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The Silent Arms Race: The Role of the Supercomputer During the Cold War, 1947-1963

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THE SILENT ARMS RACE:
THE ROLE OF THE SUPERCOMPUTER DURING THE COLD WAR, 1947-1963

THE SILENT ARMS RACE: THE ROLE OF THE SUPERCOMPUTER DURING THE
COLD WAR: 1947-1963

A dissertation submitted in partial fulfillment
Of the requirements for the degree of
Doctor of Philosophy in History

By

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ABSTRACT

One of the central features of the Cold War is the "Arms Race." The United States and the Union of Soviet Socialist republics vied for supremacy over the globe for a fifty-year period in which there were several arms races; atomic weapons, thermonuclear weapons and various kinds of conventional weapons. However, there is another arms race that goes unsung during this period of history and that is in the area of supercomputing. The other types of arms races are taken for granted by historians and others, but the technological competition between the superpowers would have been impossible without the historically silent arms race in the area of supercomputers. The construction of missiles, jets as well as the testing of nuclear weapons had serious implications for international relations. Often perception is more important than fact. Perceived power maintained a deterrent effect on the two superpowers. If one superpower suspected that they, in fact, had an advantage over the other then the balance of power would be upset and more aggressive measures might have been taken in various fronts of the conflict, perhaps leading to war. Due to this, it was necessary to maintain a balance of power not only in weapons but in supercomputing as well. Considering the role that the computers played, it is time for closer historical scrutiny.

This dissertation is approved for recommendation
to the Graduate Council.

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ACKNOWLEDGEMENTS

The topic of this dissertation is somewhat obscure. Few historians have taken on the subject of computer technology preferring to leave it to those in the field of computer scientists. In fact, in earlier works I was criticized for doing what was in the realm of that discipline. So in order to pursue my academic interests I have often had to present arguments as to how technology pertains to history and why it is important to examine in an academic environment. Considering the difficulty of creating justifications for my work I have some people I would like to thank.

First, is my dissertation advisor Alessandro Brogi who has shown considerable patience while I completed this work. He also deserves sole credit for showing me a new way of looking at the history of the Cold War. Typically the Cold War is taught from a purely American perspective and so the information presented does not differ from any American history course. Professor Brogi changed this for me by widening the scope of events outside of the United States and to consider the impact of the Cold War upon other nations.

Second, to be thanked are my early mentors in my academic career. Professors Donald W. Engels, Evan Burr Bukey, William F.

DEDICATION

To my wife Sonya T. Kirsch

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"Russia is sure to learn how to make the atomic bomb. I think Stalin has inherited Hitler's ambition for world dictatorship. One must expect a war between U.S.A and U.S.S.R."

-John von Neumann, 1945

"The IBM Company owes half its money to Johnny von Neumann."

-Edward Teller

Introduction

The Silent Arms Race

The central feature of the Cold War was the "Arms Race." The United States and the Union of Soviet Socialist Republics vied for supremacy over the globe for a fifty-year period in which there were several arms races: atomic weapons, thermonuclear weapons and various kinds of conventional weapons. However, there was another arms race that goes unsung during this period of history and that is in the area of supercomputing. The other types of arms races are taken for granted by historians and others, but the technological competition between the two superpowers would have been impossible without the historically silent arms race in the area of supercomputers. The construction of missiles, jets, as well as the testing of nuclear weapons had serious implications for international relations. Often perception is more important than fact. Perceived power maintained a deterrent effect on the two superpowers. If one superpower suspected it had an advantage over the other then the balance of power would be upset and more aggressive measures might have been taken in various fronts of the conflict, perhaps leading to war. Due to this, it was

necessary to maintain a balance of power not only in weapons but in supercomputing as well.

Even before the Cold War it was apparent that computing had an important role to play. The onset of the digital age of computing was on the horizon, but not too far in the future. During the mid to late 1920s Vannevar Bush's Differential Analyzer was the first step on the road of high-speed computing, creating mechanized methods for solving differential equations that were specific for targeting of weaponry. In the 1930s in Great Britain, Alan M. Turing wrote his now famous paper; On Computable Numbers. From this paper the well-spring of supercomputing emerged. Other men such as: Konrad Zuse, J. Presper Eckert, John Mauchly and Howard Aiken turned Turing's abstractions into machines of cold steel that were capable of practical applications and thus contributing to the outcome of the Second World War. Some of these same men would contribute to the outcome of the Cold War as well.

Another feature of the Cold War was the notion of grand geopolitical strategies such as "Containment" authored by George Kennan or "Rollback" as enunciated in NSC 68. The grand strategies of Kennan, Paul Nitze his successor at the State Department's policy planning staff, as well as others are well documented. Their authors showed their brilliance and ingenuity

in thinking about the post-war world. However, their theories were "soft" lacking the hard realities that those selfsame theories needed in enforcement. One cannot have in diplomacy what they do not own on the ground. This is something that Stalin was best aware of. In other words the grand strategies on both sides had to be tied directly to the computers and weaponry that were available to them. There also had to be a means of predicting the moves of an enemy without actually being privy to mental rationale of said enemy. Mathematicians John von Neumann and Oskar Morgenstern in 1944 gave a modern enunciation to Game Theory, which produced predictive models that had economic applications. Certain "games," most notably the "Prisoner's Dilemma," had military applications. The "Dilemma" was best suited to the possibility of thermonuclear conflict. This mathematical scheme was more pertinent and durable than any grand strategy created during the Cold War

By the time of George Kennan's strategy of Containment the armed forces of the United States had invested heavily in supercomputing. But with the end of the Second World War there was a serious question as to just whether or not the military establishment would continue on this path. The Electronic Numerical Integrator and Computer or ENIAC was America's first entry into digital computing. It represented a leap in

supercomputing over the analog methods utilized in Bush's machines that were at military installations such as the Aberdeen proving grounds. Speed was the ultimate measure of scientific computing and the fact that ENIAC performed fast calculations was enough to justify military investment during wartime. ENIAC however was not fully completed to aid in the war effort. By 1945, considering that there were no concrete hostilities on the international scene justifying such investment the need for high-speed computing became questioned. It was after the Soviets became more aggressive in Eastern Europe that the importance of a larger atomic force became apparent. Because of the further need for a nuclear deterrent, the armed forces had to make even heavier investments now into digital computing. From this investment came a series of Princeton Class Computers such as EDVAC, IAS, IBM's SSEC, ILLIAC, MANIAC and ORACLE among others. All of these supercomputers were devoted to increasing the U.S. arsenal which in these early days of the Cold War grew to roughly 200 plus atomic bombs. This was before the Soviet Union had tested their first atomic device.

The Soviets had arrived late to the supercomputer race, partly for ideological reasons. In the Soviet Union science had been subordinated to ideological justifications during the 1920s

and 1930s. This was all well and good until the country felt the need to counter the U.S. atomic arsenal. Stalin had been notified of the existence of the atomic bomb in a roundabout manner at the Potsdam Conference. He in actuality knew about the Manhattan Project due to the mature Soviet espionage efforts. In light of this, Stalin committed the U.S.S.R. to "practical math." In turn, Sergei Lebedev, a brilliant engineer created the Soviets first digital computer; the MESM in 1948. Not surprisingly in the following year the Soviets first atomic test occurred successfully. This is not to say that the U.S.S.R. was fully committed to supercomputing. There were still many bureaucratic hurdles to overcome and this was partially what created a "Supercomputer Gap" in favor of the West.

In light of international events in Turkey, Greece and China, George Kennan's policy of Containment was subjected to political criticism and found to be wanting. Thus the Truman Administration found the need for a new grand strategy more suited to combat Soviet aggression. The idea of rolling back the Soviets came to fruition in NSC 68, authored by Paul Nitze. The increase in the military budget opened a clear path for further supercomputing efforts in the United States. But the United States was not the only power developing supercomputers. In Great Britain Alan Turing, who had worked on decryption efforts

during the Second World War with Colossus; the first programmable computer, was developing his ACE computer and asking some philosophical questions about computing and intelligence that would characterize the academic treatment of computing efforts for all times.

During the same time in the U.S. an outcropping of the Airforce came into existence. Project RAND was created as a think-tank for military strategies. The project's analysts subjected geopolitical strategies to mathematical analysis, which created further needs for supercomputing beyond encryption and nuclear calculations. For this RAND analysts consulted John von Neumann about their particular needs for high-speed computing, which led to the creation of RAND's JOHNNIAC. The work done at RAND was complex and its results were at times prescient, RAND by creating solutions to complex problems RAND's credibility rose. The benefits of these calculations were for the United States alone, as the country perfected its own deterrent, leaving its allies around the globe vulnerable to attacks despite solemn commitments from Washington.

Because the interests of the United States were paramount, the Air Defense System Engineering Committee was created to discuss defense strategies. The committee understood that the U.S. was vulnerable to first strikes and that new automated

defenses would have to be developed. To this end, Project Whirlwind was initiated. The project was ambitious and called for stringent and specific calculating abilities for optimum computerized self-sufficiency. This meant that the priority was to have the minimum amount of human labor to interact with the computer. During the same period the atomic phase ceased gave way to the thermonuclear age. At this point, there was no alternative to supercomputers. Thermonuclear calculations were too complex for human efforts alone and so the supercomputer was now a hard necessity for national and international security. This was made even more so by the incoming Eisenhower Administration's policies.

President Eisenhower created a geopolitical strategy of Massive Retaliation relying heavily on thermonuclear arsenals. He was able to use the policy as a "bluff" to deter Soviet aggression. At the same time, his policy had an economic component, which would bring Cold War military spending in line with fiscal responsibility. In short, missiles were cheaper than conventional forces. But to have more missiles more supercomputers would be necessary. Eisenhower also used covert operations to ensure security. Supercomputers had their roles to play in this as well. For example, in 1954 computerized means of translation from Russian to English had been implemented

creating an inroad for new information about Soviet activities. Furthermore, U.S. allies were aided by companies such as IBM to create infrastructures for their countries as well.

In the Soviet Union a political power vacuum was left in the wake of Stalin's death in 1953. Although Stalin had granted Soviet supercomputing efforts his blessing, his successors went even further, accelerating the nation's scientific work. Nikita Khrushchev, Lavrenti Beria and Nikolai Bulganin all had ties to computing circles in the Soviet Union and supported those projects whole-heartedly. Two large supercomputing projects were initiated creating both the BESM and the Strela I. In 1955 Sergei Lebedev, who created the BESM, and his chief rival, Iurii Bazilevskii, who created Strela I attended the International Federation for Information Processing conference held in Darmstadt, Germany. The event put the world on notice of Soviet Supercomputing achievements. The Soviets could not be seen trailing the West in this area. Soon the Soviets had in their arsenal not only the BESM and Strela but also the M-1, M-2, M-3, SESM and other systems, and with each computer came an increase in nuclear strike capability and the development of other advanced weaponry.

In 1957 the United States lost John von Neumann to cancer. The man who had helped create a durable computer architecture

and formed the mathematical basis for managing nuclear conflict was gone. His legacy, however, would live on for the remainder of the Cold War. In that same year, on October 4th the Soviets launched the first artificial space satellite, Sputnik, causing panic in Washington D.C. and giving rise to one on the largest myths of the Cold War, namely the "Missile Gap." New agencies such as the Advanced Research Projects Agency (ARPA) invested heavily in supercomputing projects. Furthermore, the National Defense and Education Act produced a generation of scientists and engineers who worked in defense projects of all kinds.

There was a "silver lining" during 1957. Project Whirlwind culminated in IBM's Whirlwind II supercomputer, which powered S.A.G.E., the Semi Automatic Ground Environment system. SAGE was an early warning system, which covered the U.S. and part of Canada, alerting and directing military forces in case of attack. SAGE was a model of self-sufficiency, which marginalized human labor to respond to attack conditions more efficiently. Defense was now handled by machine calculation rather than exclusive human interactions. For the next 26 years SAGE was our defensive eyes and ears. However, the Soviets countered with the M-4, M-4m, M-20, M-40, and Setun, the first tertiary logic based supercomputer. The supercomputer arms race was becoming very competitive by the end of the Eisenhower Administration.

John F. Kennedy, the incoming president, appointed Robert Strange McNamara his Secretary of Defense to do a study on the "Missile Gap." It was then that Kennedy understood that the gap did exist but in favor of the United States. Despite U.S. strength a series of foreign policy failures on the part of the Administration may have allowed the Soviets to become more aggressive. On the other hand Khrushchev may have also acted out of a feeling of insecurity. Whatever his rationale the Soviet actions were hostile.

In 1962 when the Cuban Missile crisis erupted von Neumann's construct was put to the test. Khrushchev broke from von Neumann's rational position in the Prisoner's Dilemma in order to cow the United States. The mathematical nature of the Cold War was put to the test and luckily held. Nevertheless not all people were happy with the outcome of the crisis. The analysts at RAND and other think tanks wanted to test their mathematical schemes in a scenario of rationalized limited nuclear exchange. By 1963, in an effort to avoid nuclear conflicts in the future, President Kennedy proposed the Limited Nuclear Test Ban Treaty, which was signed by the United States, the Soviet Union and Great Britain. But the U.S. soon bypassed the treaty's restrictions using Seymour Cray's CDC 6600 supercomputer. The computer was powerful enough to simulate thermonuclear

explosions without actually detonating a device. Thus the U.S. could continue its testing covertly, abrogating the treaty. If there was any direct example of a supercomputer affecting international affairs it was this. The United States could continue testing by the use of the premiere supercomputer on the planet, leaving the other signatories of the Test Ban at a disadvantage.

The mathematical nature of the Cold War was a hard fact, not a flight of fancy of H.G. Wells or Jules Verne. Supercomputers were the central lifeblood of the protracted U.S./Soviet conflict, crucially contributing to the arsenals necessary to keep the Cold War "Cold." This silent arms race has been neglected for far too long and deserves the full attention of historians that specialize in that period.

Chapter One

Precursors to the Cold War

The Development of Computers and Their Effect on the Outcome of World War II: 1928-1945

The history of technology is not always treated kindly by historians. There is a reason for this, albeit an unfair one. The typical focus of history is on events and the dates in which those events have occurred. Things are often overlooked and they are, at best, shunted aside and dismissed as mere "antiquarianism." It is myopic to ignore the things that have led us to conclusions of one era and the beginning of another. Coincidental to the subject at hand, it is in a Marxian sense, that material is the prime motivator of historical events: "The hand-mill will give you a society with the feudal lord, the steam-mill a society with the industrial capitalist."[1] This is definitely the case when it concerns the computer's role in the shaping of historical outcomes. To ignore this is at one's own peril, as the Axis Powers during World War II found out. No writer on the subject of computers, historian, philosopher, mathematician or others can agree upon when the computer was

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[1] Bottomore, T.B., ed. *Karl Marx: Selected Writings in Sociology and Social Philosophy*. New York: McGraw-Hill Book Company, 1964, Pp. 95.

invented or built. One could go back to Blaise Pascal in 1642 with his invention of the Pascaline, Wilhelm Leibnitz in the 1670s with his "Reckoner," and quoted most often of late, Charles Babbage in the 1820 and 1830s with the Difference Engine and the Analytical Engine. Where this begins depends on your conception of what a "computer" is. We are not talking about mere counting machines such as the Pascaline or failed projects such as Babbage's Analytical Engine proposed to Parliament in 1842, which was not only a failed project but one that was so expensive to the British government (approximately $608,247 U.S. Dollars adjusted for 2012), it caused a great deal of animosity between Babbage and British Prime Minister Sir Robert Peel. Peel cancelled the project even though the investment had been so large. We are speaking of a machine that is capable of managing complex mathematical problems, storing the data and providing solutions.[2] The best point of departure would be before World War Two.

Differential Equations

Most of the mathematical nature concerning World War II centers on what is called a differential equation. A simple explanation of a differential equation is a mathematical equation that is in its workings refers back to itself and all

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[2] Swade, Doron. *The Difference Engine: Charles Babbage and the Quest to Build the First Computer*. New York: Viking Penguin, 2001, Pp. 148, 149.

the variables thereof. As it applies to this work the differential equation is a problem of physics, namely for the solution of ballistics trajectory as well as other applications. The equation must take into account more than just geometric directions and velocity of a projectile, but also atmospheric conditions such as wind resistance and air flow. In short, the differential equation is a difficult problem. It is true that equations of this type can be solved by human computers manually. But solving such equations could take a month or several months to complete by hand.

No one can definitively pinpoint the creation of the computer. For purposes of this work it is reasonable to begin with Vannevar Bush and his creation the Differential Analyzer.

Jerome B. Wiesner stated in his biographical sketch for the National Academy of Sciences in 1979:

> No American has had a greater influence in the growth of science and technology than Vannevar Bush, and the 20th century may yet not produce his equal. He was a statesman of integrity and creative ability… [He] Led history's greatest research program during World War II.[3]

The statement might be a bit of hyperbole and exaggeration; however, it is not too much of a stretch. President Franklin

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[3] Wiesner, Jerome B. "Vannevar Bush 1890-1974: A Biographical Memoir." *Biographical Memoirs National Academy of Sciences* 50 (1979): 89-117, Pp. 89.

Delano Roosevelt's scientific advisor seemed to be a fountainhead of both intellect and invention. Indeed, during a lifetime that spanned eighty-four years there were not many topics having to do with science for which he was not consulted. His work, which had a notable impact on the world, began at Tufts University.

Isolationism and the Computer. Bush's worldview was shaped by post-World War I politics. The 1920s was a time in which Americans had tired of foreign affairs and the policies that went along with them. As was typical of the American character in regards to foreign affairs before World War II, the nation retreated into isolationism exchanging international participation for President Harding's "normalcy." In fact, there were few notable events having to do with foreign affairs for the entire decade: the Washington Naval Conference in 1921-1922, the Dawes Plan, the Young Plan, the Kellogg-Briand Pact of 1928, and the Clark Memorandum. The lack of active participation in international affairs did not mean that the United States did not excel. During this period Americans immersed themselves in other fields such as sports and business. Most notably, this was a decade in which the belief in scientific solutions was paramount. As America was maturing, the switch to electrical power for its urban areas was ascending. However, the electrical

grids were hardly what one would call reliable. Presented with this problem, Bush and one of his graduate students, Herbert Stewart understood that there must be a method to simulate these electrical networks.[4] The result of their work was a machine called the Network Analyzer.

The Differential Analyzer. The year that marked the ascendancy of Bush's scientific career was 1925. He began the construction of machines that could calculate and simulate. In 1928 Bush and another of his graduate students, Harold Hazen began the construction of another machine that was capable of much more: the Differential Analyzer. The analyzer was completed in 1931. Its total cost was $25,000.[5] It was at this early date that Vannevar Bush would make an indelible mark on science. In fact, it is rare for this analog computer, to not be directly referred to as Vannevar Bush's Differential Analyzer.

As important as it is to recognize the scientific worth of the Differential Analyzer as a computer, it is hardly what we today in 2012 would conceive as such a machine. The analyzer is what is called an analog machine. This means that the machine calculates by a physical method. A mathematical problem is fed

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[4] Zachary, G. Pascal. *Endless Frontier: Vannevar Bush, Engineer of the American Century*. New York: The Free Press, 1997, Pp. 48.

[5] Adjusted cost for 2012 $374,445.

into the machine by adjusting the computer itself. This is done by physically manipulating gears and shafts. As opposed to a "digital" machine which manipulates symbols such as 1's and 0's to calculate a problem and come up with its solution by electronic means.

Despite this crude method of calculation, the machine was lauded by the New York Times as a device that could solve problems, which it would require a phalanx of human mathematician's months to solve.[6] The machine was set to a number of tasks that are, even today, considered to be daunting. Many of the problems are surprising when one considers the context of history. From 1928 well into the 1930's and 1940's the analyzer was set to deal with atomic physics, astrophysics, the properties of cosmic rays, the study of the earth's magnetic field and quantum physics.[7] To say that the analyzer proved useful is something of an understatement. In 1931 the analyzer had proven that it was indispensible. The Rockefeller Foundation became interested in the machine. Unfortunately, in the depths of the Great Depression the Foundation would not give Bush a grant for a new, more powerful analyzer until 1935.

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[6] Owens, Larry. "Vannevar Bush and the Differential Analyzer: The Text and Context of an Early Computer." *Technology and Culture* 27, no. 1 (1986): 63-95, Pp. 64.

[7] Ibid, 76, 77.

Nevertheless, in historical context, one would not typically associate a computer to solve complex problems to the late 1920's and early 1930's.

Despite the ability of the Differential Analyzer to provide answers to purely scientific questions it was created to solve one type of problem. This was the differential equation. It would make the analyzer pertinent to world affairs.

Ballistics and Computing. By the 1930's, the U.S. Army and Navy became interested in the analyzer. The rationale for this was the necessity of accuracy when firing weapons that had explosives. Specifically, the armed forces needed to understand the accurate firing of shells and gain more accuracy in their trajectories. For this purpose Differential Analyzers were sent to the Aberdeen Proving Grounds in Maryland to fulfill their needs. This instance was perhaps the most important event in the history of computing; the beginning of a relationship between the armed forces and the scientists who invented the "thinking machines." This perhaps was the first time such a relationship was so firmly established, but it wouldn't be the last. There are reasons for this, one was the armed forces' need for practicable solutions that could only come from computing, and another was the scientists, mathematicians and engineers' needs for capital to create the machines themselves that would aid

them in their own private and professional pursuits. At this point Vannevar Bush's career as a scientist was altered from mere academician to one of scientific advisor to presidents. This relationship between Bush and the U.S. Presidents would last well into the Cold War.

By 1935 the United States was becoming suspicious of Japan's global maneuvers. The forces of the Empire of Japan invaded Manchuria in 1931 and created Manchukuo in the following year. The U.S. attempted to assuage the situation to no avail.[8] This prompted the Navy to create special sections such as OP-20-G to break Japanese codes. Bush was approached to find new ways of computing to break these codes. Bush examined the Navy's equipment and found its IBM machines lacking for this purpose. IBM had been building tabulators and other machines since its incorporation in 1924 but its machines were not specifically designed for this type of work. Bush built a machine called a comparator for this purpose and the Navy awarded him a $10,000 consulting fee.[9] Bush was even offered a commission for his work.[10] It was also during this time that the international scene

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[8] Ferrell, Robert H. *American Diplomacy: A History*. Revised and Expanded ed. New York: W.W. Norton & Company, Inc., 1969, Pp. 587.

[9] Adjusted cost for 2012 $149,778.

[10] Zachary, *Endless Frontier,* 77, 78.

was heating up in Europe. By 1938 aviator and national hero Charles Lindbergh went to Nazi Germany to examine their air-force, the Luftwaffe. His reports to the U.S. were disheartening. He believed that the Luftwaffe could overwhelm Europe in little time. Thus the U.S. began wind-tunnel testing. Bush also devoted himself to the development of radar as a way of detecting planes and increasing the ability to hit such targets. In order to develop both technologies, the abilities of the Differential Analyzer were necessary.

World War II

By 1941 Bush had risen in stature. He was taken into complete confidence by President Roosevelt. In the face of Japanese aggression in Asia, which was in violation of the Kellogg-Briand Pact, and because of Nazi aggression in Europe in violation of the Treaty of Versailles, Roosevelt made a fateful decision. By the 1940's work in the field of atomic physics was prolific in the scientific community. Work was being done by exiled physicists such as: Werner Heisenberg, Enrico Fermi and Leo Szilard as well as others in the field. Nevertheless, the United States was not at war and so there was no real justification for an atomic bomb project. What was unknown to the general public was that FDR met with Vice-President Henry Wallace and Bush on October 9, 1941, before the war against

Japan had begun, to vigorously proceed with a project that would produce such a weapon.[11]

Atomic calculations are not impossible to solve by manual labor, but it is difficult. It is made even more so during crisis situations in which time is a significant factor. So the analyzers were set to the task. However, as the U.S. was officially pulled into the war on December 8, 1941, the Differential Analyzers were increasingly becoming an insufficient means of calculation. Still, they were used for aeronautics problems, ones that would herald another historical era that was closer on the horizon than one might have thought.

World War II taught the United States many lessons. One of these lessons was that technology develops very quickly in the midst of war. In crisis situations technology is no longer the fancy of a few futurists who had been pontificating on glorified clocks and cash-registers. Advances in technology became imperative. Bush was managing the Manhattan Project, the U.S. atomic bomb program and pushing the use of radar against submarines; he also created a weapon called the Proximity Fuse. The weapon was the forerunner of the guided missile; four vacuum tubes emitted a radio wave, if a target broke the wave the weapon detonated. This weapon was used against enemy aircraft as

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[11] Weinberg, Gerhard L. *A World at Arms: A Global History of World War II*. Cambridge: Cambridge University Press, 1994, Pp. 244.

an effective defense.[12] General George Patton was sold on the technology describing it as:

> The new shell with the funny fuse is [devastating]…I think that when all armies get this shell we will have to devise some new method of warfare.[13]

It seemed that General Patton was prescient. It was difficult to convince Generals George Catlett Marshall and Dwight D. Eisenhower. Eisenhower did reconsider his position when one of Bush's worst fears was brought to his attention.

On June 13, 1944 the first "revenge weapon" the V-1 was unleashed upon London. Bush was alarmed at the potential capacity of this missile to carry "radiological or biological" compounds. In fact the Germans were prodded to move more quickly with their atomic program with the production of the V-1 and V-2.[14] Bush was so disturbed by the idea of unmanned guided weapons that in the spring of 1944 he visited Eisenhower, personally. He told the General:

> Without better preparation… German rockets might rain down on Plymouth and Bristol and turn the Normandy

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[12] Zachary, *Endless Frontier,* 174.

[13] Ibid, 183.

[14] Weinberg, *A World at Arms,* 570.

invasion into chaos. Eisenhower said: "You scare the hell out of me."[15]

It was then that Bush suggested a complete bombing of the land-based sites where the rockets were located, which Eisenhower did. If the V-1 scared Bush, the V-2 was even a worse prospect to him. It carried a larger payload and traveled at supersonic speeds. There was no defense against the weapon. Although the V-1's and V-2's were produced too late for them to have a significant effect on the outcome of the war, the danger that they represented was perceived as very real. None of these weapons could have been produced without computing power. The nature of atomic and aerodynamic equations made this so. The computer was necessary to produce advanced weaponry to aid the war effort.

The same speed and necessity that brought the Differential Analyzer to the forefront of computing efforts was to also herald its obsolescence. This passing happened not because of the advent of a new machine, but rather a man.

The Universal Machine. Alan Mathison Turing was an extraordinary mathematician and a man that bore an indelible mark on the computing world for all time. In 1935, he presented

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[15] Zachary, *Endless Frontier,* 177.

his dissertation on the Central Limit Theorem of Probability. At the same time that Turing began to show interest in mathematical logic. He presented a paper titled *On Computable Numbers* in November 1936 to the London Mathematical Society. Turing came up with the idea that machines could be "programmed" for several different types of tasks. A "Turing Machine" would be a universal machine unlike the analyzers. Like most of his predecessors, Turing recognized the need of a machine to deal with tedious computations. One of the obvious observations in Turing's paper was that human memory was "necessarily limited."[16] He also noted that a human doing calculations would have to use "successive observations."[17] Turing concluded:

> It is possible to invent a single machine which can be used to compute any computable sequence.[18]

The mathematician postulated that in order for machines to do these calculations they would have to be simplified. To this end, he used symbolic binary logic. He stated: "that an Arabic

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[16] Turing, Alan M. "On Computable Numbers with an Application to the Entscheidungsproblem." 35. London: London Mathematical Society (1937), Pp. 231.

[17] Ibid, 250.

[18] Ibid, 241.

number can be recognized by a symbol."[19] And outlined exactly what the machine was supposed to do:

> To each computable sequence there corresponds at least one description number, while no description number does there correspond more than one computable sequence.[20]

Turing then set a task for future computer scientists. One of the main problems with computers is memory. Without the ability to store data the computer is as useless at solving complex problems. Turing came up with an abstraction of computer memory by using a tape as data storage.[21] His ideas were nothing more than ideas. These abstract ideas became known as a "Universal Turing Machine." The machine has three parts:

1. A control unit utilizing symbolic binary code:

> I assume then that the computation is carried out on one dimensional paper, i.e. on the tape divided into squares. I shall also suppose that the number of symbols which may be printed is finite.[22]

2. Data Storage utilizing paper tape.

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[19] Ibid, 250.

[20] Ibid, 241.

[21] Ibid, 247.

[22] Ibid, 249.

3. The machine must have a way to transcribe information, and
    then feed it to other parts of the machine for calculation.

Turing had mathematically conceptualized how to overcome two of the most difficult obstacles plaguing the computing world, at that time: having a programmable machine and having a mature conception of memory which was essential.

On Computable Numbers assured Turing's reputation as a first-class mathematician, and the premier computer scientist. He was invited to Princeton to work with Alonzo Church, and during this time he received his Ph.D. on the subject *of Systems of Logic based on Ordinals*. This is not a surprise considering that he had laid out the use of symbolic binary logic in *On Computable Numbers*. Turing was offered a post at Princeton, but turned it down to return to Cambridge. At the outbreak of the Second World War in Europe in 1939, Turing technically worked at the British Foreign Office. In reality he was 50 miles away from London at Bletchley Park. During the war, Bletchley Park had a thousand scientists and mathematicians, and even international chess players to work on decryption of codes created by the Enigma machine.

Enigma. The Enigma machine was created by a German engineer named Arthur Scherbius in the 1920s. It was made available for

commercial purchase, but by the time of the war it had definite military applications.

Enigma had five rotors within it, a keyboard, and a light-up lamp-board display corresponding with the keyboard. For example, if one pressed on the keys for the letter "W" and the letter "E" forming the word "we," one might get an encryption that had the letter "X" and the letter "P;" the transmission was then sent in Morse code to another station that had a codebook; the rotor would be reset to decrypt the message after it was fed to another Enigma machine that was set to the same cipher-code. The codes were changed by the Nazis at midnight every night. There was not very much headway made in decrypting the messages sent by the Enigma. The calculations necessary to decrypt it were too complex. It was of the utmost importance to break the Nazi codes quickly to save lives as well as defeat the Nazi war-machine.

Alan Turing at Bletchley worked in various huts. In hut six there were decrypting staffs for the Nazi army and Luftwaffe transmissions and in hut three there were staffs committed to naval transmissions which were much harder to break. In hut three there was a machine called a "Bombe" (pronounced "bomb"), supposedly named after a dessert shaped like a dome. The Bombe worked on the decryption by emulating several different Enigma

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machines at once. Two hundred of the machines were manufactured by the British Tabulating Company in Hartfordshire. The machine had 102 rotors in all: 33 in the first row, 36 in the second, and 33 in the third. Each of these corresponded with rotors in the Enigma machine. By imbuing the Bombe with so many rotors of its own, it had the "brute force," meaning it could examine all possible combinations to break the Enigma's codes. Later more powerful versions of the Bombe, using the decoding methods of thirty-six enigma machines were produced by both the British and Americans.[23]

Although the Bombe was a remarkable achievement, it paled in significance to another of Turing's devices called Colossus. Colossus was a different machine constructed at Bletchley in 1943. In order to increase the speed of decryption a new architecture was formed. Colossus utilized photoelectric cells and about 2400 radio tubes to process information. The machine's top speed ran at five kilohertz, a blazing speed for its time, processing five thousand characters per second, and with this new architecture, Colossus could break ciphers in seconds rather than in minutes or hours. The new processing power in Colossus also had a direct effect on one of the most important offensives of the war.

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[23] Ferro, David L. and Eric G. Swedin. *Computers: The Life Story of a Technology*. Baltimore: The Johns Hopkins University Press, 2005, Pp. 33.

On June 6, 1944, forty-seven allied divisions under the command of the Supreme Allied Commander Dwight D. Eisenhower formed the largest amphibious assault in history: D-Day. The Germans mounted their defense at Pas de Calais. Notable historians such as Stephen Ambrose and John Keegan pick up their narrative by stating things about "deceptions" and that Hitler and his army moved their forces away from Normandy. However, these descriptions of the event, while well documented and accepted, are incomplete and this is where we all owe a huge debt to Colossus.

Colossus and D-Day. Germany's Lorenz code was a complex encryption that was thought to be "unbreakable." Therefore, it was thought the encrypted messages could safely be transmitted by radio with complete secrecy.[24] The Nazis believed the code would remain a secret because random characters would be added to the encryption making it confusing. The first crack in a Lorenz message was due to a simple mistake. The Nazi decoders had a problem with a four thousand word transmission that neither side seemed to be able to translate. The message was sent again and still there was no correct transmission. At that point the decoders mistakenly set their encryption machines in synchronous positions and because of this the code was broken

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[24] Hashagen Ulf and Raul Rojas, ed. *The First Computers: History and Architecture*. Cambridge: The MIT Press, 2000, Pp. 351.

manually, but it was taking human decoders a month and a half to break each cipher. This was not acceptable. The people at Bletchley Park fed the information into Colossus and the code was decrypted. Within hours the decrypted message pointed to the fact that Hitler was moving his forces to Pas de Calais leaving a much smaller contingent at Normandy. Thusly, Colossus correctly transmitted data giving vital information to the allied armies that allowed them to move ahead in an operation that historian Stephen Ambrose believes ended the war within a year.

For more than thirty-five years after the war the work at Bletchley Park was still unknown. Winston Churchill called the people who worked at Bletchley "The geese that laid the golden egg but never cackled."[25] Turing himself went without credit until 2009 when the British Government finally would recognize his contribution to his homeland.

By breaking these ciphers, historians speculate that the work done at Bletchley ended the war about two-years before it might otherwise have ended. The investment that the British government made in what Prime Minister Winston Churchill called "the wizard war" yielded practical solutions to problems that

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[25] Baker, Nadia. *The Enigma and the Bombe* [Website]. 2010 [cited October 2010]. Available from http://www.youtube.com/watch?v=eikTtUaOqfc.

otherwise could not have been solved.[26] In short, the machines affected the outcome of the war in a way that was tangible, and justified the investment that the British government made in the work at Bletchley Park.

American Code Breaking. The role of machine encryption and decryption on the American side of the war effort is somewhat more sublimated. Perhaps this is because there was no one "colossal" (no pun intended), figure such as Alan Turing for historians to focus on. This is not to say that there was no effort to develop computing machines since the threat of global war became a concern in Washington.

In 1934 and 1935 the Japanese utilized a cipher machine called Ango Kikai Taipu. That term came to be known by the US code-breakers as "Red." Red's code was broken in the following year. The code that followed Red was shiki O-bun Injiki, which came to be known as "Purple." The Japanese placed great faith in "Purple's cipher. The supposedly unbreakable code was used in common diplomatic communications to Japanese embassies across the world.[27] It wasn't until 1940 that this cipher was broken by

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[26] Wrixon, Fred B. *Codes Ciphers & Other Cryptic & Clandestine Communication: Making and Breaking Secret Messages from Hieroglyphs to the Internet*. New York: Black Dog and Leventhal Publishers, Inc., 1998, Pp. 85.

[27] Ibid, 267-269.

the U.S. by constructing "Purple Analog".[28] If there had been more of an investment in computing perhaps the code could have been broken sooner and the U.S. could have reacted in a different manner to Japan's military plans.

American Progress. In 1937 Bell Telephone Labs had decided that machine computing was a worthy project to invest in. Bell Labs recruited a little known mathematician and employee, George Stibitz, to direct the project.

The machine that Stibitz invented was called the BTL I. Two years later, in 1939, it was completed at a cost of $20,000.[29] Seeing the cost of construction for the BLT I, Bell Labs did not want the program to go any further. Funding for the BTL I project was cut and apparently further investment in the field, as far as Bell Labs was concerned, was not viable. American efforts in this particular area lagged behind Europe because the United States was not at war until 1941.

On December 7, 1941, with the onset of WWII the War Department decided that high-speed computing was not only necessary to the war effort, but imperative. To this end, six more BTL I's were built, bringing the total cost up to

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[28] Supra.

[29] Adjusted cost for 2012 $327,572.

$120,000.[30] The machine itself was a fixed, although complex, arithmetic calculator, not quite what Alan Turing would have had in mind when thinking of the idea of computer architecture. Nevertheless, the machine solved circuit analysis problems for defense, and transmission of data via teletype. The largest BTL was built after the war. By that time it would utilize floating point arithmetic and ran at twenty kilowatts of power at the cost of $500,000.[31] The BTL 1's were retired in 1949.[32]

International Business Machines

There is a colossus in the computing world and it is located in Armonk, New York. Its name is International Business Machines, more commonly known by its initials IBM. The company was formed early in the century and did its business by selling cash registers, but made its fortune by providing tabulating services to the U.S. Census Bureau. However, it came to the "computing" world late. Usually the name International Business Machines is synonymous with the cutting edge of technology. This is especially pertinent today, considering that IBM has consistently been listed in the top ten supercomputer lists for

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[30] Adjusted Cost for 2012 $1,858,473.

[31] Adjusted Cost for 2012 $5,881,846.

[32] The Computer History Museum. *The Dawn of Electronic Computing: 1935 1945* [Website]. July 1, 2009 1996 [cited October 5, 2010]. Available from http://www.youtube.com/user/ComputerHistory#g/u.

several years. Furthermore, the performance of IBM's machine named "Watson" this past fall exceeded expectations playing Jeopardy against its two foremost champions, and causing a stir in the press. But for all of IBMs accomplishments, its reputation for leadership in the field of computer technology is somewhat undeserved.

From 1928 to roughly 1936 Vannevar Bush's Differential Analyzers reigned supreme in computing. By 1936, however, those analogue machines were quickly becoming extinct. Bush and others did not know about the work of Alan Turing and Maurice Wilkes. In the field of computing many advances happened by accident and discoveries were independent of one another. IBM decided in 1938 to build what it felt was a computing machine that was advanced. In fact it was not as advanced as Colossus, and would be devoted purely to scientific work. The computer was officially designated the Automatic Sequence Controlled Calculator Mark I, though the machine would be more commonly be referred to as the Harvard Mark I.

While a 20th Century industry, IBM for the most part held values matched that matched those of its founder Thomas J. Watson, a man whose worldview belonged to the 19th Century. IBM's business is "business" and business is to be done with as many customers as possible as long as it makes profits allowing the

company to grow. This was the philosophy of Thomas Watson. Companies are not human beings, although in many cases they are legally treated as such. Thus, companies lack a moral center. However, because the character of IBM was tied so tightly to Watson himself, its political and moral center was amorphous and at times mercurial. By the time that IBM was considering constructing the Harvard MK I near the end of 1937, the company was doing business in Europe and with Nazi Germany. This was not uncommon. Other companies such as General Motors, Ford Motor Company, Standard Oil and ITT did business with the Nazis. IBM had the distinction of accepting through Thomas Watson Germany's Cross of Merit. This was the Nazis second highest honor, which could be given to someone that was not a citizen of the German state.[33] The award caused quite a stir in America. With each egregious action by the Nazis, that medal caused more attention to be focused on Watson and IBM. Watson's business ethic at the time was peace through trade. This also was not uncommon. Others such as Joseph P. Kennedy had espoused the same idea.[34] But by 1940 it was apparent that the Nazis would not have the idea of peace whether it was good for business or not. Watson returned the medal and then committed to the war effort stating:

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[33] Maney, Kevin. *The Maverick and His Machine*. Hoboken: John Wiley and Sons, Inc., 2003, Pp. 208.

[34] Kessler, Ronald. *The Sins of the Father: Joseph P. Kennedy and the Dynasty He Founded*. New York: Warner Books, 1996, Pp. 159.

> International Business Machines Corporation has offered its full manufacturing facilities to the federal government for national defense purposes... IBM is prepared to change over at short notice to the manufacture of essential war materials.[35]

Various IBM machines were used during the war, many for the same tasks as others, such as code-breaking and trajectory plotting, but IBM never sold its machines to anyone and the U.S. government was no exception. All throughout the war and beyond, the government would have to rent all IBM machines. One would think that IBM might forego this policy during wartime, but it did not. This pointed to an oddity in IBM's political stance.

Aiken and Mark I. In 1937 Harvard physicist Howard Aiken contacted IBM to propose a new machine for the purpose of solving differential equations. IBM became interested because non-linear differential equations were very difficult to solve on a Differential Analyzer. Furthermore, the ASCC would be great publicity for the company and its commitment to furthering science. In December of 1937 Aiken took a training course to familiarize himself with IBM machines. What was interesting about the Mark I is that the construction of the computer was a collaborative effort between Harvard and IBM. The materials to build the machine would come from IBM, but it was to be

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[35] Maney, *The Maverick and His Machine*, 299.

constructed at Harvard. This would be the beginning of the relationship between academia and the computing industry. At that time there was no academic field known as "computer science." Unfortunately, as with all experimental methods, the first ones tend to be difficult.

Although the Mark I was proposed in 1937, Thomas Watson did not give his personal approval to the project until February 16, 1939.[36] Nevertheless, Aiken visited IBM's Endicott Labs between January 31 and February 3, 1938. During that visit he was informed by Watson himself that before entering the labs he had to sign a non-disclosure agreement.[37] This was and is typical procedure for IBM that has a reputation for tight security measures. One is not even allowed to go to the bathroom alone while on the IBM grounds one must be with an employee at all times.[38] Aiken, being a somewhat disagreeable personality took offense and protested in a most inflammatory declaration that he would not sign any such thing.[39] This began one of many showdowns involving Aiken and IBM and most specifically, Thomas J. Watson

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[36] IBM. *ASCC Chronology* [Website]. 2010 [cited October 6, 2010]. Available from http://www-03.ibm.com/ibm/history/exhibits/markI/markI_chronology3.html.

[37] Cohen, I. Bernard. *Howard Aiken: Portrait of a Computer Pioneer*. Cambridge: The MIT Press, 1999, Pp. 199.

[38] Purdy, Deborah A. Dell and J. Gerry. *Thinkpad: A Different Shade of Blue, Building a Successful IBM Brand*. Indianapolis: Sams Publishing, 2000, Pp. 8.

[39] Cohen, *Howard Aiken,* 99.

himself. The animosity between Aiken and his co-workers had detrimental effects not only on Aiken himself and the company, but perhaps the war effort as a whole. In fact, to this day IBM renounces Aiken's status as an employee of the company.[40]

The Mark I, at first glance, seemed to be a much more advanced machine than what had come before. It was capable of solving Problems in chemistry, quantum theory of hydrogen and, of course, advanced mathematical problems involving atomic physics.[41] Despite its abilities, no one quite knew what to do with this machine, and because of America's participation in the war, the Mark I project was low on IBM's list since the company had shifted it production facilities to the creation of tanks, bomb sights and rifles.[42] This plus the strained relationship between Aiken and Watson more than likely had a bearing on the development of the Mark I. The project was not discontinued. IBM had invested heavily in it laying out an initial budget of $15,000 to be followed by another $185,000 in subsequent years. The company was not about to lose its investment in the project.[43]

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[40] Stanford, Dawn. IBM Archives E-Mail to David Warren Kirsch, December 29, 2010.

[41] Cohen, *Howard Aiken*, 79.

[42] Maney, *The Maverick and His Machine*, 311.

[43] Adjusted cost 2012 $3,300,604.

Another setback came when the war began. Aiken became a commander in the Navy, and since the Mark I was not completed, IBM transferred its outdated Hollerith Tabulators and a high speed calculator, the Aberdeen Relay Calculator, to the Aberdeen Proving Grounds replaced the Mark I in aiding the calculations for the Manhattan Project.[44] It would be an additional two years before the Mark I would do its initial calculations. Furthermore, these first calculations had nothing to do with wartime necessities. The example of the Mark I's first calculations is indicative of problems that concerned the use of supercomputing not only during the war, but also during the entire Cold War. During the war the computers and their applications were considered classified, as was the entire field of mathematics itself.[45] Due to this, the first operations of the computers often occurred before the machines were unveiled and became known to the public. For example, even the Mark I, which did not initially aid in problems having to do with the war effort, was publicly announced at Harvard on August 7, 1944, still during the war, but this announcement came after its first

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[44] Cohen, *Howard Aiken,* 100.

[45] The Computer History Museum. *Pioneer Comuters* [Website]. The Computer History Museum, 1996 [cited 11-2-2010 2010]. Available from http://www.youtube.com/watch?v=qundvme1Tik&playnext=1&list=PLE308B553A347E305 .

operational calculations.[46] Furthermore, the Mark I was delivered to the Naval Mine Warfare School around or about the spring of 1944, where Aiken himself was serving.[47] It was only during this time, in 1944 when another computer luminary, John von Neumann would do implosion calculations on the Mark I. These calculations had to do with the atomic bomb; however, no one but von Neumann knew that at the time.

The Mark I hardly was cutting edge technology; IBM was and is still notorious for not taking risks on technology. It was then and is now a conservative company that waits until computing trends have already been established and builds upon those principles. Thus, the Harvard Mark I was a comparatively slow machine producing only 3.3 operations per second. It did aid in the war effort, though only in a small way. And yet it would not be fully "retired" until 1959, well into the Cold War. Because of its relatively small role it is difficult to assess its overall usefulness. Furthermore, the Mark I architecture relying on electromagnetic relays to do its computations was a "technological dead-end."[48] Within two years the overall

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[46] IBM. *ASCC Chronology* [Website]. 2010 [cited October 6, 2010 2010]. Available from http://www-03.ibm.com/ibm/history/exhibits/markI/markI_chronology3.html.

[47] Cohen, *Howard Aiken,* 114.

[48] Bashe, Charles J., Lyle R. Johnson, John H. Palmer, and Emerson W. Pugh, eds. *IBM's Early Computers*. Edited by I. Bernard Cohen. Cambridge: The M.I.T. Press, 1986, Pp. 32.

computing world would change its entire architectural basis making the Mark I if not obsolete, then, for the most part, irrelevant.

ABC Computer. The next leap in computing came in the form of the ABC computer. The ABC was named for the last names of its inventors and creators John Vincent Atanasoff and Clifford Berry. John Atanasoff was a mathematician and physicist. Together with Clifford Berry, who was one of his graduate students, he decided in 1939 to build a "digital" computer. To this date computers had been "analog" computers, which was the standard thinking of computer architecture during the 1940s. These machines had serious limitations such as complex programming, inability to store data, and general unreliability. On the other hand, a "digital" computer was more reliable and provided storage. The financial backing to construct the computer was given to Atanasoff and Berry by Iowa State University.[*] Patents, it was agreed, would be shared between the University and the creators of the ABC. In 1939 a prototype of the ABC was constructed, but it prototype was extremely limited, only capable of addition and subtraction. Still, the machine overall had potential. Further funding came from Research Corporation in the amount of $5,330 not an insignificant

[*]Then Iowa State College.

amount.[49] The ABC was completed in 1942, but it did not see any use in the war effort because of legal infractions and the patents on the machine were never applied by the University, thus the machine gathered no information, but did gather dust in a basement of the University. Atanasoff was bitter over the outcome and eventually moved on to participate directly in the war effort, working at the Naval Ordinance Laboratory. Incidentally, Atanasoff, after the war had the Naval Distinguished Service award conferred upon him for this work.[50] The fate of the ABC would not be fully resolved until 1973 in a lawsuit. Even though the ABC did not see any "action" during WWII it is fair to say that if it had been utilized, the results would have been noteworthy because of the ability of the computer to store data. This ability would have removed the necessity of the operators of the machine to do further redundant calculations before having concrete answers. It might seem irrelevant to include the ABC as a significant player but its architecture would be a part of every computer from the time of its inception to the present day. Therefore, the ABC deserves recognition.

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[49] Swedin and Ferro, *Computers,* 33. Adjusted cost 2012 $87,961.

[50] Ralston, *Encyclopedia of Computer Science*, 136,137.

Zuse's Lie?

The computer pioneer for the Nazis was a man by the name of Konrad Zuse. Zuse was born in Berlin on June 22, 1910. He had always been something of a dreamer (this is ordinarily the case with computer scientists) and did not show any particular talent in his schoolwork. He attended the Gymnasium Hosianum. At the age of sixteen he knew that he wanted to be an engineer focused on city planning. He did show some brilliance, and at the age of seventeen he passed his abitur exam, a task that he found to be "relatively easy."[51]

After the exam he then attended the Technical University in Berlin. Again he did not find the traditional forms of engineering interesting. He did not have any gravitas for classical forms of architecture, i.e. Greek columns and the like. He also did not like engineering statics (the effects of physical force on structures), the field of friction, and movements on physical constructions. Traffic problems in cities caught most of his attention, as well as photography. A fan of science fiction, Zuse considered the realm of outer space. The practical outcropping of this interest led him to think about rocketry. However, he apparently lost interest in this as well:

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[51] Zuse, Konrad. *The Computer-My Life*. Berlin: Springer, 1993, Pp. 12.

These things lay too far in the future to keep hold of my attention. Then, when the V2 missiles appeared towards the end of the Second World War, I figured that a moon rocket would have to be about as high as Cologne Cathedral and, above all, at least as expensive; an estimate that was essentially confirmed by the Apollo Project.[52]

His interest in the field of rocketry may have been fleeting, at the time of his attendance at Charlottenburg, but it would return at a later date, during the war. In 1935 Zuse obtained employment with the Henschel Aircraft Company, as a structural engineer. The company was founded by Georg Christian Carl Henschel in 1890 at Kassel. The Henschel Company became one of the largest locomotive manufacturers in Germany by the beginning of the 20th century. Early in 1935 Zuse was employed there. The company gained its reputation building tanks, designing and manufacturing the prewar Panzer I. During World War II Henschel was involved in large-scale production of the PzKpw III, and the Tiger I in 1941. Henschel was the primary manufacturer of the Panzer VI. Together with chief designer Erwin Adlers, he also designed aircrafts, the most important being the Hs123 Bi-Plane Bomber, the Hs126 airplane used for reconnaissance missions and the Hs129 tank-buster. The team also designed and built experimental guided missiles such as the

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[52] Ibid, 21.

Schmettering, the Henschel Hs293 glide bomb, and the Henschel Hs294 anti-shipping glide bomb. During 1945, the company's factories were one of the most important bomber targets in the war, and were nearly destroyed.

When Zuse left his job he was thinking about computing technology. There is not much outside information about Zuse. The information that we have about him and his work comes from his own recollections in sparse interviews and his own book. Because of this, there are inconsistencies about his role with the Nazis and the role of his machines during World War II. For example, he stated:

> We students at the Technical University observed this new political doctrine [National Socialism] of salvation very dispassionately. Their Bible, Hitler's Mein Kampf, was read by some here and there but it was not really taken seriously.[53]

This is interesting considering that he went to work in a munitions factory that produced advanced weaponry for the Nazi war effort. He was originally inducted into the army as a mere soldier, but he did not stay there and probably did more damage to the allies than if had stayed a mere soldier. It would have been nigh unto impossible for Germany to have a rocket program and an advanced jet program without the use of some kind of

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[53] Ibid, 23.

computing machine to work out the differential equations that would have applied to the pertinent aeronautic problems.

Zuse began work on his Z1 computer in his parents' apartment with the help of his fellow students. They provided the much needed labor sometime in 1935.[54] Upon completion of the Z1, Zuse demonstrated it for the aeronautical research institute. The institute had interest in the machine and, apparently Zuse was able to hire more help to create new machines.[55] The notable thing about Zuse's machines Z1 through Z4 is that they were highly advanced for their time, anticipating technology that would arise about fifty years later. The machines were constructed to utilize what is known as a floating point operation. This means that the machine can handle infinitely large numbers before and after the decimal point notation, but the calculations can take longer. Nevertheless, the loss of speed was made up by the complexity of the calculations that the computer could solve. The practicality and desirability of this might have been obvious to people such as Turing or John von Neumann, but they eluded the Nazi regime's attention, for the leaders failed to understand its importance. For example, when Zuse applied to be excused from his service as

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[54] Ibid, 34.

[55] Ibid, 36.

a soldier, about the time that the Z2 was completed, he was told by his commander:

> What does it mean here one it says your machine has applications in aircraft construction? The German Luftwaffe is top-notch, what needs to be calculated there? Permission denied.[56]

Eventually Zuse was excused by being a structural engineer by the Henschel Aircraft Company. Nevertheless, Zuse later returned to Henschel. By this time Zuse had created the Z3, which was used to solve quadratic equations, an operation that, as Zuse put it, "Was an essential step in the computation of critical flutter frequencies of aircraft."[57] This is important because it illustrated the necessity of the computer to solve these aeronautic design problems and it also shows that someone was interested in the computer enough to keep investing in the project to contribute to wartime necessities. Zuse mentioned that the Z3 project was of a "low priority." The government still did not see the potential of the machine itself. But this is unlikely because of the example set by the interest in the Z2, which led Zuse to request reassignment. The allies, of course, had invested heavily in computing for the necessity of solving aeronautic problems. Henschel Aircraft had designed the

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[56] Ibid, 56.

[57] Ibid, 63.

Hs123, 126 and 129 planes as well as the Hs293 and 294 glide-bombs, particular types of projects that would have required advanced specific computation.

Another inconsistency with Zuse's claim about governmental disinterest spoke to the matter of atomic calculations. By 1944 the German Aeronautic Institute was under the aegis of the military. It was then that Zuse's projects gained attention as higher priority projects. America needed computing power to devote to calculation for the Manhattan Project. The Nazis were also engaged in atomic projects, and while it was true that they fell behind significantly in those projects, the mere existence of them was enough to rattle the nerves of the allies. Zuse once again stated that his machines were not put to these tasks. He also recounted that when his projects came of higher priority classification, he became able to procure radioactive materials.[58] It seems unlikely that the machines were not used for the purpose of atomic calculations, otherwise, why would Zuse and his aides have need for such materials? By that time the war was coming to an end. In the midst of invasion, Zuse's machines were shuffled around Berlin to avoid capture. That was another example of governmental interest and importance. Why would the Nazi army waste precious labor to move a machine

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[58] Ibid, 80.

around the city, which was not important, when soldiers could be used for fighting the enemies encroaching on their capital? Eventually the Russians did manage to capture one of Zuse's machines. Zuse himself stated that he was not confident that the Russians knew what it was and knew how it could be utilized.[59]

Finally there was the matter of the V-1's and V-2's. Zuse denies that any of his machines were put to this task as well. He states that he only met Wernher von Braun during their escape to Munich.[60] However, historian Donald Cardwell in his book *Wheels, Clocks and Rockets: A History of Technology* states that Zuse's machines were definitely used on both the V-1 and V-2 projects.[61] It is not clear why there is an inconsistency between Zuse's account and Cardwell's statement, but Zuse's account has been allowed to stand by the computer science community. Perhaps an explanation could be based upon idolization, which is frequent in the discipline of computer science. In any case, it is true that neither the V-1, V-2 nor for example, the Messerschmitt 262 jet, could have won the war for the Nazis.[62] Those weapons, however, could not have functioned without the

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[59] Ibid, 71, 72.

[60] Ibid, 93.

[61] Cardwell, Donald. *Wheels, Clocks, and Rockets: A History of Technology*. New York: W. W. Norton & Company, 2001, Pp. 468.

[62] Weinberg, *A World at Arms,* 617.

solution of linear and non-linear differential equations. Those equations could not have been solved manually given the war time crises where time was a luxury.

Zuse's computers, despite being so advanced, had some of the same problems endemic to the Differential Analyzer and the Harvard Mark I. Like Vannevar Bush before him, and IBM's machine, Zuse preferred electromechanical architecture.[63] The notion of digital properties of the computer was not enticing enough for him to consider, and again these machines were rendered insignificant within a few years.

The truth of Zuse's account is not as relevant as the effects of his machines on the part of the Nazi war effort. If Zuse is correct, that the government had little interest in his computers until much later in the war, then it is easy to understand that victory in the war belonged to those who saw, understood and invested in the "thinking machines." The Nazis came to the game late and paid the price for their shortsightedness.

The Atomic Bomb.

In the case of the war effort against the Empire of Japan in the Pacific, the Japanese had no computing projects and no

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[63] Zuse, *The Computer-My Life*, 38.

atomic projects to speak of. What information they did have came from their German allies, since the Nazis did not put the proper priority on their atomic project the consequence for the Axis allies was their defeat. As far as the Japanese were concerned, there could be no time to catch up to the allied efforts in both areas. Thus, the Americans reached the conclusion of their atomic efforts first. In July 1945 the Trinity Test was a success. By the time of completion of the atomic bombs, the tide had irrevocably turned against Japan and "unconditional surrender" was put forth as the only acceptable military and diplomatic conclusion to the war. When this was not forthcoming, on August 6, 1945 the first atomic bomb was dropped on Hiroshima. The blast was equal to 13 Kilotons of TNT. All things up to 1,600 feet away were incinerated. The blast killed approximately 100,000 people. For those who believe that there was some controversy in the use of this weapon, consider that when President Truman was returning from the Potsdam Conference he was told of the devastation unleashed upon Hiroshima, and he excitedly exclaimed: "This is the greatest thing in history!"[64] Despite the results of the first bomb, unconditional surrender was still not forthcoming. A second bomb was dropped on Nagasaki, killing 40,000 people and injuring another estimated

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[64] Zachary, *Endless Frontier,* 282.

60,000.[65] It was only then that acceptable surrender came and World War II came to a conclusion.

According to David Holloway in his book *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939-1956*, states that Stalin had not given real support for his atomic projects until after the United States used the bomb on Hiroshima.[66] He also states that it was simply the lack of radioactive materials that kept the Soviet Union behind in the development of the atomic bomb.[67] This one-dimensional explanation is not sufficient. While it is true that the lack of materials play a role in stunting Stalin's atomic program, it is also true that without the aid of supercomputing the bomb could not be properly developed. One cannot discount U.S. investment in computing machines that made the atomic device possible within the required time to end the war.

This is not to say that investment in the computer was the single variable that secured ultimate victory, but its role was a significant variable. Without computing power, cannons could not be aimed and fired with any accuracy. Radar would not have

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[65] Bernstein, Barton J., ed. *The Atomic Bomb: The Critical Issues*. Boston: Little, Brown and Company, 1976, Pp. vii.

[66] Holloway, David. *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939-1956*. New Haven: Yale University Press, 1994, Pp. 133.

[67] Ibid, 223.

been developed. Bombsights would not be accurate. Newer and faster planes and rockets would have taken longer to develop. Because of all these necessities the role of computers in the allied victory in World War II must be recognized.

<div align="center">

Chapter Two

Kennan and the Machine: Two Grand Strategies

1947-1949

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It did not take long from the dropping of the atomic bombs on August 6th and August 9th of 1945 respectively before the next enemy was rearing its head. It is fair to say that there has been a healthy dislike for Communism in America if not before World War I, as a doctrine of thought, certainly after the war with the Red Scare of 1919. In fact, during the intervention of the Entente powers after the war and during the Russian Civil War, it was the United States' contingent of troops that was the second largest, only to be outdone by the Japanese. The battalions from 339th Infantry Regiment were sent to stop the spread of Bolshevism in September of 1918.[68] The Russians would never forget this.

The Second World War, however, made strange bedfellows, no more than for the Soviet Union. Stalin sanctioned an alliance with Nazi Germany, the Molotov-von Ribbentrop Non-Aggression Pact on August 23, 1939, which promised the Soviets a good

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[66] Kinvig, Clifford. *Churchill's Crusade: The British Invasion of Russia 1918-1920*. London: Hambledon Continuum, 2006, Pp. 40.

portion of the Baltic States: Estonia, Finland, Latvia and Lithuania. Of course the treaty was rendered useless when the Nazi military machine entered Soviet lands on June 22, 1941. Stalin needed aid and found them in the Allied powers. However, with the grand Axis Powers defeated, there was nothing to hold an alliance together between the U.S. and the U.S.S.R. President Truman, who had no foreign policy experience, relied heavily upon his military and especially George Catlett Marshall, who felt that the alliance during the war had been too gracious.[69] Truman listened and, by this point, looked askance at the relationship with Stalin. By early 1946 the president needed new information on the Soviets and on February 22, 1946 he received it from George Frost Kennan in what became known as "The Long Telegram," which conveyed just what the Soviets sought in the international arena.[70]

As with all historical events, the Cold War had no real definitive separation from its previous era. It is the same for computers and strategies. Similar to international relations, computing would go through a vast change in 1946 on the eve of

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[69] Woods, Randall B., and Howard Jones. *Dawning of the Cold War: The United States Quest for Order*. Athens: University of Georgia Press, 1991, Pp. 24.

[70] Telegram, George Kennan to George Marshall ["Long Telegram"], February 22, 1946. Harry S. Truman Administration File, Elsey Papers.

what historians generally agree was the beginning of the Cold War, with the advent of ENIAC.

The years between 1942 and 1944 were watershed moments for the Cold War. The new weapons for the coming conflict were being invented: jets, missiles and atomic bombs. These were weapons that were punctuation marks on World War Two, but were integral to the Cold War. Surprisingly, a new doctrine for the coming conflict was being created as well. Usually, the premiere strategy for the Cold War is "Containment" articulated by George Frost Kennan. Therefore, Kennan is considered to be the "architect" of the Cold War. This is somewhat misleading on several levels. The first of these are obvious. There are historians such as Arno Mayer and Kennan himself who, because they frame the Cold War as an ideological conflict and one that was inevitable, place the Cold War origins much earlier than 1946-47.[71] Furthermore, there are those who can point to the Teheran Conference held between November 28th and December 1st of 1943 when Stalin first revealed his desire to seize Eastern Europe and let it be known that it was within his purview, or more commonly the Yalta Conference held between February 4th through the 11th of 1945, when FDR is usually accused, albeit unfairly, of "selling out" those domains to Stalin. But the

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[71] Kennan, George F. *Soviet American Relations, 1917-1920: The Decision to Intervene*. Princeton: Princeton, 1958, Pp. 470,471.

focus on technology I am proposing here shows that the correlation between strategy and politics became crystallized in 1943. In order to fully understand that statement, one must understand one man: John von Neumann.

John von Neumann

In 1903 John von Neumann was born in Hungary. Between the years of 1911 and 1921 he attended the Lutheran Gymnasium where he excelled in mathematics. Von Neumann had a stable childhood, something of a rarity in Europe in those days. However, in the wake of World War I Hungary became a Communist state under the leadership of Bela Kun. When Kun's government fell Jews like von Neumann were blamed and a white terror was set off forcing immigration from that nation.[72]

Following those events, von Neumann attended University of Berlin in 1921 and for the next two years he studied chemistry and two years after that, in 1925, he received a degree in chemical engineering from the Swiss Federal Institute of Technology. The following year, from the University of Budapest, he received his Ph.D. in math with a minor in physics and chemistry. Von Neumann owed his extraordinary intellectual

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[72] Poundstone, William. *Prisoner's Dilemma: John Von Neumann, Game Theory, and the Puzzle of the Bomb*. New York: Bantam Doubleday Dell Publishing Group, Inc., 1992, Pp. 14, 15.

capacities to having a photographic memory that became legendary in his work.[73] He began teaching at Princeton in 1930. In 1933 von Neumann was one of the first professors at Princeton's Institute for Advanced Study. Like many other professors with mathematical and scientific backgrounds, von Neumann owed the meteoric rise of his career to World War II.

During the war von Neumann, predictably, worked on the Manhattan Project, but he had started two endeavors, which were to have an enormous impact on the Cold War. The first of these was what is now called Game Theory.

Game Theory. It is necessary to understand that Game Theory has nothing to do with "games" per se. It has more to do with mathematical representations of human interactions. Game Theory has a rich history that dates back to the Eighteenth Century, when Karl Leibniz thought that there might be a utility in studying military affairs with a particular explanation using mathematics. This was in 1710, and three years later James de Waldergrave came up with an idea of what we call minimax (hereinafter Minmax) strategy. Minmax is a strategy in which there is an outcome in strategy of "maximum utility or

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[73] Ralston, *Encyclopedia of Computer Science*, 1452.

satisfaction."[74] This was first enunciated by Emile Borel between 1924 and 1927 in a series of papers.[75] Unfortunately for Borel, he was never able to make Minmax a complete mathematical theorem.[76] It was not until 1943-1944 that John von Neumann and economist Oscar Morgenstern, who were both at Princeton's Institute for Advanced Study, enunciated the modern version of Minmax in their book titled *Theory of Games and Economic Behavior*.

In von Neumann's and Morgenstern's "two player games," the "game" is one of competition and expectation. The nature of competition is obvious in that both players are completely opposed to one another and that every move that a player in the game makes must be to his own greatest benefit and to the destruction of his competitor. The actions of the opposition are not known and so each move is based on one player's expectation of the other's movements. It is important to note that each player is also assumed to be a rational player i.e. out for his own best interests, an easy enough thing considering the role of human nature and its survival instinct. Despite not knowing the

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[74] von Neumann, John, and Oskar Morgenstern. *The Theory of Games and Economic Behavior*. 3rd ed. Princeton: Princeton University Press, 1953, Pp. 8.

[75] Wiener, Philip P., ed. *Dictionary of the History of Ideas: Studies of Selected Pivotal Ideas*. Edited by Philip P. Wiener. IV vols. Vol. II. New York: Charles Scribner's Sons, Publishers, 1973, Pp. 265.

[76] Ibid, 265.

other players moves, because all actions are completely interdependent and rational, the game plays out as if all moves are known.[77]

Game Theory as Grand Strategy. The best example of where a two-player, zero-sum game fits into the Cold War is in the theory of deterrence. Deterrence, in its most simple definition and as it pertained to the Cold War, was to discourage the Soviet Union from embarking on a nuclear strike against the United States and our allies by pure fear of having a nuclear counter-strike directed against their nation and perhaps their satellite nations. Although the definition of what constituted "deterrence" changed vastly over half a century's time, this was the nature of the conflict between the two nations during the Cold War era.

Games of competition are not the only ones covered in von Neumann's work. There are also games of cooperation. The most common game of cooperation is called "The Prisoner's Dilemma."

The specific origin of the Prisoner's Dilemma is unknown, but the most refined game came out of the RAND Corporation. The rationale behind the dilemma was that there was some concern with John Nash's equilibrium theory. The idea was to find that there were scenarios in which the players of the game were non-

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[77] Schelling, Thomas C. *Conflict Resolution* II, no. 3: 203-46, Pp. 205.

cooperative. The easiest expression of this was the idea of prisoners that had been caught in the commission of a crime. There was no deeper meaning behind the use of prisoner's, just the example. In fact the outcome of the game was a positive refutation of Nash's theory.[78]

The dilemma can best be described in the following manner: two suspicious opponents, each without knowledge of the other's possible reaction (unlike the game of pure competition where the possible reactions are known due to the nature of that scenario) vote against their own best interest in order to avoid an undesirable outcome. In short, this is a negative response, or irrational playing to avoid ultimate conflict. Graphically represented the dilemma looks like this:

We'll call this game "Nuclear War." The aim of this scenario is that both the United States and the Soviet Union cooperate in order to avoid nuclear conflict.

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[78] Poundstone, *Prisoner's Dilemma*, 107.

Union of Soviet Socialist Republics

United States		
	C,C Optimal Cooperation No Nukes	C,D Soviet Defect Upper Hand US Escalation
	D,C US Defect Upper Hand USSR Escalation	D,D Nuclear War

C= Cooperation

D= Defection

The optimal situation is when both nations cooperate i.e. decide that nuclear war is to be avoided: Cooperation/Cooperation. However, in this game, moves are not known, but extrapolated from a series of facts, or what von Neumann termed "expectation." Cooperation cannot ultimately be relied upon. For example, if the United States or the Soviet Union decides to "Defect" from the cooperative scenario the player that defects will have the upper-hand, in this case the larger nuclear arsenal, which constitutes deterrence. However, the cooperative player sensing its apparent disadvantage will become diffident and escalate to match or overtake the opposing player for the same deterrent effect. The defection point at

first seems to be the very scenario of the Cold War arms race between the U.S. and the U.S.S.R. However, the object of the game is not simply the deterrent effect on the opposing player, but creating an atmosphere of grudgingly, albeit unknown, cooperation to avoid nuclear war. Unfortunately, there is the possibility of both players deciding to defect from the main principle of the game scenario and of course, in that case, the two players decide to launch nuclear strikes against one another. Interestingly enough, considering the very nature of the game as a two-player system, it is best expressed as a mathematical model. As we have seen, up to this point, the "thinking machines" have designed the atomic bomb, a great mathematical feat. They are also well suited to playing a mathematical two-player game, a binary game, if you will. This is the entire basis of Boolean logic, first developed in 1847.[79] A computer uses "logic gates" to perform its functions. In philosophy, this would be designated as truth tables i.e. true or false. In the case of the machines it is designated as 1 or 0, determining an open or closed circuit.[80] In short, they can play "nuclear war."

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[79] Honderich, Ted, ed. *The Oxford Companion to Philosophy*. Oxford: Oxford University Press, Inc., 1995, Pp. 500.

[80] Ralston, *Encyclopedia of Computer Science*, 180, 181.

Math and the Cold War. Then the question is what does this mean for "Grand Strategy?" The first thing is that there is a definite mathematical component to the Cold War. However, is this mathematical construct the real grand strategy for the Cold War? If this is the case then who is the real father of the Cold War, Kennan or von Neumann?

It is easy for people who are unfamiliar to the intricacies of the Cold War to look at it broadly and say: "It was merely an "arms race." It was certainly more complex than that but the nuclear arms race was central to the Cold War. The fear of nuclear weapons kept the war from widening. It is true that conventional wars ran concurrently with the Cold War. One must also consider that an estimated 22 million people lost their lives involved in the Cold War in those concurrent conflicts.[81] The nuclear weapon and heavy armaments were not the only weapons used during the fifty year conflict. One hardly needed the power of a supercomputer to design or, in some cases re-design, light weaponry. However, it would be more than fair to say that if the arms race was a significant variable to consider during the Cold War, then definitely von Neumann would have to be the one and only "architect" of the Cold War. Cold War grand strategies are multivariate, grand theories are pertinent, but not concrete. In

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[81] Nixon, Richard M. *Seize the Moment: America's Challenge in a One-Superpower World*. New York: Simon and Schuster, 1992, Pp. 22.

diplomacy one cannot negotiate for what one cannot enforce. Thus in the case of game theories and other mathematical models, one cannot diminish von Neumann and a host of others, both human and machine, that were integral to the Cold War, and to ignore this fact is to irresponsibly delete a crucial piece of information that could have changed history. But were these computers used for that purpose i.e. nuclear escalation and cooperation scenarios and were they utilized for other purposes such as other rational "war game" scenarios?

Before attempting to answer those questions once again we must consider the material side of history. 1946 marked not only a transitional period of the geopolitical world from war to post-war, but also the world of computing. The Differential Analyzers and electromechanical calculators, such as the Harvard Mark I that had been used during World War II were quickly becoming obsolete. They were no longer able to provide the speed and reliability to effectively handle the complexity of new problems. A new approach had to be found. This new approach was "digital" computing, which was embodied in ENIAC.

Digital Computers. ENIAC, or Electrical Numerical Integrated and Calculator, was the first, truly digital computer. The late Historian David Halberstam, in his book *The Fifties*, gave a small treatment of the ENIAC on his way to the

UNIVAC, which will also be discussed later. Halberstam's treatment however gave short shrift to this discovery. Like other historians Halberstam mistakenly gave credit for the creation of the ENIAC to John von Neumann. In fact von Neumann had little to do with the machine itself.

ENIAC came into being as the labor of two men, J. Presper Eckert and John Mauchly. Eckert was born in 1919 in Philadelphia. He received a Bachelor of Science degree in engineering from the University of Pennsylvania, Moore School of Electrical Engineering in 1941. His Master's degree came two years later in 1943. Eckert's partner in this endeavor was John W. Mauchly. Mauchly was born in Ohio in 1907. He attended Johns Hopkins University originally pursuing an engineering degree. He then switched his major to physics. Similarly to other scientists analyzed here, his work required a great deal of complex calculations. With war on the horizon, he took a defense training course in electronics with the Army that was offered at the Moore School. The Army needed to create firing tables. In August of 1942, Mauchly gave a proposal called "The Use of High Speed Vacuum Tube Devices for Calculation" to the Army for an electronic calculator that would fulfill their needs to create the tables in a small amount of time when compared to the

Analyzers, which were then in use.[82] Mauchly's proposal was rejected by the Army. Another proposal was given to the Army in 1943. The recipient of the proposal this time was Herman H. Goldstine, ,a mathematician and a lieutenant in the Army. He saw the potential of the project and accepted it. At that point, the Army gave the ENIAC project number W-670-0RD-4926, and a $61,700 starting budget. By the end of the project ENIAC cost $486,804.[83]

Despite the fact that ENIAC was too late for true wartime participation, at the end of the war the Army wanted ENIAC to produce results on a new problem, namely thermonuclear weapons. The hydrogen bomb had been considered because the atomic bombs that had been dropped on Hiroshima and Nagasaki, although very destructive, were of limited explosive and radioactive yield. The hydrogen bomb would have unlimited yield. This new weapon seemed necessary because of a combination of Cold War caution and fear of the Soviets, or just simply because it was there to be made. What was clear was that it was Cold War and perhaps the need for deterrence required a fusion device that held no bounds for destruction. This hellish creation brought about by Edward Teller was only possible because of the power of ENIAC: "[They] had to calculate what was happening inside the reaction at

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[82] McCartney, Scott. *ENIAC: The Triumphs and Tragedies of the World's First Computer*. New York: Walker and Company, 1999, Pp. 49.

[83] Ibid, 101.

increments of one-ten millionths of a second."[84] Furthermore, ENIAC was sent to Aberdeen to also check weather patterns to predict the effects of fallout.[85]

So the ENIAC computer was the invention of Eckert and Mauchly. John von Neumann was brought into the project at a later date by Goldstine.[86] Goldstine, who worked closely with von Neumann and was in awe of him, gave von Neumann and interestingly, himself the credit for ENIAC: "It was he [von Neumann] who took the raw idea and perfected it."[87] The veracity of the claim was in question. But von Neumann was very much involved with the next supercomputing project W-670-ORD-4926: the Electronic Discrete Variable Calculator, EDVAC.

Once again the latest machine, ENIAC, proved insufficient. According to an informal report by J. Carson Mark of the Los Alamos Scientific Laboratory: ENIAC was the most advanced computing machine in the country of that time, an indeed, until

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[84] Ibid, 103.

[85] Ibid, 108.

[86] Goldstine, Herman H. *The Computer from Pascal to Von Neumann*. Princeton: Princeton University Press, 1972, Pp. 185.

[87] Ibid, 186.

about 1948."[88] And yet calculations done on the ENIAC were becoming too complex for a machine only:

> Capable of doing 5000 addition cycles per second and do the work of 50,000 people working by hand. In 30 seconds, ENIAC could calculate a single trajectory, something that will take 24 and 20 hours with the desk calculator or 15 minutes on the differential analyzer.[89]

The Report on EDVAC. The calculations for ENIAC increasingly had to be parsed out, meaning they had to be split into several groupings so that the computer could carry the load.[90] At a certain point this must have been anticipated. Similar to the situation when Vannevar Bush inspected the IBM machines at the proving ground before World War II, when they were found to be lacking, the Army must have learned from that experience and decided to not rely on one type of machine. So the Army accepted a proposal for EDVAC. It was submitted to the Army in June 1945, before ENIAC was officially in operation. The EDVAC was to be built at the University of Pennsylvania's Moore School where ENIAC had been built and so von Neumann, Mauchly

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[88] Mark, J. Carson. "A Short Account of Los Alamos Theoretical Work on Thermonuclear Weapons, 1946-1950." 14. Los Alamos: Los Alamos Scientific Laboratory at the University of California, 1974, Pp. 11.

[89] McCartney, *ENIAC*, 101.

[90] Mark, "A Short Account of Los Alamos Theoretical Work on Thermonuclear Weapons, 1946-1950," 11.

and Eckert were still in close proximity to each other. The preliminary events that brought EDVAC into being are somewhat murky. As was not the case with ENIAC, EDVAC really had to be "sold." The purpose of EDVAC was to solve: "non-linear partial differential equations."[91] These are the types of equations that ENIAC would have choked on if they had not been parsed. In any case, the "pitch" to the Army came from the *First Draft of a Report on the EDVAC*. This document was what led Eckert and Mauchly to ultimately split from von Neumann and Goldstine. Apparently, the outline of what the EDVAC architecture was supposed to be was the idea of Eckert and Mauchly, but in the report their contributions to the project were stated as merely "suggestions."[92] Furthermore, Goldstine made this seem as if he and von Neumann were throwing them an intellectual "bone."[93]

John von Neumann had worked on the logic systems of the machines, but the real importance of von Neumann's efforts came when "selling" the machine. The Army already had ENIAC, and although ENIAC did not officially come "on-line" until February 14, 1946, it had run calculations in 1945. Apparently it was not

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[91] von Neumann, John. "First Draft of a Report on the EDVAC." Philadelphia: University of Pennsylvania Moore School of Electrical Engineering and The United States Army Ordinance Department, 1945, Pp. 1.

[92] Ibid, 19.

[93] Goldstine, *The Computer from Pascal to von Neumann*, 196.

uncommon to retro-date an operational date. This was for obvious reasons of "national security." In any case, it would not have been completely clear to the Army why they needed EDVAC. After-all, these computers required hefty investments, and justification would be necessary. Von Neumann had a role with the military since 1941 and his word would lend the report credibility. Eckert and Mauchly had no other option than to depend on von Neumann to get their funding, which finally amounted to $467,000.[94]

Interestingly this was the first time that the inner systems of the computer were likened to the human brain. Neurons and circuits would now be the same. This would have serious ramifications for supercomputing. The idea was underlined in a Silliman lecture at Yale University later, just before von Neumann's death, and it has shaped the computer industry as a whole ever since.

The Supercomputer Gap

One of the big myths of the Cold War was the supposed "Missile Gap." The concept itself was revealed in 1961 but the notion was ever-present. The missile gap was the supposition that the Soviet Union had surpassed the United States in its

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[94] Godfrey, Michael, and D.F. Hendry. "The Computer as von Neumann Planned It." *IEEE Annals of the History of Computing* 15, no. 1 (1993): 11-21, Pp. 6.

nuclear forces. Of course we now know this was not true. To understand just how far-fetched this "gap" was one only has to look at the list of the U.S. atomic arsenal from 1945 to 1950. It was as follows:

Complete Number of Bombs Mid-Year

Year	*Number of Bombs*
1945	About 2
1946	About 6
1947	About 7
1948	Between 7 & 50
1949	Between 50 & 240
1950	Between 292 & 688

Source: Poundstone, 163.

As we can see the United States had quite an atomic arsenal even before the Soviets tested their atomic device. There was no gap in atomic weapons as was conceived in the collective minds of U.S. scientists and some political insiders. However, there was a supercomputing gap that was very real. It was this supercomputing gap that had serious implications for the outcome of the Cold War.

Computing on a vast scale began early for the United States. However, it is also necessary to examine the position of the main antagonist namely the Soviet Union in the conflict.

Sergei Lebedev. If there was a single avatar of Soviet computing, on the level of a, Vannevar Bush or Alan Turing, it was Sergei Lebedev. Lebedev was born in 1902 in Siberia. His higher education began at the Baumann Institute in 1923, where he studied high voltage technology. In 1928 he was a research assistant at the V.I. Lenin State Electrical Engineering Institute and by 1939 he defended his doctoral thesis.[95] Like Bush, by the 1930s Lebedev, had been working on analog machines, but the Soviet machines were inferior. At this early stage, the Soviets pursued supercomputing. Vast projects for hydro-electric dams and power lines were created such as the Kiubyshev-Moscow Hydro-Electric project.[96]

The first supercomputing gap disfavored the Soviet Union. Unlike the western allies, who had put a lot of stock in the power of computing to develop new and better weapons, the Soviet Union had put these types of projects on hold in order to

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[95] Malinovsky, Boris, Anne Fitzpatrick ed., Emmanuel Aronie trans., and Kate Maldonado ed. *Pioneers of Soviet Computing* (2nd) [Electronic Book]. SIGCIS.org, 2010 [cited October 13 2010]. Available from www.sigcis.org/files/SIGCISMC2010_001.pdf. Pp.2.

[96] Supra.

prosecute their portion of the war. It's true that Lebedev had worked on problems of trajectory for tanks guns and other weapons, but for the most part, computing played a lesser role for the Soviets since the Nazi invasion. The Second gap came after the war. The Soviet ambassador to the United States Nikolai Novikov interpreted U.S. designs on September 27, 1946 in his telegram to Stalin:

> The foreign policy of the United States, which reflects the imperialistic tendencies of American monopolistic capital, is characterized in the postwar period by a striving for world supremacy.[97]

The supremacy, of course, applied to weaponry as much as to economics but the U.S.S.R. had no serious foundation in computing in order to properly engage the United States in the arms race. It was clear, however, that they had considered the situation and feared the power of the U.S. in both strategic and scientific areas. Novikov wrote:

> For this purpose, broad plans for expansion have been developed and are being implemented through diplomacy and the establishment of a system of naval and air bases stretching far beyond the boundaries of the United States, through the arms race, and through the creation of ever new types of weapons.[98]

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[97] Telegram, Novikov, Nikolai to Josef Stalin, September 27, 1946.

[98] Idem.

Nevertheless, the importance of supercomputing did not sink in for the Soviets until a much later date.

This is one main reason for the Soviet lag in developing the atomic bomb. Although the Soviets had apparently a more developed spy network, their computing lag was a significant variable in holding back their progress until August 1949. This is not to say that the Soviets stole all their computing technology from the west. For example, the principle of a binary "flip-flop" was invented in the Soviet Union two years before the United States had it.[99] A principle of computing and actually having a computer, however, are two different things. Lebedev was developing analog machines in 1945 whereas the United States had been doing this same work in 1928. And yet there is some contradictory evidence about the history of "Analog Computing" in the U.S.S.R. According to Doctor Boris Kogan, a Soviet computer scientist who won many state prizes for his contributions to the discipline before emigrating to the United States, the first analog computers did not appear in the Soviet Union until the time between 1947 and 1949 when the EMU-1 was constructed. It is somewhat unclear if Kogan is referring to completely "analog" computers or "hybrid" machines in the same

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[99] Hally, Mike. *Electronic Brains: Stories from the Dawn of the Computer Age.* Washington D.C.: Joseph Henry Press, 2005, Pp. 139.

class as the Harvard Mark I.[100] In either case, the Soviets were not in a position to compete with qualitative developments in the west. Furthermore, the Soviets had to catch up in their quantities of computing machines. This problem with the difficult calculations necessary to produce a bomb with any order of magnitude in speed kept a serious gap between the two powers in place.[101]

The Soviets did attempt to purchase an ENIAC machine. This overture was almost ridiculous, considering that the U.S.-Soviet wartime alliance was crumbling by February 1946, and that the United States was already working on the hydrogen bomb. This was the first time that the United States blocked the sale of a supercomputer, and it would not be the last time. So, the Soviet computer scientists were now isolated from both within and without. The Soviets at that point were unable to glean any insight from other works in the computing field. It seems that "containment" was able to produce results in more ways than one.

Greece and Turkey. In the meantime, things were heating up on the geopolitical arena. At the end of the Second World War Stalin had agreed to pull his troops out of Turkey, Greece and Iran. This was to be done by 1946. The U.S. was concerned about

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[100] Abramovitch, Daniel. "Analog Computing in the Soviet Union." *IEEE Control Systems Magazine* 2005, 52-62, Pp. 55.

[101] Hally, *Electronic Brains*, 141.

this because of the need to have open access to the Suez Canal. It became more apparent as time progressed that the Red Army would not be withdrawn. In this climate the Truman Administration felt compelled to act. Thus on March 12, 1947 President Truman delivered an address to a joint session of congress during which he requested aid be given to both the nations of Greece and Turkey. $400 million in aid was given to both nations with begrudging of some people in congress.[102] George Kennan thought that the stance that the president had taken was "too strong" and that it would antagonize the Soviets and push them towards action.

Bureaucratic disagreements were matched by those within the scientific community as well. The feud between Eckert and Mauchly and Goldstine and von Neumann had forced each grouping to go their separate ways: Eckert and Mauchly decided to go into the private sector forming the computer company UNIVAC. At the same time von Neumann was still involved with EDVAC and had also decided to return to Princeton and the Institute for Advanced Study where he took up the role of mathematician. He would remain primarily connected to the institute the rest of his life, while still being involved with governmental projects as well as supercomputing projects.

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[102] Ferrell, Robert H. *American Diplomacy: A History*. Revised and Expanded ed. New York: W.W. Norton & Company, Inc., 1969, Pp. 690.

The Marshall Plan. In the meantime, the Marshall Plan had been implemented offering monetary aid to the war torn nations of Europe and interestingly enough the Soviet Union as well. The Soviets, however, did not accept the offer viewing it as a means to undermine Soviet strength. George Kennan supported this economic plan wholeheartedly. This was not difficult to understand, considering the gist of his Mr. X article in Foreign Affairs was basically a description of the weaknesses of the Communist economic system:

> Both the maintenance of internal political security and the building of heavy industry, has been carried out at a terrible cost in human life and in human hopes and energies. It has necessitated the use of forced labor on a scale unprecedented in modern times under conditions of peace. It has involved the neglect or abuse of other phases of Soviet economic life, particularly agriculture, consumers' goods production, housing and transportation.[103]

Kennan believed that this condition could be exploited and bring about a downfall "overnight" of the Soviet Union. Of course Kennan was completely wrong about a quick dissolution of the Soviet Union, but the Marshall Plan certainly did go far in upsetting Soviet leadership.

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[103] Kennan, George. "The Sources of Soviet Conduct." *Foreign Affairs* 25, no. 4 (1947): 566-582, Pp. 577.

Just after mid-year on July 26, 1947 The National Security

Act was accepted and in the following month was amended and put

into effect. The point of the Act was to:

> In enacting this legislation, it is the intent of
> Congress to provide a comprehensive program for the
> future security of the United States; to provide for
> the establishment of integrated policies and
> procedures for the departments, agencies, and
> functions of the Government relating to the national
> security; to provide a Department of Defense.[104]

Thus the Central Intelligence Agency and the National

Security Council were created.[105] The restructuring of American

foreign policy with containment strategy was to hold the Soviets

in stasis. In past conflicts arms races produced wars. Germany's

Blue Water fleet preceding World War One is an example.

Conventional forces could produce mass destruction but not

destroy the human race in one fell swoop. During the Cold War

extinction of the human race was a distinct possibility. The

fear of atomic strikes created conditions so that containment

was enforced. The scientists and the supercomputers created a

weapon that translated into fear. In turn that fear produced

conditions that required caution and rationality. Thus national

security structures were created to serve strategic theories and

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[104] *The National Security Act of 1947*, 102-496. July 26, 1947, Pp. 5.

[105] Ibid, 7.

those theories were bolstered by military investments in scientific computing.

IBM SSEC. In the midst of this grand systematic transformation of governmental and policy structure, IBM was playing "catch up" with the world of electronic computing. It needed to re-establish its leadership in the field. To this end the company embarked upon the Selective Sequence Electronic Calculator. The SSEC was an ambitious computer, for IBM. The machine also had an ambitious budget of $950,000 the equivalent of over $9 million dollars today. The machine itself was to be roughly 250 times faster than the previous IBM computer, the Harvard Mark I.[106] In fact the machine did live up to its potential for the most part. The SSEC was used on problems from planetary orbits to the composition of atomic fields.[107] At the zenith of its operation it worked on the HIPPO Problem (thermonuclear calculations) that von Neumann and Edward Teller had proposed for which they both needed a definitive answer.

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[106] Maney, *The Maverick and His Machine*, 347.

[107] Bashe, *IBM's Early Computers*, 57.

Thermonuclear Calculations

From 1946 through 1950 a notable list of persons worked on a problem they called "Super." Among them were: Edward Teller, Enrico Fermi and John von Neumann. Super was a codename for the mathematical research on the possibility of a thermonuclear explosion, specifically:

> Any likely type of thermonuclear system. Among such lines of necessary background theoretical work may be mentioned (i) work on capacities and equation of state materials, (ii) great numerical refinement of the picture available of the processes occurring in a fission explosion, and (iii) advances in the general area of computational ability, both in the matter of computing equipment and also in the field of computing technique and experience.[108]

HIPPO was an integral part of the "super" problem. Von Neumann was involved in every way.[109] The machine computations for the problem were done on ENIAC, but the problems had to be cut to fit on the machine. ENIAC was a general purpose computer, but not very flexible in its workings. The SSEC, which was favored by von Neumann, was better suited for the problem. But the SSEC had a problem. As in the case of the ASCC, IBM was cautious in its architecture, using tried and true methods in

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[108] Mark, "A Short Account of Los Alamos Theoretical Work on Thermonuclear Weapons," Pp. 2.

[109] Bashe, *IBM's Early Computers*, 57.

machine calculations. In other words, the SSEC was a conservative, hybrid machine, not fully electronic. The persons working on "super" found the machine to be reliable in its calculations, but "cumbersome."[110] Unfortunately, the SSEC was quickly outdated.

In the first year of George Kennan's containment policy the supercomputing world did not do much to affect policy. These effects would only be apparent later. Nevertheless, the United States, between 1945 and 1947 had a distinct advantage in "electronic" computing that was yielding tangible mathematical results. This is not to say that the first year of "containment" was much ado about nothing in the field of computing, but it was a slow year for the United States. The Soviets showed no serious interest in scientific computing during this time and American efforts seemed sufficient. This would not be the case during 1948.

The Berlin Airlift. 1948 was a year of serious crisis during the Cold War in which both the Middle-East and Europe were involved in turmoil. On April 18, 1948, the Christian Democrats (DC) won Italy's national elections. Their victory was seen as the first major step forward for the CIA. This operation proved that covert operations could be done easily, effectively

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[110] Ibid, 11.

and cheaply as compared to using US troops. On May 14, 1948 The British mandate over Palestine ended and the U.S. had to consider support of the newly created Israel. Kennan was not too keen on the issue, but the government's concern over Soviet intervention was very real.[111] Furthermore, the first Berlin Crisis began on June 24, 1948, when the Soviet Union instituted a blockade on the occupied city to protest Western efforts to integrate their zones of occupation in western Germany. The Administration in Washington D.C. knew that it had to act, however it did not wish to provoke the Soviets into a full blown war. General Lucius Clay did push for a military response, promoting the idea of sending tank divisions straight into Berlin.[112] The U.S. tactically hinted that a nuclear retaliation was more than possible.[113] Both Kennan and Nitze advocated a withdrawal of the occupying forces in Berlin.[114] Ultimately, the US reacted using The Berlin Airlift. From June 24, 1948 to May 12, 1949 B-29s were used to deliver supplies to keep the West Berliners alive. This was not only a good strategic move, in

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[111] Kennan, *Memoirs 1925-1950*, 380.

[112] Gardner, Lloyd. *Architects of Illusion: Men and Ideas in American Foreign Policy 1941-1949*. Chicago: Quadrangle Books, 1970, Pp. 266.

[113] Thompson, Nicholas. *The Hawk and the Dove: Paul Nitze, George Kennan, and the History of the Cold War*. New York: Henry Holt and Company, 2009, Pp. 89.

[114] Ibid, 90.

that it did prevent war, but a great propaganda move for the US, because the Communists looked weak.

The Berlin Airlift is on point with the idea of soft power as described by Joseph Nye Jr. in his book titled *Soft Power: The Means to Success in World Politics*. According to Nye it was this type of action i.e. indirect confrontation that was an integral part of the Cold War. To resort to both direct and indirect action in the face of Soviet aggression was both ingenious and effective. Nye credits Kennan for this approach, although it is uncertain that Kennan would have agreed. Nevertheless, soft power did have its role to play. But soft power might have had a far smaller impact, if it hadn't been backed up by hard power elements, and even more, by scientific power which fused together aspects of hard and soft power.

Nye tends to downplay the use of hard power while elevating the effectiveness of soft power. His assessment of hard power was that it provided the essence of military containment while soft power in the form socio-cultural transmissions to both the allied nations and certain sectors of Communist nations undermined the workings of the Soviet state. Nye's argument is somewhat problematic especially if applied to the early period of the Cold War in 1948. By his own admission soft power "eroded

the Soviet system from within."[115] Erosion is a key word. Erosion, in this case, the slow disintegration of a system takes time. At the time of the airlift time was not a luxury that the United States possessed. The airlift was a gamble and still a projection of hard power. It was uncertain that it would not provoke the U.S.S.R. but the consequences of direct confrontation were certain. On the other hand, the known commodity of hard power the military and most specifically the power of the U.S. nuclear arsenal, is what really made the Soviet Union buckle under its own weight. The nuclear arms race had both technological and economic consequences that were not sustainable by the Soviet Union.

Princeton Class Computers. Indeed, on the technical front, there was a shake-up that would determine the architecture of not only supercomputers, but all computers to the present day. By the time that ENIAC had begun running its first public calculations, the Moore School of Engineering had lost its cutting edge in computer technology. The feuding between Eckert and Mauchly on the one hand and von Neumann and Goldstine on the other had taken its toll. This left von Neumann to find another place to hang his technological hat. He ultimately decided to return to Princeton at the Institute for Advanced Study.

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[115] Nye Jr., Joseph. *Soft Power: The Means to Success in World Politics*. New York: Public Affairs, 2004, Pp. 50.

Princeton was a place known for its academic achievements for people in the liberal arts and other fields, rather than for technological projects that would have practical applications. The conflict between lofty ideas in the classroom and gritty engineering work often did not mix. Nevertheless, von Neumann had proven his worth in both areas and thus pulled a lot of weight in both the academic, as well as governmental and military spheres. In truth, Princeton was glad to welcome him home and when he pitched his next project at a price tag of $300,000 the University immediately came up with a third of his proposed budget upfront.[116] His project would be a new machine without a real moniker as of yet. It would become known simply as the IAS machine.

The IAS would be a further jump in technique from the existing ENIAC or EDVAC. Those computers both required rewiring to program for calculation. The IAS would not. At this point the "von Neumann" architecture would be put to the test: true high-speed electronic computing with advanced, for the time of course, random memory storage, which was a huge roadblock in early computing. The IAS was something of an anomaly. It was conceived by von Neumann himself. The concepts he applied to the construction of the machine rather than the machine's actual

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[116] Adjusted for 2012 $2,855,502.

performance. These concepts represented a true leap forward. The machine's calculating time was much slower than it should have been.

There was real beauty in the IAS, however: the potential of its architecture, which was imitated by following generations of computers. Thus, a series of "Princeton Class" machines proliferated with names such as ORDVAC, which was delivered to the traditional home of military computing, the Aberdeen Proving Grounds, MANIAC, which went to Los Alamos, AVIDAC at Argonne National Labs, ORACLE, which was sent to Oak Ridge National Laboratory, ILLIAC at the University of Illinois (Urbana), and finally IBM's entry into Princeton Class machines was the 701. The IAS was not only a national phenomenon, it extended well beyond U.S. borders.[117] SILLIAC was at the University of Sydney, WEIZAC in Israel, PERM in Germany, and BESK in Sweden.[118] The western world now clearly had a distinct quantitative advantage over its eastern counterparts. Interestingly enough, at least one author claims that some machines were being made in China before its fall to Mao Tse Tung's Communists, and more boldly states that the Soviet Union's BESM was a descendant of the

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[117] Macrae, Norman. *John Von Neumann*. New York: Pantheon Books, 1992, Pp. 313.

[118] Ibid, 314.

Princeton class computers.[119] One claim is unlikely and the other is not true. China was not in an economically stable to position to focus on such projects. That the IAS was the parent of the BESM is not completely verifiable. According to Boris Malinovsky who worked with Sergei Lebedev, while the two machines were similar, the architectural layout was arrived at independently.[120] The fact remains that the Soviet Union now became aware of the potential of supercomputing.

Soviet Ideology and Computers

The Soviets entered the supercomputer race against the west late in 1948. Lebedev's computer, the MESM, was merely conceived in that year, but not constructed for various reasons. One reason was that many scientists in the Soviet community did not see the ramifications of supercomputing. Another reason was that the Soviets had a problem that was endemic of the commercial personal computing field during the 1980's. This problem was, and is to the present time, called NIH or Not Invented Here, and it owes a lot to hubris.[121] In short, the Soviet scientific mindset was one where ideology played a pivotal role in its

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[119] Ibid, 314.

[120] Hally, *Electronic Brains,* 145.

[121] Carlton, Jim. *Apple: The inside Story of Intrigue, Egomania, and Business Blunders.* New York: Random House, 1997, Pp. 51.

work.[122] If something was not discovered, invented and or created

by Soviet science then it was not worth pursuing at best, and at

worst it could be seen as detrimental or in some cases

treasonous. The exception was espionage efforts at Los Alamos.

The atomic bomb was a hard example of overwhelming power and

therefore had to be acquired at all costs. On the other hand,

the benefits of supercomputing were not immediately apparent.

In a closed system there was a lack of flow in information.

To say that the field of computing in the Soviet Union had a

serious case of NIH is something of an understatement. This is

one of the reasons MESM arrived so late for the Soviet Union,

Lebedev had to come up with his designs independently of western

efforts.[123] An example of the principle is seen in the

competitions for state prizes in science:

> Lebedev failed to receive the State
> Prize…Unfortunately, the Board of Directors of the
> Ukraine Academy of Sciences, which at the time was
> headed by a biologist, did not understand or perhaps
> did not even attempt to understand the significance of
> Lebedev's work. The Secretary of the Central Committee
> of the Ukrainian Communist Party, Ivan Dimitrievich
> Nazarenko, who visited Lebedev's laboratory in the end
> of 1950, failed to properly endorse Lebedev's work
> either. After familiarizing himself with the MESM and
> the prospects for advancement and application of

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[122] Gerovitch, Slava. *From Newspeak to Cyberspeak: A History of Soviet Cybernetics*. Cambridge: The M.I.T. Press, 2002, Pp. 17.

[123] Graham, Loren R. *Science in Russia and the Soviet Union: A Short History*. Cambridge: Cambridge University Press, 1994, Pp. 256.

computer technology, he expressed his surprise and delight in one word: "Sorcery!" Leaving the laboratory.[124]

It is hard to imagine that any scientific endeavor could thrive in such an environment, much less one such as computing, which is based heavily in abstractions. Even Stalin himself thought that the combination of hard mathematics and ideology was literally laughable.[125] This is not to say that there was not the same type of competition in the western world. But there certainly was more scientific independence, which was a boon to computing overall. The NIH in the Soviet Union is hardly a surprise. In a society based in severe bureaucratic conflicts the distinctions within the scientific community would be much sharper. In sum the Soviet computer scientists were besieged by their own governmental structure.

The philosophical principle behind the Soviet Union was an economic eschatology; materials would move history in such a direction that a global Communistic society was a fait accompli. Many historians as well as academics from other disciplines have debated the honesty in fact, that Lenin, Stalin and others had for the Marxist underpinnings of their nation, this debate we

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[124] Malinovsky, *Pioneers of Soviet Computing*, 14.

[125] Gerovitch, *From Newspeak to Cyberspeak*, 34.

need not repeat here. Suffice to say that economics was at the heart of the matter and that the Soviet economy was not an open system. In the end, the inability to trade with others of equal or better economic strength was fatal to the nation. The same could be said of Soviet computing efforts.

Although Soviet computing circles knew of ENIAC and its apparent capabilities, the actual layout of the machine was as unobtainable to the Soviets as the machine itself. Furthermore, although many discoveries in the field of computing were achieved independently, having knowledge of others' efforts certainly would have aided the Soviet scientists. But works such as von Neumann's were not obtainable until much later.[126] The inherent closed Soviet system along with the external conflict with the western world kept Soviet computing isolated and perhaps stunted when compared to the efforts in the west.

Joe I. The Soviet Union exploded its first atomic bomb on August 29, 1949 in Semipalatinsk, Kazakhstan. The American reaction to this momentous event was somewhat mixed. It would be easy to say that the American public was seriously scared of this, and certainly Congress was of this mindset, but both the CIA and President Truman himself were not going to be as easily shaken by the event. The CIA and Truman had understood that

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[126] Ibid, 16, 17.

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atomic secrets could not remain secrets forever. For its part, the CIA had been wrong in its estimates about just how long it would take the Soviets to create the weapon. They assumed that the date would be around or about 1953. Apparently, there was evidence to the contrary that was ignored by the intelligence agency.[127] Despite this it seems that their reaction was measured. President Truman, for his part, delivered a speech on September 23rd stating:

> I believe the American people to the fullest extent consistent with the national security are entitled to be informed of all developments in the field of atomic energy. That is my reason for making public the following information… Ever since atomic energy was first released by man, the eventual development of this new force by other nations was to be expected. This probability has always been taken into account by us… This recent development emphasizes once again, if indeed such emphasis were needed, the necessity for that truly effective and enforceable international control of atomic energy which this government and the large majority of the members of the United Nations support.[128]

It was in the same month that BINAC was delivered to Northrop Aircraft. The Binary Automatic Computer was a project

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[127] Ed., William Burr. *U.S. Intelligence and the Detection of the First Soviet Nuclear Test, September 1949* [Website]. National Security Archive, 2009 [cited June 13, 2011]. Available from http://www.gwu.edu/~nsarchiv/nukevault/ebb286/index.htm.

[128] Truman, Harry S. *Atomic Explosion in the U. S. S. R.* [Website]. 1949 [cited March 7 2012]. Available from http://avalon.law.yale.edu/20th_century/decad244.asp.

for Northrop that began in 1947 because the company needed a computer to deliver a new missile, the SNARK. It was also, more than likely, to detect and measure Soviet atomic experiments. The BINAC was constructed by Eckert and Mauchly who had moved into the commercial sector, but who, wisely, were not above taking military contracts. Unfortunately, Eckert and Mauchly's ventures were not without trials and tribulations that went beyond their feud with Goldstine and von Neumann. By this point during the Cold War, anti-Communism had taken a significant hold on the governmental structures and was aimed at those who were involved with the government in the smallest of ways, much more with those who were involved with top secret projects like BINAC. Unfortunately for Mauchly, those outside direct governmental service must have a background check. The Army Intelligence Division had carried out an investigation of Eckert and Mauchly's company and found persons that were suspect, including Mauchly himself.[129] The accusations rested upon simple evidence such as supporting the liberal Henry Wallace. Mauchly had belonged to a group the "American Association of Scientists" and supported civilian control of atomic energy. This affiliation triggered an FBI investigation of Mauchly and the others. Fortunately all were cleared of subversive activity on November 11, 1948 and were allowed to continue with the BINAC

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[129] Hally, *Electronic Brains*, 38.

project.[130] If Mauchly had not been cleared his partnership with Eckert more than likely would have ended thus handicapping future supercomputing projects. Furthermore, Eckert would have been under scrutiny and thus would have handicapped the State Department in their future use of Eckert to examine Soviet computing efforts.[131] The BINAC project was pivotal in a political as well as a scientific way. The power of anti-Communism in Americas was as powerful as the ideologies that motivated the Soviet Union and in the same manner could have obstructed scientific progress as in the Soviet Union, but this case proves that measured against the importance of scientific breakthroughs, ideological censorship took second place in the United States.

Strangely, BINAC was to be made under some very stringent specifications. Firstly, the computer had to be incredibly accurate, so much so that it would have to eclipse other machines by far.[132] Secondly and oddly, Northrop wanted the BINAC to be able to fit and be used in an airplane. Northrop paid

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[130] McCartney, *ENIAC*, 160.

[131] Ibid, 223.

[132] Eckert, J. Presper, and John W. Mauchley. "The BINAC: A Product of the Eckert-Mauchley Computer Corp." 1-9. Philadephia: Eckert-Mauchley Computer Corp., 1949, Pp. 3.

Eckert and Mauchly $100,000 to develop the machine.[133]

Unfortunately, the project was plagued by problems. At best computers, even today, are fragile machines and at worst temperamental. Building a piece of "big iron" (the nickname for these early mainframes) that could be moved would be almost impossible. Another problem was that BINAC was considered to be nothing more than a side project for Eckert and Mauchly: their attention was never fully devoted to the computer, and they were just looking for capital to throw into UNIVAC. In the end, the BINAC was completed at a cost of $280,000 and so it was vastly over budget and, more importantly, it never worked correctly.[134] Northrop ended up putting the machine in storage, never to be utilized.[135] Up until this point, scientific and military computing required heavy investment, but it had always provided what it had promised. In this case, BINAC was a miserable failure. Unfortunately, this was the first time that the computing field had failed to deliver and it would not be the last time. During this same time Containment suffered another blow.

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[133] Adjusted for 2012 $963,831.

[134] Adjusted for 2012 $2,698,729.

By the autumn of 1949 Mao's Communists were getting the better of the fight with the Kuomintang (KMT) forces. By October of the year Chiang and the KMT forces were pushed off the mainland and retreated to Taiwan and on October 19, 1949 China fell into the hands of the Communists, and the People's Republic of China (PRC-Communists) was declared. Obviously the U.S. would not recognize the PRC provoking Mao into strengthening his ties to the Soviet Union.

As with other crisis moments in the Cold War, events in China prompted the search for speed in the development of weaponry. By 1949 the U.S. still had a clear advantage. The development of these weapons could not have been achieved in an order of magnitude necessary without the use of machine calculation, which came from the supercomputers such as ENIAC, EDVAC and the IAS Princeton Class machines. The U.S. military saw the practical use of the computers and invested heavily in those projects to develop their atomic bomb program. The Soviets atomic developments came from their espionage networks and not from advanced computing, which although began in 1948 under the aegis of Sergei Lebedev, was not on a realizable path until a later date. This is why the United States had such a quantitative and temporal lead in the area of atomic weaponry, which was vast. In short, the U.S. military had invested and the

investment paid off with significant results. Events in China further prodded U.S. military projects the notion of monolithic, global Communism presented the need for more military might. Conventional forces and atomic stockpiles would have to be increased as well as investments in supercomputing.

Containment Crumbling. While the mathematical aspects of the Cold War were moving ahead, George Kennan's containment strategy was beginning to disintegrate. The first Soviet atomic test Joe I, as noted, came as a shock to American public and the political sector of society who thought that this would come much later. But the scientists guessed that this was about the time that the event would happen. This awareness, plus the "Loss of China" were chipping away at Containment. Furthermore, the tenets of Containment were unclear. Kennan, as a theorist, was similar to Karl Marx in that Marx talked a lot about "class," but never truly defined what class meant. In this way Containment was similar: no one truly understood what Kennan's strategy was and maybe he did not understand it, in a mature way, himself. Many times these viewpoints only become clear at a later date. One thing is for certain: Kennan preferred economic defenses rather than direct military offensive postures. This is why he did not agree with the NATO military alliance. In short, time was running out for both Kennan and his grand strategy. He

was living in a world in which the climate of fear had just escalated and caused further transformations in the American mindset as well as the political structures.

It would not take much more aggression to destroy the first grand strategy, which was not based in numerical prowess, of the Cold War. At the onset of the "official" Cold War a strategy had already been developed by von Neumann and his colleague Oscar Morgenstern, Game Theory, which provided a mathematical structure for dealing with the Soviets. The "Two Player Game" scenario, The Prisoner's Dilemma fit well into managing the atomic competition, which created the central characteristic of the Cold War. This, of course, raises the question of who was really the true "architect" of the Cold War, Kennan or von Neumann.

Chapter Three

NSC 68: Rollback 1950-1952

Into the Whirlwind

By 1950 Kennan's Containment policy was still ongoing. The Marshall Plan was still in effect, until the end of the Truman Administration, bringing desperate economic aid to a still recumbent Europe. Also the North Atlantic alliance had been formed in 1949. With the fall of China to Communism, however, the Administration had given some pause for thought to the efficacy of containment. Of course the political backlash of the "Who Lost China" issue from the Republicans, and the Red-Baiting by McCarthy did nothing to help our national security policy to that point.

Containment vs. NSC 68

Containment was being re-evaluated also because Under-Secretary of State Dean Acheson, whose star was rising, was never convinced about its effectiveness:

> His [Kennan's] recommendations… to be good of heart,
> to look to our own social and economic health, to

present a good face to the world, all of which the government was trying to do were of no help.[136]

While Acheson was not convinced about Containment, Kennan's replacement as head of the Policy Planning Staff revealed even more doubts. Paul Nitze did not believe, as Kennan did, in nuclear disarmament and reliance on other methods to deal with the Soviets. He considered this method to be "impractical." Furthermore, Nitze thought that this soft approach would make overtures more difficult.[137] At the inception of containment in 1946 and 1947, the government and President Truman in particular did not see any reason to stop pursuing experiments to bring about a thermonuclear weapon while continuing to gather intelligence on the maneuverings of the Soviets. It was obvious that Truman wanted a more hawkish stance against the Soviets. In the light of events in Greece, Turkey, China, and the Joe I test Kennan's "unsound" plan for nuclear weapons had to be abandoned. Nitze drafted a new stance in National Security Document number 68 (hereinafter NSC 68). The policy now was truly a global policy and made military force a primary character, departing from Kennan's emphasis on economic policies. On April 14, 1950

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[136] Chace, James. *Acheson: The Secretary of State Who Created the American World*. New York: Simon & Schuster, 1998, Pp. 150

[137] Acheson, Dean. *Present at the Creation: My Years in the State Department.* New York: W.W. Norton and Company, 1969, Pp. 347*.*

NSC 68 was adopted as the new alternative to George Kennan's policy of Containment. Under the section titled "TERMS OF REFERENCE," the document stated:

> These objectives on our strategic plans, in the light of the probable fission bomb capability and possible thermonuclear bomb capability of the Soviet Union.[138]

The document attributed the primacy not only to militarization, as NSC 68 is typically characterized; but to atomic and nuclear weapons as well. The document continues:

> More fundamental decisions (a) as to whether, in the event that a test of a thermonuclear weapon proves successful, such weapons should be stockpiled, or (b) if stockpiled, the condition under which they might be used in war, if a test of a thermonuclear weapon proves successful, the pressures to produce and stockpile such weapons to be held for the same purposes for which fission bombs are then being held will be greatly increased...A general reexamination of this country's strategic plans and its objectives...to consider national policy...with respect to possible thermonuclear weapons, but also with respect to fission weapons.[139]

The document assessed the geopolitical conditions. In section IV titled: "The Underlying Conflict in the realm of Ideas and Values between the U.S. Purpose and the Kremlin

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[138] Nitze, Paul. "NSC 68: United States Objectives and Programs for National Security." 1-16. Washington D.C.: National Security Council, 1950, Pp. 2.

[139] Ibid, 3.

Design" the binary nature of the conflict was completely established:

> The Kremlin regards the United States as the only major threat to the conflict between the idea of slavery under the grim oligarchy of the Kremlin,... the polarization [is] the exclusive possession of atomic weapons by the two protagonists...two powers at opposite poles.[140]

Of course the conclusion was based on an educated guess about Stalin's intentions and global ambitions. In light of the Soviet's first atomic test in August of 1949, von Neumann's "Prisoner's Dilemma" now seemed a reality. Stalin probably did not wish to use his atomic arsenal except in the face of U.S. aggression in kind. This was a reasonable extrapolation on the parts of both parties: a type of "expectation" on both sides of the conflict. If this is in fact the structure of the scenario, then both a state of "competition" and a state of "cooperation" existed on the issues regarding atomic and nuclear arsenals; that was the very character of the dilemma.

The structure of the Cold War, with its primacy on the quantity and progressive quality of nuclear weapons made equations increasingly difficult to maintain within the human sphere. This was not only true in the building of the arsenals

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[140] Ibid, 5.

but in the overall ability to provide global security. In short, if there were no arsenals there would be no security for the United States and its allies. Given the rising Cold War tensions and conflict the two sides felt the need for speed in calculation to maintain what they considered the advantage. To this end, the Soviet Union entered the Supercomputer Race. Their entry was late and therefore there was a "Supercomputer Gap" that had a direct impact on the outcome of the Cold War in favor of the United States.

In the early days of the Cold War there was a fear that Communism was monolithic, its scope global in nature. Certainly, there was evidence for this perception. Stalin held sway over Eastern Europe, both Greece and Turkey were involved in struggles against Communist movements, Berlin was blockaded, and China had fallen to Communist forces. These events had prompted the United States to adopt a new geopolitical strategy to roll the Communist forces back by adopting NSC 68. The new policy would have its first test in the Korean War.

The Korean War and Turing. Before World War II the U.S. had interests in Asia; however, President Roosevelt realized the problem of defending them. In the post-war world the U.S. position on Asia was initially characterized by FDR's internationalist, anti-colonial stance. He wanted to eliminate

the threat of what was seen as western imperialism. With the fall of China and the establishment of the PRC Truman was no longer in the mood to be magnanimous. The heightened fear of the rise Communism in Asia was well founded, even if Secretary of State Dean Acheson was not sensitive to this. On June 25th 1950 North Korean forces invaded the non-Communist South. In the beginning of the war the Communists pushed the South Korean forces back to Pusan, nearly off the peninsula. Then the Inchon landing turned the tide for U.N. forces commanded by General Douglas Macarthur. The U.N. forces pushed the Communists back to the Yalu River bordering on China. The PRC sent troops to reinforce the North Koreans. Eventually the conflict between the two forces held along the 38th parallel, where it would freeze into a stalemate for the following two years. The conflict proved that conventional forces would not always be effective, and so the need for nuclear arsenals was a likely substitute. With the Korean War as the ultimate justification for the policies laid down in NSC 68, the flood gates were now irrevocably opened to supercomputing projects.

Not all of the advances in supercomputing occurred because the United States held a position as leader of the "free-world." The other major western nation, Great Britain, also held a prominent role in this scientific field. At the end of World War

II Winston Churchill's "Wizards" were discharged and operations at Bletchley Park were dismantled as well as the computers, most notably Colossus. The genius behind that work, Alan Turing ended up at the National Physics Laboratory at Teddington (hereinafter NPL), where he began to plan and construct a new machine called ACE. The ACE (Automatic Computing Engine) was to be the first "brain," as Turing called it when he originally drew up the plans for the machine to do complex calculations all at once rather than parsing out information. The work of programming the computer was daunting and the NPL in the end decided not to build the ACE to Turing's specifications. The ACE was eventually constructed at the NPL and initiated its first calculation on May 10, 1950 without Turing.[141] Frustrated, Turing Left the NPL and returned to academia in 1947. At Cambridge he did hold positions not in mathematics or computing but neurology instead. This may seem odd, but perhaps it was this oddity that sealed Turing's reputation for all time in the field of computers.

In October of 1950, Turing wrote an article that asked a simple question: "Can machines think?" Turing came up with some interesting insights about the question. He said that ultimately the question is the wrong one to ask. The computer could not

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[141] Ward, Mark. *Alan Turing and the Ace Computer* [Website]. BBC News, February 5, 2010 [cited June 25, 2011]. Available from http://news.bbc.co.uk/2/hi/technology/8498826.stm.

experience the world as a human could. This did not mean there was no similarity between what the machine could do and what humans did. In a contest of mathematical skills Turing said that a man would: "clearly make a very poor showing… given away by his slowness and inaccuracy."[142] He laid out a "game," which he called: "The Imitation Game." First, he said that only digital computers could play this game because only they could "mimic the actions of a human computer very closely."[143] Then in a section titled *Contrary Views on the Main Question*, he laid out what was and is still called "The Turing Test:"

> I believe that in about fifty years' time it will be possible to programme computers, with a storage capacity of about 109, to make them play the imitation game so well that an average interrogator will not have more than a 70 per cent chance of making the right identification after five minutes of questioning.[144]

The Turing Test was now set in stone as an ultimate goal of computing. The idea of the independent electronic brain would have its benefits. The computer already had a strong advantage in speed of mathematical operations, but the possibility of the actual ability to "out-think" a human being could have a great

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[142] Turing, Alan. "Computing Machinery and Intelligence." *Mind*, no. 49 (1950): 433-60, Pp. 434.

[143] Ibid, 437.

[144] Ibid, 340.

impact on strategic games. The military applications were obvious at that point and investment was forthcoming and plentiful. The discipline was a new outcropping of the Cold War. The viability of artificial intelligence to aid in Cold War efforts remained to be seen, but the possibilities were there. Meanwhile, tried and true efforts and tactics still remained.

Engineering Research Associates. Admiral Chester Nimitz, from his experience during the war recognized the importance of computer technology. After-all, the Navy was a serious investor in the technology, which had paid off a thousand-fold for them in the area of code-breaking. To this end, the Admiral contacted his lieutenants William C. Norris and Howard Engstrom in late 1945 to gather together a group to continue work on such projects. Finding financing for such a venture was not easy work and the men were at their wits end to find a way to do what the Admiral wished. In the end, understanding that the Soviets were likely to become aggressive in the post-war era, Nimitz brought the men to James V. Forrestal, who had not, at that point, become the first Secretary of Defense, aided them in their quest. Forrestal's aid translated into an initial investment of

$300,000 and then an additional 10,000 to form Engineering Research Associates (hereinafter ERA) in January 1946.[145]

ERA was open to projects from any area, including private businesses; one of their first projects was called "Project Boom." Their task was to engineer an underground test explosion.[146] Certainly not a project meant for use by commercial industries. It was obvious to the engineers at ERA that "Boom" was for the military. In these early days of the Cold War it was hard to tell if ERA was really a private concern or another extension of the government. For example, military personnel were assigned to ERA to guard the entrances and exits as well as the work areas. The work was supervised by a captain of the Navy. The company was to develop computer memory that would aid in cryptology. In the first year of its operation the National Security Agency (hereinafter NSA) oversaw the work. ERA's inner-workings had to be a closely guarded secret even from other governmental agencies. ERA's contracts were granted from the Navy, but they did some work for the Air Force in explosion testing, with the NSA watching very closely. Furthermore, ERA had no official budget, so other agencies could not trace its

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[145] Murray, Charles J. *The Supermen: The Story of Seymour Cray and the Technical Wizards Behind the Supercomputer*. New York: John Wiley & Sons, Inc., 1997, Pp. 16, 17.

[146] Ibid, 27.

activities.[147] Various memory devices were created at ERA for the specific purpose of Soviet code-breaking. One of them, codenamed DEMON produced results, until February of 1949, when the Soviets changed their system.[148]

Nevertheless, ERA still produced what was necessary for the NSA, in the form of a new computer called ATLAS. ATLAS was delivered to the NSA at the end of 1950 where it would work on cryptanalysis 24 hours a day needing minimal maintenance.[149]

Soviet supercomputing and espionage. By this time the United States and many of its western allies in Europe were immersed in computing projects, most of which were for scientific and military purposes. The Soviet Union was still struggling to get its first digital computer on-line. By November of 1950 the Malaya Elektronnaya Schetnaya Mashina or "Small Calculating Machine" (hereinafter MESM) was in its initial testing stages.[150] It had taken the Soviets quite some time to understand the need for high speed computing to keep up with the west. One reason for this again was the extent to which ideology figured into Soviet science itself. There had been

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[147] Gray, George. *Unisys History Newsletter* [Website]. Unisys, 1999 [cited June 23, 2011]. Available from https://wiki.cc.gatech.edu/folklore/index.php/Engineering_Research_Associates_and_the_Atlas_Computer_(UNIVAC_1101).

[148] *Supra.*

[149] *Supra.*

[150] Malinovsky, *Pioneers of Soviet Computing*, 9.

serious conflicts in that area ever since the time Bolsheviks had consolidated their power in Russia. In July 1948 Trofim Lysenko, a biologist, came out against western sciences as a bourgeois concept and therefore unacceptable for the needs of Soviet society. Science had to be rethought, following dogma rather than experimentation. Projects had to first be rationalized to fit the ideology and then justified in some way. Of course, this self-imposed limitation affected Soviet computing for quite some time. Nevertheless, by 1950 the Vice President of the Ukrainian Academy of Science and Director of the Mathematics Institute, Mikhail Lavrent'ev stood up for computing projects. He wrote directly to Stalin, a risky move indeed, in which he explained the necessity for computing projects in defense projects which spoke directly to the Soviet Union's national security.[151] Stalin, finally understanding the connection between computing and more and better nuclear weapons, moved quickly. Lavrent'ev was assigned a directorship over two massive supercomputing projects.[152]

Due to the Soviets' late entry, the gap between nuclear arsenals in the United States and the Soviet Union was as vast as the supercomputing efforts in both nations; and while the

[151] Gerovitch, *From Newspeak to Cyberspeak*, 134.

[152] Malinovsky, *Pioneers of Soviet Computing*, 15.

Soviets were still stumbling, the United States showed no signs of slowing down in either area.

Things for the supercomputing efforts in the Soviet Union certainly would have been aided by the espionage efforts in which the Soviets had invested a great deal since the wartime period. The famous Rosenberg case, *Rosenberg v. United States*, 346 U.S. 273 (1953) is the most notable example of this effort along with the cases involving Klaus Fuchs and Kim Philby. Julius Rosenberg and Ethel joined the Communist Party sometime in 1939. They learned of vital information in the Manhattan Project at the New Mexico atomic research facility. Unfortunately, the authorities did not learn about the atomic espionage efforts until 1948, when code-breakers working for the U.S. Army decrypted about 3000 of the codenamed Venona cables between Soviet intelligence agencies in Moscow and spies in the United States. The cables led to David Greenglass, Ethel's brother, who had worked as a machinist at Los Alamos during the war. A message to the Soviets was dispatched by Lieutenant General P.M. Fitin on September 21, 1944:

> Julius Rosenberg recommended the wife of his wife's brother, Ruth Greenglass… She is 21 years old, a U.S. Citizen [and] a [member] of the New York Communist League since 1942. [Ruth] learned that her husband had been called up by the army but he was not sent to the front. He is a mechanical engineer and is now working at the Atomic Energy Project plant in Santa Fe, New Mexico. Bernard Schuster is the member of the Communist Party line Julius Rosenberg is in touch with

Schuster they meet once a month for the payment of dues. Schuster is interested in whether or not we are satisfied with the collaboration.[153]

In a roundabout way, Soviet efforts to obtain the atomic secrets were less productive than if Moscow had obtained the secrets and blueprints for one if not all of the U.S.'s supercomputers. Certainly there would have been some complications in doing this, but they were not anymore insurmountable than obtaining atomic information. One thing is for certain: although the machines were at National laboratories such as Los Alamos, Oak Ridge, and Livermore, the planning and construction of the computers were often at American universities, such as the aforementioned Moore School at the University of Pennsylvania (ENIAC) or at Harvard (Mark I, II and III).[154] Soviet agents had penetrated American universities at least since the 1930's. In the wake of the Great Depression, the feeling among many American leftist intellectuals was that Communism was indeed the wave of the future and that to bristle against the ideology was utter "stupidity."[155] To this end, the U.S.S.R. created various fronts for their campaign to recruit sympathy for their cause especially in labor movements and the

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[153] Apresyan, Stepan. Venona Cable No. 1340, September 21 1944.

[154] Cohen, *Howard Aiken*, 203, 204.

[155] Saunders, Frances Stonor. *The Cultural Cold War: The CIA and the World of Arts and Letters*. New York: The New Press, 1999, Pp. 51.

publishing industry.[156] Andrei Zhdanov, Stalin's chief of the Cominform once stated very confidently:

> Communist parties of Europe have achieved considerable successes in conducting work among the Intelligentsia. Proof of this is the fact that in these countries the best people are, science and literature belong to the Communist Party.[157]

The spread of Communism was not confined to the nations of Europe. In fact, New York was once described as: "the most interesting part of the Soviet Union."[158] Soviet espionage efforts were more mature than American networks. From 1917 to 1929 the United States had an outstanding cryptographic intelligence department, MI-8, also known as the Black Chamber. They had broken codes from various nations, including the Soviet Union. But that department was dismantled in 1929 because Henry L. Stimson, the new Secretary of State, was offended by the very notion of the department's work, stating "We will do better by being an honest simpleton in the world of nations than a designing Sherlock Holmes."[159] In 1931, however, Soviet codes were under scrutiny by the government. The efforts against the

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[156] Ibid, 17.

[157] Ibid, 27.

[158] Ibid, 47.

[159] Kahn, David. *The Reader of the Gentlemen's Mail: Herbert O. Yardley and the Birth of American Code Breaking*. New Haven: Yale University Press, 2004, Pp. 98.

Soviet Union at the time were considered to be of low priority and ultimately unsuccessful.[160] American espionage efforts stagnated between the wars. On the other hand, Soviet efforts were undone by the very movement which had created them. In this case, the revolutionaries ate their own. The combined effect of the show trials in the late 1930s, Stalin's own treatment of autonomous Yugoslavia, and then finally the detonation of the Soviet bomb made Communist sympathizers in the U.S. disillusioned with the ideals of Communism, as represented by the Soviet Union. Still the Soviets could have increased their efforts to procure the necessary items to produce a digital machine, but decided to devote more attention to the atomic project in Los Alamos. Due to the Soviets' focus on the atomic bomb they widened the Supercomputer Gap, again to their detriment.

The Defense Calculator. Meanwhile, in October of 1951 IBM once again entered the fray. IBM decided that it would mass produce the 701, otherwise known as the "Defense Calculator."[161] The construction of the 701 was predicated on the following:

> When the outbreak of hostilities in Korea made the production of the devices embodying all of these components imperative IBM was ready with the necessary prototypes.[162]

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[160] Yardley, Herbert O. *The American Black Chamber*. New York: Amereon House, 1931. Reprint, 1996, Pp. 217.

[161] Bashe, *IBM's Early Computers*, 135.

IBM promised the Naval Ordinance Laboratory that the machine was 25 times faster than its previous machine, the SSEC, because the Defense Calculator utilized germanium diodes rather than vacuum tubes. IBM further impressed the Navy by highlighting the machine's versatility and ability to do calculations on an unprecedented scale:

> used for calculation of radiation effects in atomic energy; for aerodynamic computations for planes and guided missiles, including vibration and stress analysis, design and performance computations for jet and rocket engines, propellers, landing gear, radomes, etc.; on studies related to the effectiveness of various weapons; and on steam and gas turbine design calculations.[163]

The computer was indeed impressive, though IBM would not deviate from its standard practice of renting its computers as it had during World War II. The defense calculator had been specifically presented to the government as a scientific computer that was capable of new complex calculations, and IBM purposefully sped up production of the 701 because of the crisis in Korea.[164] The Navy would have to pay a hefty price for new technologies, at least from IBM. The price tag was $11,900 monthly depending on how much storage capacity was needed based

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[162] IBM. *Installation of the First 701* [Website]. IBM, 2010 [cited October 24, 2010]. Available from http://www-03.ibm.com/ibm/history/exhibits/701/701_first.html.

[163] Idem.

[164] Idem.

upon calculation requirements.[165] Despite the overall price, the Navy signed contracts for the computer which ended up being called Naval Ordinance Research Calculator or NORC, to be delivered to its research laboratories.[166] The Air Force also ordered 701's.

Approximately, two months after the delivery of NORC, the Soviets' MESM began its first calculations. It was almost 1952, and the Soviets had their first digital computer. At the end of 1951 the west was so far ahead it would be hard to imagine that the Soviets could ever catch up. To put this into perspective, the United States alone had at least nine major supercomputers. Some authors indicate an even higher number: ENIAC, EDVAC, The IAS Machine, IBM's ASCC, SSEC, The Defense Calculator (NORC), University of Illinois ILLIAC I and II, and ERA's ATLAS. Overseas the United Kingdom had three major supercomputers: EDSAC, the Manchester Mark I and ACE all faster than the Soviet MESM and all working on military escalation.

This is not to say that Lebedev's MESM was not impressive especially considering the lack of resources at Lebedev's disposal, but once the Soviet government committed to the computing projects, it also expected incredible results. On January 8, 1951, as the MESM had just begun its work, Lebedev

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[165] Adjusted Cost Per Annum 2012 $1,259,880.

[166] Bashe, *IBM's Early Computers*, 133.

was called before the Scientific Council of the ASU Institute of Electronic Technology and Heat-Power Engineering to answer questions about his project. He was asked quite simply how the MESM compared to machines in the West. Lebedev answered:

> I have data on about 18 machines created by the Americans, but this information is primarily advertisement, without any notion about the way they were built. We must catch up with foreign construction in building computing machines. We need to do this quickly. According to the foreign literature of design and implementation of a machine takes 5-10 years, but we want to make it happen in 2. For a comparison of MESM's characteristics to American computers, the multiplication time on ENIAC is about 5.6 milliseconds, EDVAC 4 milliseconds and our machine 8-9 milliseconds.[167]

MESM lacked speed. Lebedev accelerated his programs to two years to try to catch the Americans. One thing is for certain, Lebedev severely underestimated not only the time it took for the west to construct a machine, but also the time it would take the U.S. to develop new computer technologies that would keep the Soviet computer efforts "contained," if you will.

The RAND Corporation

If there is any one place that is more important to the Cold War than, let's say, the NATO headquarters, it is the RAND Corporation. There is also no other place that was not a direct

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[167] Fitzpatrick, Anne, Tatiana Kazakov, and Simon Berkovich. "MESM and the Beginning of the Computer Era in the Soviet Union." *IEEE Annals of the History of Computing* July-September 2006 (2006): 4-16, Pp. 8.

arm of the government or the military that had an effect on United States policy than RAND, and it is here that the particulars of Paul Nitze's NSC 68 fell into place, at times with the pure brute force of calculation.

RAND began its life, as most things during the Cold War, by the grace of 50 U.S.C. 401 (1947), otherwise known as the National Security Act of 1947. Other than creating the National Security Agency, the Department of Defense and the Central Intelligence Agency, it also split the Army Air Corps away from the Army and created the United States Air Force. Even before the Act, General Henry "Hap" Arnold was advocating such a split as was recommended by a research group that was part of Douglas Aircraft Company at that time, December 1945, called "Project RAND."

Like George Patton and Nimitz before him, Arnold saw the advances in science during the Second World War. He had seen the proximity fuse that had come to life as a result of Vannevar Bush's Office of Scientific Research and Development. More importantly, he saw the dire need to continue such research in a quiet manner. To this end RAND became independent of Douglas Aircraft on March 2, 1946. By taking this step, Arnold ensured that the think tank would be independent. Its researchers could assess proposals and they had the power to turn said proposals

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down.[168] RAND was set apart. RAND's infrastructure was informal and had a small collection of researchers, only 200 by 1948. In this way it was similar to Princeton's IAS.

It has been said of IBM that is not a company based on computers and technology, but rather "solutions."[169] RAND is the same in this way:

> RAND studied systems and ways of doing things, rather than particular devices, particular instrumentalities, particular weapons, and we are concerned not merely with the physical aspects of these systems but with the human behavior side as well.[170]

This orientation towards research and "solutions" created a need for more than just scientists, mathematicians and physicists in the strict sense of the word. RAND pulled from various sources to craft solutions: it included economists, engineers, chemists and psychologists.[171] Before RAND had even become incorporated on May 14, 1948, it was already well on its way in doing what its mission statement declared: "To further

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[168] Campbell, Virginia. "How RAND Invented the Post-War World." *American Heritage*, Summer 2004, 50-59, Pp. 52.

[169] Black, Edwin. *IBM and the Holocaust*. New York: Crown Publishers, 2001, Pp. 12.

[170] Campbell, "How RAND Invented the Post-War World," 52.

[171] RAND. *Rand Corporation: History and Mission* [Website]. RAND Corporation, March 18, 2011 1994 [cited June 20, 2011]. Available from http://www.rand.org/about/history.html.

and promote scientific, educational, and charitable purposes, all for the public welfare and security of the United States of America."[172]

Just to put the think tank into context, RAND stands for Research and Development, but it has often been quipped that it really stands for "Research and no Development." The question is: If RAND does not "develop" where does the fault in that lay? For example, RAND's first report titled *Preliminary Design of an Experimental World Circling Spaceship*, was 236 pages of research on the feasibility of space flight both in the theoretical aspects as well as the practical engineering side of such an undertaking as the deployment of satellites and other such orbiting spacecraft. The report was ignored and only gained its importance more than a decade later.[173] The fault in ignoring the report is irrelevant; what was worthy of note is that development could and possibly should have come on the heels of the report. In short, RAND had fulfilled its purpose.

Because of the nature of the problems set in front of RAND, calculation was set at a premium. One year after the report on spaceflight was issued, RAND hired a distinguished consultant: it was John von Neumann, who joined them on December 16, 1947.

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[172] Supra.

[173] Bradley, Brent. *Project Airforce: 1946-1996*. Santa Monica: RAND Corporation, 1996, Pp. 11.

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Why von Neumann? Before we answer that question we must assess the state of supercomputing at RAND during those early years. Although RAND was interdisciplinary, the institute was heavily disposed to mathematics and science. It needed the fastest, most advanced computers just as well as Los Alamos and the other labs working on atomic and nuclear problems. RAND started out with an analog computer, a Reeve's Electronic Analog Computer, or REAC for short and six IBM 604s. The IBM 603 could do 6,000 calculations per hour and its multiplications alone were done at a speed of .027 seconds. According to IBM, its customers liked the 603 and its improvement, the 604. Northrop Aircraft had purchased one in 1948 to aid with its research to run calculations that previously took weeks to solve. Its speed was due to new mini tubes.[174] Furthermore, according to Herbert Grosch, a scientist at IBM's Watson Laboratory, the 604 was "six or seven times faster than their 602 and 602a and ten times faster than their aging 601 line."[175] IBM had also touted the 603 and 604 lines with a huge advertising campaign that lured many businesses to rent the computer. No doubt that this campaign was what caught the eyes of RAND, which needed speed. Despite the grandiose touting by IBM of its computer, RAND was soon

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[174] IBM Archives. *IBM 603:The First Commercial Electronic Calculator* [Website]. IBM Archives, 2011 [cited July 08, 2011]. Available from http://www.ibm.com/ibm100/us/en/icons/ibm603/.

[175] Supra.

regretful of its decision to rent the computers. Within two years RAND apparently needed more computing power, or maybe they didn't.

It was up to von Neumann to verify how badly needed that power was. RAND had all this impressive computing power but the scientists ran into mathematical "brick walls" where it seemed no computer could solve the problem but...

> RAND was working on a problem so complex that no existing computer could handle it, and they asked von Neumann's help in designing a new, more powerful computer. Von Neumann asked that they first tell him the problem. The scientists' explanation took about two hours, accompanied with furious scribbling on a blackboard. Von Neumann just sat there with his head buried in his hands. At the end of the explanation, von Neumann scribbled something on a pad of paper in front of him. "Gentlemen," he said, "you do not need a new computer. I have just solved the problem.[176]

JOHNNIAC. Despite von Neumann's impressive abilities, by 1950 the researchers at RAND understood that they indeed did need more computing power. They screamed that reliability was a serious problem and that this must be resolved.[177] Considering that University of Illinois and Argonne National Labs both had Princeton class machines based upon von Neumann's IAS computer

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[176] Poundstone, *Prisoner's Dilemma*, 95, 96.

[177] Gruenberger, F.J. "The History of the JOHNNIAC." 138, Memorandum 5654-PR, Santa Monica: The RAND Corporation, 1968.

and were more than satisfied with their abilities, RAND decided that they would build their own machine: the JOHNNIAC, named after von Neumann.

Because of its architecture, the JOHNNIAC would be easy to use, faster, and more reliable. Another decision to build rather than purchase or rent was that IBM's employees and RAND's engineers were butting heads over most trivial issues, and other manufacturers were not prepared to ship machines to RAND at that point.[178] Over the next several years RAND did purchase and rent other computers, including IBM's 701 Defense Calculators, but RAND was still not satisfied with their performance. In RAND's early years the JOHNNIAC was their star performer.[179] RAND considered the cost of renting the 701s versus constructing the JOHNNIAC, but in the end the 701's were labeled "rich man's machines." That rental would cost RAND an estimated $380,000 without considering maintenance[180]; this was almost within the range of all of RAND's expenditures for its employees in 1950.[181] RAND's grudge with IBM notwithstanding, the time needed to construct the JOHNNIAC had to be considered. John Williams, who was the head of the mathematics division of RAND, calculated the

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[178] Ibid, 6.

[179] Ibid, 17.

[180] Ibid, 23.

[181] Ibid, 29.

construction time would be two and two-thirds years to build the machine. But the job was done before that time frame, proving that not only Williams but also Lebedev were incorrect in their assessment of how long the Americans would take to build the machines.[182]

RAND and NATO vulnerability. So, why is all of this important to the overall scheme of the Cold War? The answer in a word was: "defense." More specifically, calculation and speed favored the American strategists' inclination towards a peripheral strategy, placing the U.S. first strike ability and self-defense above the forward defense of NATO. RAND's penchant for statistics privileged this scenario. Every piece of data that figured in RAND's assessments went through computers and for the early years the JOHNNIAC in particular. The Airforce, which relied heavily on their brainchild, had more or less taken over the responsibility of first strike bombers in attack scenarios as well as defensive ones, and they needed assessments and advice. RAND's data and assessments carried a lot of weight. So, when two RAND researchers, Albert Wohlstetter and Harry Rowen wrote their recommendations to the Airforce titled *Campaign Time Pattern, Sortie Rate, and Base Location* the Airforce took their recommendations very seriously.

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[182] Ibid, 30.

Wohlsetter's and Rowen's report suggested that a first strike against the Soviet Union could not be a "Sunday Punch," meaning that one massive strike was not practicable and would most likely be ineffective, considering the effect of the two bombs striking Japan in 1945 left certain materials intact. This being the case, that one had to consider several strikes and military maneuvers requiring time to do reconnaissance for other strikes, recuperative ability of airbases and making sure that targets were "killed dead," i.e. unable to resurrected. Furthermore, the report conveyed a real concern about air engagements at a one to one basis. In the end, the report concluded that the cost of bombers in the U.S. and Europe were the same, but the ability to recuperate would be a factor and thus the bomber strike force would be better served by being in the U.S.[183] This report was delivered to Nitze, who took it very seriously. The effect of the report would essentially leave NATO forces in Europe "out in the wind," vulnerable to attack both from the air and on the ground. Time would work against Europe and possibly seal its fate. Especially the inability of the continental powers to protect themselves would not have helped their self-esteem both as regional and global powers.

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[183] Wohlstetter, Albert, and Harry Rowen. "Campaign Time Pattern, Sortie Rate, and Base Location." Santa Monica: RAND, 1952.

France had pressed hard since the end of the Second World War to regain its credibility since surrendering to the Nazis in 1940.[184] In the postwar period France was in a difficult position, as far as its national identity was concerned; it had to show dignity and pride and at the same time cultivate U.S. favor; Italy was in no better position. This left both nations in an awkward position vis-a-vis their membership in NATO. At this early stage of the Cold War both Italy and France were left vulnerable when they needed reassurance and at least some semblance of their own ability to participate as full partners in international affairs. Nevertheless they were charged with responsibilities whether they were prepared to handle them or not. For example, the Mutual Defense Assistance Program's Article 3 called for all signatories to resist armed attack; it also noted that the signatories would have to:

> Gain time for reinforcements to arrive and for cumulative effect of the strategic air offensive to be felt...the North American Area, its "initial basic understanding is to initiate the strategic air offensives against the enemy from the outset of hostilities.[185]

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[184] Brogi, Alessandro. *A Question of Self-Esteem: The United States and the Cold War Choices in France and Italy, 1944-1958*. Westport: Praeger Publishers, 2002, Pp. 15.

[185] Pedlow, Gregory. *NATO Strategy Documents: 1949-1969* [Website]. 1997 [cited July 12 2011]. Available from www.nato.int/docu/stratdoc/eng/intro.pdf, Pp. XIV.

The cost of refueling bombers from U.S. airbases cost about the same as in Europe and so it did not matter where the airbases were located. The report did state a serious concern about one-to-one air combat. This being the case, the task of mounting initial air offensives was the responsibility of the "European nations."[186] The language used in the document points to the fact that the U.S. would be responsible for atomic offensives, and more importantly that these offensives, although they would be carried out with deliberate speed, would take time to reach the U.S.S.R. and would leave Europe in a vulnerable position.

Bull Computers. France did not put forth a serious effort to engage in an atomic program. The definitive decision was made after the Suez Crisis in 1956. France did, however, pursue supercomputer projects. Compagnie des Machines Bull produced an experimental model, Gamma-2 in 1949. But the company's engineers needed aid. They received it from Remington-Rand (ERA had been purchased by Remington by this time), Howard Aiken, and J. Presper Eckert. Gamma-3 was built in 1952 followed by the Gamma-E.T. in 1957. These computers did not possess the power of their American contemporaries. It was not until Bull produced the Gamma-60 in 1958 that it had a computer that could match some of

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[186] Donnelly, C.H. "Note by the Secretary to the North Atlantic Military Committee on the Strategic Concept for the Defense of the North Atlantic Area." edited by NATO, 19-25. Brussels: NATO, 1949, Pp. 24.

the IBM computers. The first atomic test by France occurred in February 1960, much later than the Americans and the Soviets. But the test only occurred after the Gamma-60 was created. Whether or not France's vulnerability prompted it to pursue supercomputing and initial atomic projects is unknown. But circumstances do indicate that possibility.

Ultimately, it cannot be known if NATO nations would have, in reality, been sacrificed by U.S. domestic defensive interests because there was no nuclear exchange during the Cold War. However, the analysts at RAND clearly were recommending that the government do so.

Whirlwind I. While RAND was considering the utilization of atomic forces across the globe, the Air Defense System Engineering Committee (hereinafter ADSEC) met for the first time in late December 1950, to consider one of the most important projects of the entire Cold War. The committee understood that it needed digital computers to handle air defense problems. This was especially true given the need of jet fighters to intercept high-altitude bombers. Despite advances in rocketry since WWII, delivery systems were, still in the minds of the military forces, focused on bombers. Bombers or missile delivery systems notwithstanding, the United States still did not have an adequate air-defense system. During the war there had been some

detection equipment but, with the end of the war, these systems had been retired in the wake of demilitarization. Project Whirlwind was under the direction of Jay Forrester at the Massachusetts Institute of Technology. The Whirlwind was a computer that was to handle air-traffic problems. The project was originally under the auspices of the Navy. The Air Force had looked at Whirlwind in a cursory manner and had decided to look further. Whirlwind was a large-scale machine capable of speeds unimagined to that point, and so, on January 20, 1950 the Air Force notified Forrester that they needed Whirlwind to coordinate air defense problems.[187] As we have previously seen, the military had been investing in computing projects since the early 1930's; but it was with Project Whirlwind that the Air Force started its heavy investment in earnest. For example, for the fiscal year in 1951 1,650,000 was given to Whirlwind alone ($14,608,242 adjusted 2012).[188] Furthermore, by this time the armed forces were taking the initiative by granting funds to universities out of their own budgets to glean the results that they wanted.[189]

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[187] Redmond, Kent C., and Thomas M. Smith. *From Whirlwind to MITRE: The R & D Story of the Sage Air Defense Computer*. Cambridge: MIT Press, 2000, Pp. 29.

[188] Ibid, 35.

[189] Ibid, 42.

Given the stringent goals of Whirlwind, i.e. the complete defense of the United States, it was understood that this computer would have to be like no other before it. Anyone who owns a Windows PC knows first-hand how frustrating it is to have their computer "crash." It is even worse when, because of the crash, your data is irretrievably lost. If a computer like Whirlwind crashed the consequences for the entire world would be disastrous. So, the computer needed an unprecedented amount of reliability:

> Reliability was essential…"a single error of anywhere in the machine can destroy the entire calculation." A practical computer should tolerate no more than one error per 100 billion (i.e., 10 to the 11th power) operations equivalent to one wrong number every two years in a telephone network handling 130 million calls a day.[190]

No one would deny that Forrester and his team understood what would be at stake if Whirlwind failed in its assigned tasks. Another problem, which might have seemed frivolous or the stuff of science fiction now became a practical problem in reality when concerning Whirlwind: the ability to "think." As we know, Turing had addressed that very question. He wrote that in time a computer might be able to think, but not at the present

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[190] Ibid, 56.

time. Similarly, the people working on the Whirlwind had the same problem:

> The computer could not think, in the sense that humans do; however, if it were programmed carefully enough in advance, step by step, it could be made to calculate and choose among the alternatives provided in, say, combat operations or "the supporting activities of logistics, design, information centers, etc…[191]

The solution to this "thinking" problem was perhaps the largest gamble concerning Whirlwind. The computer needed the ability to anticipate scenarios before they happened in a way that the same function in the human mind would be called intuition. This was completely impossible for an electronic brain, but it was an adequate solution in place of a true "thinking" machine. This could be done through statistical analysis and prediction that had been created and refined since the early 1200s.

Whirlwind was in the process of becoming a nerve ganglion, in the parlance of many persons who dealt with computers. In the early "Bedford Tests" in 1951 Whirlwind was connected to sensors that tracked aircraft. The computer was reaching its potential to the relief of those who worked on the system as well as those

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[191] Ibid, 60.

who had invested in it. Because of the success of the machine, the project would continue and grow.

The Thermonuclear Era

During the same time, the United States was to outpace its Soviet competitors once again. The break-neck pace of the supercomputers was paying off; the U.S. was leaving the Atomic Age behind and entering the Thermonuclear Age. The atomic bombs to this point were fission weapons. In short, fission is the process of splitting an atom to produce a reaction. The problem is that the atomic yield, i.e. the power of the explosion is limited. On the other hand, a fusion device has an unlimited yield and furthermore, the destructive power of the radioactive fallout was not really fully understood at that point.

With the transition of atomic to thermonuclear powered weapons more controversy was generated not only within the scientific community, but also among the political circles within the United States. Most are familiar with the division between those who were sympathetic with Robert Oppenheimer and the supporters of Edward Teller. The question of more bombs or fewer bombs is not adequate to describe the fervor that the thermonuclear weapon produced. For example, Vannevar Bush who headed Manhattan completely approved of the development and use of the Atomic Bomb; however, he lobbied very strenuously to

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avert the testing of a thermonuclear device. Apparently he felt

that an explosion of such a device would place the United States

into a permanent conflict with the Soviet Union.[192] He simply did

not realize the state of the conflict had already congealed into

a state of permanency. One of Dean Acheson's science advisors

harbored similar feelings.[193] Kennan had also lobbied very hard

against the development of the weapon, much less the testing of

such.[194] Despite these pleas President Truman would have none of

this and so, on November 1, 1952 at 7:15 in the morning

Operation Ivy came to a conclusion with the detonation of "Mike"

on Elugelab Island, Eniwetok Atoll. The power of the explosion

is somewhat uncertain, estimates being between five and 100

megatons. Radiation was expected and so the pilots monitoring

the explosion, which transformed Elugelab from an island to a

two mile crater, had to be protected. Red Flight, which was the

first monitoring B-36, took in three to four roentgen levels.

Just to put this into perspective, of the following flights,

white flight took in .5 to 1 roentgen, and blue took .2 to .4.[195]

Nevertheless, the scientists were pleased because the pilots who

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[192] Goodchild, Peter. *The Real Dr. Strangelove: Edward Teller*. Cambridge: Weidenfeld and Nicolson, 2004, Pp. 205.

[193] Supra.

[194] Kennan, *Memoirs 1925-1950*, 110.

[195] Ogle, William, and John Lofland. "Operation Ivy: Mike Shot Cursory Reports on Experimental Programs." 19. Los Angeles: Los Alamos Scientific Laboratory of the University of California, 1952, Pp. 12.

had been provided protective clothing had a reduction in radioactive exposure four or five times less than expected.[196] Despite the elation of a successful test and lower radiation exposure to the pilots, the notion that one could be happy about low radiation levels to the pilots seems ridiculous. Nevertheless, the United States apparently was "on top" again in the nuclear weapons arena. The machines not only paid off in the creation of the thermonuclear weapon, but also now became an irreplaceable part of the overall thermonuclear machine that the U.S. had no intention of relinquishing to the Soviets. The Soviets had just entered the Supercomputer Race and their early efforts were impressive, considering the bureaucratic difficulties that they faced. On both sides of the Cold War calculations now were too complex to solve, much less entrust to human beings. Human produced atomic calculations were now a thing of the past.

IBM and Ike. Almost every presidential election during the Cold War depended heavily on aspects of foreign policy. To play with Carl von Clausewitz maxim that "War is Politics by Other Means" during the Cold War, "Politics is Foreign Policy by Other Means." The foregoing maxim could not have been truer than in the presidential election in 1952. Dwight David

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[196] Supra.

Eisenhower was sought out by both the Democrat and Republican Parties. There were reasons for this. Eisenhower had impressive credentials. First and foremost he was a war hero, commanding Operation Overlord on D-Day. His other credentials were equally impressive: he was a former assistant to General George Catlett Marshall as well as a special assistant under General Douglas MacArthur during the depression; he obtained his fifth star general's rank in 1945; he was president of Columbia University from 1948 until 1950 and he was reactivated by President Truman to become the Supreme Allied Commander for NATO. These qualifications made Eisenhower particularly attractive. He was able to build his political base from various segments of American society: the military, the general public, and big business. It was one business in particular that Eisenhower received somewhat more personal aid. That was IBM.

IBM was making money "hand-over-fist" in the post-war world. This was especially true since the outbreak of Korea. The various agencies dealing with nuclear arsenals had flocked to buy computers and of late the 701.

To IBM Eisenhower had looked particularly good as a possible candidate since 1948; at least this is how Thomas J. Watson, the president of IBM thought. Watson and Eisenhower

bonded after WWII.[197] In an effort to further ingratiate himself with the former general, he offered Ike the presidency of Columbia University. Eisenhower had turned Watson down during the previous years at feeling that he had neither the credentials nor the ability to run a university. However, when Eisenhower also turned down the possibility of a candidacy in 1948 he had put himself in a place where Watson could leverage both the general and the university into the position. In the end, it was only Eisenhower and not the University that needed convincing. The trustees of Columbia unanimously voted for Eisenhower in 1947 and he would take over in October of 1948.[198]

Eisenhower was a life-long Republican, but in the end he chose the Republican Party due to a complex rationale. Eisenhower was not a rabid enemy of the policies of the New Deal, but he absolutely had little regard for President Truman. Nevertheless that fact did not make his choice of the Republican Party a fait accompli.

When Eisenhower was appointed the commander of NATO forces, he met with the person most likely to be the top Republican choice for the presidency, Senator Robert Taft of Ohio at the

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[197] Maney, *The Maverick and His Machine*, 392.

[198] Ibid, 394.

Pentagon.[199] Taft was a Republican of the old style, meaning that he was a firm isolationist in regards to world affairs. Eisenhower had hoped to glean the senator's support for NATO forces. This support did not come to pass.[200] Eisenhower realized that Taft's isolationist style of republicanism was unrealistic in the context of new geopolitical realities and thus a real threat to the United States in the Post-War World: "This aroused my fears that isolationism was stronger in Congress than I had previously expected."[201] At this point he understood that he had to stop both Taft and Truman at the same time. Thus, he became the Republican Candidate and an asset not only for the Republican Party but IBM as well. However, just because IBM had Ike did not mean that they could not be sidetracked in the supercomputing world.

In 1949 the Air Force presented a contract to the Eckert-Mauchly Computer Corporation for the construction of the BINAC supercomputer. BINAC had been a failure on a grand scale for two separate reasons. Firstly, the Air Force's specifications for BINAC were too grandiose. The computer had to be self-checking and furthermore it had to be mobile, while maintaining accuracy.

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[199] Parmet, Herbert S. *Eisenhower and the American Crusades*. New York: The Macmillan Company, 1972, Pp. 35.

[200] Ibid, 36.

[201] Supra.

These two things were, at the time, unattainable, for any computer. Secondly, Eckert and Mauchly, while accepting the Air Force contract, did not put in a serious effort into BINAC. The reason for this was the two wanted to concentrate on computing in the private sector after their falling out with von Neumann. Both scientists wanted to divert the funds from the BINAC project to a new machine that could be mass-produced and marketed to not only the military and its scientists, but to various businesses as well. This computer would be a Universal Automatic Computer otherwise known as UNIVAC.[202]

UNIVAC. From the beginning UNIVAC seemed to have an evil star passing over it. The Eckert-Mauchly Computer Corporation was fine at creative engineering, but lousy when it came to finances. When Eckert and Mauchly went out on their own they obtained their first capital from their families. The two pushed very hard to sell the first UNIVAC's and the first was delivered to the U.S. Census Bureau in March of 1951 with the funds being sent from the U.S. Army.[203] Unfortunately, UNIVAC was not a "hot" commodity and so Eckert and Mauchly considered selling the machine to other nations. They of all people should have known

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[202] Hally, *Electronic Brains,* 31.

[203] Edwards, Paul N. *The Closed World: Computers and the Politics of Discourse in Cold War*, *Inside Technology*. Cambridge: M.I.T. Press, 1996, Pp. 61.

better than to even attempt this move, considering their experiences with ENIAC and BINAC being classified projects. The United States government predictably blocked the sale of the computer to foreign nations for reasons of national security.[204] Although the government had blocked the sale of ENIAC to foreign nations, there was surprisingly no real legislation in place to do such a thing. By the time that the sale of UNIVAC became an issue, the legislators had started to take some action. In the Marshall Plan there was an amendment that would not allow the sale of commodities that: "would be ordinarily refused a U.S. export license."[205] Furthermore, the CIA and the Department of State came up with two categories of commodities that could not be sold. Computers fell into the category of:

> Equipment and items 'primarily used in the production of munitions or which very importantly contribute to the war potential of the U.S.S.R. and its satellite countries.[206]

And so under that amendment the potential sales were blocked, and because this was under the provisions of the Marshall Plan, it applied to allied nations as well. UNIVAC was in serious trouble and so the company was sold to Sperry-Rand

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[204] McCartney, *ENIAC*, 158.

[205] Cain, Frank. "Computers and the Cold War: United States Restrictions on the Export of Computers to the Soviet Union and Communist China." *Journal of Contemporary History* 40, no. 1 (2005): 131-47, Pp. 132.

[206] Ibid, 133.

(not to be confused with the RAND Corporation). IBM was another possible buyer, but because they were also under scrutiny by the U.S. government for illegal practices, they were out of contention.[207] In order to drum up business for UNIVAC, Sperry-Rand, which by that time became Remington-Rand, decided on a public campaign to tout the computer's abilities. The executives at Remington-Rand pitched the idea of UNIVAC predicting the results of the election based on early returns to Columbia Broadcasting, CBS who were interested in the idea. Up to election night all the pundits were calling for a close election between Eisenhower and Stevenson. UNIVAC disagreed with them. Based upon only five percent of the returns UNIVAC predicted a landslide victory for Eisenhower.[208] CBS was certain that the computer had to be wrong and this would be an embarrassment for both them and Remington-Rand and refused to let the report go public.[209] Later when it was apparent that the results that UNIVAC had predicted were correct, 98% correct in fact, the prediction was then released.[210] In the end, Stevenson lost the election. The Electoral College vote was 442 for Eisenhower and

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[207] McCarthy, *ENIAC*, 166.

[208] Ibid, 170.

[209] Supra.

[210] McCartney, *ENIAC*, 171.

89 for Stevenson and 55% to 44% in the popular vote. UNIVAC had predicted 438 to 93 in the Electoral College.[211]

The outcome was that UNIVAC did sell. Not only had the Census Bureau purchased, but other UNIVACs were sent to Los Alamos and later would be at the White Sands Missile Range in New Mexico. UNIVAC, however, was never the biggest or most impressive machine on the planet. Many of the other systems outperformed it by leaps and bounds. What was more important about UNIVAC is that it made a serious impact on the American consciousness. The "Giant Brain" was further proof of American ingenuity and superiority in a time of international competition against a nation that touted its superiority; UNIVAC was another challenge to those claims.

In conclusion, the first Grand Strategy of the Cold War, Containment was not convincing to those within the Truman Administration such as Secretary of State Dean Acheson and then Kennan's eventual successor Paul Nitze. The coffin-nails for Kennan's policies were the "Fall of China" and then the Korean War. NSC 68 placed atomic weapons at the forefront of United States Cold War Grand Strategy. Because of the primacy and centrality nuclear weapons, supercomputers became an ultimate necessity, justifying all investments in said projects and to any amount. This was not only true of U.S. efforts. At this time

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[211] Supra.

Great Britain was also making headway with supercomputing projects under the continued efforts of Alan Turing, who was also proposing that theoretically computers could "think." This also went squarely along with the organic analogies that were put forth by von Neumann and others.

By this time the Soviets finally understood the benefits of supercomputing through correspondence between Lavrent'ev and Josef Stalin who, in the end, was not as ideologically dogmatic about mathematics as he was in politics. Despite a solid commitment to supercomputing, Soviet efforts in this area were independent, both because of ideological reasons, as well as more practical ones. Perhaps the Soviet Union's computing projects would have been better served if they had put the same effort into absconding with supercomputer plans as they did with atomic bomb plans. They would have had plenty of opportunities to do this because their spy networks had penetrated universities where many supercomputers were being constructed. This would have immensely aided their efforts to catch up with the U.S. Unfortunately, the Soviets did not do this and ultimately Lebedev's MESM supercomputer was slower than U.S. machines and there were not enough MESMs to match the output of the plethora of U.S. supercomputers which blossomed in the United States.

The supercomputers were also being put to greater use in the strategic arena as well. The "think tank" RAND had been founded to provide solutions for the military's questions about Cold War problems. RAND firmly believed in statistical and systems analysis and, to find these mathematical solutions, the institute invested heavily in supercomputers and every piece of data that RAND researchers used in creating their solutions were analyzed by the JOHNNIAC. Specially built by RAND and named after John von Neumann, JOHNNIAC became their main investment. RAND created the tactical plans used to bolster NATO strategies in Europe. Unfortunately for the NATO allies, RAND's calculated strategies resulted in the policy to keep U.S. bomber forces stationed in the United States rather than sending them to Europe. This effectively left NATO forces out in the wind in case of Soviet attack. Both the Airforce and Paul Nitze were convinced by RAND's efforts and proceeded accordingly.

By 1951 a new supercomputing project began. One of the most ambitious projects of the Cold War, Project Whirlwind was to be the main part of a network, which would act as an early warning system to control U.S. defensive forces. Whirlwind's creators understood that, because of the computer's massive responsibilities, it had to be reliable to degrees never attempted before. Furthermore, there were serious considerations

about the ability of Whirlwind to "think," in Turing's sense of the word. Ultimately, Whirlwind's creators came to the same conclusion that Whirlwind could not "think," but it could have the ability to anticipate, to consider what was happening during attack scenarios. More and more significant aspects of the Cold War were being handed over to the supercomputers and at the same time marginalizing human abilities.

During the same time the computing industry was making an impact on the political and psychological arenas as well as in the military and strategic areas. Because the Korean War seemed to have no real end in sight, President Truman was becoming increasingly unpopular. Dwight Eisenhower had been sought out as a candidate by both parties in 1948. Eisenhower decided instead to become the President of Columbia University, which had been arranged by the CEO of IBM Thomas J. Watson. This formed an enduring relationship between Eisenhower and IBM, which would have crucial implications for the handling of the Cold War. This is not to say that IBM's vaunted power always prevailed. The company was somewhat "blindsided" by UNIVAC in the 1952 election. The UNIVAC predicted a landslide victory for Eisenhower and was 98% accurate in that prediction, when none of the human pundits believed that this could be the possible outcome. Although UNIVAC's usefulness in military circles was

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limited, its public impact was immense. UNIVAC placed a permanent footprint on the American consciousness in the belief of the abilities of the "Giant Brain" and thus giving Americans a psychological boost over the Soviets, which was needed in light the Soviet advances in the last several years of "Containment" and the first years of Rollback.

Chapter Four

Massive Retaliation

And

Some S.A.G.E.ly Advice

President Eisenhower came into office with the sweeping landslide that UNIVAC predicted. Before the president could even set a new line for the nation's foreign policy he had to deal with the Korean War. The war had been one of the largest issues in his press campaign: the "K" in K-C2. In a speech given on October 25th 1952, just before the election Eisenhower gave a scathing critique of the Truman Administration's conducting of foreign policy:

> A small country, Korea has been, for more than two years, the battleground for the costliest foreign war our nation has fought, excepting the two world wars. It shall been the burial ground for 20,000 American dead. It has been another historic field of honor for the valor and skill and tenacity of American soldiers… I shall go to Korea… Carefully, then this new Administration, unfettered by past decisions and inherited mistakes, can review every factor-military, political, and psychological-to be mobilized in speeding a just peace.[212]

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[212] Eisenhower, Dwight D. *I Shall Go to Korea* [Website]. dwightdeisenhower.com, 1952 [cited July 31 2011]. Available from

Several things can be gleaned from this speech beside the fact that Eisenhower and a good portion of the American public felt that the Truman Administration had failed to- as Eisenhower had put it- "outwit the totalitarian mind."[213] Another thing is that the candidate was very much concerned with the cost of the war that he felt was avoidable.[214] And yet another was that he was willing to leave all options on the table, including the nuclear option.[215] The question at that point was how seriously did Eisenhower consider the use of nuclear weapons? The evidence that has been considered in order to find a final answer to the question is inconclusive. According to Michael G. Jackson in his article "Beyond Brinksmanship: Eisenhower, Nuclear War Fighting, and Korea, 1953-1968," Eisenhower while participating in National Security Council meetings staunchly upheld the possibility of nuclear engagement.[216] Furthermore, in the event that a possible armistice could be signed and China intervened,

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http://www.dwightdeisenhower.com/koreanwar/Speech,%20I%20Shall%20go%20to%20Korea.gif.

[213] Supra.

[214] Supra.

[215] Reed, Thomas C. *At the Abyss: An Insiders History of the Cold War*. New York: Ballantine Books, 2004, Pp. 96.

[216] Jackson, Michael G. "Beyond Brinksmanship: Eisenhower, Nuclear War Fighting, and Korea, 1953-1968." *Presidential Studies Quarterly* 35, no. 1 (2005): 52-75, Pp. 55.

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there definitely would be nuclear retaliation.[217] Even the hawkish Secretary of State John Foster Dulles was not sanguine of a reaction of this nature.[218] On the other hand, Campbell Craig in his book *Destroying the Village: Eisenhower and Thermonuclear War* argues that Eisenhower was convinced by Dulles to adopt Massive Retaliation as a cornerstone of the Administration's foreign policy.[219] What both Jackson and Campbell agree on is that the deterrent value of Massive Retaliation was what cowed the North Koreans in 1953.[220]

In any case, when Eisenhower did take over the office of the presidency, he was dropped into a much more complex situation than just a primary standoff with the Soviet Union. He now had a second front of the Cold War in Asia, which was completely undesirable to him. Furthermore, since the proclamation of the State of Israel in 1948, the Middle-East had become a veritable "hornet's nest." The Islamic nations despised the United States for its support of the new Jewish State, making the number of allies in the region quite small. Iran under the leadership of Mohammed Reza Pahlavi was anything but a

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[217] Ibid, 57.

[218] Ibid, 58.

[219] Craig, Campbell. *Destroying the Village: Eisenhower and Thermonuclear War.* New York: Columbia University Press, 1998, Pp. 44.

[220] Ibid, 48.

strong leader and so his nation would require U.S. vigilance. Furthermore, West Germany would become part of NATO in May of 1955, which would heighten tensions with the U.S.S.R. on the main front of the Cold War. It was apparent that the new Administration would have to be more active than the last.

Stalin's Death and Soviet Computing

The Eisenhower Administration would catch a break in Stalin's death on March 5, 1953. Generally, this event could only be seen as a good thing and perhaps even a "public service" to the world. Certainly during this time the Soviet Union would have to straighten out its political affairs, before embarking on a new foreign policy. The leadership of the nation fell to a troika composed of Nikita Krushchev, Georgi Malenkov and Lavrenti Beria. In the wake of Stalin's demise many anti-Communists welcomed the chaos within the Soviet Union. Not everyone was of the same mind. The new Secretary of State, John Foster Dulles for example, feared the leadership of Nikita Khrushchev, for he understood his personal foibles:

> I'm not worried about calculating people. Stalin was a calculating man. What I am worried about is a miscalculation that might bring on war. Khrushchev is

not a calculating man. He is excitable, irresponsible, prone to lose his temper.[221]

Dulles' concerns were reasonable but he failed to understand was that even the most temperamental Soviet leader was involved in von Neumann's dilemma as the second player in his game. Supercomputers made calculations that enhanced thermonuclear weapons on both sides. And in this scenario war was to be avoided at all costs. The foreign policies that were crafted created a rational structure for deterrence.[222]

In the midst of leadership succession, Soviet efforts in supercomputing were flourishing. Smaller computers such as the M-1 and M-2 were developed by Isaak Bruk and Mikhail Kartsev.[223] The M-1 was utilized for the solution of multi-dimensional matrices at the Institute of Energy of the U.S.S.R. Academy of Science. The M-2 had a wider scope, not only being used at the Institute of Atomic Energy, but also at the Institute of Theoretical and Experimental Physics, the Institute of Problems of Mechanics, the Airforce Academy as well as the Artillery Academy. Specifically, however, the M-2 was used for missile

[221] Berding, Andrew H. *Dulles on Diplomacy*. Princeton: D. Van Nostrand Company, Inc., 1965, Pp. 52.

[222] Craig, Campbell. *Glimmer of a New Leviathan: Total War in the Realism of Neibuhr, Morgenthau, and Waltz.* New York: Columbia University Press, 2003, Pp. xi.

[223] Gerovitch, *From Newspeak to Cyberspeak,* 145.

design.[224] The utilization of the M-2 showed that the Soviets had finally and definitively understood that in order to match the western nations, weapon for weapon, and maintain their own security, they had to also match the west computer for computer. While the M-1 and M-2 were relatively advanced machines they had their limitations. More performance was needed. And so the Soviet government approved two new supercomputing projects of massive proportions Lebedev's BESM and SKB-245's Strela.

Meanwhile, the U.S. computer projects were showing no signs of slowing their pace. In January Argonne National Laboratory had a Princeton class machine AVIDAC, its first electronic brain followed in March by ORACLE.[225] As with other supercomputers, these two machines had been put to the task of nuclear experiments, but AVIDAC and ORACLE were not working on pure theoretical problems, nor were they working on first strike capability. Because of their work the U.S. Naval forces would be able to widen their scope of intelligence gathering and attack capabilities in the creation of America's first nuclear powered submarine, the Nautilus.[226] By the end of March, Nautilus'

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[224] Ibid, 137.

[225] Argonne National Laboratory. *Argonne History: Computers: AVIDAC to Virtual Reality* [Website]. Argonne National Laboratory, 2011 [cited October 24 2010]. Available from http://www.anl.gov/Science_and_Technology/History/Anniversary_Frontiers/comphist.html.

[226] Supra.

reactor had been completed and tested, and in January of 1954 the nuclear- submarine would go into active service.[227] The Navy now had a weapon that required no refueling, which meant unlimited range of attack and thus changing the nature of submarine tactics and strategies.

The Death of Analog Machines. In the midst of the burgeoning advances in digital technology from ENIAC to the Princeton class and now the experimental Whirlwind I machine there was a "last gasp" from the proponents of analog computers. As guided missile systems progressed from theory to practical use the dialog focused on the issue of reliability. In an article presented at the Eastern J.C.C. Proceedings Bernard Loveman took up the case for the *Reliability of a Large REAC Installation*. Project CYCLONE was to create simulations on engine control, stability and navigation.[228] Loveman pointed out several shortcomings concerning the operation of digital machines, especially in light of such delicate problems such as the ones that would be presented to Project CYCLONE. His first criticism was somewhat questionable: he noted that problems on an analog computer could be solved in a minute or occasionally a minute and a half, whereas a digital machine could take up to

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[227] Supra.

[228] Loveman, Bernard. "Reliability of a Large REAC Installation." Paper presented at the AIEE-IRE Eastern Joint Computer Conference, New York, December 8-10, 1953, Pp. 53.

one-hundred hours.[229] He also stated that electrical current problems could cause error that would "invalidate" all calculations up to that point. He concluded that Project CYCLONE's time-schedule of fifty hour per week would be better suited by the use of the analog REAC rather than any digital computer.[230]

But Loveman's original premise had no basis in fact, especially in light of the advances in digital computing. During the same time the National Bureau of Standards had been since 1950 running a SEAC computer on a 24 hour day, seven days a week schedule.[231] Loveman did not take into account the flexibility of the SEAC machine, which had undergone several expansions to meet new requirements.[232] It is true that SEAC had down time, but this was limited by its self-checking abilities.[233] This ability had been attempted by BINAC, but had been an apparent failure at that time. As to the problem caused by unstable electrical

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[229] Ibid, 54.

[230] Ibid, 56.

[231] Kirsch, R.A. "SEAC: Review of Three Years of Operation." Paper presented at the The Eastern Joint Computer Conference, Washington D.C., December 8-10, 1953, Pp. 83.

[232] Ibid, 84.

[233] Ibid, 85.

currents, after two years of service the techniques established to deal with the problem had virtually eliminated the issue.[234]

The issue of SEAC's value could be called into question, because it was only in operation at the National Bureau of Standards and not for use on military projects. This supposition is wonderfully deceptive. The SEAC was also loaned out to "unspecified" governmental agencies, such as the NSA, whose matrix calculations were solved within fifteen seconds per calculation and not the 100 hours that Loveman proposed in his report.[235] This unspecified connection is definitely murky. The SEAC was capable of being operated by a teletype terminal at another location far from the computer itself. This capability would not be significant for its work at the National Bureau. But these capabilities would be necessary for military applications especially in areas of remote guidance that were already being researched in connection with the aforementioned Whirlwind I. In any case, flexible digital computers such as SEAC sealed the fate of analog computing in significant military and strategic projects.

Khrushchev's Support of Supercomputing. The promotion of Krushchev to leadership, even in the early days of the troika,

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[234] Ibid, 87.

[235] Snyder, Samuel S. "Earliest Applications of the Computer at NSA." 19-23. Washington D.C.: National Security Agency, Released 2007, Pp. 21.

was a boon to Soviet computer science. Krushchev had supported Mikhail Lavrent'ev since 1949 when the scientist showed him the MESM, and thus was not diffident about bringing about two powerful supercomputers to the forefront.[236]

The first project was the BESM, Bystrodeeistvuiushcaia Elecktronnaia Schetnaia Mashina, or the high speed electronic calculator. It was supported by Stalin and commissioned by the Institute of Precision Mechanics and Computer Technology in 1951 to be put into operation by 1953. The BESM was the brainchild of Lebedev. By this time however Lebedev, the leader in Soviet computing, had rivals. The other project was the Strela computer or the "arrow." Strela was conceived at the Nauchno-Issledovat'elskii Institut Schetnovo Mashinostroyeniya-NII Setomash, (hereinafter SKB-245) and the Zavod Schetno-Analiticheskhik Maschin or the Calculating Machine Factory.[237] The project was headed by Mikhail Lesechko, Iurii Bazilevsky, Bashir Rameev and Lev Gutenmakher. All of them had impressive credentials within Soviet computing circles. Despite their unquestionable talent, Lebedev had the advantage of having Lavent'ev on his side, and because of this Lebedev was able to recruit from the best talent pool that the Soviet Union had to

[236] Ichikawa, Hiroshi. "Strela-1, the First Soviet Computer: Political Success and Technological Failure." *IEEE Annals of the History of Computing* 28, no. 3 (2006): 18-31, Pp. 22.

[237] Malinovsky, *Pioneers of Soviet Computing*, Pp. 18

offer to create the BESM.[238] Understanding the benefit of the two
projects, the Soviet leadership created six computing centers:
the Chief Directorate of Artillery, the Soviet Naval Academy,
the Ministry of Aircraft and Defense, the Institute of
Aeronautical Hydrodynamics, which was working on problems of
nuclear physics and two unnamed organizations.[239] Unfortunately,
as with any other project of this magnitude, competition became
fierce. The project leaders at SKB-245 accused the BESM computer
of being nothing more than a carbon copy of American machines, a
very scathing and dangerous accusation at the time.[240] If the
BESM was a "carbon copy" of American machines it was a poor one.
David Holloway states that the "BESM was close to matching the
performance of the IBM 701."[241] This could not be further from
the truth. The 701 operated 16,000 to 17,000 operations per
second. BESM, and for that matter Strela paled in comparison,
operating at far lower speeds. BESM was only capable of 600 to
800 operations per second.[242] And the Strela was capable of 2,000
operations per second.[243]

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[238] Ibid, 19.

[239] Ichikawa, "Strela 1," 25.

[240] Ibid, 24.

[241] Holloway, *Stalin and the Bomb,* 314.

[242] Ichikawa, "Strela 1," 26.

[243] Malinovsky, *Pioneers of Soviet Computing*, 20.

The rivalry between Lebedev's group and SKB-245 was not any different than those that occurred in the western nations; but there were only two main supercomputing projects in the Soviet Union at the time, and this rivalry could not be afforded. Nevertheless, it existed and in the end Lebedev's BESM won out. The outcome was, at first glance, a little strange. In 1953, when both machines were put into service Strela was so much more powerful, and it certainly had the speed that is the ultimate worth of a supercomputer (after all it did 70 million calculations in a ten hour period, and this was the equivalent of 100,000 of human calculations) why did the BESM win out?[244] One reason was that the Strela was constantly being modified right down to the deadline in 1953 and, because of these modifications the project did not meet its deadline. It ended up being delivered almost a year late.[245] More importantly, the Strela was not able to do the equations that it had been designed to solve, namely nuclear fission equations; so in this respect the Strela was more or less useless.[246] Another more important reason is that the project went into cost overruns, the death knell of most military projects. In the end, the Strela cost 800 rubles in 1954 while the price of an analog

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[244] Ichikawa, "Strela 1," 25.

[245] Ibid, 26.

[246] Supra.

machine cost the government less than half as much. Furthermore, while special purpose computers could be bought for prices ranging between 1,000 and 3,000 rubles, these machines turned out to be more reliable than the Strela.[247]

Despite its shortcomings, the Strela was put into service and its creators at SKB-245 were awarded state medals of the 1st, 2nd and 3rd degrees. Bazilevsky was from then on called a "Hero of Socialist Labor."[248] The computing failure of the Strela did not affect its political success. This was especially important for Bashir Rameev, whose father had previously been tagged by the government as an "enemy of the state;" this success in a sense rectified that problem.[249] Another reason for the Strela to be put into service was a practical one. Again, with only two major projects, the Soviets could afford neither a scientific failure nor a political one whether it was in a domestic arena or an international one.

Beria and Missed Opportunities. Lavrenti Beria had been a member of the Politburo in 1946 and was chief of atomic energy development, which would have brought him into connection with Soviet computing circles. Beria's outlook on science in the

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[247] Ibid, 27.

[248] Malinovsky, *Pioneers of Soviet Computing*, 22.

[249] Ibid, 20.

Soviet Union was typical in that during the 1930s and 1940s he along with the majority of Soviet bureaucrats and scientists sided with the Lysenko-ists condemning western science.[250] However, Beria was a calculating man, like Stalin himself, and was also governed by practicalities. As chief of the atomic projects, he understood "ways and means," so to say, meaning more computers… more missiles. In fact, Beria had Mikhail Lavrent'ev, who had been in charge of Sergei Lebedev's projects, also oversee the Soviet H-Bomb project at Arzamas-16.[251] Eventually Beria did attain his goal of becoming chief of the NKVD (the KGB was not founded until 1954). His tenure would be cut short. After the death of Stalin and the struggle for power within the Kremlin in the aftermath, Beria did the unexpected. At the time Walter Ulbricht had incited riots within East Germany. Conditions quickly became volatile and the Soviet Union was forced to step in. Beria himself proposed a sort of rapprochement that would create a somewhat more independent East Germany.[252] He would forfeit his position and his life at a meeting of the Presidium on June 26, 1953 Beria was charged with being an imperialist and a traitor to the state and was summarily executed. For Soviet computing it was a missed

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[250] Gerovitch, *Newspeak to Cyberspeak*, 32.

[251] Holloway, *Stalin and the Bomb*, 306.

[252] Gaddis, John Lewis. *We Now Know: Rethinking Cold War History*. Oxford: Oxford University Press, 1997, Pp. 130.

opportunity to branch away from purely military projects and towards a wider variety of scientific projects, which were happening in the West. Instead Soviet computing would continue to be singularly linked to military projects.

The "New Look"

In the West, before the actual death of Beria, formal talks began to consider the admission of West Germany to NATO. Eisenhower's administration had committed itself at the outset to matters of foreign policy. Despite actual involvement in world affairs up to this point, there had been no change in policy at the NSC. However, on October 30, 1953, in NSC document 162/2 there emerged Eisenhower's "New Look."

The New Look was as much of an economic plan as it was a strategic stance in which to prosecute the Cold War.[253] Truman's 149/2 through 153/1 was superseded because they lacked clarity. Supporting everyone everywhere was not realistic in the mind of Eisenhower. The former general and commander of NATO forces was completely familiar with the financial, strategic and political costs of an expansive global foreign policy that made little or no distinction between means and ends. NSC document 162/2 read:

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[253] Craig, *Destroying the Village*, 44.

The United States must maintain a sound economy based on free private enterprise as a basis for high defense productivity… The economy of the country has a potential for long-term economic growth. Over the years an expanding national income can provide the basis for higher standards of living and for a substantial military program. But economic growth is not automatic and requires fiscal and other policies which will foster and not hamper the potential for long-term economic growth and which will operate to reduce cyclical fluctuations.[254]

The new policy also took into account the continually developing weapons systems. Eisenhower understood that they were becoming more complex by the day, and a new type of scientifically oriented personnel was now required to be part of U.S. national defense.[255] As to the Soviet Union the policy called for: "A strong military posture, with emphasis on the capability of inflicting massive retaliatory damage by offensive striking power."[256] Specifically, the Administration policies were based on the effectiveness of spies and missiles to promote a more efficient and effective U.S. national strategy.

Previously RAND had suggested in their reports that it was not sufficient to have a "Sunday Punch" nuclear strategy. There

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[254] National Security Council. "NSC 162/2 Report to the National Security Council." 27. Washington D.C.: National Security Council, 1953, § 19, 20, Pp. 14.

[255] Ibid, § 29-b, 16.

[256] Ibid, § 9-a, 5.

is no doubt the president knew this, and so the question was: if "Massive Retaliation" was not the "Sunday Punch…" then what was it?

The importance of "credibility" as a commodity of an effective foreign policy can be overstated. This is something that Eisenhower possessed more of than many of his predecessors did. This was including FDR who while politically adept did not have military experience, and certainly more than those presidents that succeeded him. He was not only a general but "the general" of the allied forces; this carried a lot of weight. It also helped that his Secretary of State John Foster Dulles was humorless. When these men spoke they meant what they said. They were good strategic players in the realm of international affairs. Possibilities were what gave Massive Retaliation its credibility as a policy. It was not the action, but the threat of action that was important against the opposing superpowers.[257] Vojtech Mastny in his book *The Cold War and Soviet Insecurity: The Stalin Years* stated that it was the United States' increasing reliance on nuclear forces that concerned the Soviets most.[258] Also Eisenhower's use of the CIA with other, smaller countries was effective in promoting free

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[257] Gaddis, John Lewis. *The Cold War: A New History*. New York: The Penguin Press, 2005, Pp. 68.

[258] Mastny, Vojtech. *The Cold War and Soviet Insecurity: The Stalin Years*. Oxford: Oxford University Press, Inc., 1996, Pp. 78.

anti-Communist nations. It did not matter that often these nations were anything but free. As long as the nations remained staunchly anti-Communist, that was enough to satisfy the needs of the United States. Finally, the "New Look" focused on espionage efforts and missiles, not only because they were effective measures, but also because this switch in policy away from the use of conventional forces promised to be healthier for the U.S. economy in the long run.

Atoms for Peace. Like Truman before him, Eisenhower's primary focus would be on the Soviet Union and the arms race; but where the Truman Administration was rigid in its diplomatic efforts, Eisenhower could afford to be somewhat more flexible. In front of the United Nations General Assembly on December 8, 1953 Eisenhower delivered what would become known as the "Atoms for Peace" speech. In the speech Eisenhower spoke of the dreadfulness of nuclear conflict and the sincerity of the United States to act "swiftly" and in a resolute manner in the face of aggression.[259] He further stated that: "The retaliation capabilities of the United States are so great that such an aggressor's land would be laid waste."[260] This put all on notice of his plans for Massive Retaliation, as noted in the "New

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[259] Eisenhower, Dwight D. *Atoms for Peace* [Website]. International Atomic Energy Agency, 1953 [cited September 6 2011]. Available from http://www.iaea.org/About/history_speech.html, Pp. 3.

[260] Supra.

Look." His tone then softened to point out that this conflict was not what the United States was after. Rather, Eisenhower proposed negotiations with France, Great Britain and the U.S.S.R. in order to:

> Make joint contributions from their stockpiles of normal uranium… to an international agency… under the aegis of the United Nations…The atomic energy agency could be made responsible for the impounding, storage and protection of the contributed fissionable and other materials providing special safe conditions that are immune to surprise seizure.[261]

Eisenhower made it clear that the U.S. was willing to work towards conciliation with the Soviets on certain issues such as nuclear weaponry. This is to say that Eisenhower's Massive Retaliation was not inevitability as he saw it. Still the Soviet Union continued to be mired in internal conflicts and certainly not trustful of U.S. intentions. Truth be told, such an open plan would not have been beneficial to the Soviets. In such a scheme the weaknesses of the Soviet military would have been laid bare. Internationally, the Soviets could thus be exploited and internally the nation that had prided itself on its military might being equal to that of the West would suffer a credibility blow. In short, the belief in the strength and inevitability of a Communist world would be called into question and under this

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[261] Ibid, 5.

type of scrutiny could possibly dissipate. Moscow was thus forced to reject the proposal.

Kenneth Osgood in his book *Total Cold War: Eisenhower's Secret Propaganda Battle at Home and Abroad* argues much the same, but he questions the sincerity of the proposal. From his point of view the proposal was specifically designed to be one-sided so that the Soviets would reject it, for the purpose of a propaganda coup.[262] That may be true. It would not be the first time that a party to an agreement sought to take his best advantage of the negotiations. But humans, for all their talents, are not prescient. There was always a chance that the Soviets could have accepted the proposal, for whatever their rationale might have been. Again the possibility of the Soviets accepting the agreement was slim because the U.S. outnumbered them in the quantity of bombers, Inter Continental Ballistic Missiles (ICBMs), and Submarine Launched Ballistic Missiles (SLBMs).[263] Hard or soft power notwithstanding, the U.S. was simply in a better position to make the offer.

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[262] Osgood, Kenneth. *Total Cold War: Eisenhower's Secret Propaganda Battle at Home and Abroad*. Lawrence: University Press of Kansas, 2006, Pp. 194.

[263] Schwartz, Stephen I., ed. *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940*. Washington D.C.: The Brookings Institution, 1998, Pp. 187.

Computers and American Espionage. In this context, Supercomputing became even more connected to the development of nuclear weapons. Under these conditions, supercomputers seemed unlikely to contribute to the second prong of the Administration's policy: covert activities, especially of those activities relating directly to the Soviet Union. In fact, this was not the case.

Although the utilization of spies seemingly fulfilled Ike's need for inexpensive ways of prosecuting the Cold War, while still remaining fiscally responsible, this is not actually the case. It is often expensive to recruit human intelligence, and even then there is an issue of trust, meaning that human spies can be lured away and many times difficult to control. How can one actually trust those that are capable of doing the task that you have set them to? Furthermore, there are also problems regarding placement of the spies.[264] This can not only be costly, but can also present tactical problems. Another problem with spying the Soviet Union is that Russian is a difficult language to learn. The cost of teaching a new language is in terms of time. At the time, there were only a small amount of people who

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[264] Clarke, Richard A. *Cyber War: The Next Threat to National Security and What to Do About It*. New York: Harper Collins Publishers, 2010, Pp. 229.

could translate Russian.[265] This is where IBM stepped in once again with a solution.

IBM developed the 701 defense calculator in 1952, and for the most part the machine was an impressive one. But the scientific and mathematical aspects of the machine were inadequate for the RAND Corporation. Furthermore, RAND deemed the computer to be too expensive, a "Rich Man's" computer. This is ultimately what pushed RAND into building the JOHNNIAC instead. But the 701 remained valuable for one task: it excelled in language translation.

On January 7th of 1954 the result of IBM's Georgetown experiments were released to the world. The IBM 701 had successfully translated Russian.

In 1949 the Georgetown University Institute of Languages and Linguistics was founded as part of its School of Foreign Service. The person that headed the Institute was Leon Dostert, a former OSS officer and Eisenhower's interpreter during World War II.[266] Dostert and Cuthbert Hurd of IBM decided to include language translation among the functions of the 701. This decision was motivated by the lack of information about the

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[265] IBM Archives. *IBM 701 Translator* [Website]. International Business Machines, 2011 [cited March 29 2011]. Available from http://www-03.ibm.com/ibm/history/exhibits/701/701_translator.html, Pp. 2.

[266] Hutchins, W. John. "The Georgetown IBM Experiment Demonstrated in January 1954." 11, 2004, Pp. 1.

Soviet Union. The machine was touted to be able to translate German, French and other languages. Russian however, was chosen for obvious reasons. The ability to translate languages for a person is a tedious task to say the least and the ability to have a computer to do this would have benefits. The problem is that translation for a computer is a complex task requiring hardened specificity. Nevertheless, when the outcome of the experiment was released it caused quite a stir. According to IBM:

> A girl who didn't understand a word of the language of the Soviets punched out the Russian messages on IBM cards. The "brain" dashed off its English translations on an automatic printer at the breakneck speed of two and a half lines per second…More than sixty Russian sentences were given to the "brain" altogether.[267]

Unfortunately, one of the drawbacks here was not only the limited amount of people who could translate, but also the limited amount of data. Much of the information that the U.S. had on the Soviets came not from espionage activities but from various collections of literature.[268] Interestingly, the reliance on Russian literature for data may not have been as much as a handicap as one might think. Historian John Lewis Gaddis in an

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[267] IBM Archives. *IBM 701 Translator* [Website]. International Business Machines, 2011 [cited March 29 2011]. Available from http://www-03.ibm.com/ibm/history/exhibits/701/701_translator.html, Pp. 1.

[268] Ibid, 2.

interview about his new book, *George F. Kennan: An American Life* stated that Kennan's understanding of Russian literature, not politics, uncovered the Russian national character.[269] Despite the 701's shortcomings, the public response to the 701's performance was generally favorable and reporters who covered the event were excited. The London Financial Times thought that the machine was "remarkable" in its performance and the simplicity of its translation program.[270] This is not to say that all were pleased about the 701's efforts. More than a few of the observers that were computer knowledgeable felt that the computer could be put to better use:

> A number of reports picked up the observation made by the developers that the expensive 701 computer was overdesigned for language translation; it has too many functions not essential to this task that were built in to solve problems in astronomy and physics.[271]

It is true that if the 701 were to spend the bulk of its time translating Russian that the scientific functions should have been marginalized if not completely removed. Certainly one could look at RAND's assessment of the machine to see that in

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[269] Burt, David. *Office Hours with David Burt: John Lewis Gaddis* [Website]. Yale Daily News, 2011 [cited January 18 2012]. Available from http://www.youtube.com/watch?v=1ycSoFUOL8s&feature=fvst.

[270] London Times Correspondent. "Language Machine Demonstrated." *The London Times*, January 8, 1954.

[271] Hutchins, *The Georgetown Experiment*, 3.

competition with the Princeton class computers it was severely lacking; so limiting the 701 to translation made perfect sense.

The translation by the 701 of Russian to English produced tangible results that were used to further gather information about the Soviets. Not only could literature be translated but whatever information could also be gleaned from human intelligence and transmitted back to the United States could be translated quickly. Because the results of the Georgetown experiment were openly announced in public, there were also diplomatic repercussions: in short the Soviets panicked. Lebedev's BESM was to also have the capability to translate English into Russian. This task was assigned to Yuri Panov, a professor at Moscow State University. Unfortunately for the Soviets, their computers could not perform this task for another two years. Once again they were outmaneuvered by computer scientists in the west who had free reign to explore and develop new technologies.

American Philosophy and Technology. Just a month after the Taiwan crisis, supercomputing in the United States began to take an alternate route in its approach to the Cold War. On October 1, 1954 IBM introduced its 705 computer. Unlike its predecessors, the machine was not specifically meant for military use, but for business purposes. Much of Eisenhower's

162/2 focused on having a healthy economy. Certainly the faux pas by Secretary of Defense Charles E. Wilson, who famously stated "What's good for General Motor's is good for the country," was an indicator of the vitality there was in post-war economy that had been tagged as "conspicuous consumption."[272] The move of supercomputing into the private sector became a two-pronged attack against the Soviets, even if it was unintentional. America, at least since the Age of Jackson has been geared toward the type of philosophical dynamism that John Foster Dulles spoke of in 1952 in an interview for the Longines Chronoscope.[273] In the U.S. there always has been an emphasis on management and technology that has shaped a national character. What immediately comes to mind is Frederick Taylor's *Principles of Scientific Management*:

> The best management is a true science, resting upon clearly defined laws, rules, and principles as a foundation. And further show that the fundamental principles of scientific are applicable to all kinds of human activities, from our simplest individual acts to the work of our great corporations.[274]

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[272] Halberstam, David. *The Fifties*. New York: Villard Books, 1993, Pp. 118.

[273] NARA. *Longines Chronoscope Interviews, 1952, V.22: Elbert Carvel, John Foster Dulles* [Website]. National Archives and Records Administration, 1952 [cited September 12 2011]. Available from http://www.youtube.com/watch?v=bP6q8fY1BnA.

[274] Taylor, Frederick Winslow. *The Principles of Scientific Management*. New York: W.W. Norton & Company, 1911, Pp. 7.

As the 20th Century moved along the notions of efficiency and predictability through the use of technology by the U.S. created a type of hyper-capitalism in the nation.[275] This economic-technological union could not be matched by the Soviet Union despite their own focus on efficiency proposed in the most intricately managed GOSPLAN (Gosudarstvennyy Planovyy Komitet) schedules.[276] The 705 model was not the first supercomputer meant for the open market. Eckert and Mauchly had tried with UNIVAC unsuccessfully. With the IBM name behind the 705, businessmen could trust that the computer was here to stay. More importantly, the computer in the business sector represented the ultimate rationalism that Americans consistently sought. This created societal conditions that concretely favored technology. The United States had never gone through the same negative experiences via technological progress such as with the Luddites in Great Britain in 1811 and 1812. In America there had been no great social dislocation. This fostered a real collective belief in data and the computer's ability to provide the ultimate rationalization. To the American the lure was simply

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[275] Ritzer, George. *Modern Sociological Theory*. New York: McGraw-Hill Higher Education, 2000, Pp. 433.

[276] Curtis, Adam. *Pandora's Box*: BBC, 1992. Documentary.

irresistible.[277] In the context of the 1950s it was a boon to the United States' struggle against the U.S.S.R.

The Darmstadt Conference

Considering the very public announcements about the advancements in computing in the West, the Soviets had to react, lest they would lose the credibility contest. To this end, in the same month as the 705 was announced to the public, the Soviets also announced that they had a national program for supercomputers. By the end of October, the International Federation for Information Processing (hereinafter IFIP) had been formed with the help of UNESCO. It was more or less an organization comprised of Europeans, even though the idea behind the organization was Isaac Auerbach, an American.[278] The first IFIP conference was held in Darmstadt, West Germany at the Technische Hochschule. Overall this first conference was a success: there were many papers presented and creative partnerships were forged especially between the Germans and Americans.[279] In an unprecedented way, the Soviets were invited to participate as well, and unlike many political summits, the

[277] Sale, Kirkpatrick. *Rebels against the Future: The Luddites and Their War on the Industrial Revolution, Lessons for the Computer Age*. Reading: Addison-Wesley Publishing Company, 1995, Pp. 59.

[278] Tatarchenko, Ksenia. "Cold War Origins of the International Federation for Information Processing." *IEEE Annals of the History of Computing* 32, no. 2 (2010): 46-57, Pp. 46.

[279] Ibid, 48.

Soviets attended the conference. The two major competitors in Soviet computer science, Sergei Lebedev and Iurii Bazilevskii, creators of the BESM and the Strela respectively, traveled to West Germany to make their announcement and present information about their work. One of the main reasons for Soviet attendance was a report that was delivered to the Institute of Precision Mechanics and Computer Technology:

> The gap between the United States and the Soviet Union in the area of digital computers and control devices continues to grow. We are falling behind in the number of machines, as well as in their technical parameters. We are also falling behind in production technology and applications of computing devices, particularly, for military purposes.[280]

Despite their attendance at the conference, Lebedev and Bazilevskii were not allowed to disclose all the information about their work. Nevertheless, they did boast that the BESM was the fastest computer on the European continent. But the speed of the BESM was not to be compared to the U.S. Naval Ordinance Research Calculator and many others that were being produced in abundance in the United States.[281]

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[280] Ibid, 49.

[281] Ibid, 50.

Open Skies. Meanwhile, a more traditional diplomatic even was taking place. On July 21st, 1955 Eisenhower introduced his "Open Skies" proposal at the Geneva Summit. Open Skies proposed that there would be mutual flight surveillance between the U.S. and the U.S.S.R. The rationale behind this was to make known the nuclear capabilities of each nation and to reassure each of them. The proposal was made to Soviet Premier Bulganin and to General Secretary Nikita Khrushchev. Khrushchev, fearful of exposing Soviet weaknesses, rebuked Eisenhower's offer as a thinly veiled excuse for the US to gain an advantage over the USSR. The outcome of Khrushchev's rejection was that opinion of the Soviet Union dropped significantly in Western Europe.[282] Also, Khrushchev unknowingly revealed to Eisenhower that he had risen to the ultimate political position in the Soviet Union.

The proposal of Open Skies would have been a dramatic diplomatic victory in the area of nuclear diplomacy. Unfortunately, nothing would come of the proposal until near the end of the Cold War. Nevertheless, the proposal did have a significant impact on those who had attended the IFIP. Many attendees both western and Soviet who had felt that the conference fulfilled a type of diplomatic victory of its own that was as important as the nuclear diplomacy that was being

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[282] Osgood, *Total Cold War*, 194.

discussed at Geneva. Considering the essential role of supercomputing to the Cold War, perhaps they were correct.

The Warsaw Pact

In Moscow, despite the domestic infighting between Khrushchev and Malenkov, foreign affairs remained a focal point of the direst nature. The two leaders were definitely skittish as to the military and diplomatic moves in the United States and Western Europe. As with Stalin, the new leaders of the Soviet Union sought a security zone. The Soviets saw not a perceived threat but a very real one in the NATO Treaty. To this end, the Soviets implemented the East European Mutual Assistance Treaty; it was signed on May 14, 1955 by the USSR and Eastern European Satellite Nations as a military alliance system to confront NATO in the event of "imperialist" aggression. In strategic and political terms, this move marked merely a consolidation of what the Red Army had done since the end of World War II. The Treaty in fact did nothing more than produce a façade of unity against the western powers. In the face of the Warsaw Pact, not all of the NATO members were in agreement. For example, British Prime Minister Anthony Eden put forth a plan to reduce tensions between the NATO members and the Warsaw Pact nations by cutting armed forces and creating a hard agreement on a buffer zone between the two military alliances. Eden also somewhat naively

proposed free elections in Germany. He believed that Khrushchev "was not another Stalin."[283] John Foster Dulles believed that if the Soviets were willing to quickly settle on the matter this would be a concrete sign of Soviet weakness; but Eden's plan was threatening to separate the NATO nations, and this could not be stomached.[284]

On February 25, 1956 the political picture in the Soviet Union became more clarified. Nikita Khrushchev delivered the 20th Party Congress Speech, which soon became no longer secret. Khrushchev thoroughly denounced Stalin and renounced Stalinism as a platform of the Soviet Union:

> Stalin on the other hand used extreme methods and mass repressions a time when the revolution was already victorious, when the Soviet state was strengthened, when the exploiting classes were already liquidated, and socialist relations were rooted solidly in all phases of national economy, when our party was politically consolidated and strengthened itself both numerically and ideologically… he often chose the path of repression and physical annihilation, not only against actual enemies, but also against individuals who had not committed any crimes against the party and the Soviet government.[285]

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[283] Hoopes, Townsend. *The Devil and John Foster Dulles*. Boston: Little, Brown and Company, 1973, Pp. 298.

[284] Immerman, Richard H. *John Foster Dulles: Piety, Pragmatism, and Power in U.S. Foreign Policy*. Wilmington: Scholarly Resources, Inc., 1999. Pp.136.

[285] Khrushchev, Nikita S. *The Secret Speech on the Cult of Personality, 1956* [Website]. Fordham University, 1956 [cited September 28 2011]. Available from http://www.fordham.edu/halsall/mod/1956khrushchev-secret1.html.

Khrushchev continued saying: "Stalin thought that now [he] could decide all things alone and all he needed were statisticians."[286] The things that Stalin did not discount were the very "scientific" nature of the Soviet state and the use of mathematics in a political manner. Again, this was not just the ideological side of Stalin but the practical one as well; the tyrant was devoted to the cold rule of numbers. Khrushchev's speech was soon broadcast by Radio Free Europe, as a propaganda coup. The CIA apparently obtained a copy of the speech by Israeli secret services. For the citizens of the U.S.S.R. this seemed to be the beginning of a time of détente and openness with Russia, and in this political situation the citizens of Poland wanted change by 1956. Unfortunately for the Polish peoples they completely and utterly misjudged Khrushchev, perhaps thinking him reasonable. Khrushchev saw the demonstration as a threat to Soviet power and the Red Army was sent to Warsaw to consolidate Soviet control of the country. At a time of apparent upheaval this might have been an opportunity for Eisenhower and NATO, but nothing was done. Eisenhower and Dulles refused to send armed forces into Poland because they believed this would have facilitated a third World War. Thus, Poland remained in the Warsaw Pact. The Soviet crackdown in

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[286] Supra.

Poland dampened western hope of a type of rapprochement with the U.S.S.R. Ideology and nationalism still drove the Soviet Union. Furthermore, domestic politics continued to rule its foreign policy. If anything was left of Stalin after Khrushchev's speech, it was a continuation in foreign policy which still was in the hands of Vyacheslav Molotov. It did not remain that way for long. Molotov was eventually replaced by then chairman of the Soviet council of ministers Nikolai Bulganin.

New Leaders and Linkage to Computer Science

Bulganin and Time Sharing. Nikolai Bulganin had risen through the ranks of the Soviet system in a remarkable way, holding most of the important political positions. In 1955 one of the functions of the Chairman of the Council of Ministers, which Bulganin held, was the overseeing of supercomputing. This had its benefits and pitfalls. One of the problems was the distribution of computer time. At this point there were few machines and many calculations to be made for the military forces. A computer time sharing scheme was an unfortunate necessity and regular reports had to be transmitted to Bulganin who was in charge of the distribution of computer time.[287] But the computing complex ultimately benefitted from having powerful patrons in Khrushchev and Bulganin, who both understood the

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[287] Gerovitch, *Newspeak to Cyberspeak*, 140.

importance and necessity of supercomputing to the state. It was during this time that the SESM and the M-3 came to fruition and the Soviets were beginning to "catch and overtake" their western rivals in a narrow but significant sense.

SESM Propaganda. The SESM or Spetsial'naya Elektronno Stshetnaya Mashina was a special purpose machine devoted almost entirely to the solution of linear algebra problems.[288] There is not much known about the SESM other than its specific functions and one other notable feature. All other computers, up to this point, even Soviet ones, had been based upon the von Neumann architecture. SESM did not follow this technological scheme. This may seem an esoteric point; but it is important to remember that Soviet science had to set itself apart from western knowledge for ideological reasons. In Soviet computer science von Neumann's architecture had been a thorn in the ideological side. Nevertheless, in the military, so much relied upon speed, the Soviet scientists did not have an alternative.[289] SESM provided that alternative, while satisfying the imperative ideological need of the Soviets to be different from their capitalist rivals. The SESM was also helpful as Soviet propaganda. For an unknown reason the SESM was not classified,

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[288] Trogemann, Georg, Alexander Y. Nitussov, and Wolfgang Ernst, eds. *Computing in Russia: The History of Computer Devices and Information Technology Revealed*. Wiesbaden: Vieweg + Teubner, 2011, Pp. 126.

[289] Ibid, 127.

and so papers on its capabilities were distributed both in Europe and the United States. Officially the computer science circles in the United States welcomed the news, for it gave them a chance for some insight to the advances in Soviet computing.[290]

During this same year the M-3 supercomputer was added to the Soviet supercomputing phalanx. The M-3 was the brain-child of Isaak Bruk. The machine was a small computer as compared to the STRELA and the BESM, but it was also specialized and a significant aid to the larger machines. It was not as fast as the others, but it had a quality of the utmost importance in computing; it was reliable and efficient.

1956 was something of a slow year for supercomputing projects in America. While the Soviets had taken to the international stage at Darmstadt and quickly producing other computers, the United States as well as the Soviet Union was embroiled in international crises. On October 23, 1956 Hungary was in full scale revolt and at the same time the Suez Crisis erupted. Unfortunately, Hungary was sacrificed by the Administration in favor of Suez.

In the aftermath of the Suez Crisis in January 1957 the Eisenhower Doctrine on the Middle-East was enunciated. It stated

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[290] Impagliazzo, John, and Eduard Proydakov. "Perspectives on Soviet and Russian Computing." Paper presented at the First IFIP Wg 9.7 Conference, Petrozavodsk, Russia, July 3-7 2006.

plainly that the U.S. would respond to Communist aggression with the use of U.S. troops upon request of any government that opposed Communism. These words seemed empty to the peoples of Hungary, the Administration's refusal to help U.S. western allies at Suez. Eisenhower's doctrine, while not empty, certainly seemed diluted.

von Neumann's death.

The doctrine was announced at the beginning of 1957, a year that Cold War America would have liked to forget. Just after Eisenhower's announcement of his doctrine the principle architect of the mathematical Cold War died. On February 8, 1957 John von Neumann succumbed to cancer. Early in 1956 von Neumann had lost his physical strength. He was confined to a wheelchair; the cancer was quickly eating away at his bones. His spine was filled with lesions, and somewhat ironically, the man who had been such an integral part of the Manhattan Project was subjected to radiation treatments to fight off the malignancy. The treatment restored his strength for a time. But, no matter how hard von Neumann worked to commit his arguments to paper, the disease sapped him enough that he could not deliver his final treatise titled *The Computer and the Brain*.[291] Yale

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[291] von Neumann, John. *The Computer and the Brain*. New Haven: Yale University Press, 1958, Pp. ix.

University published his unfinished work, and despite death, von Neumann managed to give a scientific "shove" to the computer world and aid the fledgling field of Artificial Intelligence. In this work the scientist painstakingly applied an analogy between the human brain and all the aspects of computerized information processing. Digital switches and chemical neurons would serve those same functions.[292] He cited Turing's codes as the ability to make a machine "behave;" a very human term, in a particular manner.[293] Furthermore, he said that the functioning of human processes were largely a statistical method.[294] Because of this work, the notion of computers as intelligent entities became more solidified and became a serious intellectual inquiry.

In the realm of Cold War strategy von Neumann had once played a serious role, but as his physical condition deteriorated, so did that role. He could no longer contribute in that manner, but that did not matter. His contributions had been noted and became seriously entrenched in Airforce strategy and

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[292] Ibid, 40.

[293] Ibid, 71.

[294] Ibid, 79.

Tactics by way of RAND.[295] Their devotion to the utility of von Neumann's theories cannot be overstated:

> The doctrine of decision embodied in the 'Estimate of the Situation' is a conservative one benefiting a nation of unquestioned military supremacy. Keen military thought should be devoted to the question as to whether technology and the trend of world politics have made such conservatism a luxury we can no longer afford.[296]

The assessment here of the Cold War scenario is that the U.S. could not afford to sit idly by in the face of Soviet competition. A proactive role had to be the goal of the nation. John von Neumann's technology, whether it was in the world of computers, his role in the development of the thermonuclear weapon or the development of Game Theory, profoundly affected global politics. His role may have been somewhat lost to the realm of geopolitics but his legacy was as important, if not more important than geopolitical strategists such as Kennan or Nitze, or in fact the diplomatic maneuverings of John Foster Dulles. Strategic and diplomatic theories without practical means of enforcement are empty. The practicalities of

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[295] Oliver G. Haywood, Jr. "Military Doctrine of Decision and the Von Neumann Theory of Games." 112. Santa Monica: RAND Corporation, 1951.

[296] Ibid, 85.

enforcement during the early Cold War are what von Neumann delivered.

Von Neumann was gone but his legacy in computers continued at a break-neck pace all through the fifties. Argonne national labs produced GEORGE another Princeton class machine that worked on nuclear calculations for 24 hours per day.[297] In the need for faster speeds the vacuum tube was becoming more of an obstruction rather than a solution by this time. A new technology was produced to replace the clunky tubes. The Philco Company from the mid-fifties was involved with experiments on the surface barrier transistor. The experiments originated with the NSA and the official investor was the U.S. Navy. The name given to the project was SOLO. The aim of the development of what became known as the TRANSAC S-1000 was to provide "cryptographic and other security work."[298] There were certain drawbacks to the use of the transistor. Although the new technology would enable engineers to construct faster and smaller machines, the transistor could not be replaced like the vacuum tubes could. This presented a new problem concerning reliability. This certainly was one of the reasons that the TRANSAC S-2000 was not chosen to receive a bid that would

[297] Argonne National Laboratory, *AVIDAC TO Virtual Reality*, 1.

[298] Rosen, Saul. "Recollections of the Philco Transac S-2000." *IEEE Annals of the History of Computing*, April-June (2004): 34-47.

integrate the computer with the Ballistic Missile Warning System (BEWS) that would operate in Greenland and other locations.[299]

BEWS was yet another system like the Cape Cod experiments handled by Whirlwind I. The Early Warning Automated System (EWAS) was on the mind of the entire military complex. Indeed there were good reasons for this. As technologies improved in the performance in bombers and missiles, it became harder for humans to handle defense. A new solution to this problem would have to be found. Enter the SAGE Defense System.

S.A.G.E.

SAGE or Semi Automatic Ground Environment had begun to be conceived at the earliest stages of the Cold War. As early as 1949 the Air Force Scientific Advisory Board found that air defense for the United States was "inadequate."[300] The same board recommended that there had to be large-scale computers placed in various locations within the nation and linked to radar systems that could locate attacking forces. These computers would constantly monitor the airspace around the United States and portions of Canada. Of course this began with the aforementioned Whirlwind I, which was conceived at MIT. The problems with Whirlwind were that it was an experimental system and it was too

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[299] Ibid, 44.

[300] Bashe, *IBM's Early Computers*, 240.

small in scope to cover the entire U.S. In fact, it only monitored the eastern states. A system that was larger in scope would be necessary.

To say that SAGE was carefully planned would be an understatement. MIT was where SAGE was conceived, and the Air Force as well as the Army and Navy created the Lincoln Laboratory for the specific purpose of creating the SAGE system.[301] Coordination was on a massive scale involving IBM, Boroughs Corporation, Western Electric, SDC (Part of RAND) and hundreds of other companies to create the system.[302] In pitching the need for a massive system the Air Force made a seriously frightening point:

> Even highly skilled men unassisted cannot work fast enough to track mass high-speed raids… High-speed bombers could be in on us before we could determine their tracks. Then it would be too late to act.[303]

At this point, the Air Force outlined the inner-workings of SAGE. IBM AN/FSQ-7A (Army Navy Fixed Special equipment) computers would be the heart and brain of the system. The main

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[301] Forrester, Jay. "Project Lincoln Division IV Program July 1952-June 1953." 1-3. Cambridge: M.I.T., 1952, Pp. 1.

[302] Western Electric Company, In Your Defense, Defense Projects Division, U.S. Air Force.

[303] Supra.

systems were two of these machines, later given the moniker Whirlwind II, each weighed 250 tons requiring new command centers.[304] In fact, the SAGE machines were the largest ever built. The reliability factor, which was stressed previously herein, was meticulously planned. Although SAGE would use tube technology that was in the process of becoming obsolete, the system was created in a manner that its work was truncated. One Whirlwind was operational while another was on constant standby in case of failure. This created conditions under which Whirlwind II was operational: "far in excess of 99%."[305]

The actual work that SAGE was to perform was defense against supersonic bombing runs. What SAGE could do better, faster than any human was to respond to attacks. Calculations of speed, altitude, distance and other factors now took only seconds. SAGE centralized command of all NORAD (North American Aerospace Defense Command) combat centers. Its information came from various sites such as Texas Towers, Navy vessels, ground radar and secondary radar stations. It is important to understand that the computer itself directed all the attack and defense scenarios.[306] It coordinated interception through the use

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[304] Bashe, *IBM's Early Computers*, 244.

[305] Ibid, 245.

[306] M.I.T. Lincoln Laboratory, Counterbalance, Film.

of Nike and BOMBARC missiles in the outlying cities as well as jet fighters.[307] Once the attack was repelled, SAGE would direct the interceptors to their bases of origin. Maguire Air Force base in New Jersey was the first SAGE installation. Although Whirlwind II was the main supercomputer that directed the defense network, SAGE was also linked to others, most notably TRANSAC S-2000, which had been placed in a NORAD defense center in Colorado Springs, Colorado.[308]

The remaining question about SAGE was a human one. Given the use of language by both the Air Force and Lincoln Labs, just who was doing the work of defense, SAGE or man? Were soldiers, who were still a part of the division of labor, in the system of defense? The Air Force stated that SAGE "directed the battles" and M.I.T. used the words "minimum level of human involvement." In all due deference to the free-world, it was somewhat ironic that the soldiers were being alienated from their labor in the manner suggested by the avatar of Communism, Karl Marx. Human participation may still have been necessary, but as the ideas of machine intelligence matured human interaction was lessened. In this particular area, in order to increase efficiency the need of machine intelligence was paramount.

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[307] Supra.

[308] Rosen, "Recollections of the Philco TRANSAC S-2000," 45.

It is true that SAGE could not replace human leadership in every possible way, but SAGE was directing strike forces, which would have normally have been decisions made by high ranking soldiers, leaders if you will. As far as a question of shaping policy was concerned, SAGE did shape policy in a significant manner. Mao Tse Tung once said "Political power grows out of the barrel of a gun." During the Cold War nuclear weapons were the central feature of the conflict and the ultimate expression of hard power for which no strategy based on soft power would have been possible. The analogy presented here is, if nuclear weapons were the bullets in the scenario then SAGE was the gun. Supercomputers gave the United States political power to enforce strategies because of their role in the development of newer and more effective weaponry.

In the final analysis, SAGE performed amazingly well. This is not to say that all of the thousands of persons from IBM alone were pleased. The scientists and engineers who had worked on creating the machines and the various network installations were extremely impressed. Except, one particular person at IBM had this to say:

> SAGE was celebrated as one of the great technical achievements of its day. But although the system worked fine, the arms race made it obsolete before it

was even finished. It could guard against attacks by bombers, but not missiles so SAGE became passé.[309]

The person who threw SAGE under the proverbial "bus" was the president of IBM itself Thomas J. Watson Jr. His assessment may have been essentially correct: SAGE ultimately could not protect against attacks by ICBMs, and yet, for 23 years from Eisenhower to Reagan, SAGE played a more than significant role in keeping America safe from attack. In addition to this, the fact that SAGE could operate for those many years consistently and efficiently despite outmoded technologies is a testament to the efforts of those involved in its planning and creation.

The completion of SAGE, although not fully deployed until 1963, seemed to be something of a comfort. What was not known at that point was that the Soviets were making headway in the field of supercomputing as well.

Soviets Catching Up. Between 1956 and 1957 the Soviet computers scientists produced several large-scale machines utilized for specific tasks. One of these machines, the VESM, was used for English to Russian translation of scientific reports. The VESM was also used to compile an "international astronomical calendar." Apparently the data produced from VESM

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[309] IBM Archives, SAGE: The First National Air Defense Network, http://www.ibm.com/ibm100/us/en/icons/sage/words/, Pp. 2.

gave the positions of 700 small planets and the areas that they would occupy for every forty days in the span of a decade.[310] In 1957 two other machines comprised the largest computer complex for the Soviets. The M-4 and the M-4m were both meant for defense purposes, specifically the radar controlled guidance of missiles.[311] More importantly, during this time Lebedev developed the AS-6 machine. Like SAGE, it was a self-correcting machine. In case of malfunction in either the main systems or any of its adjoining systems, the software would reset with no loss to the systems.[312] The development of the M-4 and the M-4m quickly led to the Soviet version of SAGE. The Soviets also created the URAL series of mini-computers. It seemed for the time being the Soviets had finally caught up to America. Now it was time for the Soviets to do what they had always imagined that they could do; that was to overtake the West.

Kissinger's Critique of Technology

During this same year there were those within the United States who were working to come to grips with the terrible weapons that the computers had designed. One of these men was a then little known Harvard academic named Henry Alfred Kissinger.

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[310] Mary Murphy, "Computer Developments in the Soviet Union" The Journal of the Academy of Management, Vol. 3, No. 2 (August, 1960), Pp. 103.

[311] Trogemann, *Computing in Russia*, 206.

[312] Ibid, 129.

Kissinger had spent his academic career pontificating on European Realpolitik in the 19th Century. This seemed hardly suited to create a doctrine dealing with 20th Century nuclear weapons. Nevertheless, this is what he attempted to do in his book *Nuclear Weapons and Foreign Policy*. The argument in this book encompassed the idea of limited nuclear war as opposed to the doctrine of massive retaliation against the Soviets. This was not the first time that this idea was put forth as an option. For example, Paul Nitze had argued for this as a possible stance against the Soviet Union himself, but for whatever reason Kissinger seemed to garner more attention in 1957 and thus placing his relationship with the much older and more experienced Nitze on a negative footing.[313]

Although the book was a critique of the Eisenhower/Dulles policy and ultimately an incorrect analysis, it garnered much attention by the administration.[314] Christian Herter, the Undersecretary of State to Dulles, brought it to his attention, and the President himself was "very much interested in it."[315] A memo went out to General Andrew Goodpaster stressing that he

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[313] Isaacson, Walter. *Kissinger: A Biography*. New York: Simon and Schuster, 1992, Pp. 89.

[314] Gaddis, *The Cold War,* 67.

[315] Christian Herter Papers, 1957-1961 Box 2 Chron File August 1957, Bowie, Dulles, Kissinger, Herter Letter, Dwight D. Eisenhower Presidential Library & Museum.

should read it as well. Goodpaster pointed out that the work had: "many interesting ideas, not all valid."[316] The president directed the need for Dulles' attentions as well:

> I have not read the complete book, but I am sending you herewith a copy of a fairly extensive brief made by General Goodpaster of my office. This at least I think you will want to read, and I believe that when Foster returns he will have some interest in it as well.[317]

Much has been made of the book's critique of Massive Retaliation. The book was also much wider in scope than a mere critique of the Eisenhower/Dulles policy; it was an outright attack on technology as a facet of American foreign policy. This was not a surprise, considering Kissinger's European background. During the 19th and 20th Centuries Europeans had good reason to fear the advance of technology, technology was a two-headed snake at once displacing them from their traditional social positions, alienating them from their jobs and advancing the abilities of weapons to cause mass destruction of life and property.

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[316] Gray, Gordon, Confidential File, Box 7, November 1957, Atomic Energy and Bomb, Kissinger's Analysis of U.S. Foreign Policy, Dwight D. Eisenhower Presidential Library and Museum.

[317] DDE Series, Box 25 July 1957 DDE Dictation Book by Kissinger Memo DDE to Herter 7-3-1957, Dwight D. Eisenhower Presidential Library & Museum.

During WW I new technologies such as, machine guns, poison gas, tanks and planes were utilized for war before man's philosophies of the consequences of the new technology could be properly assessed. This caused destruction on unprecedented levels on battlefields. The war left an indelible mark on the European nations. The role that technology played in the war left many people to question the benefits of technology versus its detriments. The detrimental effects in turn created political conditions that were ripe for another war.

During WWII philosophies may have matured somewhat, but technology still outpaced them. With the creation of the atomic bomb, Kissinger made this point plain stating: "We've had an obsession with technology-as if a superior weapon, by itself, could get us a strategic advantage."[318] His main complaint was that the atomic bomb was an end unto itself, sought before people had actually thought about how to utilize it.[319] Unfortunately for Kissinger, he had come up with a problem for which there appeared no comprehensive solution. Nevertheless, he howled at the wind of technology, all the while understanding its inertia:

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[318] Confidential File, Box 7 October 1957 Atomic Energy and Bomb, Kissinger's Analysis of U.S. Foreign Policy, 10-24-1957 Pp. 6, Dwight D. Eisenhower Presidential Library & Museum.

[319] Kissinger, Henry. *Nuclear Weapons and Foreign Policy*. New York: Harper and Brothers, 1957, Pp. 12.

> The attempt to develop a doctrine for a more flexible application of our power is inhibited by many factors, however, the chief of which is the very technological race which makes it necessary. Were technology stable, equilibrium might come about between the power of the new weapons and the fear of the consequences. Technology is far from stable, however; it is advancing at a constantly accelerating rate.[320]

Kissinger understood that obsolescence in this environment was timed in minutes rather than years. This condition did not always give room for developing intricate and comprehensive policies. Indeed, the Cold War seemed to steer clear of them. Despite the trouble of presenting a true workable doctrine for nuclear weapons, the efforts of intellectuals such as Kissinger and others were truly engaged with the problem.

Sputnik and the Missile Gap. American foreign policy more often than not is reactive in character. For example, one could point to the failure to stop Hitler at Munich or the Japanese attack on Pearl Harbor, which was the ultimate provocation necessary to bring the United States into World War Two. John Lewis Gaddis in his book *Surprise, Security, and the American Experience* argues that "surprise" is becoming less of an element

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[320] Ibid, 16, 17.

in history.[321] This was certainly not the case on October 4, 1957 all of the United States was blindsided once again by the launch of the first artificial space satellite Sputnik.

The VESM, M-4 and M-4m and the aforementioned AS-6, which was produced for space flight control centers had paid off for the Soviets. [322] Although they were far behind the U.S. in production of nuclear weapons, they did concentrate their efforts on rockets that could propel objects into space. In actuality, the West had little to fear from Sputnik, which was essentially little more than a beeping ball orbiting the earth.[323] It only measured the content of the ionosphere. However, it caused fervor not only with the American public but also with the politicians on Capitol Hill who were not insiders in the administration itself.[324] There are two major Cold War myths that came out of this event (certainly there were many other ones of minor consequence): the first myth was that the Eisenhower Administration was caught unaware by the activities and launch of the satellite. The plain fact was that U-2 flights over the U.S.S.R. were making the administration quite informed

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[321] Gaddis, John Lewis. *Surprise, Security, and the American Experience*. Cambridge: Harvard University Press, 2004, Pp. 2.

[322] Trogemann, *Computing in Russia*, 129.

[323] Wicker, Tom. *Dwight D. Eisenhower*. Edited by Arthur M. Schelsinger Jr., *The American Presidents*. New York: Henry Holt and Company, 2002, Pp. 100.

[324] Campbell, *Glimmer of a New Leviathan,* 117.

of the activities at the Baikonur Cosmodrome and the testing of the R-7 booster rocket. Furthermore, on this same point, the U.S. had also been active in testing of rockets.[325] Certainly there had been progress made by both nations since the Nazis had fired V-1s and V-2s from Germany to London. The second myth, although suspected previously (albeit spuriously), was that the United States was trailing behind the Soviets in its missile force. This "Missile Gap" proved that perception is often more important than reality. This myth would hold up throughout the Cold War, even though the reality was that the U.S.S.R. never matched the United States warhead for warhead during the entire conflict. Nevertheless, in 1957 the Soviets had their victory. In the following year Kissinger released "*The Answer to Sputnik.*" The panic that Sputnik produced caused many institutions to increasingly rely in federal funding. For example, Harvard University, which produced many intellectuals with expertise on national security, such as McGeorge Bundy, then the Dean of Harvard's Faculty of Arts and Sciences, had its budget increased from eight million dollars to 30 million in federal funds.[326] Only a small amount of this money went to

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[325] Reed, *At the Abyss*, 85.

[326] Bird, Kai, *The Color of Truth: McGeorge Bundy and William Bundy: Brothers in Arms A Biography*, (1998), Pp. 137.

social science departments. Even an institution like Harvard began investing in the hard sciences.[327]

The Microchip. 1958 was a slower year for American supercomputing: Argonne National Laboratory had created the PACE computer, but not much had changed since the establishment of the SAGE defense system. And yet, American computer science had hit a milestone. By 1958, computers like the TRANSAC were beginning to become the norm rather than the exception. Transistor powered computers solved reliability issues and, more importantly, took up less space. Despite this shift in technology, engineers in the field still fretted about what they called a "tyranny of numbers."[328] What this meant was that there was only so much space that transistors could take up and be made by hand. The transistors also did not completely solve the issue of the tremendous amounts of heat that a computer would create.

In the search for solutions, the U.S. Army invested in the Texas Instruments Company to solve the problem. The initial solution was what the company called the micro-module. This contraption was more durable than traditional transistors; one

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[327] Supra.

[328] Reid, T.R., *The Chip: How Two Americans Invented the Microchip and Launched a Revolution*, (2001), Pp. 72.

of TI's engineers however thought that this was the wrong solution to the tyranny of numbers problem. Jack Kilby set out to design a set of transistors that could be reduced to being etched on a piece of silicon. On September 12, 1958 the microchip came into being giving a seemingly unlimited potential for future computer architecture.[329]

Kilby did not deserve all the credit for the microchip. Virtually at the same time an engineer at Fairchild Semiconductor, Robert N. Noyce, independent of the events at Texas Instruments, also created a microchip. Despite the ensuing legal infighting began between TI and Fairchild, in the end both companies shared a patent for the invention, which was going to have a notable impact on defense within the following years.

In Washington the tumult over Sputnik did not subside, and Eisenhower, although knowing that there was no missile gap, had to respond. In order to quell the panic, the president created two new agencies to satiate the political elements and show the public that the administration was actively pursuing the Russians. One agency was very public and this was the National Aeronautics and Space Administration (NASA); the other less known to the public but more influential was the Advanced

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[329] Ibid, 79, 80.

Research Projects Agency (ARPA). To this day, ARPA (now renamed DARPA) identifies its mission in the following way:

> To prevent strategic surprise from negatively impacting U.S. national security and create strategic surprise for U.S. adversaries by maintaining the technological superiority of the U.S. military.[330]

Note how the word "surprise" is emphasized. This points to a certain continuity in history. Fool me once shame on you, fool me twice shame on me. In any case, ARPA would coordinate defense projects for the entire military and assess their necessity. In a way, ARPA became the RAND of the defense department.

The National Defense and Education Act. Eisenhower did not only respond in the executive arena, but in the legislative one as well. Ten days before the invention of the integrated circuit (the microchip), on September 2, 1958 Congress passed the National Defense and Education Act. The Act actively promoted the availability of low interest loans for purposes of obtaining a college education. Many of the benefactors of this act would go on to be successful engineers and scientists, which is what the US needed in order to keep up with the Soviets in the space and arms races. Only weeks later however, there was a distinct feeling that the Administration had put the U.S. on its heels

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[330] http://www.darpa.mil/our_work/

vis-à-vis the Soviet Union. Indeed an unacceptable geopolitical position.

Also, in 1958 the PRC made another attempt to intimidate the KMT in Taiwan. The shelling of Quemoy and Matsu began once again in the second Taiwan crisis. Whether this was a test of the PRC's strength or a sign of a rift with the Soviet Union was of no matter; the well being of the KMT was the responsibility of the United States. Once again Eisenhower was forced into a show of military strength sending U.S. Naval forces into the area, and by October the PRC, who had no stomach for a head to head confrontation with the United States backed down again. During the previous year the PRC had launched the "Great Leap Forward." This was the Communist attempt to quickly industrialize the country, to add infrastructure and modernize. Unfortunately, the leap forward was in actuality anything but. The program succeeded in killing half a million Chinese citizens who were unable to produce enough food-stuffs and at the same time industrialize the nation. The economic experiment was a failure. The rift between Mao Tse Tung and Khrushchev made it impossible for the PRC to turn to the Soviets for aid without an extreme loss of face. The PRC was isolated.

IBM and Taiwan

When the KMT forces fled mainland China they faced similar economic problems. Taiwan had no infrastructure. The people needed hydro-electric dams for power and water. The government needed a fast way to undertake a census and create an industrial foundation.[331] The United States picked up the slack on aid to Taiwan. The goal, as usual, was to provide a standard of living that was superior to the Communist nations, in keeping with the strategy first set out by the Marshall Plan. Not only did Taiwan receive materials from America, but also the proper techniques and machinery to carry out these tasks. This is where IBM stepped in.

During 1958 and 1959 the KMT received several IBM mainframes to deal with problems concerning the census, economic statistics and accounting problems of all types.[332] These machines were integral to the well being of Taiwan. IBM 650 and 1620 systems were leased (in keeping with the IBM tradition of not selling a computer) to Chiao Tung University in order to calculate relationships between their thermal power-plants and their hydroelectric equivalents.[333] In this way, supercomputing

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[331] Tinn, Honghong. "Cold War Politics: Taiwanese Computing in the 1950s and 1960s." *IEEE Annals of the History of Computing* 32, no. 1 (2010): 92-95, Pp. 92, 93.

[332] Ibid, 91.

[333] Ibid, 92.

had its role in the "butter" portion of the "guns and butter" strategy in the Cold War.

Soviet Burst

In the meantime, the Soviets produced three new supercomputers in 1958: the M-20, M-40 and SETUN. The M-20 computer was developed and utilized at the Institute of Precise Mechanics and Computer Technology. It was used in two separate nuclear weapons labs.[334] With 20,000 operations per second, the M-20 was more than able to handle the data for these complex calculations. What was possibly worse for the United States in the arms race was the M-40, which was capable of double the operations per second. Its task was anti-ballistic missile defense.[335] Added to this was Lebedev's BESM-2. The BESM-2 was a much more conservative computer operating at only 8 to 10 thousand per second, but each computer that could be added to the overall workload would advance the Soviet arsenal.[336]

All three of the aforementioned Soviet machines, while very capable, were typical von Neumann, binary architecture machines. In short, there was no real difference in these Soviet machines from their western counterparts, except for the fact that the

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[334] Gerovitch, *From Newspeak to Cyberspeak*, 141.

[335] Ibid, 139.

[336] Ibid, 141.

Soviets were behind in both quantity and tube versus transistorized technology. One Soviet machine, however, would cause quite a stir in the west: the SETUN.

SETUN was created by Nikolai P. Brusentsov at Moscow State University. The fact that the supercomputer was constructed at a university rather than a military installation was out of the norm for the Soviet computing establishment. It was more akin to how ENIAC and other machines in the west had begun. The notable feature of SETUN is that it was not based in binary logic. The computer operated on a ternary logic, meaning three digits (1,0,-1) instead of the traditional 1 and 0. The rationale for the use of ternary logic was not merely to be ideologically and scientifically opposed to the west; the Soviets all thought that ternary logic was mathematically simpler for computers to handle in various ways.[337] In fact, the ternary structure had been considered for Whirlwind II that powered SAGE, but was abandoned.[338] This fact alone caused serious inquiry in the west. As we already know, there had been contact between east and west at Darmstadt, when Lebedev had revealed Soviet supercomputing efforts. Contacts were then maintained. American scientists were sent to the Soviet Union to learn more about the state of Soviet

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[337] Hunger, Francis. *SETUN: An Inquiry into the Soviet Ternary Computer*. Leipzig: Institut fur Buchkunst, 2007, Pp. 79.

[338] Ibid, 85.

computing efforts. In August 1958 several scientists were sent to the U.S.S.R.[339] They, were shown various Soviet machines: BESM I and II, STRELA, the M Series computers, SESM, as well as several new series of machines URAL I and II and the Kiev series.[340] Apparently the scientists were shown SETUN and were told that the machine was simply an experimental machine used for training engineers.[341] It is possible that this was true or at least a partial truth, though documentation and other sources were incomplete and or subjected to tampering.[342] To invest so heavily in an experimental machine and then use it for specifically training neophyte engineers seemed a waste of resources, but it would not be the first or the last time that the intractable GOSPLAN schedules would interfere in matters of common sense. One thing is for certain: it was the paranoia set off by the launch of Sputnik that caused such a heightened interest in Soviet computing. In this way the U.S., at least in some circles, was caught off-guard twice, first by Sputnik and then by the notable advances in Soviet supercomputing that made the launch itself possible. The U.S., however, was not in as bad shape as one might be led to believe. It was not that the

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[339] Ware, W.H. ed., RAND Research Memorandum RM 2451, Soviet Computer Technology 1959, March 1, 1960, Pp. x.

[340] Ibid, xi.

[341] Ibid, 81.

[342] Hunger, *SETUN,* 63.

Sputnik launch was a nothing, but it was also not the horror it was made out to be in the actual arms race. The Soviets had focused on space flight as a public declaration of their superiority, one that they themselves were not sure of. Nevertheless, even with the advances in supercomputing efforts, the United States held more than a comfortable lead in the arms race.

Dulles Dies

On May 24, 1959 Eisenhower and the administration suffered a blow. Secretary of State John Foster Dulles had been diagnosed with cancer before and by February he went to Walter Reed for a hernia operation. While Dulles was not particularly liked, politicians on both sides of the aisle were concerned.[343] The administration needed Dulles to attend the upcoming Geneva Summit.[344] But his cancer had returned. It was hoped that he would regain his strength and deal with foreign policy as he had done for most of his life, from the Versailles Conference at the end of World War I to the thermonuclear era. But it was not to be. He lost his strength and by April 16, 1959 he tendered his resignation to his president and friend Dwight D. Eisenhower.[345] Considering the major role Dulles had played in the

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[343] Mosley, Leonard. *Dulles: A Biography of Eleanor, Allen and John Foster Dulles and Their Family Network*. New York: The Dial Press, 1978, Pp. 446.

[344] Ibid, 447.

[345] Supra.

administration, his death was a disaster. The only saving grace, if there was in fact one, is that Eisenhower was in his lame-duck years of the presidency and the effectiveness of the administration would dwindle in any case, but not before other events gnawed away at Eisenhower's power. An event was on the horizon that would further curtail the president's power. It involved the loss of an airplane.

U-2 and Corona. The benefits of U.S. supercomputing efforts were not limited to nuclear weapons alone. The U-2 spy-plane that could fly at altitudes of 70,000 feet was a product of supercomputing. The U-2 had been a great advantage to the US during this period. The CIA had been using the U-2s to fly espionage missions since the early 1950s. Unfortunately, this type of operation became public on May 1, 1960, when pilot Francis Gary Powers was shot down over Soviet territory by an SA-2 missile while on a mission. Powers who did not take his cyanide capsule was captured and put on public trial in the U.S.S.R. Khrushchev had the wreckage of the plane on display as proof of aggressive U.S. interference. President Eisenhower tried to avoid the notion that there was an intentional plan to infringe upon Soviet Airspace, but this tactic did not work, and when Eisenhower refused to apologize to Khrushchev at their Paris Summit for the incident, Khrushchev walked out of the summit. This incident worsened U.S. Soviet Relations, which had

been easing somewhat since 1956. All of Eisenhower's and Dulles' work to bring about Détente with the Soviets had now in one event failed. Nevertheless, the existence of the U-2 did not deter their continued flights over the Soviet Union and other areas. Simply the U.S. now knew that there were risks in utilizing the U-2. This also was not as bad as it might at first seem. In the wake of the launch of Sputnik, America rushed to put its own satellites in orbit. This was achieved with both the Vanguard I and II. By the time of the U-2 incident insiders in NASA, the Air-Force and the CIA knew that the U-2's days were numbered.[346] A system of satellites known as Corona had gathered more information on the Soviet Union than the totality of the U-2 program.[347] This simply meant that everyone who was an important insider in the Eisenhower Administration knew the actual weakness of the Soviet military machine.[348] There simply was no bomber gap and no missile gap. As a political issue it was very much concrete, but in reality it was ethereal as could possibly be.

The Military Industrial Complex. On January 17, 1961 President Eisenhower gave his farewell speech to the nation. Unexpectedly, he warned the American Public to beware the power

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[346] Reed, *At the Abyss*, 183.

[347] Supra.

[348] Supra.

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of the burgeoning Military Industrial Complex and be very wary of its ability to curtail our liberty in the name of security. This was an astounding announcement in light of Eisenhower's career as a General. He, better than anyone else, understood that the need for U.S. security at the expense of fiscal matters could work against the U.S. in both domestic and foreign policy realms. The question remained: "Did anyone listen?"

During the Eisenhower Administration the United States experienced the greatest acceleration of supercomputing projects and the culmination of the largest one, the Semi-Automatic Ground Environment better known as SAGE. Eisenhower's "New Look" by its greater reliance on nuclear arsenals made the push for newer and more powerful supercomputers a necessity to bolster his Cold War strategy.

What might seem strange is that the New Look, a Cold War strategy, was aided by historical societal values that placed great faith in technology and efficiency dating from the Age of Jackson forward. Computers were the definitive example of both technology and efficiency. The computers represented the ultimate rationality. This experience was different from America's Western European allies. Europe had been involved in two world wars, in which technology had played an integral role to the detriment of all Europeans. Because of this, all of

Europe has had a distinct mistrust of the benefits of technology. France is probably the most significant case in that the nation lagged so far behind in the ability to create a supercomputer combined with its financial troubles and ongoing wars in Vietnam and Algeria that its nuclear program did not come to fruition during the Eisenhower Administration but in the following one.

The United States' strong belief in technology also created a widening of the scope of the use of scientific computing. UNIVAC had predicted the outcome of the 1952 presidential election accurately. The computer called for a landslide victory for Eisenhower despite the opinion of political pundits who were predicting a much closer contest. This demonstration captured the public's imagination about the abilities of the "electronic brain." This in turn translated into a feeling of American superiority through scientific advances. IBM was no less productive. IBM's 701 computer, although not suited for RAND's specialized purposes, had a role in an unlikely undertaking that was the translation of the Russian language into English. This feat aided in American intelligence efforts, which Eisenhower valued in his foreign policy. Furthermore, IBM's 650 and 1620 models were integral in aiding the creation of infrastructure for the government of Taiwan. It was important that Capitalism

could provide for its allies in a manner that Communism could not.

The Soviet Union had also made great strides in its supercomputing efforts. Sergei Lebedev had created the BESM, Iurii Bazilevskii created Strela at SKB-245. The SETUN the first supercomputer to utilize ternary logic seemingly fulfilled Soviet ideological values to have their computer architecture differ from the binary computer architecture in western nations. The Soviets also produced other models of supercomputers such as the "M" series all of which aided in their military efforts.

Despite Soviet advances not all was well. Stalin's death in 1953 created political instability in the U.S.S.R. A troika was formed to lead the nation. The members of the Troika, Khrushchev, Malenkov, and Beria all had contact in one form or another with the computing community. And the foreign minister Nikolai Bulganin who replaced Molotov was intimately involved with computing circles by managing their time-sharing schedules. This political shake-up seemed to bode well for Soviet computing efforts, but it did not. Lavrenti Beria was tempted to make reforms in the Soviet political and ideological stance was executed for treason. Malenkov and especially Khrushchev were not of the mind to make any drastic change in the Soviet geopolitical stance. The execution of Beria represented a missed

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opportunity for Soviet scientists to have greater contact with their western counterparts. This kind of exchange would have to wait for another two years. Lebedev and Bazilevskii both participated in the IFIP Conference in West Germany to publicly tout Soviet supercomputing advances. Unfortunately, the two scientists were not allowed to disclose their work in any meaningful way. Ideology, however, continued to thwart scientific advances in the Soviet state. These were advances that could have aided the Soviets in immeasurable ways. But in the end, by placing such a premium on ideology the Soviets handicapped themselves in their competition with the west.

Chapter Five

Flexible Response I

The Dangers of Defection

As the Eisenhower years wound down and the American public was duly warned about the unharnessed spending by the military industrial complex, the closest presidential election until the one that would take place in 2000 was underway. A young lieutenant during WWII who became a US House of Representative from 1947-1953 and then Senator from Massachusetts from 1953-1960, John Fitzgerald Kennedy faced Vice President Richard Milhous Nixon. The election was a referendum on Eisenhower's policies over the past eight years and the campaigning was particularly hard fought. Kennedy's platform contended that Eisenhower was a "do-nothing" president, and due to his lack of responsibility, the country had stagnated militarily, allowing the U.S.S.R. to gain an advantage in nuclear armaments. Furthermore, Eisenhower had allowed a Communist government to establish itself in Cuba a mere ninety miles away from the US. According to Kennedy, it was: "Time to get the country moving again." Vice-President Nixon, on the other hand, campaigned focusing upon his experience that he had gleaned under Eisenhower and his ability to keep the worldwide peace that Eisenhower had made a hallmark of his presidency.

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The nation was evenly divided between Kennedy and Nixon. A few factors may have been crucial for Kennedy. His performance in the September 26th television debate and Eisenhower's late endorsement of Nixon may have tipped the scales. In the end, Kennedy won by a small margin: 118,550 votes out of 68 million. This was hardly a mandate for Kennedy's presidency. This fact had a profound impact on Kennedy. He proceeded with caution despite his strong campaign rhetoric. Caution may also been a factor for his decision to rely on a seemingly stronger cabinet made up of experts from all areas of academia and enterprise.

Kennedy's "Best and Brightest" minds indeed came from across the U.S. from all fields of endeavor: academics, politicians, military, and business. In this way he hoped to have a more diversified field of experience to choose advice from. This was to be different from Eisenhower's cabinet, which was chosen primarily from big business and the military. While it may have seemed logical to have diverse points of view as greater sources of information, this would have dire consequences for U.S. foreign policy.

Finally the Truth about the Missile Gap. Kennedy's ideas on foreign policy were informed by the initial impression of a rising missile gap between the U.S. and the U.S.S.R.: so he immediately endorsed a buildup of nuclear missiles. Also,

Kennedy opted for a flexible response, as opposed to the Eisenhower/Dulles policy of Massive Retaliation.[349] President Kennedy and his Secretary of Defense Robert Strange McNamara would build up conventional forces as well as a deterrent to Soviet mischief. President Kennedy's first action was to assign McNamara to do a Department of Defense study of the details concerning the missile gap. McNamara found there indeed was a missile gap in favor of the US by a wide margin.[350] Considering the vastly superior economic position that the United States had then it would have been logical to assume that there would have been a larger missile force. Although the Soviets had built up their supercomputing arsenal, they still lagged behind the U.S. both quantitatively and qualitatively, and this was a crucial relationship to a large and reliable arsenal.

At the time the U.S. was still reeling from Soviet gains in their space program, despite the fact that those gains were, more or less, a diversion from the continuing arms race. Yet the president felt compelled to engage in the "space race" by pledging to put a man on the moon by the end of the decade. With Project Mercury the fledgling NASA thus acquired a challenging

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[349] Gaddis, John Lewis. *Strategies of Containment*. Oxford: Oxford University Press, Inc., 1982, Pp. 199.

[350] "The Fog of War: Eleven Lessons from the Life of Robert S. McNamara." edited by Errol Morris: Sony Pictures Home Entertainment, 2004.

but profitable objective. Naturally, supercomputers were to contribute to these goals.

By 1960, IBM had manufactured its 1400 series computers. These were of little consequence, as this series was mostly geared towards business applications. However, Univac began a strictly military project for the U.S. Navy, which only produced two computers. The Livermore Advanced Research Computer (LARC) was considered by many to be the "first" supercomputer (not really the case) because of its unmatched speed. According to J. Presper Eckert the LARC was "100 times faster than today's scientific computers and internally 1,000 times faster than today's business data-processing system."[351] In fact, Eckert considered the LARC project to be the first long-range strategy for supercomputing.[352] Despite the performance of the LARC and its self-assigned "grand strategy," only two computers were ever delivered. One machine went to the Livermore Radiation Labs in California. The other went to the U.S. Navy at the David Taylor Model Basin. One was geared to assist nuclear weapons development and the other to assist the design of experimental ships. The outcome of the LARC project remained quantitatively limited. This was not an abnormal situation during this time.

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[351] Eckert, J. Presper. "Univac LARC, the Next Step in Computer Design." Paper presented at the 1956 Proceedings of the Eastern Joint Computer Conference, New York, December 10-12 1956, Pp. 16.

[352] Ibid, 20.

For example, in April of 1960 IBM's latest entry into supercomputing, the 7030, better known as the "Stretch," was announced only to be withdrawn from service one year later. Of course, since the government negotiated with IBM a price of $10,000,000 and with a monthly rental of $300,000, the machine proved to be too costly even for such a facility as the labs at Los Alamos.[353]

Meanwhile one of RAND's analysts, Herman Kahn, was causing a stir. Like many at RAND, Kahn was searching for solutions to the problem of nuclear war with the Soviets. Kahn had made his reputation at RAND by examining Game Theory. Most of this work, not surprisingly, was done in 1957, before Sputnik. He found that the Game Theories, as they applied to nuclear conflict, were difficult to analyze, but that mathematical knowledge aided such analysis.[354] He also stated that the theories had shortcomings because nothing can predict the future. In short there was, as he put it, no "oracle."[355] He did point out, however, that the theory was useful for policy papers and

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[353] IBM Archives. *7030 Data Processing System* [Website]. IBM Archives, 2011 [cited November 8 2011]. Available from http://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_PP7030.html.

[354] Kahn, Herman, and Irwin Mann. "War Gaming." 16. Santa Monica: The RAND Corporation, 1957, Pp. 3.

[355] Ibid, 11.

"hardware."[356] What was meant by hardware is unknown but the term has been applied to computers in reference to the actual, physical systems that constitute the building blocks of the computer. In the end, Kahn stated that hardware and Game Theory could no longer be ignored in current war-gaming scenarios.

The Optimal Solution

Kahn made his biggest impact with his book titled _On Thermonuclear War_ published in 1960. In this study he argued that the nation that depended more on defense, rather than the nation that attacked first, would bare more of the brunt in the aftermath of the war.[357] Kahn also stated that nuclear war did not have to be "unlimited." This was not much different from the thesis posed by Henry Kissinger, Paul Nitze, and others. Kahn, however, was overly optimistic about the notion of nuclear war, how to survive it, how the scenario of the war would play out and how to strike back. One of the reasons for this optimism was a shift in his approach of analysis. He stated that the earlier approaches at RAND were to find optimal solutions to problems.[358] He then added:

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[356] Ibid, 9.

[357] Kahn, Herman. _On Thermonuclear War_. Princeton: Princeton University Press, 1960, Pp. 10.

[358] Ibid, 119.

Naturally the high-speed computer often played a central role in all this. Sometimes our researchers took a curious pride in the prowess of their high-speed computers. They would make such remarks as, "More than a million campaign calculations went into this analysis." Or, "This is the first analysis done by man in which 10,000,000 multiplications were made." Or even a more extreme boast, "These results came out of complicated calculation performed by the most modern of high-speed computers using the most advanced mathematical techniques available. Do you want to argue with an electronic machine backed up by all the resources of modern science?" The only possible answer to that question is "Yes."[359]

Kahn's new approach was to find simpler systems and apply them broadly, taking into account all levels of solutions.[360] This would be fine, except that broader solutions do not fit the intricacies of such a conflict.

In the case of thermonuclear war, there must be an optimal solution. This would require reliance on complex calculations that only the supercomputers could supply. Furthermore, the thesis went against the work that Kahn had produced for RAND up to that point. He knew that game theory sought an optimal solution in which massive computing was integral to the process. In short, he was going against the entire mathematical doctrine that the Cold War was predicated on. This was a dangerous

[359] Supra.

[360] Ibid, 120.

gamble. His rationale was that simply weighing numbers in situations where a decision-making committee is charged with finding a solution makes it almost impossible to find a consensus.[361] While Kahn may have been incorrect in his analysis about optimal solutions, he was more insightful on the pitfalls of the necessity of consensus.

McNamara and RAND. The "Best and Brightest" were chosen not on their experience, but rather their "style" and their personal loyalty to Kennedy himself. This was an attempt to gain tighter control over the apparatus of the executive branch and most specifically the national security apparatus. As a first act, the president's National Security Advisor, McGeorge Bundy eviscerated Eisenhower's National Security Council. The staff was cut from 71 advisors to 48 and its duties were drastically limited.[362] Another move was to appoint Robert McNamara to the department of defense. Civilian control of defense under McNamara was not exactly welcomed by the military, but RAND was thrilled, understanding the statistician's love of analysis and numbers.[363] This analysis would be the cornerstone of foreign

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[361] Ibid, 121.

[362] Rothkopf, David. *Running the World: The inside Story of the National Security Council and the Architects of American Power*. New York: Public Affairs, 2005, Pp. 84.

[363] Kuklick, Bruce. *Blind Oracles: Intellectuals and War from Kennan to Kissinger*. Princeton: Princeton University Press, 2006, Pp. 97-98.

policy not only for Kennedy but for Lyndon Baines Johnson as well. In this manner President Kennedy may have seemingly gained more control over the apparatus with a wider range of ideas, but in actuality by cutting out those with experience, by stating that he would rather have smaller meetings with department heads, he hamstrung himself in foreign affairs in a series of failures.

The Bay of Pigs and Berlin. In an effort to seem vigorous and strong in international affairs Kennedy embarked on mischief in Cuba. The President had inherited Castro's Cuba from the previous Administration. The CIA had planned an operation aimed at overthrowing Castro in April of 1961. The ensuing fiasco at the Bay of Pigs marked the first failure of the Administration. The Kennedy administration sought success by molding its strategy in a calculated manner to produce a firm response. Unfortunately, the strategy and the tactics utilized at the Bay of Pigs were unable to produce success.

A more crucial test of the administration's foreign policy, international commitments, and the rational schemes of the Cold War came with the Second Berlin Crisis. At the Vienna Summit Chairman Khrushchev met with President Kennedy and made it known in no uncertain terms of his intent to seal off Berlin from the west. In August 1961 Khrushchev was attempting to make good on

that promise. Soviet tanks pulled up to the Brandenburg gate. In response, U.S. forces met the Soviets nose-to-nose. Again the Soviets were testing the established boundaries in the main front of the Cold War in Europe. The tank commanders were independent and this increased the danger in the standoff. In this defection from von Neumann's scheme, both Dean Acheson and Henry Kissinger argued for a stern response. This is not what the President did. Instead, Kennedy was willing to not push the matter further, and the Soviets erected the Berlin Wall splitting the two Berlins and creating another rational equilibrium.

The question of success and failure in the crisis is a matter of point of view. There was no definitive escalation to the point of defection and that was a success. The outcome can be seen as a failure for Kennedy for not taking a stronger stand. The President did not see a viable reason to kill American soldiers over access to Berlin thinking that the two Berlins would never be united again.[364] In doing this he made his allies seem "unimportant."[365]

On the other hand, for Khrushchev the outcome was murky. If he sought a unification of the two Berlins under the Soviet

[364] Gaddis, *We Now Know*, 149.

[365] Schulzinger, Robert D. *American Diplomacy in the Twentieth Century*. Oxford: Oxford University Press, 1984, Pp. 272.

banner then he failed in his purpose. But, if he sought to stem the tide of peoples leaving East Berlin for the west then the wall was an effective, if not an elegant, solution. Apparently the Chairman was in line with Kennedy as well. He saw no need to risk Soviet lives for East Berlin. He even went a step further, stating that the "Wall" was a general good for the U.S.S.R. in that an additional Soviet labor force would not have to be sent to East Germany to aid their troubled economy.[366]

Privately, both leaders had gotten what they had wanted out of a potentially deadly situation. The crisis was averted, and a new cooperative equilibrium was established, but it was not the last time "defection" would be a possibility during Kennedy's tenure. Nevertheless, rationality held firm. The reasons behind the new equilibrium were different from the equilibrium set at the outset of the Cold War. Fear of each opponent in the game nearly flared out of control. Before this crisis there had been distrust of the opponent and perhaps fear, but rational loss of control had never come this close.

Both the Bay of Pigs and the second Berlin Crisis were stringent tests of Game Theory. At the Bay of Pigs Kennedy through the CIA was making an aggressive move towards the defection point. Although Cuba was strictly in the U.S. sphere

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[366] Gaddis, *We Now Know*, 149.

of influence in the western hemisphere, Castro had committed Cuba to an anti-American stance even before Kennedy became president and in 1960 approached the Soviets. The CIA operation under the direction of Richard Bissell had come up with a seemingly logical, calculated, scheme to oust Castro. But Bissell did not pay attention to the details of the domestic situation in Cuba. Ultimately, this variable was significant and led to an obvious failure. Furthermore, this pushed Castro indelibly into a close relationship with the Soviet Union. The Soviets could have reacted at any time but the line of defection had not been crossed in a significant manner.

On the other hand, the second Berlin Crisis was a significant move toward defection. Soviet and U.S. forces encountered one another directly. Thankfully and interestingly, the defection from von Neumann's rational scheme did not produce war. The Berlin Wall had been erected and because both Kennedy and Khrushchev did not see the point in risking war over Berlin thusly a new rational equilibrium was established. Both crises tested the boundaries of Game Theory and even in face of irrational actions on the part of both nations Cold War rationality held.

Soviet Defense Expands. During this time the Supercomputer Race continued unabated. The Soviets were not resting on their

laurels simply because they were ahead in the space race against the U.S. In that year the U.S.S.R. released three new series of supercomputers: Bashir Rameev created the URAL series followed by the MINSK I of which 220 were produced by August and the M-3 followed by December. And in 1961 Sergei Lebedev and his scientific comrades, most notably Vsewolod Burtsev struck once again with the introduction of the 5E-92-B. This computer was more than notable because it was the first computer to deal with anti-missile defense. Testing began in 1961 and, although the system was not complete (similar to the situation with SAGE) its testing was successful in destroying a ballistic missile, a hard task indeed because of the acquired speeds and the smaller mass of the new missiles. This, in and of itself produced a certain amount of security for the Soviets, and possibly led to a stronger stance by the U.S.S.R. vis-à-vis the U.S.

Despite the successful tests of the 5E-92-B, the Soviet Union still lagged behind the United States in the quality of supercomputers. It was producing new models and, for certain periods, outpacing the U.S. in quantity. The Soviet Union had also increased its stockpile of nuclear weapons, though its arsenal was still well behind U.S. production. Nevertheless, the difference may have been irrelevant, given the destructive power of the weapons.

The U.S. during this time only produced one serious supercomputer: the IBM 7090. The 7090, although described by IBM as a general purpose system, was actually specifically intended for the "design of missiles, supersonic aircraft and nuclear reactors."[367] IBM, oddly, disclosed where the 7090 was located. The 7090s were located at Werner von Braun's development group in the George C. Marshall Space Flight Center for NASA. The machine was charged with the design of the Saturn rocket, meant to be used for space flight.[368] Once again IBM followed its procedure of gouging the government. The 7090 was sold at a price of $2,898,000 and rented for $63,500.[369] Luckily for IBM and others who took part in the defense of the United States, Kennedy's Flexible Response included the largest peacetime increase in the military's budget to that point.[370] The budget had increased by $9 billion and this was more than all of U.S. allies in NATO put together.[371] This meant that the government could afford an IBM computer that would crash after only fifteen minutes of work, but did perform impressive calculations in that

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[367] IBM Archives. *7090 Data Processing System* [Website]. IBM Archives, 2011 [cited November 11 2011]. Available from http://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_PP7090.html.

[368] Supra.

[369] Supra.

[370] Shapley, Deborah. *Promise and Power: The Life and Times of Robert McNamara*. Boston: Little, Brown and Company, 1993, Pp. 102.

[371] Supra.

short period of time.[372] The budget increase was engineered by McNamara, who had gained the reputation of a "human computer."[373]

President Kennedy's handling of foreign affairs had produced failures in Cuba and Austria. And in the Berlin Crisis the Berlin Wall, was erected and attributed by some to Kennedy's failure to confront the Soviets on the most important front of the Cold War. The next event, however, would test the President's resolve to the utmost degree and show the dangers of both von Neumann's "defection" and Kahn's "consensus."

Cuban Missile Crisis and Game Theory

Between October 14, 1962 and October 28, 1962 the Cuban Missile Crisis occurred. This was possibly the most dangerous event of the Cold War and the closest to the defection scheme of von Neumann for both superpowers. The U.S.S.R. had been secretly delivering nuclear missiles to Cuba. The CIA in over-flight surveillance of Cuba discovered thirty sites with intermediate range nuclear missiles near San Cristobal that were able to strike targets in the United States; later it was found that there were more than 100 sites.[374] The only cities that might be

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[372] Reed, *At The Abyss*, 130.

[373] Deborah Shapley, *Promise and Power*, 103.

[374] "The Fog of War: Eleven Lessons from the Life of Robert S. McNamara." edited by Errol Morris: Sony Pictures Home Entertainment, 2004.

spared were in Washington State, Alaska and Hawaii.[375] John von Neumann's blueprint for the management of the Cold War had not been abandoned. Similarly the Berlin Wall stood as a demarcation of stability as was suggested by Harvard scholar Thomas Schelling. Both Herman Kahn and Schelling had advanced the use of Game Theory as a cornerstone of nuclear management. Now with the possibility of missiles ninety miles off the coast of the United States, the prospect of defection was very real and threatening the destruction of the globe in the process.

As noted, according to von Neumann's game, the best possibility for the avoidance of nuclear war was cooperation by both hostile adversaries, even though there was no real information about the intentions of the other player. The scenario was played on a rational basis. The problem here was that Khrushchev had "defected" from that scenario. There is no doubt that the move was not a rational one. Khrushchev had been convinced in June of 1962 by Fidel Castro to deliver to Cuba these weapons to thwart possible invasion attempts by the United States into Cuba. Khrushchev's move brought brinksmanship to new levels. This was the case on October 14th, when U-2 flights over Cuba had found launch sites. Washington immediately wondered what Khrushchev sought to gain. By defecting from the game, the

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[375] Chace, *Acheson,* 398

apparent immediate outcome was that the U.S.S.R. had an upper-hand in nuclear deterrence. By upsetting the equilibrium however, the leader of the Soviet Union had to know about the probable consequences of his actions, too: the United States would feel provoked into a counter-action. To think otherwise would make Khrushchev a dunce. It was certainly not that Khrushchev did not understand the implications of nuclear war, as he once stated: "It will be too late to cry over lost hair after your head is cut off."[376] Furthermore, the Chairman knew that he did not have a nuclear advantage. He was even prone to muse sarcastically, as he once did in a conversation with his son Sergei on the subject of the Soviet R-7 missile. Sergei asked his father: "How can you say that we are producing rockets like sausages, Father? We don't have any rockets." His father replied: "That's alright. We don't have any sausages either."[377]

Apparently, there was no real gain to be had by delivering missiles to a government in Cuba that was openly hostile to the United States. But Khrushchev believed that he could score again in the political battle. Defection from the game is caused by a perception that the opponent does not have the credibility to defend himself. Following the Bay of Pigs and Berlin debacles,

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[376] Poundstone, *Prisoner's Dilemma*, 205.

[377] Ibid, 95.

the president, in Moscow's opinion, lacked the credibility that Eisenhower possessed. This emboldened Khrushchev to strengthen his Communist allies, thereby bolstering his own position in global affairs and tweaking America's nose at the same time. The Soviet leader believed Kennedy would not react to the move in Cuba. After-all the Soviets had not reacted to U.S. missiles in Turkey, which were very close to the U.S.S.R. Missiles in Cuba was an equitable move.[378] Furthermore, President Kennedy did not prevent the Berlin Wall from being erected in 1961. While this reasoning was logical in its premise, it was bound to fail.

Analysts Herman Kahn and Daniel Ellsberg stated plainly that these moves were a game of "chicken," the outcome of which was that the most belligerent player was likely to win the game. RAND had won the confidence of McNamara and so their words carried weight.[379]

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[378] Schulzinger, *American Diplomacy in the Twentieth Century*, 266.

[379] Poundstone, *Prisoner's Dilemma*, 204, 205.

	C,C	C,D
United States	Optimal Cooperation No Nukes	Soviet Defect Upper Hand US Escalation
	D,C	D,D
C Cooperation D Defection	US Defect Upper Hand USSR Escalation	Nuclear War

At this point on October 16th the Soviets had moved from the optimal "C, C block" to the "C, D block," in which they had the upper-hand, at least temporarily. On the same day, President Kennedy was briefed on the situation. Unable to come to a decision about what to do, Kennedy called in EXCOMM (executive committee): this was composed of the Kennedy cabinet members and such foreign policy experts as General Maxwell Taylor, Paul Nitze and former Secretary of State Dean Acheson. The time it took EXCOMM to deliberate and the President's need to build consensus formed the "C, D scenario."

Secretary of Defense McNamara and EXCOMM came to the decision not to launch a strike against Cuba but to blockade. The blockade was renamed a "quarantine" thinking that the word "blockade" was too aggressive a term. Any Soviet ships that were going to Cuba were subject to the quarantine. NATO was put on alert, a further deviation from the normative situation. Acheson was sent to consult with France. Kennedy revealed the existence of missiles in Cuba on television on October 22, 1962. This caused not only concern, but panic as well. There was no doubt that this was a dire moment. Interestingly, in hindsight, it was likely that Cuba remained a focal point, not only because the crisis emanated from there, but also because the supercomputer defense systems SAGE in the United States and the 5E-92-B in Russia made both the U.S. and U.S.S.R. targets, if not untouchable, definitely undesirable ones. Defense and response time would have been too quick, and given the independent nature of the systems, the ability to pull back from total war may have been impossible. Perhaps this was considered by both superpowers and was an additional fact in containing the focal point to Cuba alone. Khrushchev knew that the missiles in Cuba were not tied into the Soviet defense network strike commands were independent of the computers possibly giving him more control over Cuba during the crisis.

Diplomacy a Return to Rationality. Meanwhile, on October 25th in the U.N. ambassador Adlai Stevenson confronted Ambassador Valerian Zorin as to the presence of nuclear devices in Cuba. The Soviets continued to deny the existence of the missiles. Photos of the sites were revealed to the U.N. audience. This was an attempt move towards the "C, C" Cold War normative state. However, in presenting the evidence in such a hostile manner, Stevenson could have produced the "D, D" defection point. Khrushchev's temperament was still unknown at that point.

Khrushchev sent a telegram to Kennedy that was not quite coherent, but essentially stated that he wanted a cessation to the hostilities:

> What would a war give you? You are threatening us with war. But you well know that the very least which you would receive in reply would be that you would experience the same consequences as those which you sent us. And that must be clear to us, people invested with authority, trust, and responsibility. We must not succumb to intoxication and passions. These are indeed transient things, but if indeed war did break out, then it would not be in our power to stop it.[380]

Seemingly, this was an attempt at the rationality that was necessary to achieve equilibrium and return the actors to the normative C, C state that had existed up to this point. The problem was that the game depended on cool rationality and the

[380] Shapley, *Promise and Power*, 179.

situation, at this point, still did not give itself to the requisite amount necessary for such a return.

Unfortunately, later Kennedy received another telegram that was much more hostile, stating unequivocally that the US must back down. Kennedy and EXCOMM did not know which telegram was authentic; they even speculated that a coup d'état must have taken place in the U.S.S.R. and that Khrushchev was out. They then decided to respond to the first telegram. Meanwhile, secret negotiations were taking place between Attorney General Robert Kennedy and the Soviet Ambassador Anatoly Dobrynin. Their agreement, in the end, was to remove U.S. Jupiter missiles in Turkey aimed at Moscow in return for suspending the installation of the R-16 missiles in Cuba. The U.S. had to promise it would not invade Cuba. President Kennedy had previously wanted the Jupiter missiles removed, but the decision was revoked for fear that it would ignite resentment in Turkey.[381] By October 26th, there were repeated attempts by the Soviets to have the United States remove the Jupiter missiles from Turkey; on this point, the administration would not budge. Khrushchev also wanted the president's statement that the United States would not invade Cuba to be made public. All this time, progress was still being made on the operational status of the missiles and further

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[381] Ibid, 180.

encroachments on the quarantine zone. In the midst of the crisis, the avatar of calculated rationality, Robert McNamara wondered if he would see "another Saturday night."[382]

A deal was struck on October 27th when Kennedy wrote to Khrushchev pledging not to invade Cuba. But the deal was secret, and in the public's eyes the crisis was still ongoing. Until, all of a sudden, on October 28th the Soviet ships withdrew and the crisis was over. This was a huge success for the president, and mostly what his legend in foreign affairs was based upon. Rationality had won out and the C, C (normative position) was re-established, and perhaps even strengthened. Realizing that this situation was not worth bearing again, a hotline was installed in the White House that connected directly to the Kremlin. The application and veracity of von Neumann's theory were born out. The crisis was an example of a situation where human judgment mostly recreated von Neumann's equilibrium. But the realization of the nature of mechanized, automatic defense systems such as SAGE and the 5E-92-B more than likely played a part in containing the focal point to Cuba alone despite the NATO alert.

Controlled Nuclear War and Equivalency. The Missile Crisis did have a sobering effect on both Kennedy and Khrushchev. The

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[382] Ibid, 181.

proliferation and positioning of nuclear weapons would upset von Neumann's cooperation matrix and cause a nuclear conflict. As in the Berlin Crisis, an irrational move created a new equilibrium, but was the new standard set by rationality and calculation, or by fear?

It would seem that the avoidance of global Armageddon would be enough for all people to enjoy. However, many people were not satisfied. It was not so much that the avoidance of nuclear war was not the preferable outcome, but it was the manner in which the crisis was handled that rankled Acheson and Nitze in the EXCOMM meetings. This form of disagreement was bearable, but among those who were not pleased at the avoidance of war itself were the analysts at RAND, and specifically Herman Kahn at the Hudson Institute (he had left RAND by the time of the Crisis) who wanted to test their theories of Controlled Nuclear War.

According to Kahn a quantitative scheme would be applied to major cities in both the United States and the Soviet Union, and a scheme of equivalency would thus be applied. Herman Kahn's daughter Debbie reminds us that the scheme would play out in this manner:

> There's an accident, we drop a bomb on Kiev. It was a fluke we didn't mean to. The Russians believe we didn't mean to. Then there's a negotiation about where can we drop a bomb on something that is of equal value

of Kiev. If we drop the bomb we can stop now. If you destroy something equal then you have sort of a status quo.[383]

Accidental or not, the possibility of controllable missile strikes was taken seriously. Here was rationality gone wild. The idea of trading city for city might seem rational, if one discounted the horrifying results of a nuclear war. Eighteen years since the nuclear genie had been out of the bottle, people, even smart and powerful ones did not seem to understand the unlimited effects of nuclear conflict. The quantitatively minded analysts were loosened. They had been powerful before McNamara took power at the Defense Department, but never as powerful as they were now that he was there. Luckily, for all of humanity, President Kennedy was not convinced of the notion of controlled nuclear war. Kennedy did threaten massive retaliation and, despite Herman Kahn's notion of that type of response as a "wargasm," the crisis did end to the benefit of all. If the rational schemes had been utilized to their ultimate extent, the result would indeed have been nuclear Armageddon. Kahn's equivalency scheme was quantitative. In order to give a comprehensive program of equivalency many variables such as: population, industrial value, agricultural production, and

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[383] Curtis, Adam. *Pandora's Box*: BBC, 1992. Documentary.

others would have to be calculated on an unprecedented scale. The supercomputers would be the only way to compile this amount of data and a project such as this might have even stretched their abilities. Furthermore, as a military project Secretary of Defense McNamara would have had to examine and approve any such scheme. Kahn's scheme would have tested McNamara's devotion not only to RAND and other think-tanks, but to rationality itself. Later, at the end of his tenure as Secretary, McNamara did question the rationality of the Cold War. This, however, was after his frustrating experience in directing the Vietnam War. It is unknown what the younger McNamara would have done in considering a rationalized scheme.

On October 28, 1962 the rest of the world was able to breathe a huge sigh of relief as the crisis abated not just for the superpowers, but everyone. Despite the severity of the crisis, nations on both sides of the Cold War did not pause in their efforts to build their arsenals aided by supercomputer technology. In fact, not only did the arms race continue unabated, it increased in tempo as well.[384] Shortly before the crisis over Cuba, the Soviets created over 100 of the Minsk II series. By March of 1963 they also had the M2-4M, which was used

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[384] Gaddis, *We Now Know*, 280.

to design rocket hulls.[385] The NATO allies were no different. In 1962 Great Britain ATLAS was created and the French, who tested their first nuclear weapon in 1960, just after Kennedy had been elected president, had the aid of Bull and CAE supercomputers. The nuclear game was not merely continuing but becoming more complex. This expansion, and the fear generated by the crisis, largely motivated both superpowers to promote an international agreement for a "Limited Nuclear Test Ban."

CDC 6600 and Abrogation

Kennedy, in a further effort to avoid future nuclear confrontation in July of 1963 proposed the Limited Nuclear Test Ban Treaty. By 1963 a new "bright-light" (perhaps the brightest in the history of supercomputing) made his definitive mark on the geopolitical landscape.

The link between the Limited Nuclear Test Ban Treaty and supercomputing has to be established by going back to 1952. Communications Supplementary Activity Washington or CSAW would be incorporated into the National Security Agency (NSA).[386] From that group emerged a supercomputing company Engineering Research Associates or ERA. During the previous year ERA was being

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[385] Malinovsky, *Pioneers of Soviet Computing*, 73.

[386] Murray, *The Supermen,* 73.

absorbed by Remington-Rand (Univac). It was during that year that ERA hired Seymour Cray. Cray was a brilliant engineer who wanted only one thing: to build the fastest computers in the world. By 1957 Cray would leave Remington Rand for a new company Control Data Corporation (CDC). It was there in 1963 that Cray created the CDC 6600.

The CDC 6600 possessed ten thousand logic gates, which made it fifty times faster than CDC's previous model the 1604 and even faster than that amount when compared to any of IBM's models that had appeared in the previous seven years. The 6600 had been purchased by the National Security Agency, the Los Alamos National Laboratory and Livermore Labs. Nothing at the time could compare to the speeds that the 6600 produced. The machine was instantly recognized to be above and beyond the capabilities of all others. To this end, France had attempted to buy a CDC 6600 to augment its nuclear program. The U.S. State Department had blocked the export of the machine, perhaps a sign of a furthering rift between the U.S. and its ally for reasons of "National Security." In any case, the real significance of the CDC 6600 was its impact on the Test Ban Treaty. The provisions of the treaty were that the parties would not carry out any detonation in their respective areas, in the atmosphere,

underground or in the seas with any device that would produce radioactivity.

Any treaty is a contract between states or nations and in a legalistic sense it is treated as such. The basis and perhaps the most integral part of the contract is "good-faith," meaning:

> A state of mind characterized by honest belief, absence of malice or intent to defraud, absence of a design to seek unconscionable advantage or of knowledge that such advantage is likely to occur.[387]

This is one of the oldest and most respect tenants of Contract law. If this "state of mind" does not exist in the consideration of the contract, or in this case the treaty is null and void prima-facie. This was the case ultimately for the Test Ban Treaty. One of the reasons that the government of the United States was willing to enter into this agreement was that it knew the capabilities of the CDC 6600. 6600s were sent to Los Alamos and Livermore Labs to calculate thermonuclear problems for simulation modeling. The model would show the blast pattern and radiation output of the detonation of devices without atmospheric testing of any kind and at 3 million instructions per second it could be done quickly. Because of this modeling simulation done exclusively in the labs the U.S. could publicly

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[387] Statsky, William. *West's Legal Thesaurus/Dictionary*. St. Paul: West Publishing Company, 1986, Pp. 352.

appear to enter into this treaty in good faith, but privately nothing would change. In short, the U.S. government knew that it would not have to limit its own nuclear testing. This was a decisive edge for the U.S. It was not that Great Britain and most certainly the Soviet Union did not have supercomputers, but they did not have anything that could come close to the performance of the 6600. In short, the Limited Nuclear Test Ban Treaty was not worth the paper it was printed on. The supercomputer abrogated the treaty from its inception. Geopolitics was once again subordinated to the abilities of the machines.

In the 1960 election Kennedy had barely won against Nixon. The narrow margin of victory obviously weighed heavily on his mind. Despite his bravado during the election about the missile gap and his efforts to create a more flexible, dynamic policy in the face of Soviet aggression, he proceeded with caution when dealing directly with Moscow. During that election year the United States had only produced one supercomputer to foster its ever-growing nuclear arsenal. The Soviets still lagged behind, but in that year were outpacing the United States in supercomputer production, which also assisted their own thermonuclear efforts. Kennedy had shown lack of resolve especially in Vienna, spurring Nikita Khrushchev to more

aggressive actions. Two events in close temporal proximity, the Second Berlin Crisis and the Cuban Missile Crisis produced two serious possibilities of defection from the von Neumann scheme. Nevertheless, the strategy held up. President Kennedy's grand strategy of Flexible Response and its military build-up may have provoked the Soviets, but in the end the stability of von Neumann's theories held. By the year of Kennedy's death the SAGE system had been completed in its fullest extent at a cost of $8 billion dollars, and, despite being on the brink of nuclear war twice in three years, the competition for computational and nuclear power continued unabated. The Limited Nuclear Test Ban Treaty was a public step towards nuclear control, but ultimately behind the scenes the Treaty was void. The supercomputers on both sides could do the explosion simulations, but the United States enjoyed a clear advantage because of Seymour Cray and the CDC 6600.

Both the Berlin Crisis in 1961 and the Cuban Missile Crisis in 1962 were indicators that Game Theories; in and of themselves, were not sufficient to prevent irrational situations from coming to fruition. The human qualities of fear and understanding were significant factors in the avoidance of two cases where the outcome might have produced nuclear war. This led to an understanding between the two superpowers for the

necessity of to control nuclear proliferation in some manner. This led to the Nuclear Test Ban Treaty, but still the need for superiority remained. Seymour Cray's CDC 6600 superseded the treaty and allowed the United States to quietly test its own arsenal and perfect it. The implications were that the danger of nuclear proliferation remained and the U.S. sought to cross the "D,C block" (U.S. Nuclear superiority) without being detected. This would only happen later after the passing of President John F. Kennedy.

Conclusion

The Silent Arms Race

The first real foray into the notion of high-speed computing began in the United States in the mid to late twenties, with Vannevar Bush's Differential Analyzer. The differential equation was solvable through purely human effort, but time and margin of errors were always factors to be considered. Mechanized calculation increased speed and reduced human error. The military was particularly interested in the analyzer for the creation of accurate firing tables. This was a modest but concrete foundation for the symbiotic relationship between computing and the military, a symbiosis that continues to the present day.

The true test of the benefits of high-speed computing came during the Second World War. During the War the differential equation was not the only problem to solve. Now high-speed computing was necessary for decryption purposes and weapons design. To this end the most notable supercomputer was Alan Turing's Colossus. Meanwhile, other powers had also invested in supercomputing. One of the most obscure was Germany's Konrad Zuse. His Z-1 through Z-3 computers were particularly advanced machines. Although Zuse denied that these machines were used for

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the Nazi war effort, this is unlikely. For example, the V-2 rockets could have been designed by humans but only after a long time and vast amounts of human error. Furthermore, while the Nazi regime was on the run from the encroaching allies, it made provisions to move the computers along with the scientists. It is plausible to conclude that these machines as well as the scientific community that created them were among the most vital assets of the Nazi arsenal. It is also clear that they the Nazis underestimated the benefits of supercomputing, and without that advantage, they were not able to make substantial progress in their rocket programs.

Much the same could be said of the U.S. decryption programs in the Pacific Theater. Of course, the benefits of high-speed computing counted most in the creation of the atomic bomb. Without supercomputing efforts the atomic bomb might have arrived too late to save hundreds of thousand lives in the invasion of the Japanese home islands. In short, it was the mathematical machines and mathematical techniques that seriously helped the war effort. Those who had invested in supercomputers won and those who did not lost.

By the end of the Second World War, with no apparent enemy on the immediate horizon, supercomputing efforts seemed to take second priority. The ENIAC had been built, but somewhat too late

for the war effort, and the project was expensive perhaps to an unwarranted degree. But once the Soviet Union proved its aggressive intents in Eastern Europe, also threatening Western Europe, the need for high-tech military escalation became evident again. Soon the Cold War became founded on nuclear deterrence. Investment in atomic arsenals for deterrent effects became necessary for both superpowers. This in turn spurred on the need for more investment in supercomputers.

During the early days of the Cold War grand strategies such as George Kennan's "Containment" were developed to handle the new geopolitical environment. At the same time, John von Neumann and Oskar Morgenstern had already devised a modern version of Game Theory that could be and in fact was applied to nuclear conflict. Considering the central role of the nuclear weapon to the Cold War, this mathematical construct was in itself a grand strategy, and one that would outlast the other geopolitical strategies, which changed their focus with each incoming presidential administration.

Institutions and think tanks such as RAND established a strong cooperation with the military, utilizing high-speed computing to create and analyze strategies to manage the conflict with the Soviets. Often, these institutions' advice carried great weight. For example, by the time that NSC 68 was

adopted RAND's report on the placement of military forces, which had been mathematically calculated with supercomputers, recommended the placement of bomber forces only within the United States. This left NATO forces in Western Europe completely vulnerable to Soviet attacks. Paul Nitze, the author of NSC 68, in the end adopted RAND's advice and in an indirect way followed the mathematical methods that had been developed by von Neumann and RAND.

When the Soviet Union tested its first atomic device in 1949, Soviet supercomputer efforts had also preceded those tests. The Soviets had also invested in supercomputing. However, they had come late to the game. One of the reasons for this was that science in the Soviet Union had been subordinated to ideological concerns since the 1920s and 1930s. Another reason was that the Soviet state was still feeling the after-effects of World War II. It took time to overcome this hurdle, but finally Stalin did see the need for supercomputing efforts. He understood that mathematics could not be tied to ideology, and he even came to coin the term "practical math." To this end, he created two large institutions to produce supercomputers for the U.S.S.R. The Soviet computer genius Sergei Lebedev above all began to tackle the Soviets main problem: the need to catch up and then overtake the West.

The atomic age did not last long. By 1952 it gave way to the thermonuclear age, which has lasted until the present. During the transition supercomputing became inextricably linked to the Cold War. Thermonuclear calculations were too complex to be done by human efforts alone. This fact led to the creation of various Princeton Class Computers, with large investments from the military.

When Dwight David Eisenhower came into office in 1953, the link between supercomputers and geopolitical theories became even more concrete. Eisenhower's reliance on the U.S. nuclear arsenal required more investment. Such investment did not contradict the President's mantra. The U.S. reliance on nuclear deterrence actually bolstered its economic position in order to more effectively confront the Soviets. So, spending on supercomputing projects did not subside. In fact, the Eisenhower administration expanded the role of supercomputers in the application of strategy and tactics. Eisenhower did not only rely on the U.S. nuclear arsenal but also on various espionage efforts. By 1954, IBM computers were put to the task of translating the Russian language into English. The machines did this in an adept and efficient manner, and in doing so increased American knowledge of Soviet activities of all kinds. Furthermore, supercomputers were utilized in nations such as

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Taiwan to build infrastructures. This was another facet of the Cold War: keeping anti-Communist nations modernized to ensure the stability of their governments.

In the Soviet Union supercomputing projects blossomed especially with the support of Khrushchev and Bulganin, who had contact with computing circles prior to coming into positions of power. Lebedev, as well as Isaak Bruk and Iurii Bazilevskii were the top scientists who quickly created supercomputers such as the M-1, M-2 Strela and BESM, to aid with weapons design and radar control. In Darmstadt, Germany the Soviets revealed to the world their own supercomputers. It was both a strategic and a public relations coup that heightened the alarm in the west.

1957 was a watershed year for the high-tech Cold War. In that year John von Neumann died, and Sputnik was launched into orbit giving rise to the persistent myth of a "Missile Gap" favoring the Soviets. President Eisenhower soon discovered this "gap" to be untrue, but nevertheless he created ARPA and NASA, both agencies relying heavily on computing power. In the following year the National Defense and Education Act was passed, encouraging many of America's youth to pursue jobs in the hard sciences and engineering fields. Many went into computing.

1957 was not all doom and gloom for the United States. In that year the largest supercomputing project to that point was completed. Manual efforts to track, warn, and then direct forces to areas under attack from the Soviets at supersonic speeds was no longer possible. Project Whirlwind was a limited early warning system to counter such attacks. To guide such a system a supercomputer had to be created that would vastly reduce human interaction and be nearly 100% reliable. The project culminated in the SAGE defense system, powered by two gigantic IBM supercomputers at a total cost of 8 billion dollars. This was hardly a small investment, but, when one considers that SAGE was online from 1957 to 1983, the investment more than paid off. The Soviets would eventually have an equivalent to SAGE, but were always one or two steps behind western supercomputing efforts. As is with computing efforts in the present, any delay in producing cutting edge technology is crucial.

From 1957 onward leading academics such as Henry Kissinger and Herman Kahn criticized Eisenhower's policy of Massive Retaliation and strove to create a doctrine that was an alternative to nuclear Armageddon. This gave rise to the notion of limited nuclear war, which in retrospect was a ridiculous notion, but at the time seemed feasible. RAND analysts picked up

on this and added these ideas to von Neumann's construct. These ideas bled over into the following administration.

JFK had won the 1960 election based on the "Missile Gap." His Secretary of Defense Robert McNamara soon realized there was no such gap. Nevertheless, in the changing Cold War that prized both counter-insurgency and high-tech competition the new president set a new strategy, designed to be more flexible than simple reliance on a massive nuclear attack. To this end "Flexible Response" was created at a 9% increase in the military budget. McNamara took a leadership role in the administration. He had a mathematical background as a statistician and gained the reputation as a human computer, a paragon of rationality. This fit in well with RAND's notions and procedures. McNamara and the think tank worked in close connection. At the time, analysts such as Herman Kahn and Daniel Ellsberg had spent the bulk of their time with Game Theories that kept in tune with Flexible Response. They soon had their chance to test their theories of controlled nuclear conflict, in which mathematical schemes were applied to the trading of Soviet and American cities to try to limit the conflict. This equivalency scheme seemed logical but it was anything but rational. During the Cuban Missile Crisis the rationality, which held von Neumann's strategy together broke down. President Kennedy did not believe

in the idea of controlled nuclear war and averted the crisis without such reckless schemes of equivalency. Ironically, Kennedy, went against his own strategy, Flexible Response, in favor of threatening Massive Retaliation if the Soviets did not back down. In the end it was von Neumann's strategy that held up. Strangely, the fear generated by the idea that nuclear strikes were dangerously close to becoming a reality shook both nations back into rationality. Even after the crisis was over, the U.S. continued further investment in supercomputers, which remained highly regarded, and nuclear arsenals along with them.

The crisis prompted the main nuclear powers Great Britain, the United States, and the U.S.S.R. to sign the Nuclear Test Ban Treaty. But the treaty was quickly put into question with the creation of Seymour Cray's supercomputer the CDC 6600. The CDC 6600 was the fastest supercomputer in the world at that point. It was able to do thermonuclear modeling on a whim. Nothing the Soviets or anyone else had could match it. This simply meant that the United States did not in fact have to limit its nuclear testing. The treaty was null and void on its face because the U.S. did not enter into the treaty in good faith, but no one knew that at the time. This was because the other signatories to the treaty were unaware of the 6600's advanced capability.

Thanks to the Cold War's reliance on nuclear weapons, the supercomputers assumed a pivotal importance. Mathematical analysis ultimately sustained grand strategy. The major players in the arms race had no choice but to rely on their respective supercomputing programs in order to not only to affect greater policies and strategies; the supercomputers kept the Cold War cold and, at least in its major area of confrontation, rational. If it had not been for the supercomputers and the ultimate destructive power of the nuclear weapon, the U.S. and the U.S.S.R. might have engaged in a major "hot" war in various places around the globe, creating conditions much like that of the Second World War and a similar amount of deaths.

Rational calculation may at times favored irrational conduct, as it almost happened during the Cuban Missile Crisis; but overall, supercomputing, the cold machine, assisted not only U.S. victory, but also the best instincts and sentiments of the Cold War leaders.

Afterward

Seventeen years into the Cold War supercomputing efforts had reached their zenith. After President Kennedy was assassinated and Lyndon Baines Johnson succeeded him, McNamara continued on as Secretary of Defense with an unwavering faith in mathematical analysis, which he put into even broader use. In 1964, however, things began to change for both the United States and the Soviet Union.

By that year the Soviet Union had a new Premiere, Leonid Brezhnev. Brezhnev did not give the same support to the supercomputing projects as his predecessors had. This, most likely, was due to the fact that the U.S.S.R. already faced financial troubles (In 1964 Russia's gold reserves amounted to only an estimated $2 to 3 Billion while the West had roughly $43 Billion).[388] Instead of creating new unique supercomputers which cost the Soviet state untold amounts of monies, Moscow decided to steal the plans for the IBM 360 series of computers and copy them en masse. According to the accounts of every major Soviet computer scientist this was an unacceptable solution leading to stagnation, in keeping with the "era of stagnation" as Brezhnev's premiership is frequently referred to. Another

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[388] Green, Timothy. *The World of Gold*. New York: Walker and Company, 1968, Pp. 78.

problem facing the Soviets was a turn inward to solve their economic woes. The supercomputing projects branched out to create vast mathematical plans to govern the nation in a scientific manner. These plans were created by GOSPLAN and they were rigid to the point of being detrimental to the nation. GOSPLAN kept "optimum schedules" adhering to an ultimate rationality to the point where everything was counted down to the last toothbrush. The schedules themselves did not damage the computing projects in the Soviet Union. Rather it was the converse; the GOSPLAN schedules created by computer analysis ruined the nation's economy such as it was. Micro-managing only made domestic conditions worse for the U.S.S.R. Soviet economists, with their computer generated schemes began to hold less sway politically to the point of being ignored. The benefits of computer analysis failed in creating a better, more stable economy and the military build-up continued thereby draining the Soviet state even further. The effects on the computer scientists were that they became disgruntled with having to alter their computer manufacturing to suit foreign i.e. IBM machines. Government investment in supercomputers dwindled as there were less and less funds to devote to the industry and many talented scientists left the field.

For the United States, its foray into Vietnam also had detrimental effects on supercomputing. Secretary McNamara kept to mathematical schemes developed by RAND to have data on body-count. This hurt the war effort because officers in the field had to fill out intricate flow charts in order to get data which was easily manipulated, in turn skewing the data giving an incorrect assessment of the direction of the war. Furthermore, other automated schemes such as Project Igloo White creating a line of sensors along the Ho Chi Minh Trail, called McNamara's Line, to get a count of enemy movements was a failure. The sensors were easily located and then deactivated by enemy soldiers urinating on them.[389] In the end this was a complex mathematical failure. Rationality does not apply to irrational circumstances. And there were many of them in the Cold War before, during, and after Vietnam.

Furthermore, there were other major failures. One of the most costly fiascos of all time began in 1964. The ILLIAC series of computers had been developed at the University of Illinois Urbana campus since early in the Cold War. The first two computers performed admirably, but the third ILLIAC was destroyed in a fire and that investment obviously was lost. Even worse, the ILLIAC IV was an experiment in massive parallel

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[389] Edwards, *The Closed World,* 4.

processing. The idea was that many processors could work in conjunction on various problems increasing speed and the overall ability of the computer to solve problems that up to that point had been out of reach. Unfortunately, the computer had various complex design problems and ran into cost overruns that would put most defense overruns to shame.[390] The computer didn't go into operation until 1975 and so it arrived eleven years too late and in the end it could not solve the problems it was designed for, much less the problems that had become more complex since 1964.[391] The computer became a joke among computing circles; even Seymour Cray quipped; "Would you rather have a cart pulled by two strong oxen or 1,000 chickens."[392]

As far as mathematical strategies go, von Neumann's theories held as to the nuclear aspect of the Cold War, but in other areas mathematical strategy did not apply. As the war in Vietnam turned sour by 1966 the think tanks that had created those schemes and sold them to a receptive Secretary of Defense were subjected to the same protests that other governmental institutions were. In 1967, when McNamara was dismissed from the

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[390] Hord, R. Michael. *The ILLIAC IV: The First Supercomputer*. Rockville: Computer Science Press, Inc., 1982, Pp. 14.

[391] Ibid, 15.

Hammond, Jeff. *Herding Millions of Chickens: Programming Models for Blue Gene/Q and Beyond* [Website]. Leadership Computing Facility Argonne National Laboratory, 2011 [cited April 23, 2012]. Available from https://docs.google.com/viewer?a=v&q=cache:G4jmJZsIZqEJ:workshops.alcf.anl.gov

Defense Department, the world of computer science was changing as well. The make-up of the discipline was changing from the pocket protector sporting engineers to computer scientists who were deeply involved in the counter-culture of the late 1960s.[393] The new breed was distrustful of the government and now considered the receiving of governmental monies immoral.[394] Defense projects began to suffer.

In Nixon and Kissinger's era of Détente there were further computer woes. Nixon cut the defense budget. He signed into law the Military Procurement Act of 1970 and so ancillary areas of supercomputing, such as the pursuit of Artificial Intelligence, which had been a serious focus even before the beginning of the Cold War, faced vast financial cuts leading to what was termed the "AI Winter."[395] Furthermore, Kissinger, who focused on a diplomatic stance to foreign affairs rather than a military one, alienated many in the military. Kissinger, although he computerized the White House in order to coordinate his diplomatic efforts, was no fan of technology, in keeping with that very European mistrust of technology.[396] Compounding this

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[393] Markoff, John. *What the Dormouse Said: How the 60s Counterculture Shaped the Personal Computer Industry*. New York: Viking, 2005, Pp. 39.

[394] Ibid, 223,224.

[395] Hord, *The ILLAC IV*, 9.

problem, the nation's financial affairs had gone awry. There was an energy crisis to be confronted; moreover, the costs of the Vietnam War which had to be resolved. This crisis continued into the Ford Administration, and as inflation worsened, supercomputing projects were cut even further. For example, Seymour Cray's Cray I was purchased by few governmental institutions despite its vastly superior abilities.

During the Carter Administration there was a slight upswing, especially in espionage efforts. The Central Intelligence Agency had been defanged by the Church Committee in 1975. Nevertheless there was a necessity for intelligence gathering. President Carter's DCI Admiral Stansfield Turner decided to bolster the CIA's abilities to collect intelligence by putting a heavy emphasis on the utilization of spy satellites.[397] The erratic foreign policy in the administration, however, initially focused on diplomatic efforts to reduce nuclear arsenals, until after the Soviet invasion of Afghanistan, when Carter increased the military budget. Nevertheless, the original focus of Carter's foreign policy,

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[396] Laprise, John. "Kissinger'S Computer: National Security Council Computerization, 1969-1972." *IEEE Annals of the History of Computing* 33, no. 1 (2011): 38-51.

[397] Field, Ginny. *Directors of the National Reconnaissance Office at 50 Years* [Website]. Center for the Study of National Reconnaissance, 2011 [cited April 23, 2012]. Available from https://docs.google.com/viewer?a=v&q=cache:P_VXJIav8ZkJ:www.nro.gov/about/50thanniv/DNRO_history.pdf

which was a continuation of Détente combined with economic weakness in the nation kept supercomputing projects in check.

It was not until the Reagan Administration that there was a serious return to military projects. Neo-Rollback required a new arms race and, of course, new supercomputers were necessary to design new weapons, especially Reagan's beloved Strategic Defense Initiative. By this time, however, the computing world had changed. The emphasis was no longer really focused on "Big Iron." Smaller, less expensive but more powerful computers were displacing the large mainframes. There were still Cray computers and IBMs, and they were still necessary, but there were also Apples and various PCs that were created by engineers like Douglas Engelbart who were directly influenced by counterculture values.

The big push of the arms race during the Reagan and Bush administrations played a significant role in breaking the Soviet Union along with cultural and economic measures. The Soviet Union dissolved late in 1991 and Communist rule in came to an end. At the end of the Cold War, however, once again there were questions about the future of supercomputing as far as the U.S. government was concerned. The government had subsidized supercomputing since the beginning of the Cold War. It was necessary in order to confront the Soviets. With the Soviet

Union gone and no major enemy on the horizon there was no justification for government investment in large supercomputing projects.

During the Clinton administration supercomputing returned to the point it occupied at the end of the Second World War. The necessity of huge, expensive machines was once again in question. There were some advances in artificial intelligence, but that sector never seemed to attain its ultimate goals. One of the shortcomings of the discipline was that there were various definitions of intelligence, and with no singular goal, the ultimate needs of the discipline were not fulfilled. There were also some flirtations with new technologies in computing, such as the use of gallium arsenide to speed up computational power. This is what Seymour Cray had been working on until 1996, when he died in an auto accident. Overall it seemed like the big defense projects were over. For example, Cray's stock had dipped to only four dollars per share by September 10, 2001.

On September 11, 2001 the World Trade Center and the Pentagon were both subjected to terrorist attacks. On the very same day that the War on Terror began Cray stock quadrupled to sixteen dollars per share. Supercomputing returned from the dead. New weapons had to be designed and utilized for the new war effort and so the necessity for the big machines returned.

Much has happened in the past decade and supercomputing has benefitted directly from the wars that we are still fighting in Iraq, Afghanistan and other areas of the globe. Interestingly in a time when the People's Republic of China seems to be the new economic colossus in the world, the supercomputer race finally got a public nod. In January of 2011 in his State of the Union Address President Barack Obama turned his attention to China's lead over the United States in the field of Supercomputing.[398] China had just taken the top spot in the Top 500 Supercomputer list with its Tianhe 1A Supercomputer, displacing the United States' computer. The president felt this important enough not only to point it out in his speech, but also to mention it in a press conference that came at a later date. Furthermore, in a show of support for the industry, President Obama earmarked $126 million dollars for high-speed computing efforts. This was up from $24 million in the 2011 budget and a 21% increase from the 2010 budget.[399]

This is not a trivial amount as demonstrated by National Coordinator for Security, Infrastructure Protection and

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[398] Obama, Barack. *State of the Union Address* [Website]. 2011 [cited April 23 2012]. Available from http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address.

[399] Thibodeau, Patrick. *Obama Sets $126m for Next-Gen Supercomputing: Exascale Arrives for First Time in Federal Budget* [Website]. Computerworld, 2011 [cited April 2011]. Available from http://www.computerworld.com/s/article/9209918/Obama_sets_126M_for_next_gen_supercomputing.

Counterterrorism Richard A. Clarke's in his book *Cyber-War: The Next Threat to National Security and What to do about it.* The author states that the Chinese do not present a direct military threat to the United States. They do not even possess one Carrier Strike Group. In fact, the first line of offense for the PRC is cyber-strikes. These strikes do have the ability to wreak havoc not only on domestic systems such as in banks and utility systems, but also in any wired military forces such as our fleets. The problem, according to him, is that there are no manual backup systems and so after one effective cyber-strike our fleets would be nothing more than floating hulks in the water before we could launch any form of attack.[400] This is a sobering thought and definitely shows the continued military need for supercomputers. As during the Cold War, we cannot afford to fall behind in this crucial arms race. We can either invest or suffer the same fate as the Soviets did at the end of the Cold War.

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[400] Clarke, *Cyber War*, 70, 71.

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