistic missile revolution.

## VI. CONCLUSION

### A. Findings

After scrutinizing the history and first-mover advantages of three RMAs, I have sufficient evidence to support the FMA Theory. First, for the aircraft carrier revolution, two advantages exist—the lengthy American FMA from World War II and continuing to this day and the brief British and Japanese FMAs from World War I to the interwar period. Both FMAs confirm the FMA Theory. Second, for the unrestricted submarine warfare revolution, the Imperial German Navy's internal weak leadership and incongruent doctrine as well as external strong leadership and congruent doctrine explain brief FMA. Third, for the intercontinental ballistic missile revolution, strong leadership and congruent doctrine for both the first mover and secondary actor characterize simultaneous innovation. See Figure 20, FMA Theory Results, for proof of the FMA Theory.

**Figure 20.** FMA Theory Results

| Case Study | Internal (First Mover) | External (Secondary Actor) | First-Mover Advantage |
|---|---|---|---|
| Aircraft Carrier | Strong Leadership, Congruent Doctrine | Weak Leadership, Incongruent Doctrine | *Lengthy* |
| | Weak Leadership, Incongruent Doctrine | Strong Leadership, Congruent Doctrine | *Brief* |
| Submarine | Weak Leadership, Incongruent Doctrine | Strong Leadership, Congruent Doctrine | *Brief* |
| Intercontinental Ballistic Missile | Strong Leadership, Congruent Doctrine | Strong Leadership, Congruent Doctrine | *Brief (Simultaneous Innovation)* |

When militaries act on the factors crucial to FMA, they increase the likelihood of keeping their edge. Strategic advantage is bequeathed to those actors who endeavor to have strong leadership and congruent doctrine. For those actors who do not, military innovation is merciless, and brief FMA is a deplorable fate. Actors may not be able to control their adversary's leadership or doctrine, though they would like to; external factors are difficult to steer. But internal factors can be controlled. Over everything else, the findings of the FMA Theory demonstrate the need for militaries to remain conscious of their actions.

The theory delineated in this paper explains the leadership and doctrine factors that influence FMA length. But what decided each of these factors rests not in theory, but in people—high-profile admirals who risked their reputations to promote a new idea, uncelebrated inventors who audaciously plunged to the depths of the sea, and countless warriors who pushed against the bounds of nature.

**B. Implications For The Next Innovation**

In 1901, Wilbur Wright said to his brother Orville, "Man will not fly for fifty years." Two years later, the first airplane took flight. After leaving his post as Assistant Secretary of the Navy, Franklin D. Roosevelt remarked, "It is highly unlikely that an airplane, or fleet of them, could ever sink a fleet of Navy vessels under battle conditions." Two decades later, President Roosevelt ordered aerial bombing of the Japanese naval fleet. History is replete with examples of our inability to foresee. Just as it is difficult to judge history in the present, predicting the next revolution in military affairs is a venture I shall not attempt. As this study is written, security scholars and military planners ponder the next possible RMA. Perhaps it will be in cyber security, robotics, three-dimensional printing, or biological

enhancement; perhaps the next RMA will be something entirely different. Even more so, uncertainty surrounds which military will venture to be the next first mover.

Regardless of what becomes the next RMA, we know what will influence its first-mover advantage. An RMA originates in thought, develops in the research and development laboratory, and is assessed on the battlefield. Whomever is the first actor to adopt will only keep its advantage under certain conditions—if its leadership is strong and the RMA aligns with its doctrinal needs, and if the secondary actors' weak leadership and incongruent doctrine disallows them to catch up.

For peacetime onlookers, war can be an elusive phenomenon. Through the carnage of war, humanity is deeply expressed. War produces our greatest heroes and our most horrific tragedies. For scholarship alone, the worth lies solely in the prospect that the understanding of military innovation may contribute to the distinguished actions of the men and women who serve. If wars are to persist, let us at least win them.

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