The Sputnik Moment: Historic Lessons for Our Hypersonic Age

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I. Introduction.

Early on the morning of October 5, 1957 a Russian booster rocket, known as the R-7 Semyorka within the Soviet Union and as the SS-6 Sapwood within the North Atlantic Treaty Organization (NATO), lifted off from the Baikonur launch complex in Kazakhstan. It was carrying a 184lb aluminum alloy sphere, highly polished for the dual purpose of internal heat regulation and making it visible to ground observers as it reflected the sun’s light. Upon reaching an altitude of 142 miles and a speed of 26,240 feet per second (f/s), which allowed the sphere to effectively “fall” around the planet earth, the rocket’s engines shut off, the protective shroud around the sphere was ejected, and the sphere’s antennae opened to their operational configurations. The sphere’s internal radio transmitters began to emit a steady “beep-beep-beep” signal on the dual shortwave frequencies of 20.005 and 40.002 megacycles. On the other side of the international dateline, where it was the evening of October 4, 1957 in the United States, NBC radio beckoned its national audience to, “Listen now for the sound that will forever separate the old from the new” as it relayed the very first satellite’s signal across the United States. The sense of shock throughout the country was palpable and the reaction tremendous even as the words emanating from the White House, due to its access to secret intelligence, were subdued and measured.

This moment in time, henceforth known as the “Sputnik Moment,” for the name attached to the small aluminum ball by the Soviet Union, marked the beginning of a new era, the “Space Age,” which came with its own steep risks and benefits. The phrase later took on additional meanings within the modern lexicon. Henceforth, whenever a new technology appeared suddenly upon the global stage carrying geo-strategic implications, its arrival was heralded as a “Sputnik Moment,” shorthand for the instability, opportunity and the dread that accompanies the sense of having been ahead in the global competition only to suddenly find yourself trailing behind. However, it must be admitted that there has not been another true “Sputnik Moment” since 1957. Although new supersonic aircraft and high-speed computers have made sudden appearances, making everyone a bit uncomfortable, no new item of technology has created such a confluence of events so as to signal American or Western inferiority as Sputnik did on that evening in 1957.

This paper seeks to both explore and understand the first “Sputnik Moment” in all of its facets. It will investigate its origins; how it came as such a surprise to so many outside of the White House and the intelligence community; and how various groups—to include leaders in the Soviet Union, the separate American military services, the scientific and engineering communities and, finally, opposing political forces within the United States—moved to leverage the “moment” to their own advantage. Because of this phenomenon, great investments were made in the U.S. military, the National Air and Space Administration was created, and the U.S. public educational system was overhauled to place greater emphasis on science and engineering within its curriculums. This study will also seek to distill lessons learned from the first “Sputnik Moment” and to examine the question of whether such an event could happen again and, if so, what would be the modern reactions?

There is a suggestion today that the current American generation, as well as other sophisticated citizens of the world, can no longer be shocked. The logic of this argument advances the idea that the current understanding of history, wide access to all-too-realistic entertainment media, the growing influence of the 24-hour news cycle and the inundation of outrageously violent video games has rendered all but the most socially isolated both cynical and immune to both chaos or wonder. But if there is one thing that Pearl Harbor, the assassination of John F. Kennedy and the attacks of September 11, 2001 have taught
everyone, it is that there is always something dramatically new and stunning just beyond the strategic event horizon.

II. The Strategic Setting

It is difficult today, with all of the 20/20 hindsight that accompanied the end of the Cold War, to recreate the angst and uncertainty of the early days of what eventually would become known as the “Cold War” (and what may well become known as “Cold War I”). The end of World War II had brought about a sense of triumphalism following the surprise appearance and dropping of two nuclear fission “atomic” bombs on Japan. Despite a serious ideological as well as economic intellectual debate surrounding the Marxism-communism-socialism versus capitalism competition in the lean years that followed the war (the United Kingdom was under the control of its Socialist party at the time), there was a sense of confidence in the technological lead of the United States. Reflecting that, when president Harry S. Truman was informed that the Soviet Union had exploded its first atomic weapon in September, 1949, his first response was, “Are you sure?” His second response was, “Are you sure?” and his third response was to speculate that perhaps some of the Germans captured by the Soviets at the end of the war had built it for them. It was impossible to accept that the backward farming serfs of Russia could craft the complex atomic bomb that had taken the United States years and huge amounts of money to build.

Shock turned to cynicism and anger when the American achievement in building the world’s first “Super” hydrogen-fusion bomb on November 1, 1952 was duplicated by the Soviet Union just a scant eight months later on August 12, 1953. While the United States had been first in this accomplishment, the interval to Soviet duplication was so short as to convey either their growing technical expertise or the sense of strategic paranoia as secret after critical secret quickly made their way into communist hands. As difficult as it was to admit, the two wide oceans that had protected the United States from distant threats were no longer large enough to shield the republic from the growing clear and present danger of global communism.

The sense of worry and declining confidence dramatically escalated when North Korean forces crossed the 38th Parallel on June 24, 1950 and invaded its southern neighbor. With this invasion, the communist movement and recent historical events took on a more ominous meaning. Now the Soviet Union’s occupation of Eastern Europe at the close of World War II could no longer be viewed as the cynical spoils of war or even Russia building a more resilient defensive barrier. In addition, Mao and the People’s Liberation Army’s victory over Chiang Kai-shek’s nationalists in China was no longer the outcome of a civil war. The invasion of South Korea signified that world-wide communism was on the march in a unified, centrally controlled manner and would not be satisfied until all of mankind fell under its ideological banner. In the United States this created a psychological global boogeyman and the resulting “Red Scare” had significant impacts upon the internal political climate of the United States.

It is important to note that these events were occurring at a moment when the full magnitude of the effects of nuclear weapons were not understood. In the first decade of the “nuclear age” that began with the explosion of the first atomic bomb at Trinity Site near Alamogordo, New Mexico, nuclear weapons were described within military battle plans as “just another tool in the toolbox.” President Eisenhower’s “New Look” defense policy relied heavily on nuclear weapons to deter conflict and envisioned using the weapons at all stages of conflict to include shooting small tactical nuclear weapons from the back of a jeep. Eisenhower himself hinted that he considered the use of nuclear weapons on
three separate occasions. Popular books suggested that nuclear wars may well be winnable if one side would commit to a surprise full attack. The nature of bomber warfare suggested this was possible. The combination of the new hydrogen bomb and nascent missile technology, however, soon radically changed this calculation.

In March of 1953, Air Force Colonel Bernard “Bennie” Schriever was attending a meeting of the Air Force’s Scientific Advisory Board at Maxwell Air Force Base near Montgomery, Alabama. Schriever was present to give a brief on the intermediate-range bomber that he was developing for the Strategic Air Command. Other voices in the room, however, were discussing ideas that distracted him for the rest of his life. The voices came from mathematician John von Neumann and physicist Edward Teller, both Hungarian refugees, and both brilliant nearly without comparison. Teller and von Neumann were holding forth on the potential of the new hydrogen bomb. In particular, they informed the Advisory Board that by 1960 the new hydrogen bomb would weigh less than a ton and yet yield over a megaton of explosive power (approximately eighty times the force of the bomb exploded at Hiroshima, Japan). Schriever, whose previous career experience had exposed him to missiles, instantly realized that this reduced weight (fission bombs weighed 10,000 pounds) and increased explosive power made the hydrogen bomb’s marriage to missiles (which were not all that accurate at the time) nearly ideal.

Coincidentally, Schriever’s name had just appeared on the brigadier general promotion list and hence he was due for a new set of orders, which could potentially afford him the opportunity to make his epiphany manifest. Soon he was posted to a newly created command called the Western Development Division located in a former Catholic boy’s school in Los Angeles tasked with developing long-range, nuclear-armed ballistic missiles.

Schriever’s unit, however, would not be the only one building missiles for the United States. The U.S. Army at its Redstone Arsenal in Alabama had been leveraging knowledge gained from German scientists and engineers captured near the end of World War II for years. These Germans, headed by the famous Werhner von Braun, had come to the United States along with some of their V-2 rockets and made a new home in the sweltering heat of Alabama. Their V-2s were quickly exhausted but the knowledge gained by both the Army and American defense industries allowed for the quick design and construction of the Redstone rocket, a single stage, short-range rocket that was capable of hurling a nuclear weapon 200 miles. To improve both range and increase the lethality of the nuclear weapon, the Redstone Arsenal team quickly moved on to design and build the Jupiter rocket, a single-staged, intermediate range (1,500 mile), nuclear armed rocket. Ultimately the Secretary of Defense stepped in and gave this Army-designed missile to the Air Force.

The Jupiter was also viewed with interest by the Navy, who wanted to deploy a nuclear-armed missile capable of being launched from its ships, to include submarines. The Navy had been experimenting with firing cruise missiles from its submarines for a number of years. Eager to make its way into the nuclear competition, the Navy had configured five of its diesel electric submarines to carry first Regulus I, and later, Regulus II cruise missiles. However, since the Regulus missiles were liquid fueled, a submarine would have to surface, open its missile hatches, fuel the missiles (which had ranges of 500 and 1,000 miles respectively), and then fire them—all the while dangerously exposed to enemy ships and aircraft. Finding this vulnerability unacceptable, the Navy turned to the vertically launched Jupiter ballistic missile as an option. Ultimately the Navy decided to go with the Polaris missile, a two staged solid rocket motor, intermediate range missile (2,500 miles) that could be fired from a submerged submarine.
For the Soviet Union, it ability to build an ICBM and launch a satellite masked a larger sense of inadequacy. In a nation headed by a political party that was deeply invested in a founding myth that it was an organization of working class people who had overthrown a group of elites, there was a strong desire to demonstrate that the Soviet Union was as smart and as strong as (if not smarter and stronger) than its counterparts in the West. This was especially true of Nikita Khrushchev, who had emerged from the inter-party melee that followed Joseph Stalin’s death in 1953 to lead the Soviet Union. Khrushchev was close to illiterate and hence very sensitive regarding his education and level of sophistication. But he, as a former laborer in mines as well as the party manager of a major effort to build concrete apartment buildings, had an appreciation of hard engineering projects. He viewed science and engineering to be instruments for advancing the Soviet Union’s prestige and solidifying its position as a leading power. He was also strategically adept enough to understand that the United States’ lead in long range bombers represented a competition that he could not win, but his scientists and engineers, most importantly Sergei Korolyov, convinced him that missiles, particularly missiles mated with nuclear weapons, presented an opportunity to leapfrog ahead of the Americans in a key strategic capability.

Korolyov, the Soviet “Chief Designer,” had suffered greatly under Stalin during the 1930s and spent time in the gulags, emerging strong in mind even as he was weakened in the body by torture and starvation to begin the rapid prototyping and development of increasingly advanced rocket engine designs. The Russian desire to lift a satellite into orbit was actually assisted by their backwardness. There was no early assumption in the Soviet Union that nuclear weapons would eventually be miniaturized in their size or weight, and it was understood that the Soviet air force would never be able to keep up with American bomber production (despite an American originated “bomber gap” fable during the mid-1950s). The Russians understood that if they wanted to deliver their large atomic bombs against the West, they would need a large, powerful rocket to carry them.

While there had been some experimentation with rocketry in the Soviet Union prior to World War II, most of its post-war development was derivative of the advances made by the Germans during the war. The Soviets spent months following their victory over the Nazi’s in German rocketry labs and bases before returning to the Soviet Union. Soviet rocket engineers first attempted to develop a larger engine that could generate more thrust from a single chamber to lift its large nuclear bombs into intercontinental ballistic flight. However, difficulties with controlling sustained combustion under higher pressures forced Korolyov to shift to a more complicated, but less challenging design featuring a series of four-chambered rocket clusters, with four clusters around a fifth central core making up the first stage. The second stage was a single core of four-chambers. The rockets were fueled by a simple mixture of liquid oxygen and kerosene. Initial test flights ran into problems with equalizing the thrust across the twenty firing chambers as well as directional control from outboard vernier rockets. There were also difficulties with the process of ejecting the four clusters that surrounded the first stage core when their fuel ran out. “Staging”, or controlling the process by which the first stage’s rockets were discarded and then the second stage rockets were lit, also had to be worked out. Given the number of moving parts involved, the successful launch of an “R-7” rocket with a dummy load on August 21, 1957 was a tremendous achievement.

The United States had been monitoring the Soviet Union’s rocket activities. U-2 high altitude surveillance flights had noted and identified the newly constructed facility in Kazakhstan and its design and arrangement left little doubt as to its purpose. The high resolution cameras on the U-2 aircraft had
actually spotted an R-7 rocket on the pad and could get a sense of its size by correlating the length of
the shadow it cast and the local time of day when the photos were taken.\textsuperscript{23} In addition, a large, secret
U.S. radar facility in northern Iran monitored the test launches conducted by Korolyov and his team and
had assessed that the Soviet Union had a working ICBM after its fourth test flight ended successfully.\textsuperscript{24}
So the launch of the Sputnik satellite and its “beep-beep-beep” transmissions did not catch President
Eisenhower, the Department of Defense, or the intelligence community by surprise, but for everyone
else it represented a total shock, one that more than a few were willing to take advantage of.

III. The Sputnik Moment and Immediate Reactions

Americans don’t like surprises. The sinking of the Lusitania, the attack upon Pearl Harbor, the
assassination of John F. Kennedy, the terrorists attacks of September 11, 2001, all triggered deep,
visceral reactions among Americans. Following September 11, the noted foreign affairs analyst Walter
Russell Mead described America’s level of reaction (or over-reaction) as its “Jacksonian Impulse,” which
manifested itself in an outburst of righteous fury and a determination to defeat the enemy.\textsuperscript{25} It is not a
foreign policy but rather a short, high magnitude reaction that can often derail a more thoughtful
strategy already in place. This is what happened after the launch of Sputnik.

Again, the launch of Sputnik was not a surprise to Dwight Eisenhower, the American military or the
broader U.S. intelligence community. All were aware that the Soviet Union had a working ICBM booster
that could place a satellite in orbit. They also all knew that both the Soviet Union and the United States
had publicly set goals to place satellites in orbit during the International Geophysical Year (IGY) that ran
from July 1, 1957 to December 31, 1958.\textsuperscript{26} So, amongst these people, the launch on October 5, 1957 was
not a large surprise. What was a surprise was the shocked, almost panicked reaction of the American
public. Eisenhower, who could well remember his own reaction on December 7, 1941, did not anticipate
that his fellow countrymen would so closely associate the launch of a Russian satellite with the surprise
attack upon Pearl Harbor. He also did not anticipate the degree to which his political opponents would
seek to leverage that panic to their own political ends.

The initial strong reaction can be found in the headlines and articles of the nation’s leading newspapers.
“Russian science whipped American science,” the Boston Globe.\textsuperscript{27} Just down the coast, the New York
Times stated in an editorial that America was falling behind, “in a race that is not so much a race for
arms or even prestige, but a race for survival.”\textsuperscript{28} Other headlines across the nation proclaimed, “A great
national emergency”...“A grave defeat”...and “A technological Pearl Harbor.”\textsuperscript{29} Time magazine took the
step of naming Soviet Premier Nikita Khrushchev as its coveted 1957 “Man of the Year.” Part of the
energy behind the “Sputnik Moment” came from the fact that newspapers are businesses, and
publishers quickly realized that stories about Sputnik sold newspapers, so they pushed the story to keep
their circulation up.

The newspapers sold for two reasons. The first, and most obvious, was that the American people had an
innate fear of surprise attacks that stemmed from two aspects of their history and culture. During the
long push across the North American continent they had existed in fear of attack by indigenous
American populations who lived there. In an era dominated by John Ford-John Wayne movies and newly
arrived black and white television sets presenting weekly broadcasts of “The Lone Ranger,” the nation
became inundated with a “cowboys and Indians” frontier mentality. The second source of the
fascination with space stemmed from the fact that the American frontier had been closed for fifty years
and Americans had begun to accept, even in the age of long range bombers, that there was safety behind the barriers of two large oceans. With Sputnik’s launch, however, they became conscious of the frontier of space and the vast vulnerability of their skies as an entry point into their nation. There was also the rising sense of time compression, the realization that the enemy wasn’t weeks or days away from their doorstep but instead could make a blindingly devastating attack in mere minutes. Most Americans were not cognizant of all of the complexities of missile launches or nuclear explosions, but they instinctively assigned great value to the threat they, combined, represented.

However, the heightened concern that accompanied the Sputnik moment was also felt by deeply serious and highly educated people as well. Edward Teller, the physicist credited with designing the hydrogen bomb, stated that with Sputnik’s launch, “America had just lost a battle more important than Pearl Harbor…”30 James Killian, the head of the very prestigious Massachusetts Institute of Technology, and who shortly would become the first National Science Advisor to the president, stated after the launch that it was “an affront to my national pride.”31 The Lawrence Livermore National Lab director made a point of playing Sputnik’s beeps in the background when he was having funding meetings with Congressional delegations. The science and engineering communities were eager to talk up Sputnik and enhance the sense of threat because they viewed the launch as an opportunity to make an argument for more funding from the government for their individual research programs.32 Given that the Eisenhower had pursued a policy of fiscal frugality and a stated goal to balance the federal budget after a quarter century of budget deficits, Sputnik provided an opportunity to “break the piggy bank” in favor of science and engineering interests, and scientists were not the only ones to see opportunity in Sputnik’s launch.

Politicians as a group are warriors with words. The governor of an industrial Midwestern state composed a cutting poem following the launch,

“Oh little Sputnik, flying high
with made in Moscow beep
You tell the world it’s a Commie sky
And Uncle Sam’s asleep.”

He was not alone in his sentiment, or in his desire to take advantage of a tremendous political opportunity. For the first six years of his presidency Dwight D. Eisenhower had been unassailable on defense and national security issues. As a temporarily retired five-star General of the Armies (he would request and be granted a return to active duty following his departure from political office in 1961) who had commanded the landings in North Africa and, much more importantly, at Normandy on D-Day, Ike had the prestige to significantly cut back defense spending and modernize the U.S. military, especially his own beloved Army.34 His “New Look” strategy had emphasized nuclear weapons as a means of getting “more bang for the buck” and he had suggested actually using them. He was largely successful in his reforms because the Democrats, nominally his political opponents, who controlled both houses of Congress for all but two years of Eisenhower’s presidency, could not touch him on defense, until Sputnik.

Ike had been irritated by the magnitude of the public reaction following the launch.35 Again, having been aware of the Soviet’s progress in rocket development, he was not “surprised” by the launch. “I can’t understand why the American people have got to be so worked up over this thing,” he remarked to his
military assistant, Army Colonel Andrew Goodpaster, “It’s certainly not going to drop on their heads.” In fact, Eisenhower found some strategic relief in the fact that the Soviets had gone first, and in doing so had solidified the interpretation of “free space,” meaning that nations had the right to overfly other nations, in space. Eisenhower had set the military and intelligence communities to work developing a spy satellite a few years earlier, and now the Soviets had ensured that there would be no protests when his reconnaissance satellite launched. A few days after the launch, in an attempt to calm the American public through a demonstration of personal self-confidence, Eisenhower held a press conference about the Sputnik launch. When asked directly if he was concerned about the nation’s security, Ike bluntly replied, “Not one iota.” That response badly backfired. Eisenhower was attempting to assuage concerns and recover control of the broader national narrative, but the wise old soldier suddenly began to look simply like an old detached soldier.

A major blow to his efforts was associated with the “release” of the Gaither Committee report just a few days after Sputnik’s launch. The committee was a gathering of high profile citizens who had expressed an interest in national security. Its purpose was to consider the nation’s defensive posture following the expansion of the Soviet Union’s nuclear threat. The committee was just finishing up its work and completing the draft of its report when Sputnik launched. The report’s principal author, Paul Nitze, who had served in the Roosevelt and Truman administrations and had been the lead author of the now famous NSC-68 memorandum, plunged into a re-write of the Gaither report in an effort to take advantage of the focus on defense issues that the Sputnik launch initiated. The report recommended massive investments in civil defense through the building of bomb shelters as well as the upgrading of the bomber force’s readiness and investments in and expansion of the nation’s missile force. The underlying strategy was to build a force strong and resilient enough to absorb an attack and then retaliate credibly. Eisenhower, appalled at the high costs associated with the committee’s recommendations, attempted to ignore the report, but then, mysteriously, a few days later the report’s findings and recommendations were leaked to the press. Eisenhower, again, was irritated to the point of anger but Nitze, who was suspected to be the leaker, was unapologetic. The news reports helped to increase the public’s concerns and forced Eisenhower to seek a supplemental defense spending bill for FY-57 as well as submit a higher defense budget proposal for FY-58.

Paul Nitze was far from the most prominent member of the opposition political party to launch attacks against Eisenhower. Senator Mike Mansfield, who would go on to become the Senate’s majority leader, stated, “What is at stake is nothing less than our survival.” Senator Henry “Scoop” Jackson of the state of Washington, a well-known defense “hawk,” made a motion on the floor of the Senate to declare a “National week of shame and danger.” Senator Stuart Symington of Missouri, who had served as the nation’s first Secretary of the Air Force from 1947 until 1950, was known as the Air Force’s foremost advocate in the Congress. Symington, based upon poor intelligence being fed to him by allies within the defense industry, had been asserting that there was a growing “bomber-gap” between the Soviet Union and the United States as a result of Russia pouring more resources into their defense than the stingy Eisenhower administration. With Sputnik’s launch, and a growing understanding that the Soviets were not surpassing the U.S. in bomber production, Symington’s rhetoric shifted immediately. Now the nation was facing a “Missile-Gap.” Symington hoped to ride the issue to greater political prominence, but although he was a leading voice on the issue, it would be two other political figures who would capitalize the most off Sputnik’s launch.
Lyndon B. Johnson of Texas had become the leader of his party in the Senate in 1953 and the majority leader in 1955 when the Democrats regained control of the upper house. On the night of Sputnik’s launch he was hosting a barbeque dinner at his ranch on the Pedernales River when he received the news that the new satellite was orbiting overhead. He and his wife went for a walk and attempted to get a glance of something no previous generation had seen, an artificial satellite in orbit. He later recounted, “In the open West, you learn to live closely with the sky. It is part of your life. But now, somehow, in some new way, the sky seemed almost alien. I also remember the profound shock of realizing that it might be possible for another nation to achieve technological superiority over this great country of ours.” When Johnson returned to Washington, he inveighed upon Senator Richard Russell, the chairman of the Senate Armed Services Committee, to allow him to use the Preparedness Subcommittee, which Johnson chaired, to investigate the state of the nation’s defenses with regard to space. Johnson used the hearings to place Eisenhower on the spot with regard to spending on space and the current state of the nation’s own ICBM program. Johnson and his political aides sought to leverage the issue to position himself as “Senator Space” and to increase his national profile ahead of the 1960 election.

There was, of course, another Democrat senator with an eye on the presidency when Sputnik launched. John F. Kennedy was the junior senator from the state of Massachusetts, both in terms of age (40) and senatorial seniority in the fall of 1957, but he was already known to be a man on the move. Kennedy’s Senate career had been marred by numerous absences due to ill health and back surgeries and as 1957 turned into 1958, he was eager to get some political points on the board. Following Sputnik’s launch Kennedy began to hammer Eisenhower for his continued emphasis on the nation’s economy as its source of strength and suggested that Eisenhower, the former five-star general, was ignoring the nation’s military strength, to include its development of advanced weapons to include ICBMs. Kennedy initially described this condition as a “missile-lag” but soon he too was using the “missile-gap” nomenclature as well. Thus it was not an accident that in 1960, due to their adroit use of the ICBM-Sputnik issue, that Kennedy and Johnson emerged as their party’s standard bearers in that year’s presidential election.

There were other critics of Eisenhower’s policy with regard to space and ICBMs, each attempting to leverage the Sputnik launch to forward their own individual agendas whether it was selling newspapers, the pursuit of more funding for research and development or seeking the presidency. The bottom line was that Sputnik’s launch had laid Dwight D. Eisenhower, the victor of Normandy, bare to charges of being weak on defense and antiquated when it came to setting a course for the nation’s future. At first he simply rejected the charges, fully expecting that his immense personal dignity would once again bring the nation around to his way of thinking. A bit later, when the Soviet Union launched another, even larger satellite, this time with a living dog on board (that later died in orbit), Eisenhower asked the intelligence community to provide him with a new National Intelligence Estimate (NIE) considering the state of the missile competition. He also, after the spectacular failure of the civilian Vanguard I satellite launch on December 6, 1957, authorized the military to work with civilian scientists to get an American satellite up quickly. Ike had originally hoped to loft the first U.S. satellite with a purely civilian missile, wanting to avoid the charge of having militarized space, but when the Soviets used a military rocket to launch Sputnik, all strictures within the American program were removed.
Eisenhower did remain concerned about the fiscal costs associated with a panicked response. He had executed two balanced budgets and hoped to do so again. Ike also, as his aide Andrew Goodpaster later recalled, “supported an ongoing, serious scientific program at a reasonable rate and did not want to be drawn into having that characterized as a race.” In the end, Eisenhower did compromise on his economic frugality and submitted a budget proposal that did not balance and increased defense spending by 13 billion in Fiscal Year 1958. Eisenhower realized that he needed to change the nature of the national conversation about space, but he still held out hope that he could channel that dialogue in a rational manner.

IV. Civilian Space

So much of the logic behind the series of decisions that led to the Soviet Union placing the first satellite in space stems from the diplomatic narrative desired by the Eisenhower administration with regard to the International Geophysical Year or “IGY.” In 1954 the International Council of Scientific Unions established a special committee for the International Geophysical Year that was headquartered in Brussels, Belgium. This committee recommended that the international community of scientists consider the problems of orbiting a satellite, as well as related issues of instrumentation, telemetry, power supply and directional control. A group of American scientists agreed that these issues were important, and what’s more, were solvable and made a recommendation on March 14, 1955 to the National Science Foundation and the National Academy of Science that they be taken up in a formal way. On July 29, 1955, in cooperation with the two scientific institutions, the White House made the announcement that the United States, “as part of its contribution to the International Geophysical Year, will launch an unmanned Earth-circling satellite vehicle.”

There were a number of proposals put forward with regard to the launch vehicle that would propel the world’s first satellite into orbit. There was always the assumption within the American and western scientific communities that the first satellite would be an American vehicle. The Air Force, the Army and the Navy each put forward proposals. The Air Force’s proposal was rejected because it depended upon its new Atlas ICBM rocket, which might not be ready within the IGY’s July 1, 1957 to December 31, 1958 timeframe. The Army suggested using its Redstone IRBM rocket, which, with a small enough satellite, could place an object in orbit. In the end, the Naval Research Laboratory’s proposal, “Project Vanguard,” was selected. This design utilized commercially available sounding rockets to make up the rocket “stack.” A Glenn L. Martin Viking rocket was used for the first stage, an Aerojet Engineering Company Aerobee for the second stage, and an in-house manufactured solid rocket for the third stage. It was also thought that this approach would make it less likely that America’s satellite launch effort would distract the busy teams focused on the military’s ICBM development effort. Yet another engineer involved with rocket launches from Cape Canaveral in Florida understood the decision to be based upon an understanding that data gained from research as part of the IGY would be made available to the international scientific community, and Department of Defense officials were not inclined to reveal anything about their new ICBMs, so an ostensible “civilian” stack of commercially available sounding rockets was the preferred approach. There was also another reason that was less discussed.

There was a large legal question as to the sovereignty of space. Eisenhower had proposed an “Open Skies Treaty” that would have essentially made the atmosphere above a certain altitude over every
nation part of a global commons, much as the oceans and seas were outside of each nation’s territorial limits.\textsuperscript{59} This treaty was an extension of a legal argument first made by the Dutch legal theorist Hugo Grotius in 1609 that had established the concept of Mare Liberum, or “The Free Sea.”\textsuperscript{60} Eisenhower’s proposal would have allowed for controlled, coordinated overflight of the Soviet Union by U.S. planes, and vice versa and he offered it as a sub-component of a legal architecture for nuclear arms control. If each nation could overfly the other, then the construction of missile sites or runways for bombers could be detectable and reduce the risk of surprise. The Soviet Union rejected the “Open Skies” proposal out of hand.\textsuperscript{61} By extension, this rejection extended sovereign claims to the air above each nation, but it was undecided as to whether such claims were unlimited or had an upward cap. Hence the concept of “vertical sovereignty” was still on the table and Eisenhower, who had already invested in the U-2 high altitude spy plane and in an orbiting photo-reconnaissance spy satellite, had an interest in having an American civilian scientific satellite establish the precedent of “free space.”

Eisenhower’s concerns never came to fruition. The Soviet launch of Sputnik using a military ICBM booster negated the issue of whether or not the American program used a “civilian” rocket and the flight path of Sputnik established the accepted international norm of “free space,” a point that Ike’s advisors pointed out to him at a meeting on the day following the launch.\textsuperscript{62} Now Eisenhower felt free to use military booster rockets to launch satellites of all types but especially to launch a military reconnaissance satellite. Three weeks after Sputnik’s launch the Army team at the Redstone Arsenal in Alabama was given authorization to launch a scientific satellite using a modified Jupiter C IRBM booster.\textsuperscript{63} Simultaneously the CIA and the Air Force made their project, WS-117L, a secret reconnaissance satellite code-named Corona, a higher priority. Corona program satellites would utilize first an Atlas and later Titan booster rockets.\textsuperscript{64}

These initiatives were just as well because the civilian rocket put together for Project Vanguard produced a spectacular disaster when its engines ignited on December 6, 1957. The rocket lifted ever so slightly from its pad, but then suddenly erupted into a ball of fire with the satellite falling off the rocket as the entire assembly collapsed.\textsuperscript{65} Then the Army team moved to the head of the line and, now with permission to use their Jupiter-C based, four stage rocket, launched the 30.8 pound Explorer I satellite into an elliptical orbit on January 31, 1958. The satellite, which had been designed by the Jet Propulsion Laboratory at the California Institute of Technology, carried 11 pounds of scientific instruments designed to measure cosmic radiation levels and micrometeorite hits.\textsuperscript{66} In a major scientific breakthrough, Explorer I, during its eleven days of operations (the batteries ran out at that time) confirmed the presence of the Van Allen radiation belts that surrounded and shielded the planet from harmful cosmic radiation.\textsuperscript{67} This discovery constituted the major scientific discovery of the IGY, and helped to restore some of the nation’s prestige that had been perceived as damaged.

Eisenhower’s impact upon “civilian” research did not end with the launch of the Explorer and Vanguard satellites. Nor did the gray zone of overlapping areas of interest between civilian research and military programs fade away to stark black and white operations. In February of 1958, as a direct reaction to Sputnik’s launch, the Secretary of Defense, Neil McElroy, signed DoD Directive 5105.15 and established the Advanced Research Projects Agency, which later became known as the Defense Advanced Research Projects Agency, or DARPA, which continues to champion pioneering research in the defense field. Interestingly enough, as opposed to the Naval Research Laboratory, DARPA did not perform in house
research and experimentation but rather staffed its offices with senior program managers who worked with outside contractors to conduct research. ARPA’s original three research priorities were space technology, ballistic missile defense and solid rocket propellants. The Department of Defense initially provided ARPA with a large budget to go with its mandate and originally was able to attract some high visibility talent from industry, namely Roy Johnson of General Electric, to head up its efforts. However, as will be elaborated upon below, Eisenhower would later undercut this effort by creating the National Aeronautics and Space Administration (NASA), giving it the mandate to develop civilian space research, and reducing ARPA’s embryonic budget to stand it up.. ARPA, however, soon repurposed itself to focus on “high-risk/high-gain” research, to the delight of the nation’s scientific community. ARPA partnered then, and continues to do so today, with government labs, industry and academic research universities such as the Massachusetts Institute of Technology, Purdue University and the California Institute of Technology to pursue its research agenda.

The creation of NASA was another direct result of Eisenhower’s concern that space research not be dominated by the military agenda in the wake of Sputnik. He wanted to avoid a replay of the battles between the military and civilian research communities surrounding the development of atomic weapons versus atomic energy generation that had dominated the 1940s. Accordingly he tasked Dr. James Killian, the chairman of the President’s Science Advisory Committee (PSAC) to consider the structure of the nation’s overall space program. Killian and the PSAC concluded in February 1958 that a new space agency should be built upon the foundation provided by the existing National Advisory Committee for Aeronautics (NACA), which had been established in 1915 to consider the nation’s path forward with regard to aviation. NACA had never been a major player in the development of the nation’s aviation industrial base. It didn’t have enough money in its budget to share with aviation industry to shape it in a meaningful way. In addition, NACA had avoided space as a policy focus area right up to Sputnik’s launch. Immediately afterward Sputnik, several young engineers came forward with some novel ideas, but by that time Eisenhower was already moving out with a broader agenda.

On April 2, 1958 the White House sent a message to the Congress along with a draft bill to establish a National Aeronautics and Space Agency. Democrat leaders in the House and the Senate produced their own bills and each legislative house held hearings on the topic. These produced updated bills that went to a joint conference. The House insisted that the new organization be an “administration” rather than an “agency,” thus ensuring that it would occupy a higher place within Washington, DC’s pecking order. Eisenhower signed the resulting bill on July 29, thus creating NASA. The new administration took over NACA’s 8,000 employees, its $100 million budget as well as its major labs and research centers. NASA also pursued the acquisition of the Jet Propulsion Laboratory at Pasadena, CA and the Army’s rocket team in Huntsville, Alabama. NASA immediately took over the civilian Vanguard program and moved out quickly to begin the design and development of a new family of rockets that ultimately resulted in the creation of the Saturn I and Saturn V heavy lift boosters, as well as a series of civilian scientific satellites.

Eisenhower also paid attention to the civilian roots of both civilian and military space programs, namely the nation’s education system. One of Eisenhower’s major legislative achievements was the 1958 National Defense Education Act. Following Sputnik’s launch, Eisenhower asked for a meeting with the PSAC just a few days later. During that meeting he asked its members if the Soviet Union had surpassed
the United States in terms of its education program. Members suggested that it had not, but that it could, given ample investment in the Soviet education system. Eisenhower inquired as to what could be done and the PSAC members suggested additional federal investment in the nation’s education system.

This left Eisenhower with a conundrum. He was a careful reader of the Constitution and he believed that since education was not mentioned within its articles or amendments it, as a policy area, was to be left to the state and local communities. However, given the threat posed by the Soviet Union, Eisenhower became interested in a path to assist the states with education. Thus was born the National Defense Education Act, which was sent to Congress in January 1958. Within Eisenhower’s draft language was a program that would add one billion dollars to the nation’s education system over four years by incrementally funding college loans and matching grants to states to pay for students who would study mathematics, sciences and foreign languages (with the exception of Greek and Latin, as they were dead languages). Again, Congress got involved, held hearings and finally produced a conference bill that was sent to the White House in September for the president’s signature. Not only did the bill realize its intended goal of significantly increasing enrollment in undergraduate and graduate science, engineering, math and foreign language programs, but it also paved the way for the federal government to become more involved in the nation’s education system going forward, helping to create the premier national college and university constellation in the world.73 Much as he had done with the nation’s interstate highway system, Eisenhower had enacted a major reform of one of the nation’s internal foundational supports by leveraging interest in the Cold War competition and clothing a domestic policy issue in the attire of national defense.

V. “And there was war in heaven:”74 The Competition between the Services.

Emerging from the “Sputnik Moment” the three prime military services (Army, Navy and Air Force) each saw tremendous opportunities for mission and budgetary growth... Together, the tremendous popular panic and interest in the topic, the focus of the media, and the statements of strong political leaders on Capitol Hill created a wave with carried a tremendous amount of energy and each of the three military departments began paddling hard in an attempt to catch the wave in order to gain control of the mission and with it, budget share..

To all outward appearances the United States Navy had the preferred position. The Naval Research Lab’s (NRL) Project Vanguard had been selected to make the nation’s first satellite launch and hence would gain both initial notoriety as well as experience and data from the initial launches. However, the first disastrous launch attempt of the Vanguard satellite in December 1957 and the second rocket explosion in February took away whatever positive prestige the Navy might have gained even as the telemetry from the two launches did provide valuable data and experience for the NRL scientists. Ultimately NRL would launch a six-inch spherical Vanguard satellite into a 400 mile by 2,600 mile elliptical orbit on March 27, 1958. It should be noted that the Vanguard satellite made use of solar cells as well as batteries, so it continued to transmit a signal for years after its launch. NRL launched additional Vanguard satellites in the year that followed. These examined cloud cover and other space and atmospheric phenomenon.75

One of the problems with Project Vanguard was that the Navy’s heart really wasn’t in it. To be sure the project was run by the Navy’s prime research institution, and the program was nominally headed by an admiral, but Vanguard wasn’t an “operational” project that directly contributed to the Navy’s missions
of sea control or power projection. No Vanguard missile was ever going to be launched from a Navy ship or aircraft, so it was a scientific distraction at best.

To the extent the Navy was interested in missiles, it was as power projection tools in the ongoing Cold War with the Soviet Union. The Navy had felt left on the sidelines when the Air Force grabbed the nuclear mission following World War II, but this sense of institutional vulnerability drove innovation into the Navy’s approach to force design. In 1954, the Navy had introduced the Regulus I missile, which appeared to be (and was) an adaptation of Germany’s V-1 “Buzz-Bomb”76. The Regulus I was a cruise missile designed to be launched from a surfaced diesel submarine. Its initial launch was powered by two 33,000 pound thrust solid rocket engines that accelerated the missile to its cruising speed at which point the weapon’s Allison J-33 turbo-jet engine took over.77 The Navy modified four submarines with dry shelters to carry two missiles each and then rotated these subs into the northern Atlantic and Pacific oceans to maintain patrol stations.78 The Regulus I was superseded quickly by the Regulus II, which was a super-sonic version of the cruise missile. However, the true marriage of the Navy’s strategic missions and rockets was found in the development of the Polaris missile and the nuclear powered ballistic missile submarine.

Originally, the Navy was going to develop an Intermediate Range Ballistic Missile (IRBM) in partnership with the Army team at the Redstone Arsenal. As events unfolded, however, the Navy decided to focus instead on a solid-fueled rocket that would be safer on an enclosed Navy ship at sea and the Army continued to look at a liquid-fueled options for its IRBM. In December 1956 the Navy began to exclusively focus on a design that it called Polaris and their primary launch platform was to be a submarine. This did not rule out launches from cruisers, destroyers or even aircraft carriers, but the new missile had to be tailored to the size and capabilities of a nuclear-powered submarine’s hull. As such the new missile was to be no more than 28 feet in height, 60 inches in diameter and weigh no more than 15 tons. It was to carry a small but very powerful nuclear warhead that wasn’t even in existence yet, but was forecast by Dr. Edward Teller, the father of the hydrogen bomb. The missile went through growing pains and launch failures before success was achieved.79

As the missile was being designed and developed, the Navy set about, under the able leadership of Rear Admiral William “Red” Raborn, to work with Rear Admiral Hyman Rickover, the father of the nuclear Navy, to design and build the submarine that was to carry the new missiles.80 President Eisenhower, on December 31, 1957, eight weeks after Sputnik’s launch, authorized money to be shifted from other Navy programs to accomplish this goal. To get a submarine in the water quickly, the Navy took a Skipjack-class fast attack submarine then being built, the USS Scorpion (SSN-589), cut her in half, inserted a one hundred and thirty foot missile compartment that could hold sixteen Polaris missiles, and then welded the three components together. Thus the USS George Washington (SSBN-598), the world’s first nuclear ballistic missile submarine, was created. She was launched in June of 1959 and commissioned six months later. One year after entering the water the ship’s crew successfully launched two missiles from a submerged position that successfully travelled 1,100 nautical miles and hit their target.81 From start to finish, one of the most complex weapons systems in the Navy’s history was developed and operationally deployed in five years. Eisenhower’s interest in military missiles had helped, but it was an interest that could cut both ways.

The Army could have found itself in the preeminent position with regard to ballistic missiles. Once it had been given the green light by the President, it had quickly assembled the Explorer I satellite with the
help of the Pasadena, California based Jet Propulsion Laboratory and then launched it into orbit on the last day of January in 1958. The Army had a strong team under the military leadership of Major General John Medaris and the engineering leadership of Dr. Werhner von Braun at its Alabama based Army Ballistic Missile Agency (ABMA) and it had already developed the Redstone as well as the Jupiter rockets. To all outside observers, the deck was stacked in the Army’s favor in early 1958, but success breeds jealously and political infighting, and the Army soon felt both.

First, the Army’s program had been seriously weakened when the Navy had pulled out of the development of the Jupiter missile. The Navy had taken both men and money away from ABMA’s efforts and the Air Force and its allies in the Congress began to raise questions as to just why the land-component service had a space program. The Air Force argued that while the Army had developed the Jupiter IRBM missile, it should not be allowed to field it as an operational system. This argument carried the day and the Army was forced to transfer control of the Jupiter program to its daughter-service. Then NASA showed up.

As stated previously, Eisenhower had created the National Aeronautics and Space Administration out of the remnants of the National Advisory Committee on Aeronautics in October, 1958. NASA then set about consolidating the nation’s ongoing space related efforts under its umbrella, and Werhner von Braun’s team at ABMA was first on their list. Fortunately for the Army, von Braun’s team totaled over 3,000 personnel, and NASA’s budget was not yet large enough to absorb the entire organization and von Braun didn’t want to break up his organization. The Army, with von Braun’s support, made the argument that given the importance of the competition in space, it made no sense strategically to break up the team. Their argument initially carried the day, but then the Air Force made a flanking attack.

By 1958 the Air Force had made significant investments in the development of ICBMs. What’s more, the Air Force had taken pains to re-define itself as an “aerospace force” whose responsibilities reached from the ground upward through the air and into space. “To infinity and beyond,” as it were. The Navy had self-limited itself to sea-launched IRBMs. The Air Force would attempt later to gain operational control of even these assets under Strategic Air Command and its Single Integrated Operational Plan for nuclear war, but for now, the Air Force was happy to let well enough alone with the Navy. The Army was another matter. In 1958 the Air Force raised the issue of the Army’s missile program within the Joint Chiefs of Staff at a strategically opportune moment. In 1958, an Air Force general held the chairmanship of the Chiefs and the Chairman and the Air Force Chief of Staff were able to carry the day inside the small group, making a recommendation to the Secretary of Defense to transfer ABMA’s efforts to the Air Force.

Faced with mounting pressure and a fait accompli, Werhner von Braun had to make a decision. His main concern was his proposed heavy lift rocket, the Saturn, which he envisioned as a cluster of smaller rockets assembled around a central core generating 1.5 million pounds of thrust that would enable the United States to quickly catch up with the Soviet Union in terms of heavy lift. It represented the culmination of all of his efforts and his life’s work. The turning point for von Braun came when he suggested that the Air Force use his Saturn rocket to lift its envisioned space bomber, the Dyna-Soar (Dynamic Soaring) vehicle into space. The Air Force showed disdain for the design and stated that they would use the yet un-designed “Titan-C” rocket for the job. Faced with no other path forward for his beloved Saturn rocket in the military, von Braun decided to transfer his team to NASA. By 1959, when the decision was made, NASA had been able to quickly grow its budget and could by then absorb most
of von Braun’s team along with his laboratory facilities in Alabama. With that decision, the Army, less than two years after it had lofted the nation’s first satellite into orbit, effectively lost its bid to participate in the space mission.\textsuperscript{82} This set the stage for the Air Force and its space herald, General Bernard Schriever, to emerge from the inter-service scrum in a dominating position.

Schriever and the Air Force had been gifted with the Jupiter, but it was clear from the start that Jupiter would not meet the Air Force’s requirement to field an ICBM. He quickly initiated designs for two separate Inter-Continental Ballistic Missiles (ICBMs), the Atlas and the Titan, which utilized two different types of liquid fueled rocket engines. General Schriever (he had been promoted first to one and then to two star rank rapidly) sought and received top level support for his efforts. In just over a year after he had been named head of the Western Development Division, and with the support of the Air Force’s leadership, Schriever and his team briefed President Eisenhower on July 28, 1955 in the White House regarding the need for an ICBM. Schriever convinced the former five star general that his vehicles could reach the enemy quickly, accurately and in a highly survivable fashion. Eisenhower, who always worried about potential Pearl Harbor level surprises and also appreciated that an ICBM that could carry a nuclear warhead could also probably carry a spy satellite, got behind Schriever’s proposals, all of them. Within weeks Schriever and the Air Force had Eisenhower’s highest presidential priority behind their efforts to develop and field not one but two ICBMs.\textsuperscript{83} A few months later other voices got through to the president, and Eisenhower added the rapid development of an intermediate range ballistic missile (IRBM) to his highest priority list, and Schriever’s organization got tasked with this responsibility as well. Later, a third ICBM design and a space bomber would be considered as technology matured.

The Air Force Western Development Division began its work with the Atlas missile. 85 feet tall, 10 feet in diameter, guided by an radio updated inertial navigation system and powered by a unique “stage and a half” propulsion system that generated 300,000 pounds of thrust, the Atlas, built by Convair, could lift a 3,700 pound, 1.4 megaton warhead and place it accurately within 1.5 miles of its target half a world away. The Atlas had many problems. Its thin-skin design could not support its own weight and the rocket could collapse if its tanks were not continuously pressurized.\textsuperscript{84} It’s “stage and a half” propulsion system was awkward as well, and caused many launch failures during testing. Not confident that they could get a true second stage engine to light in the near vacuum of the earth’s upper atmosphere, the engineers at Convair had made the decision to place two booster engines outboard of the central sustainer engine. All three would light at liftoff with the outboard boosters programmed to fall away around two minutes into flight, leaving the central sustainer to power the vehicle throughout the remainder of its journey.\textsuperscript{85} The Atlas was approved for development in 1954, tested in 1957 and reached its initial operational capability in 1959.\textsuperscript{86} Eleven “squadrons” of between six and twelve missiles each were commissioned, resulting in a total of approximately 120 missiles standing at the ready to wage nuclear war.\textsuperscript{87} The Atlas served only a short time as a nuclear deterrent weapon, being retired in that role in 1965, but it carried on as both a human spaceflight booster for project Mercury and as a commercial satellite launch vehicle, evolving through to the present day as the Atlas V rocket.

Titan was originally conceived as a hedge to be considered should the Atlas missile not mature as hoped, but Eisenhower’s strong support resulted in both programs being developed to their full capabilities. The 103 foot tall Titan was a true multi-stage design with the first stage having dual thrust chambers capable of generating 430,000 pounds of thrust for the missile’s first 140 seconds of flight. At that point a single engine, only capable of operating at high altitude, would ignite with 100,000 pounds of thrust and burn for another 155 seconds, throwing the missile’s warhead 6,350 miles down range with an
accuracy of 1.1 miles. The Titan was built by Glenn L. Martin Company at a new factory south of Denver, Colorado that was constructed after a review by the Eisenhower administration suggested that too much of the nation’s strategic manufacturing base was being located on the west coast.88 Titan was the first missile to be designed to launch from hardened underground silos as part of its nuclear deterrent mission. The Titan II missile, which became the standard variant for the nuclear deterrence mission, was the first modern ICBM to shift from kerosene and liquid oxygen as its fuel components to a hypergolic mixture that combusted upon contact. The Titan was contracted in 1955, undertook its first test launch in 1959 and became operational in 1962. Six Titan squadrons were stood up to oversee an inventory of 54 Titan missiles. The Titan, much like the Atlas, also served double duty as a boost for NASA’s manned space program, acting as the booster for Project Gemini, the two-manned capsule that proceeded Project Apollo and the moon landings. The Titan was stood down from its nuclear deterrence role in 1987.89

While these two initial ICBMs were being designed, tested and built, Schriever’s WDD team came under additional pressure. The Army had hoped to remain in the missile game and had moved aggressively in 1955 to develop and build the Jupiter intermediate-missile as a follow on to its Redstone missile. This caused anxiety amongst the Air Force staff in Washington, and senior officers began to urge General Thomas Power, Commander of the Air Research and Development Command, to develop an Air Force IRBM. Power and his subordinate, General Schriever, viewed the IRBM project as a distraction from their focus on the ICBM and a potential drain on the resources needed to build the ICBMs, which ended up being a valid concern. But in November, 1955 Secretary of Defense Charles Wilson directed that the Air Force and an Army-Navy team to develop IRBMs. As previously discussed, the Army-Navy efforts resulted in the Jupiter and Polaris missiles after they split their efforts. Schriever’s team, reluctantly, got tasked with building an intermediate range missile.90

The original requirements associated with the missile were that it be able to travel between 1150 and 2300 miles while carrying a nuclear weapon and hit within two miles of its target. It was clear, given that the United States had no enemies within 2,000 miles, that these rockets were designed to be forward based in allied nations. The Air Force took the odd step of designing the missile itself and then soliciting industry to submit bids to build the design. The Air Force’s final design was for a rocket 65 feet long, so that it could be transported onboard an Air Force transport aircraft, had a range of 1,750 miles and used a cut-down Atlas booster engine for propulsion. In December, 1955 the Douglass Aircraft Company was awarded the contract to build the airframe and assemble the missile. The Thor, as the IRBM came to be known, suffered many difficulties during its development. The rocket’s engine design contained a faulty turbo-pump that caused many flight failures with both the Thor and the Atlas until the problem was isolated and corrected. The first Thor was test launched on January 25, 1957. It reached an altitude of six inches before exploding. The first successful launch occurred nine months later, after numerous failures, on September 20, 1957 and the missile became operational in the United Kingdom in August of 1958.

The technologies associated with Thor would continue to evolve even after the IRBM mission faded and Thor evolved into the Delta family of rockets that continue to launch satellites today.91 Additionally, the early combination of the Thor as a first stage booster with an Agena second stage engine lifted several of the first Discoverer spy satellites, as part of a joint Air Force-Central Intelligence Agency program, into orbit in the late 1950s and early 1960s.92
With the forced transfer of the Jupiter missile from the Army, the Air Force found itself with two IRBMs and two ICBMs. The Army had been effectively sidelined in the inter-service competition over rockets and the Navy had headed off on its own course to develop a sea-based, solid-fueled IRBM that could be launched from submarines. Bernard Schriever and his team at the Western Development Division had clearly emerged as the victors, but there was still resistance to their vision and their rockets from within the Air Force. General Curtis LeMay, the nation’s foremost bomber advocate, had derided Schriever and his missiles throughout their development. LeMay went so far as to tell Schriever on one occasion that if he had had it his way, Schriever would have never been promoted to general. LeMay’s concern was that the requirement to fill Schriever’s rockets with liquid fuel, which could take thirty minutes to an hour, could leave them vulnerable to being taken out by a surprise enemy attack. LeMay continued to believe that the bombers of Strategic Air Command, many of which were kept in an airborne alert condition continuously, were the nation’s true deterrence force. But then Schriever’s team developed the Minuteman missile.

The Minuteman ICBM was the brainchild of Air Force Colonel Edward Hall, a brilliant, mercurial engineer who was, by all accounts, difficult to work with but a genius nonetheless when it came to designing rockets. He and Schriever had a personal falling out over the multiple launch failures in the Thor program, which Schriever had placed Hall in charge of. Although Schriever removed him from Thor (a decision that Hall forever held against Schriever), he retained Hall as an engineer on his team. Hall had been intrigued by the idea of using solid rocket fuels for an ICBM. The advantage would be that such a rocket could be instantly ready, having no fueling requirement. The disadvantages were many.

Solid rocket motors at that time burned their fuel from one end of a tube to the other. This worked for short ranged missiles but failed for long range because longer duration burns tended to perforate the missile container wall, causing mission failure. Also, with solid rocket motors, it’s harder to control the precise timing of thrust termination, which reduces down-range accuracy. If the rocket burns too long, the warhead lands beyond the target. If it shuts off too soon, the warhead falls short. Solid rocket engines had always burned until their fuel was exhausted. Hall worked with engineers throughout industry to come up with solutions to these technical challenges.

First, he helped to develop a new fuel based upon ammonium perchlorate, which had greater energy density, but was also more stable for long-term storage. Second, he helped to develop large fuel cylinders that were formed with a star-shaped hole running through the center of their entire length. This allowed the fuel to burn evenly along the entire central axis of the missile from the inside out, thus protecting the integrity of the missile casing on long inter-continental flights. Third, Hall also developed blow-out ports in the rocket’s nozzle that could be opened, lowering the pressure in the chamber, extinguishing the combustion, and ejecting the remaining unburnt core, at the precise moment necessary to ensure that the warhead would hit its target. It was a crowning achievement. Due to Ed Hall’s breakthroughs, the Minuteman missile was rushed through development. Only a third the size of a Titan, it could nonetheless hurl its warhead the same distance, but with greater accuracy.

The effectiveness of the design and their near instantaneous readiness for launch won over even bomber zealot Curtis LeMay. When first briefed on the new missile LeMay, who had gotten up and walked out of many of Schriever’s previous briefs, spun around in his chair to ask his subordinates, “Do you agree it’s a go?” The first missile test flight on February 1, 1961 was a total success. The first of 1,000 missiles produced were operationally deployed in 1962. The Air Force grouped the Minuteman
missiles into wings of 150 spread across multiple missile “fields.” However, in the end, the missile did not live up to its name. It did not take one minute to launch, it took three.97

Of course the development of IRBMs and ICBMs cannot be reduced down to a conversation only about rockets. Perhaps the most important technological development of the missile age was the rapid maturation of inertial navigation systems. Initially cruise missiles and short ranged ballistic missiles depended upon radio guidance, meaning that they received positional updates from their launch sites, but as altitudes and ranges increased the missiles soon found themselves unable to receive navigation updates. The solution was evident to all: self-contained inertial navigation systems. Many advanced electronic manufacturers, such as the Sperry Company, had been building gyroscopes for decades that could help aircraft pilots understand their orientation even in bad weather. The Massachusetts Institute of Technology laboratory under the leadership of Dr. Charles Draper set about to leverage the knowledge gained from gyroscope development to create a system that could accurately measure changes in platform orientation along all three axes.

Initially the design was to place three high speed gyroscope into positions 90 degrees offset from each other with accelerometers attached to their frames to measure any sensed movement in their orientation. This design proved to be more accurate than any previous design, but the scientists noted that there was “drift” in the system due to the earth’s rotation and subtle differences in the planet’s gravitational field. This was compensated for by mounting three more high speed gyroscopes along the three defined axis but with their gyro wheels spinning in the opposite direction of their twin, thus allowing them to cancel each other’s “drift” out.98 All of this also drove material and design requirements for miniaturization as well as the need to develop first analog and later digital computers to accept data from the accelerometers and integrate it over time to compute course and speed changes in order to provide guidance for the missiles and the ships that carried them. Missiles launched from land bases knew their launch locations but missiles launched from submarines at sea were dependent upon the submarines computed location to establish their point of origin for ballistic computations.99 Advances in computers that allowed them to store more data onboard later allowed for the integration of optical sites which could take navigational fixes off stars while the missiles were in flight. In the end, the evolution of the “brains” of IRBMs and ICBMs was as rapid and technologically impressive as their propulsion systems.100

One cannot leave the topic of the inter-service rivalry that surrounded and followed the nation’s “Sputnik Moment” without briefly considering the Air Force’s attempt to build a space bomber, the “Dyna-Soar” vehicle. The Air Force was conceived as a strategic bombing force. Bombing lay at the central core of its culture. Six of the service’s first ten Chiefs of Staff came from the bomber community and during the 1950s no man impacted the Air Force more than General Curtis LeMay, the long-time leader of the Strategic Air Command and later its Vice Chief and Chief of Staff. So when the Air Force began to think about space, it could not help but consider a “space bomber.”

Knowing their customer, in April, 1952 the Bell Aircraft Company, builder of the X-1 aircraft that first broke the sound barrier and a leader in transonic flight, proposed a manned bomber-missile to the Air Force. Two years later the Air Force worked with Bell to study the concept of an advanced bomber-reconnaissance system that would operate at the edge of space. One year later, in May of 1955 the Air Force issued a formal requirement for a piloted high-altitude reconnaissance system, the Dynamic Soaring aerospace craft, or more simply, the Dyna-Soar, with a target initial operating capability date of
The Air Force’s Advanced Research and Development Command took the lead in developing a range of hypersonic projects, but things began to slow down following Sputnik’s launch and as other unmanned missile projects as space based satellites accelerated. The Pentagon’s Advanced Research and Projects Agency, which had originally partnered with the Air Force on the space bomber, pulled out of the Dyna-Soar effort in 1960.

The Air Force, with its bomber centric mentality, soldiered on however. It contracted with Boeing to design the bomber-reconnaissance Dyna-Soar vehicle and with the Glenn L. Martin Company to build the launch booster. Ultimately the Air Force decided to go with a derivative of the Titan booster, then the most powerful rocket in existence, to get Dyna-Soar into orbit. The concept of the aircraft/spacecraft was to launch and perform either reconnaissance or nuclear bombing missions, from the edge of space, and then return to a gliding landing at an Air Force base near a launch facility. John Kennedy appeared to be an initial supporter of the program, even mentioning it in his first message to the Congress in March of 1961, but just one year later he told his internal aides that, despite his public statements regarding the Project Mercury astronaut’s flights and his goal of landing a man on the moon, he was not that interested in space. In December, 1963, one month after Kennedy’s death in Dallas, Texas, Secretary of Defense Robert McNamara announced the cancellation of the Dyna-Soar project while leaving the door open for an Air Force “manned orbital laboratory.” This program was also fated never to fly.

One important aspect of this period of time was the number of test flights and failures that occurred. Prior to the development of high speed computers, the only way to test a rocket was to build it and launch it and then learn from that experience. In order to maximize the learning opportunity, the scientists and engineers embedded a multitude of sensors into their rockets that continuously transmitted data to ground stations in the form of telemetry so that when accidents did occur, and they often did, the experts could pore over the data in order to determine where the problem had begun. The Atlas and Thor programs experienced significant growing pains, the Titan and Minuteman missiles progress was markedly smooth. Bernard Schriever almost lost his job over the Thor missile, which experienced numerous failures. Colonel Ed Hall actually did. The simple lesson of the era was “build a little, test a little, then build a lot” which is a method that is seldom seen in our current era.

The period of inter-service rivalry that surrounded and followed the “Sputnik Moment” was characterized by deep bureaucratic infighting and rapid advances and multiple lines of research, development, and ultimately production. Each service sought to leverage the panic that followed the launch of Sputnik to advance their individual interests and each made significant contributions to the nation’s national security. In the end, three IRBMs and three ICBMs were conceived of and entered into active service in less than six years. Despite the Army’s best efforts, it was kicked to the side. The Navy sailed on, but only in a limited fashion that was associated with sea-launched IRBMs and later ICBMs as the service moved from the Polaris to the later Trident missile. The Air Force under the inspired leadership of General Bernard Schriever clearly emerged in a dominant position with regard to space launch. Key propulsion and guidance technologies were rapidly advanced, aiding military, intelligence and civilian space exploration efforts. Solid rocket propulsion perhaps saw the greatest advances. However, the story of Dyna-Soar also adds a cautionary tale of allowing entrenched service cultural issues steer technology rather than allowing technology to steer service strategies and help expand strategic options. These considerations, in the strategic realm, would undergo similar slow, evolutionary
changes as well, in the years following the Sputnik Moment as the nation’s great minds wrapped their thoughts around missiles and their implications with regard to war and mankind’s continued existence.

VI. Impact on Strategic Thought

When the first atomic bomb was detonated at Trinity Site near Alamogordo, New Mexico, Dr. Robert Oppenheimer, who had been the scientific lead on the Manhattan Project, instantly recalled the lines from the Hindu Bhagavad-Gita, “Now I am become death, the destroyer of worlds.” In the days that followed Oppenheimer and the Manhattan Project scientists who had been so ebullient after the test became morose as military members of the team began planning the movement of two atomic bombs to the Pacific in anticipation of them being dropped on Japanese cities. Many of the scientists quickly became critics of the use of atomic weapons and sought to place them, and the knowledge of them, under the control of an international regulatory regime. Oppenheimer himself would famously lose his security clearance a few years later in part because of his opposition to the development of the hydrogen bomb. However, outside of the scientific community there was little concern about the development of nuclear weapons or their proliferation. Outside of the 1962 Nuclear Test Ban Treaty (which didn’t seek to limit the weapons but only restrict how they were tested) from 1945 until 1972 when the Strategic Arms Limitation Agreement (SALT I) and the Anti-Ballistic Missile Treaty was signed, there were no formal agreements to limit the number of nuclear warheads or control the number of platforms (bombers or missiles) that carried them. So, oddly enough, despite the widespread panic that surrounded the Sputnik moment or the incredible energy that was poured into U.S. civilian and military missile programs, there was little thought given to arms control or how new warheads, missiles or delivery technologies (Multiple Independently targeted Reentry Vehicles (MIRVs)) might destabilize an increasingly fragile international system, which, in hindsight, seems odd.

To understand why strategic thought evolved as it did, one must understand how atomic bombs were perceived by decision makers. When the nuclear weapons first entered the American inventory that was how they were perceived, as just another weapon in the inventory. Military planners routinely included atomic weapons in their plans. Scientists may have had second thoughts about their efforts but policy makers in these early years of the atomic age, tended to give them scant attention, but as information flowed home from the bomb sites at Hiroshima and Nagasaki and the implications of radiation and nuclear fallout became better known, concerns rose. However, from a military perspective, in a period dominated by the assumption that every brushfire war throughout the world was a surrogate for the larger U.S.-Soviet Union, capitalism vs communism competition, nuclear weapons remained central and prevalent in American military planning.

Some of this prevalence was due to the strategic dominance of the Air Force’s (which gained its independence from the Army in 1947) bomber community across the entire Department of Defense (also created in 1947) and its adherence to an air power theory which held that bombers would always be able to reach their targets and that future wars could be won by air power alone. Such thoughts gained credence following the dropping of the two atomic bombs on Japan, which neatly averted the need to invade Japan’s home islands and sacrifice potentially over a hundred thousand American lives. Air power had defeated Japan (air power advocates conveniently ignored the naval and land forces that conquered the islands that the American B-29 bombers would fly from to drop their bombs) and so the lethal combination of bombers and atomic bombs would win future wars as well. The Air Force had another distinct advantage in the strategic dialogue that sprang up in the early days of the
Cold War. In the fall of 1945, with some $30 million left over from the recently completed war, General of the Army Hap Arnold, then the head of the Army Air Forces, funded the creation of an organization that came to be known as the RAND (Research ANd Development) Corporation in some spaces walled off at a Douglass Aircraft Corporation hangar in Santa Monica, California.\textsuperscript{118}

RAND quickly attracted great talent from across the spectrum of strategic thought. Bernard Brodie, Albert Wohlstetter, Charles Hitch and Andrew W. Marshall all emerged from the embryonic churn that was RAND in its early days.\textsuperscript{119} The unique combination of mathematics, game theory, economics and nuclear research allowed RAND to lay the foundation for how the modern world thought about nuclear weapons and nuclear war. However, what must be understood in hindsight is that RAND was largely funded by an Air Force that culturally was interested in promoting air power broadly and bombers specifically. A strategic appreciation for other means of transportation and other strategies for fighting wars would have to come later. Nuclear theory, to include deterrence theory and concepts surrounding nuclear arms control, would slowly evolve during the 1950s and into the 1960s and largely in an environment defined by the bomber and its central role in American nuclear military campaign planning.

The Eisenhower administration contributed a great deal to the global nuclear dialogue in its early years. First, candidate Eisenhower suggested that he might use nuclear weapons to bring about a satisfactory outcome to the ongoing conflict on the Korean peninsula.\textsuperscript{120} He later suggested that he would consider using nuclear weapons in the defense of Taiwan should the recently installed communist government on the mainland choose to attempt an invasion of the island that lay 110 miles off its shores.\textsuperscript{121} While no one knows if Eisenhower was serious about these threats (he choose not to disclose his inner thoughts on nuclear weapons) the fact that he had been the general who had committed allied forces to the invasion of Normandy and then successfully led the allied victory in Europe gave his words a sense of gravitas that many world leaders (or even subsequent American presidents) would never have. Then in 1954 Eisenhower’s Secretary of State, John Foster Dulles, gave a speech in New York to the Council on Foreign Relations in which he advocated for a policy of “massive retaliation” as a means of deterring Soviet aggression around the world. Dulles’ argument was that the United States would no longer react to Soviet revolutionary incursions into small nations on a case by case basis by sending American forces but rather that the United States would directly attack Soviet targets of its choosing with nuclear weapons in response to these low-level activities. Dulles argued that such a strategy would get the United States off its back foot and put it into a pro-active strategic mode.\textsuperscript{122} Dulles came out of the New York, east coast establishment foreign policy school that advocated for a roll-back strategy vis a vis the Soviet Union rather than Truman’s containment strategy.

The Soviet’s development of first fission and then fusion bombs along with the introduction of ballistic missiles began to subtly change the national conversation. Henry Kissinger’s popular book Nuclear Weapons and Foreign Policy emerged out of Council on Foreign Relations study in 1957. Kissinger, then an academic on the rise at Harvard, made an argument for considering nuclear weapons, especially smaller “tactical” nuclear weapons, in war planning. Kissinger’s argument was that such use was to the United States advantage in the face of the Soviet Union’s much larger conventional army.\textsuperscript{123} Herman Kahn, who had worked at the RAND Corporation and had pioneered certain aspects of the Monte Carlo war gaming technique, took the popular appreciation of nuclear strategy to new levels in 1960 when he published his best seller On Thermonuclear War. Kahn attempted to demonstrate within the book the actual outcome of a nuclear exchange between the two Cold War superpowers.\textsuperscript{124} Thomas Schelling,
another RAND alumnus, published *The Strategy of Conflict* in 1963 in which he explored game theory and trust/mistrust in great power nuclear deterrence competitions. These theorists treated nuclear weapons as amorphous objects of mass destruction, paying little attention to how they were delivered or defended against. Their approach was intellectual and strategic, more of a thought exercise rather than considering operational plans and solutions. In many ways the strategists of the late 1950s and early 1960s were like children touching a hot stove, tentatively wrapping their minds around the characteristics of nuclear warheads and their potential. They never commenced a deep dive consideration of the new missile delivery vehicles. Even the great strategist Bernard Brodie in his 1959 book *Strategy in the Missile Age*, written two years after Sputnik’s launch, failed to deeply consider how the introduction of the ICBM changed the strategic environment. Even when he briefly discussed ICBMs and IRBMs, it’s within a chapter on the topic of defending against missile attacks in which he advocates for the enclosure of bombers in blast proof shelters. Similarly, Albert Wohlstetter in his seminal essay in the January, 1959 issue of *Foreign Affairs*, “A Delicate Balance” spent most of his time focusing on the basing and movements of bombers and their tankers rather than on the game-changing Jupiter IRBMs then being deployed into the United Kingdom.

There were, however, some advances in strategic thought. Dulles’ massive retaliation strategy was abandoned, but even then there was a debate as to whether to pursue a counter-force (target only the opponent’s military units) or a counter-value (target the enemy’s civilian population centers) strategy. Eventually the decision would be made to focus on counter-force even as game theory began to provide the intellectual basis for what is now understood to be the theory of mutually assured destruction. Secretary of Defense Robert McNamara, who served during the Kennedy and Johnson administrations, came to understand that a nuclear attack on the part of either the Soviet Union or the United States would lead to a retaliatory attack that would result in both side’s destruction.

What was surprising in retrospect is how little attention these early nuclear theorists paid to missile characteristics and how they had changed the mathematics of war. Missiles tipped with thermonuclear hydrogen bombs could traverse thousands of miles in thirty minutes, striking with great devastation in a short microcosm of time. These characteristics reduced reaction time, increased the threat of surprise along with the potential of a mistaken hair-trigger response. The combination of the relative accuracy of the new IRBMs and ICBMs, less than two miles of offset after thousands of miles of flight, along with their overwhelming megatonnage explosive power, also served to put both sides on edge. Finally, the near invulnerability of ballistic missiles to defensive surface to air missiles insured that an attack, once launched, would almost certainly be successful. Such was the resistance to the full potential of nuclear tipped missiles that some strategists and force planners even suggested that the best use of nuclear tipped missiles was to knock out surface to air radar and missile sites to enable the bombers to get to their targets. The reason for this strategic blindness is clear in hindsight. Most of the strategic thought of that time was funded by the Air Force, and the Air Force was dominated by the bomber community culture. If an individual or organization (RAND) wanted to keep their funding and support, they talked about the centrality of the bomber.

Two major events in 1962 conspired to force policymakers, military officers and strategist to reconsider the number of nuclear weapons and their use. On July 9, 1962 a Thor IRBM rocket lifted a 1.15 megaton hydrogen bomb to an altitude of 248 miles over Johnston Island in the Pacific. The results of this “Starfish Prime” test were spectacular from a visual perspective, created brilliant auroras in the upper
atmosphere, and unexpected in the sense that the explosion knocked out Hawaii’s electrical grid some 715 miles away as well as destroying or damaging several satellites then in orbit.\textsuperscript{131} It was the first time that the electro-magnetic pulse phenomenon was observed on a large scale. In addition, the high levels of radiation ejected by the explosion were trapped in the Earth’s radiation belts, super-energizing them for several years to come.\textsuperscript{132} In fact, it was later stated that it was good that NASA did not send men to the moon until December of 1968, as an earlier flight may have exposed the crews to debilitating levels of radiation.\textsuperscript{133} The Starfish Prime test was sobering to the scientific and strategic communities, but not as stark as the events of October, 1962.

That month the Soviet Union, laboring under its sense of national inadequacy and eager to find an offsetting threat to counter the Thor and Jupiter IRBMs based in the United Kingdom and Turkey respectively, attempted to establish a Soviet IRBM base 90 miles off the American coast in Florida. The ensuing “Cuban Missile Crisis” that followed, wherein the nation faced the real potential for a nuclear exchange had the Soviet Union not backed down, caused many senior leaders to reconsider their approach to nuclear weapons.\textsuperscript{134} Robert and Alberta Wohlstetter, the husband and wife strategic team, wrote succinctly of the crisis with regard to war, “there are down escalators as well as up escalators, and there are landings between escalators where one can decide to get off or get on, to go up or down, or to stay there; or to take the stairs.”\textsuperscript{135} The Wohlstetters laid the groundwork for escalation/de-escalation theory and created a mental picture of warfare as a multi-floor story building with conventional escalator access to the lower floors but also a speed elevator that could take anyone to the top floor of total nuclear war at any moment. The Wohlstetter construct has been useful while considering U.S.-Soviet relations throughout the Cold War, but it also offered a tantalizing image of the interim floors between the lower floors of conventional, traditional warfare, and the “Penthouse” floor of total nuclear war.

The gap between conventional war and nuclear war was created within the burgeoning arms control community. During the late 1950s and early 1960s the so-called “Cambridge Arms Control School” consistently attempted to create and strengthen a stigma around the use of and a high threshold for the use of nuclear weapons. Alarmed at the rapid rise in nuclear weapons on both sides of the arms race, the Cambridge School began to identify a minimum adequate number of warheads to create a strategic deterrent. They decided upon 200 warheads on each side, or a “1/2 Beach”, a “Beach” being the minimum number of warheads required to wipe out all of civilization in the northern hemisphere as described in Neville Chute’s influential book, \textit{On the Beach}. They also argued strongly for nuclear non-proliferation, seeking to limit nuclear weapons to those nations who already had them with a goal of getting some, if not all of those nations to eventually give them up.\textsuperscript{136}

Later, as the 1960s advanced and conversations regarding defensive technologies began to emerge in an attempt to take away the near invulnerability of nuclear missiles, another school emerged that suggested embracing the stability of mutually assured destruction and prohibiting the development of advanced ballistic missile defense systems. It wasn’t too far a leap after that conversation that advocates for Strategic Arms Limitation Talks finally emerged and a series of bi-lateral conversations began between the Unites States and the Soviet Union.\textsuperscript{137} There were some strategic setbacks. Restrictions on the number of missiles were shortly offset by the development of Multiple Independently targetable Reentry Vehicle (MIRV) warheads, which allowed each single missile to carry multiple warheads. There was also a treaty that eliminated IRBM missiles from the U.S. and the Soviet Union’s inventories, much to Europe’s collective relief.\textsuperscript{138}
By the 1970s the general aims of the arms control community began to emerge clearly. First they sought to increase international security by maintaining a stable relationship between the United States and the Soviet Union. Second they sought to halt the continuous upward spiral of strategic arms and technologies. Atomic bombs had begat long range bombers which begat IRBMs and ICBMs which begat Anti-Ballistic Missiles which begat MIRVs, each step introducing perturbations into the international system and the chance for war. The third goal of strategic arms control was to create a process of continuous dialogue between the United States and the Soviet Union with the assumption that talks would help to reduce tensions. In many way, the arms control movement that emerged world-wide was the last manifesting echo of the launch of Sputnik in 1957 and the shock that came with it.

VII. Lessons Learned and Recommendations

When considering the Sputnik Moment and the lessons that it might offer to the current era of great power competition between the United States, China and Russia and in particular to the rapid introduction and maturation of hypersonic weapons by those nations, it would be wise to consider the sage advice of two esteemed leaders who held office at the dawn of the first Cold War. George C. Marshall, who had served as the Army Chief of Staff during World War II, had been asked by Harry S. Truman to serve as his Secretary of State and to help him consider the nation’s strategy for confronting the Soviet Union, as well as the challenge of re-building a war ravaged Europe. To assist him in this effort, Marshall had asked the long-time State Department diplomat George Kennan, a thoughtful man from Wisconsin, to head up a new Office of Policy Planning. When considering the work that Marshall needed Kennan to do, he gave him a short directive, “Avoid trivia.” Around the same time, Marshall’s deputy and eventual successor as Secretary of State advised when asked how to sell the American people on the need for the Marshall Plan to rebuild Europe that the administration needed to state the challenge in a manner that was “clearer than truth.” And so, given all the lessons that might be gleaned from this study and all that might applied to the nation’s current challenges, here are the non-trivial ones and the stark recommendations to be distilled from them.

A. Time waits for no one.

Americans had emerged from the success of World War II, to include the rapid development of the atomic bomb, with the understanding that the United States was the political, economic and technological leader of the world, and that these advantages would last. However, in their initial hubris following the war, they presented a stable target for the Soviet Union as a rising challenger. The Soviets soon caught up with Americans with regard to nuclear fission bombs, were close behind them with nuclear fusion bombs, and strategically chose to leap-frog the United States on the subject of delivery vehicles, side-stepping a bomber competition to invest heavily in missiles as their prime means of attack. The United States soon learned that standing still meant that someone was gaining on them and might even pass them, as the Soviet Union did with the launch of Sputnik.

Recommendation: Pursue a forward leaning, anticipatory policy with regard to fielding new capabilities. Rather than just respond sequentially, examine intelligence as to the investments of competitors and attempt to leap-frog them and thus place the reactive onus upon the other side of a competition. Give deference to rumors of the emergence of new capabilities without sliding headlong into panic. We must assume that new technologies developed on the home front will or have been shared/stolen with rising competitors, however, recognize that the American advantage has always been that we can use new
capabilities more innovatively than our competitors. Each military service should have a cell focused on the future security environment and how to address its challenges. The Department of Defense should hedge strategically by making appropriate larger budgetary investments in research and development as well as the accelerating the fielding of new capabilities. History repeatedly shows that great powers that sit on their laurels and cling to evolutionary improvements in large sunk-cost investments with declining operational utility are soon surpassed. Eisenhower’s reluctant but strong reaction following Sputnik’s launch should be the norm, not the exception when considering the emergence of future threats.

B. Americans are not immune to surprise.

Surprise and the reaction to it are still strong elements of the American character. However, that which surprises and engages the nation’s attention is generally an event of significant magnitude. The sinking of the cruise liner Lusitania prior to World War I, the attack upon the naval base at Pearl Harbor, the launch of Sputnik, the assassination of John F. Kennedy and the 9-11 terrorist attacks in New York City all galvanized the nation and triggered a period of significant frenzied reaction. While scientists and engineers might perceive that there have been several events (China and Russia’s development of hypersonic weapons, MaRV warheads, breakthroughs in quantum sciences) that are on par with these previous events, the simple fact is that these breakthroughs have not broken out above the ambient noise of what has become the 24-7-365 news cycle to create a feeling, as was felt with Sputnik, that a moment had arrived “that will forever separate the old from the new.” If the magnitude of energy and investment that was associated with the Sputnik moment is to ever be repeated, then a significant effort should be made to promote broader public interest in the threats associated with the introduction of hypersonics on the part of Russia and China. This can be done in an objective, professional manner, without descending into fear-mongering.

Recommendation: Develop a strategic communications plan. Scientists and engineers could author a series of essays and articles about hypersonic missiles and their associated new capabilities that will appeal to a broader popular audience. These articles should then be leveraged for a series of public speeches as well as broad media outreach (newspapers, radio and television). A serious documentary should be made to highlight the nature of the threat, not only to the United States but also to our friends and allies, in a starkly understandable manner, “clearer than truth.” In addition, a public commission should be empaneled in much the same way the Gaither Commission and 9-11 Commission were brought together to generate a sense of gravitas surrounding the issue of a hypersonic competition as a major component of the growing great power competition. Such a commission would allow for leaders in the Congress to emerge as subject matter experts on the topic as well. Such a commission could help to establish the next “Senator Hypersonic” as Symington, Johnson and Kennedy each attempted to become “Senator Space” after Sputnik’s launch. Also, the importance of the work of Henry Kissinger, Herman Kahn and Thomas Schelling in laying the foundation for how the modern intellectual community thinks about missiles cannot be overstated, yet each of their seminal defining works was funded by a larger organization. The Council on Foreign Relations sponsored Kissinger’s work and the Air Force, through RAND, supported Kahn and Schelling. If a new capability emerged today, consideration should be given to supporting leading thinkers that can establish the intellectual foundation for thinking about the challenges and opportunities associated with a new disruptive technology, as well as draw the broader public into a national discussion about what should be done.
C. Inter-service Rivalry.
Following the Sputnik Moment the three prime services engaged in intense competition to gain space-launch associated missions and budgetary dollars. This competition made sense because it was cast against the backdrop of a bi-polar great power competition that was taken seriously. It spawned significant technological innovations to include multi-stage rockets, hypergolic and solid fuels as well as new strategic and operational methods (IRBM launches from submerged platforms, space based surveillance and weapons platforms). Fostering innovation in all aspects of competition across the services should be encouraged in the early stages of research and development. However, civilian leaders should also take the second lesson from the Sputnik moment and be willing to identify when concepts of operation are not feasible and be willing to step in and truncate and/or redirect funding and programming priorities to ensure that dollars are spent in the most efficient manner. While such threats may be claimed to inhibit forward movement, the historical record suggests services under pressure will drive themselves to innovate and create new capabilities.

Recommendation: Create a Joint hypersonics development office to direct the development of new hypersonic platforms across the services but with a requirement to report progress on a regular interval to the Secretary of Defense, the Chairman of the Joint Chiefs and the appropriate subcommittees of the House and Senate Armed Services Committees. Such an office would bring focus and increased efficiency to the hypersonic development process. It would also minimize competition for talent and the dilution of the pool of qualified operational as well as research and development subject matter experts. Such an office, much as with the Joint Strike Fighter program office, should be held by a three-star officer who is not of the same service as the Chairman or Vice-Chairman of the Joint Chiefs to avoid one service’s vision from gaining dominance in internal DoD discussions.

D. Intra-Service Rivalry
Even with the advent of the “Sputnik Moment” the Air Force’s dominant bomber community sought to limit the growth and development of the ICBM force and even when rockets became reliable and accepted, the bomber community unwisely sought to co-opt them to create a manned space bomber with the Dyna-Soar program. Within the Navy, the advances and technical knowledge of the Naval Research Laboratory were set aside to focus other Navy “operational” requirements. Today’s services are similarly dominated by a few viewpoints and cultures. Naval aviation, and in particular aircraft carrier aviation, may attempt to force the development of a hypersonic missile that can be launched from a carrier based aircraft, even though such a missile would have a significantly shorter range and less maneuverability that its ship-launched counterparts. Similarly, the Army, which has as of late been dominated by ground maneuver branches (armor, mobile infantry and infantry) while simultaneously underfunding its artillery and mobile missile force, may fail to fully invest in the full potential capabilities of ground-mobile-launched hypersonic missiles except as they support traditional maneuver elements.

Recommendation: Ideas and capabilities should trump service cultures and current sunk-cost infrastructures. In World War I both sides of the conflict possessed aircraft, radios and even tanks but each side attempted to graft these new capabilities onto existing forces and concepts of operation. Aircraft were used initially much as balloons had been used to spot the fall of artillery shells. Tanks were attached to infantry units and were limited in their advance to the pace of a walking man. It was only during the inter-war period that the German officer Heinz Guderian thought through the full use of these weapons and then combined them within the concept of Blitzkrieg to create a new form of
combined arms warfare. Hypersonic missiles should not be considered as an extension of ground maneuver units or carrier based aircraft. To do so limits their full exploitation on the battlefield. Rather a fuller understanding of their capabilities ought to drive the design of the future force and the development of new concepts of operations that fully leverage them.

E. Be Prepared to Build Iterative Designs and Have a High Tolerance for Failure

Atlas, Titan, and Minuteman all went through iterative designs both in the way the missiles were built and also how they were launched. Minuteman was the third, unexpected and unplanned iteration that emerged from the research and development churn of the first two liquid fueled programs. ICBMs emerged from an expensive process that was often marked by repeated failures, the Atlas failed in 11 of its 24 launches while the Titan fared somewhat better, failing in only 17 or its 70 program launches, but it was the failures that provided the insights necessary to produce both a more lethal and more cost effective weapon. Each of the Atlas and Titan missiles, driven by their failures, went through significant design changes in a relative short period of time. While some of the historic experimentation and development cycle can be replaced by advanced hypersonic wind tunnels and computer simulations, given the cutting edge and largely unexplored nature of current weapons development, a certain portion of research associated with new capabilities can only be explored through real world iterative testing.

Recommendation: Build an incremental capability development model within program development. Allocate sufficient resources to create and sustain a robust test plan. Do not anticipate a final “final” design prior to full incremental development. With hypersonics, much as with the first ICBMs, we don’t know what we don’t know. Expect and budget for failures within program development timelines. On some occasions the failure may result in large fireballs in the sky while others may highlight a single capacitor that failed under high-speed/high-altitude conditions. Each failure will result in additional resilience in the final design. While there might be a desire to freeze design evolution in order to move to full rate production on new capabilities, such urgency might incorporate unneeded flaws that may result in expensive downstream modifications of fielded systems in the best case or mission failure in battle in the worst case.

F. Avoiding the “Not Invented Here” Syndrome.

No entity, in the private or public sector, domestic or international, has a monopoly on good ideas. China’s stealing of intellectual property is well known. Historically, the United States leveraged foreign techniques to build its own industrial sector during the 19th century. Today, with hypersonics and other advanced technologies, the Navy and other responsible actors need to pay attention to what’s going on in other services, in academia, in industry, and with other powers. We all need to be prepared to leverage good ideas from wherever they come from. The US military is fast follower in that it quickly picks up on advances in the commercial sector and incorporates them into its force structure planning and design. This characteristic should be fully exploited. Also, people really matter. Eisenhower’s top down direction from White House was clearly essential to much of what happened early on but so were the insights and efforts of people like Schriever, Teller, von Neumann and Von Braun, all of whom were technical experts and immigrants. Today’s universities are crammed with foreign students. The U.S. government ought to be prepared to listen to them, to fund their research and hire them.
Recommendation: While considering initiatives, care should be taken to integrate aspects of Eisenhower’s National Defense Education Act within them that seek to increase the population of scientists and engineers within the United States, especially those whose research focuses on hypersonics and its associated disciplines.

G. Civilian Parallel Efforts

Sputnik spurred investment and innovation via both military and civilian paths. While the military moved out with the development of IRBMs and ICBMs, NASA was first created and then fielded an entire series of test and experimental platforms that ranged from the X-15 hypersonic vehicle to Project Apollo’s landings on the moon. In addition, the intelligence community heavily leveraged military investments to launch an entire generation of spy satellites into orbit.

Recommendation: Any military organization attempting to develop new, cutting edge capabilities today ought to explore synergistic partnerships with civilian aspects of government. First this brings about burden sharing and increased opportunities for experimentation and development, but it also provides an opportunity to create and run classified programs in plain sight with a believable cover story provided. Military innovators should also look beyond civilian government relationships to civilian research universities that have sufficient resources and infrastructure such as hypersonic wind tunnels and rocket test stands that would allow them to conduct experimentation in parallel with military organizations.

H. Priorities Matter

If the national leadership says we are in an era of great power competition and the National Defense Strategy calls for new capabilities, then national leadership needs to prioritize the development of those capabilities (but there’s no consensus of what those capabilities should be) much as Eisenhower did ICBMs.

Recommendation: Program leadership must be prepared to manage the program and also convey the full strategic importance of the capability they are managing. General Bernard Schriever succeeded because he had the skills to present and promote the new capabilities and the ability manage the actual development of several highly complex rocket systems. He also took care to identify patrons within the Air Force, the Department of Defense and the broader U.S. government and then cultivated them assiduously. Ultimately program managers must understand and articulate the importance of their program in a manner that is clearer than truth if they are to be successful in arguing for augmented support within the Executive and Legislative branches of government.

I. Technical Implications

Sputnik’s launch marked the beginning of the ICBM age, and yet it would take over a decade for broader public discourse to catch up to the full implications of its launch. While public leaders like Senator’s Symington, Johnson and Kennedy did speak loudly about “Missile Gaps” and the feeling of alienation and disappointment that Communism had launched the first satellite, few brought forward for public discussion the stark reality that nuclear tipped missiles implied: the speed of attack, the limited amount of warning time, the invulnerability of the missile to defenses, and the massive devastation of the weapons they carried. In the eternal competition between offensive and defensive capabilities, the ICBM tilted the balance heavily in favor of the offense. It was only the growing understanding that there
could be no “limited” nuclear wars, and that any attack would trigger a full-scale response that re-
established a vital equilibrium and prohibited the use of nuclear weapons in the numerous small wars
that dotted the globe during the Cold War. Today, as several hypersonic weapons are emerging, there is
again a vast ignorance of their full implications. Conventional hypersonic weapons again compress time
of attack and warning. They are extremely difficult to defend against. The initial launch and ascent can
be confused with ballistic missile launches and hence introduce strategic ambiguity as to their intended
target and weapons classification and even conventional weapons traveling at hypersonic speeds hold
the potential for tactical nuclear-scale damage without the use of nuclear war-heads. While directed
energy weapons do show some potential to strengthen defenses, the balance appears to have swung
heavily towards offensive capabilities, and Russia and China have made greater gains in hypersonic
capabilities than they U.S. has and hence have an incentive to act while they retain that perceived edge.

Recommendation: The military services should heavily engage with public consultancies and think-tanks
to encourage the discussion and exploration of the strategic, operational and technical implications of
new hypersonic capabilities as they emerge into the great power competitive environment. These
organizations can host conferences, panel discussions and write reports for public consideration, thus
encouraging intellectual exploration and debate, hence broadening public knowledge and consideration
of new capabilities.

J. Strategic Implications.

The scientists who built the atomic bomb began to have second thoughts regarding their creation
almost immediately after the first test explosion at Trinity Site in New Mexico. They had a sense that the
government had not fully considered the strategic implications of the weapon and how the new
technology could easily get out of control. They were correct. It took nearly twenty years for the
strategic intellectual community to get their minds around fission and fusion bombs and the various
strategies from Dulles’ massive retaliation to mutually assured destruction demonstrate the arc of their
thinking. It was not until the late 1960s that any serious effort was made to limit the number of
weapons, the platforms that would carry them or their proliferation beyond the few nations that
developed them during the 1940s and 1950s.

Perhaps the most haunting strategic construct of this early nuclear era was the Wohlstetter’s image of a
building with up escalators and down escalators, and landings and express elevators to full nuclear war.
While this picture has driven escalation and de-escalation theory since it was first expressed and
remains pertinent today with Vladimir Putin’s statement that Russia will consider “escalating to de-
escalate,” the image is also useful when considering the introduction of new capabilities such as
conventionally armed hypersonic boost-glide missiles as these appear to open additional floors within
the Wohlstetter strategic “building” that lie above those of traditional conventional warfare but yet
below that of Wohlstetter’s top floor of full-scale nuclear war.

Much as ICBMs presented a weapon against which there was no defense, hypersonics in the near term
will challenge enemies in a multitude of ways. Their maneuverability will allow them to avoid defenses.
Their speed and range will allow them to strike deeply and quickly into enemy territory and their
precision will allow their owners to hit with great lethality with relatively low chances of collateral
damage. They will be a game changer, but they will also cause instability and uncertainty. Their
maneuverability will mean that despite knowing where they are launched from, the enemy won’t know
where they are ultimately going. There will be questions as to the type of payloads carried (the Russians
are already talking about tactical nuclear warheads), and there is no understanding at this point what the adversarial response will be. The Kissinger-Kahn-Schelling books about hypersonic weapons have not yet been written. As a people, we have not fully thought through the use of these new types of weapons.

Recommendation: The military and the broader national security community needs to think more holistically about these weapons. With so much offensive capabilities bound up in these new systems, with such high lethality and high survivability and so little thought about impacts on escalation, some care must be taken to consider the new implications that will accompany the operational introduction of hypersonic missiles. Policy makers should engage with nuclear strategic theorists as well as the broader strategic community via non-profit think-tanks and Federally Funded Research Centers to more fully consider the implications of new capabilities within the overarching strategic escalatory matrix. Consideration should be given to issues of strategic ambiguity, to include how to differentiate between ballistic launches, with their obvious nuclear implications, and boost-glide launches. Consideration should be given to technology trajectories (where is all of this heading in the near term and in the long term), how these new capabilities might be added to existing platforms, and what that might mean and what would happen if these new hypersonic missiles became equipped with “enhanced” warheads. Also, given the fact that the other great power competitors have not ruled out arming their hypersonic weapons with nuclear warheads, it is not too early to consider arms limitation agreements as well as other declarative policies that might ease future tensions and avoid conflict in the future.

VIII. Conclusion

A “Sputnik Moment” has become a shorthand term for the strategic realization that a nation which had thought itself ahead in a global competition suddenly has found itself in a trailing position and must struggle to catch up. The original Sputnik moment has many lessons to teach to current policy practitioners, not the least of which is the need to step back and take a more holistic approach to the introduction of new technologies and the weapons that can be derived from them. New capabilities can bring great advantages, but they can also radically destabilize broader phenomena ranging from local societies to the global international environment and cause arms races and even war in those instances wherein one nation with a perceived technical advantage feels the need to move with that advantage before their window of opportunity, their chance at achieving great power status, is closed. The introduction of new capabilities today, from hypersonics to directed energy weapons, and from artificial intelligence to unmanned vehicles, offers an opportunity to swing what is now an observable great power competition heavily in favor of one side or the other in terms of offensive or defensive capabilities. Policy makers should take care to consider the entirety of implications associated with their investments across the spectrum of international engagement. Having asked their engineers and scientists to engage with the real technical problems of fielding new capabilities, they, themselves should take a moment to consider the problems that will be presented to them, in their own sphere, with the appearance of these new capabilities and their impact upon the great power competition.

President Eisenhower attempted to do this following the launch of Sputnik. He did not want to enter into either an arms race or a civilian space race. Ike’s appreciation of the strategic environment and his knowledge of the true state of the technology competition between the United States and the Soviet Union informed him that such competitions were unnecessary and irrational. He wanted to proceed in a carefully planned competition that balanced military interactions between the two nuclear powers
against his desire to maintain a balanced Federal budget and a growing American economy. Unfortunately, from his vantage point, other forces within the American body politic moved to take advantage of the Sputnik Moment in order to seize either a greater portion of the Federal budget or a broader aspect of political support from the American people. Sputnik caused a shift within the American nation that President Eisenhower, despite his great personal prestige, was unable to contain.

Given the current state of the great power competition and the relative popular ignorance of the current state of the hypersonic competition, there is still a moment of opportunity, the moment before the moment, when a rational plan might still be formed and implemented so as to efficiently organize the nation’s investment in the new hypersonic capability in order to field new systems in the most efficient and safe manner. This moment of rationality should also be used to consider the impact of the new capability upon the established international system. While it may be true that our competitors appear to care little for that system or seem concerned about destabilizing it, the United States remains, in large part the leader and organizer of it. Defining the uses of the new hypersonic weapons and establishing rules and declarative policies remain tasks left to be done.
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Dr. Jerry Hendrix is a retired Navy officer with experience in strategy, force structure planning, carrier strike group operations, and anti-submarine warfare. Outside of his military experience, Dr. Hendrix has held posts with senior staffs including the Chief of Naval Operations Executive Panel, the Secretary of Defense’s Office of Force Development, and the Office of Net Assessment where he served as the Senior Military Assistant to its Director.

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